HO'OPILI

O'AHU

FINAL
ENVIRONMENTAL IMPACT STATEMENT

VOLUME 2 OF 2
APPENDICES

JULY 2008

Prepared by:

PBR HAWAII & ASSOCIATES, INC.

Prepared for:

D.R. HORTON America's Builder
Schuler Division

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Decision Analysts Hawai'i, Inc.

Ho'opili:
Impact on Agriculture

Prepared for:

D.R. Horton – Schuler Homes, LLC
dba D.R. Horton – Schuler Division

Prepared by:

Decision Analysts Hawai'i, Inc.

February 2008

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EXECUTIVE SUMMARY

1. PROPOSED DEVELOPMENT

D.R. Horton—Schuler Homes, LLC (dba D.R. Horton—Schuler Division) proposes to develop Ho'opili ("the Project"), a planned community to be located on 1,555.145 acres in the 'Ewa District, O'ahu. This area includes 1,553.844 acres that is referred to as the "Petition Area," plus another 1.301 acres in the State Urban District. Off-site drinking-water reservoirs and storm-water detention areas will add 45.120 acres, resulting in a total Project Area of 1,600.265 acres. The Project will include about 11,750 single- and multi-family homes; business and commercial space; light-industrial space; parks and open space; public facilities; and associated infrastructure.

The Petition Area—which is surrounded by a combination of existing and planned urban development on three sides and the H-1 Freeway on the fourth side—is designated for residential and related development in the County's 'Ewa Development Plan and is within the Urban Growth Boundary. The Project will require a State Land Use District Boundary Amendment to Urban, and a change in County zoning.

2. AGRICULTURAL CONDITIONS

Existing agricultural leases indicate that about 1,375 acres (88%) of the Petition Area are arable land. Soil ratings indicate that about 1,340 ± 65 acres of the Petition Area have favorable agronomic conditions for crop production. This area has high-quality soils, flat or gently sloping terrain, high solar radiation, low pumping costs for irrigation water, and good access. Because of the sunny conditions, the fields are well-suited for growing crops during the Winter months.

3. LOCATIONAL ADVANTAGES AND DISADVANTAGES FOR CROP PRODUCTION

The Petition Area is well-located for serving the Honolulu consumer market and export markets. This is due to the short trucking distance to the Honolulu markets, the Honolulu International Airport, and Honolulu Harbor.

4. LOCATION AND SURROUNDING LAND USES

The Project is *makai* of the H-1 Freeway, *mauka* of 'Ewa Villages, west of Fort Weaver Road and Old Fort Weaver Road, and east of other planned projects in East Kapolei (Figures 1 and 6). These planned projects include: the University of Hawai'i West O'ahu (UHWO) campus and related residential and commercial development, Department of Hawaiian Home Lands (DHHL) East Kapolei residential projects, DHHL commercial center, and the Kroc Community Center on DHHL land.

Urban development has occurred or will occur to the east, south and west of the Petition Area. To the north on the *mauka* side of the H-1 Freeway are agricultural fields in Kunia and grazing lands in the Kunia foothills.

5. EXISTING AGRICULTURAL OPERATIONS

Currently, four agricultural operations lease or sublease about 1,497 acres (96%) of the Petition Area:

— Aloun Farms, Inc.: about 1,100 acres, of which about 100 acres are subleased to Fat Law's Farm

In total, Aloun Farms and its affiliate lease about 2,440 acres in 'Ewa, Kunia, and Central O'ahu. Three acres within the Petition Area are used for Aloun's primary operating facilities.

— Fat Law's Farm: about 100 acres subleased from Aloun Farms

This is the entire acreage for this operation, but the company also markets produce grown elsewhere by other farmers.

— Sugarland Farms, Inc. ("Jefts Farm"): about 197 acres

In total, the consultant estimates that Jefts Farms owns or leases over 5,000 acres in 'Ewa, Kunia, the North Shore of O'ahu, and Moloka'i.

— Syngenta Seeds, Inc.: about 200 acres

In total, Syngenta leases and subleases about 740 acres in 'Ewa and Kunia, and about 3,000 acres on Kaua'i.

6. DIRECT ON-SITE AGRICULTURAL IMPACTS

Ho'opili will result in the gradual loss of about 1,497 acres currently being leased for various agricultural operations. In isolation, and allowing for the replacement of Syngenta by another agricultural operation (see Section 8), this gradual loss of agricultural land will result in a related gradual loss of the following: approximately $6 million per year in revenues, average employment of about 80 jobs, and about $1.7 million per year in payroll.

In practice, however, most or all of the agricultural operations on the Ho'opili land are expected to relocate to other lands. In view of these anticipated relocations, mitigating measures are discussed at the end of the Section 10 which addresses cumulative impacts.

7. CUMULATIVE LOSS OF LAND FOR THE AFFECTED AGRICULTURAL OPERATIONS

In addition to the leased and subleased lands that gradually will be lost as the Project is developed over a 20-year period, three of the four agricultural operations in the Petition Area will eventually lose agricultural lands to (1) other private and State urban projects in 'Ewa and Central O'ahu that are within the County's Urban Growth Boundary, and (2) other agricultural operations in Kunia. For the affected agricultural operations, the approximate cumulative reductions in agricultural land will total about 3,600 acres (see Table ES-1). Syngenta's and Jefts Farms' losses of acreage to Monsanto (another agricultural operation) may occur within a few years. The agricultural land lost to urban projects is likely to begin in a few years and continue until as late as 2030.

By 2030, the acreage losses shown in Table ES-1 will leave Aloun Farms with about 160 acres of their current leased land, Fat Law's Farm with none of their current subleased land, and Syngenta with none of their leased acreage on O'ahu although some of their subleased acreage will remain available. Although reduced in size, Jefts Farms will retain over 4,000 acres of their current agricultural land.

8. CHANGES TO AGRICULTURAL OPERATIONS BEFORE HO'OPILI IS DEVELOPED

Monsanto's 2007 land purchase in lower Kunia includes the core of Syngenta's operations on O'ahu. Because of this purchase, the consultant anticipates that Syngenta will relocate from Kunia to some other area within the next few years—with or without Ho'opili, and before Ho'opili construction even begins.

Table ES-1. Cumulative Loss of Land for the Affected Agricultural Operations
(approximate acreage estimates by DAHI)

	Aloun Farms	Fat Law's Farm	Jefts Farms	Syngenta	TOTAL
Urban Projects					
Ho'opili, 'Ewa	1,000	100	197	200	1,497
State Projects, 'Ewa[1]	850	-	95	-	945
Koa Ridge, Central O'ahu	430	-	-	-	430
Agricultural Uses					
State Ag Park, Kunia	-	-	150	-	150
Monsanto Co., Kunia	-	-	220	360	580
Total	2,280	100	662	560	3,602

1. UHWO, DHHL and other State projects.
Source: Decision Analysts Hawai'i, Inc.

Syngenta could relocate to Kaua'i where they already lease about 3,000 acres, although the North Shore of O'ahu is a possibility. If the company relocates to Kaua'i, the economic activity for Syngenta's O'ahu operation would be transferred to Kaua'i. This would include about a dozen full-time workers, 15 to 20 part-time workers, and about 60 to 90 temporary workers during the peak Winter season.

After Syngenta vacates the 200 acres it now leases in the Petition Area, it is expected that the land will be leased short-term to another agricultural operation until construction of this site is ready to begin.

9. AVAILABILITY OF REPLACEMENT LAND

The impact of the cumulative loss of land on the affected agricultural operations will depend on the amount and quality of available replacement land Statewide and on O'ahu.

a. Statewide

Statewide, a vast amount of land has been released from plantation agriculture: about 251,800 acres between 1968 and 2005, resulting in an average release of over 6,800 acres per year over a 37-year period (see Figure ES-1). The 2006 Del Monte closure in Kunia increased this figure by another 4,400 acres, resulting in a total release of at least 256,200 acres from plantation agriculture between 1968 and 2007. Over the 1968-to-2005 period, the demand for land for diversified crops increased by about 26,300 acres (about 10% of the land released from plantation agriculture).

The acreage released from plantation agriculture has far outpaced the demand for land for diversified crops. The net decrease in diversified crop land amounts to about 229,900 acres. While some of this land has been converted or is scheduled to be converted to urban uses and tree plantations, an estimated 160,000+ acres remain available for diversified crops.

If the Hawai'i Superferry is successful, cultivating crops on the Neighbor Islands for the Honolulu market, and vice versa, may become more economically feasible.

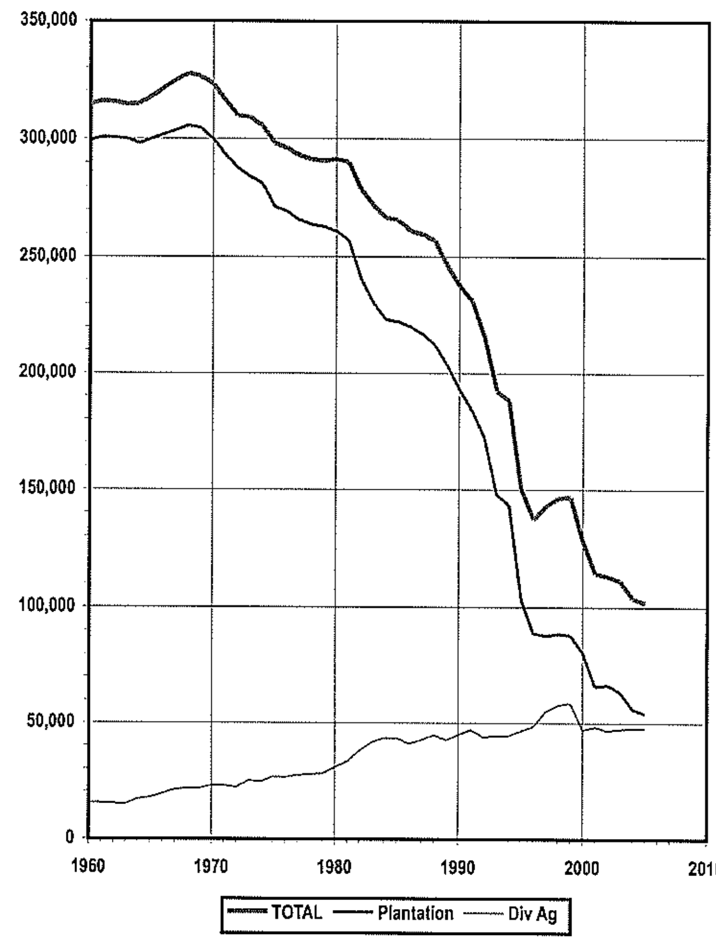
The above information indicates that considerable land is available in Hawai'i to accommodate the relocation of agricultural operations as well as the growth of diversified crop farming.

b. O'ahu

On O'ahu, a similar release of plantation land occurred. In total, about 10,900 acres of former plantation land remain available for other crops, including about 3,150 acres of former pineapple land in Kunia plus about 7,750 acres of former sugarcane and pineapple lands on the North Shore.

However, much of the available 10,900 acres have limitations for growing certain crops. Some limitations reflect permanent agronomic conditions. For example, the higher elevation fields in Kunia and on the North Shore have less solar radiation compared to 'Ewa. Nevertheless, some limitations can be overcome with investment in improvements. For example, on the North Shore, portions of the water delivery systems need major repairs, and the types of crops on fields irrigated with water from Wahiawa Reservoir (Lake Wilson) will be restricted as long as partially-treated wastewater continues to be discharged into the lake.

Figure ES-1 - Statewide Acreage in Crop: 1960 to 2005



10. CUMULATIVE AGRICULTURAL IMPACTS

a. Loss of Land for the Affected Agricultural Operations

As summarized in Table ES-1, the Project will result in a direct loss of about 1,497 acres currently being leased for various agricultural operations. In combination with land lost to other State and private urban projects and to other agricultural uses, the four agricultural operations in the Petition Area will incur a cumulative loss of about 3,600 acres of their leased land. As noted above, it is expected that Syngenta will relocate for reasons unrelated to and before the Ho'opili construction begins.

b. Required Replacement Land

If Syngenta remains on O'ahu, then about 3,600 acres of replacement land will be needed on O'ahu by the four the affected agricultural operations. But, if Syngenta relocates its O'ahu activities to Kaua'i where most of its operations are located, then the O'ahu demand will be reduced to less than 2,900 acres of replacement land.

As summarized in the previous section, sufficient land is available on O'ahu and the Neighbor Islands. Nevertheless, major water-related improvements are required before all available agricultural lands on the North Shore of O'ahu will be suitable for growing diversified crops. Also, the available lands possess different agronomic conditions than those found in 'Ewa and lower Kunia.

c. Anticipated Changes in Agricultural Operations

Until 2030, the agricultural operations located in the Petition Area are likely to adjust to gradual acreage losses by implementing a combination of (1) leasing replacement lands, (2) possibly cultivating remaining lands more intensively, and/or (3) reducing their operations. By 2030, however, Aloun Farms will lose nearly all and Fat Law's Farm will lose all their leased lands, thereby necessitating relocation to Kunia and/or the North Shore.

Assuming that the affected lessees secure replacement lands, and assuming the necessary water improvements are made, then the affected agricultural operations could maintain about the same level of production, sales revenues, employment and payroll. However, major adjustments in their operations will be required since the replacement lands will have different agronomic conditions. Also, the lessees will incur additional expenses to prepare the soils and irrigation systems for their particular crops, and to move their offices, and cooling and packing facilities.

If sufficient replacement land is not available on O'ahu (due to the unlikely possibility that it will be used to grow an energy crop), then one or more of the agricultural operations could turn to a Neighbor Island. Potential feasibility is illustrated by the fact that two of the lessees already have agricultural operations on Neighbor Islands, while many Neighbor Islands growers supply O'ahu markets. However, the affected companies which may move to the Neighbor Islands will incur higher transportation costs, and delivery times will be longer. The costs and delays will be similar to those that Neighbor Island farmers now incur to supply the Honolulu market. In the future, these costs and delays may be somewhat lower because of the Superferry and the planned improvements to interisland barge service. The disadvantages of a Neighbor Island location could be partially offset by lower rents. However, for some perishable crops, the ferry service may not be sufficiently frequent or travel may take too long.

d. Flexibility of Affected Agricultural Operations to Resize

Since the affected diversified crop operations can be flexible with regard to their sizes, it is anticipated that they will survive regardless of the amount of replacement land they lease in the future. More to the point, changes in available agricultural land due to the Project are not likely to threaten the survival of Aloun Farms, Fat Law's Farm, or Jefts Farms.

e. Statewide Impacts

From a Statewide perspective, the cumulative agricultural impact of the Project will be modest regardless of how the affected agricultural operations adjust to losing all, or portions of, their leased acreage. Their lost agricultural production from the Petition Area and from other areas they now lease will be offset largely by (1) maintaining their current levels of operation and production by leasing replacement lands in Kunia and/or the North Shore, and possibly cultivating their remaining lands more intensively; (2) one or more of them relocating all or portions of their operations to a Neighbor Island; (3) other farmers on O'ahu and the Neighbor Islands increasing their production; or (4) some combination of the three.

Thus, it is likely that there will be little or no loss in Statewide agricultural production, revenues, employment or payroll.

f. Urbanization of Agricultural Lands

Reconfigurations of farms such a those described above are common and appropriate when agricultural operations lease land in the path of planned urban expansion. For the affected operations, much of the land they lease is located in areas that the County and, for much of the 'Ewa Plain, the State have designated for eventual expansion of Kapolei. Also, all current tenants entered into lease agreements with this knowledge and, except for Fat Law's Farm, have benefited from rents that are now below market.

For diversified crop farmers who supply nearby markets, locations on the edge of town can be ideal for them because of the lower trucking costs. And until these lands are urbanized, the best "temporary" use of them may be agriculture—a use that may last decades. For example, the affected operations have cultivated their acreage on the 'Ewa Plain for 10 years or more, and some of this land will probably remain available to them for agriculture until as late as 2030.

But when urbanization does occur, the operations will incur the expense and disruption of relocating all their operations or major portions of them to other lands. Since lessees only have temporary rights to the land, the costs of relocating falls on the farmers and are not an obligation of the landowners. If the costs were an obligation of the landowners, they would avoid leasing their land to crop farmers and put their land in a lower value agricultural use such as cattle grazing which has similar land-management and property-tax benefits.

g. Mitigating Measures

The mitigation measures recommended below will contribute to the successful relocation of the four agricultural operations that will be displaced by Ho'opili in combination with other land-use changes in 'Ewa, lower Kunia and Central O'ahu. They are designed to (1) address water issues that limit crop production on the North Shore where most available farm lands on O'ahu are located, and (2) provide sufficient time to make the necessary improvements and arrangements for relocating. Some of the recommendations will also benefit other growers who may relocate to or expand on the North Shore.

The recommended mitigation measures are categorized by those which may be best implemented by government, and those which are within the purview of D.R. Horton:

— Government

- Upgrade the Wahiawa Wastewater Treatment Plant (WWTP) to treat wastewater to the State's R-1 standard, or eliminate discharging wastewater into the Wahiawa Reservoir.

This recommendation to the County is consistent with a 1998 Consent Decree with the U.S. Environmental Projection Agency (EPA). Its purpose is to allow farmers to use water from the Wahiawa Reservoir to irrigate any type of crop using any type of irrigation system.

Until the quality of the reservoir water is improved, most of the available agricultural land on the North Shore cannot be used to grow the types of vegetable crops the farmers grow in 'Ewa and lower Kunia. In turn, one or more agricultural operations that will be displaced by Ho'opili and by other projects may not be able to fully relocate to the North Shore until the improvements are made (assuming that relocating to the North Shore is their best option).

- Repair the Wahiawa Irrigation System (WIS)

Repairs to portions of the WIS are needed to address major and minor leaks and to prevent future leaks. Because of the leaks, a number of mid-level and high-level fields on the North Shore can no longer be irrigated in the summer months with water from Wahiawa Reservoir. Until these repairs are made and more fields can be irrigated reliably, one or more agricultural operations being displaced by Ho'opili and by other projects may not be able to fully relocate to the North Shore (assuming that relocating to the North Shore is their best option).

Because of the high cost of the repairs, State and Federal funds may be required.

— D.R. Horton

- To the extent possible, coordinate the development of Ho'opili with the affect agricultural operators and with developers of adjacent lands so as to maintain farming in 'Ewa for as long as possible.

The development of Ho'opili and of projects on adjacent State lands could continue until 2030. Until then, farming can continue in 'Ewa, provided that Ho'opili works with the agricultural operators and developers of adjacent land to: (1) maintain access to fields and irrigation water, and (2) phase development to minimize the potential for nuisance issues (discussed in the next section). This will allow more time for others to make the necessary improvements to the WWTP and the WIS.

- Continue to lease agricultural land at below-market rents.

  The affected agricultural operators will have to make frequent adjustments to their operations as development proceeds. These adjustments may include contracting their 'Ewa operations, rearranging water systems, building berms to reduce nuisance problems, etc.

  Continued below-market rents will allow the affected agricultural operators to retain more funds to help finance the required adjustments.

11. NUISANCE ISSUES

a. Potential for Nuisance Issues

Nuisances arising from agricultural operations can become an issue for both residents and farmers. Residents who live close to and downwind from agricultural operations may complain about occasional noise, dust, chemical spraying, etc. In turn, the farmers may have to change their operations in order to address these complaints.

Regarding the existing homes that are located downwind of the agricultural operations in the Petition Area, they are buffered from nuisance problems by (1) farming activities on State land, (2) fallow fields on State land, and (3) the Kapolei Golf Course.

However, nuisance issues could arise during the 20 or so years while agricultural operations continue in portions of the Petition Area and homes are built and occupied nearby as part of Ho'opili or other projects on adjacent State lands.

Once Ho'opili and adjacent lands are fully developed, nuisance issues arising from agricultural activities will not occur since the lands will no longer be cultivated.

b. Mitigating Measures

To mitigate potential nuisance issues related to agricultural activities near newly built homes, the following mitigation measures are recommended:

— To the extent possible—and subject to transit alignment, water and other infrastructure improvements—phase the development of homes and coordinate agricultural leases to provide wide separations between homes and upwind agricultural activities.

— For each phase of development of Ho'opili and nearby projects, require farmers to provide a buffer of fallow fields and berms upwind of the homes before the homes are occupied.

— As necessary, limit agricultural activities (restricted hours of operation, restricted plowing and use of chemicals on windy days, etc.) so as to avoid or minimize nuisance problems.

— As long as agricultural operations continue in the Petition Area and on adjacent lands, inform home buyers in the area that they will be living near agricultural activities.

12. GROWTH OF DIVERSIFIED CROPS

The Project will commit about 1,554 acres of agricultural land to a non-agricultural use, of which about 1,375 acres are arable. The impact of this commitment on the growth of diversified crops is addressed below.

a. Potential Acreage Requirements for Diversified Crops

Crops to Replace Imports of Fruits and Vegetables

For low-elevation fruits and vegetables that have a history of profitable production in Hawai'i, potential land requirements in 2010 for 100% import substitution for the Hawai'i and O'ahu markets are estimated at 12,700 acres and 8,600 acres, respectively, plus additional acreage for fallowing land between crop plantings. When allowing for competition from imports, these estimates drop to about half.

Since Hawai'i farmers already supply a portion of the Hawai'i market, land requirements for increased import substitution are a fraction of the above estimates.

Export Crops

The many entrepreneurial agricultural efforts being undertaken on former plantation lands may lead to one or more major new export crops over the next 20+ years. However, the history of agricultural efforts in Hawai'i reveals that developing major new export crops that are successful in overseas markets is difficult and infrequent. For example, over the past 50 years in Hawai'i, farmers have explored numerous possibilities for export crops, but they have developed overseas markets for just one diversified crop that requires more than 10,000 acres (macadamia nuts at 18,300 acres in 2005); one additional crop that requires more than 5,000 acres (coffee at 8,000 acres); and only five additional crops or crop categories that require more than 1,000 acres each.

At 4,220 acres in 2005 and growing at an average rate of 264 additional acres per year, the seed industry is expected to soon become only the third diversified crop that requires more than 5,000 acres. The fourth crop could be nursery and flower products: 3,895 acres and increasing at 235 acres per year.

Feed Crops

If feed crops could be grown in Hawai'i and priced competitively against mainland imports, they could replace some of the grains and hay that are now being imported to the State. Unfortunately, a number of commercial attempts in Hawai'i to grow grains and alfalfa have been unsuccessful.

Biofuel Crops

Crops can be grown to produce biomass to fuel a boiler, or as feedstock to produce fuels. In Hawai'i, the common practice has been to produce biomass as a by-product of some principal crop. However, a company plans to build an ethanol plant at Campbell Industrial Park using conventional technology but, at least initially, using imported molasses as the feedstock. For the longer term, this company is exploring the economics of growing sweet sorghum to supply feedstock to its ethanol plant. Acreage requirements for a new sorghum biofuel plantation on O'ahu would range from about 6,000 acres for viability to 15,000 acres if juice from sorghum were to replace all imported molasses. Also, two companies plan to build biodiesel refineries in Hawai'i: one on O'ahu and one on Maui. Both will use imported palm oil from Malaysia and other countries as their feed stock, but would refine locally produced vegetable oil if available.

However, a number of substantial difficulties must be overcome to develop one or more biofuel plantations. For example, it will be difficult to lease the large amount of land required for economic viability. Most major landowners will be reluctant to lease their land at comparatively low rents for the approximately 30-year period required to capitalize the investment. Also, per-acre returns from biofuel crops are comparatively low. In the long-term, emerging technology that is in the early stages of commercialization holds promise for a cheaper source of feedstock for ethanol. Instead of producing ethanol using sugars from conventional sources, the sugar would come from "cellulosic" sources. This would include green waste for which there would be no land rent and no growing costs, but there could be a disposal fee paid to the processor. In the long term, this less expensive source of feedstock could result in an unprofitable biofuel plantation.

These and other difficulties and risks suggest that the probability of successfully developing and sustaining a biofuel plantation in Hawai'i is low. The more likely scenario is that ethanol will be produced as a by-product of sugar and, over the long-term, it will be produced from green waste.

Recent Crop-Acreage Trends

For all diversified crops (i.e., all crops other than sugarcane and pineapple, including crops to replace imports and crops for export) Statewide land requirements grew as shown in Figure ES-1. As illustrated, growth in acreage has slowed over time, with an average growth of about 160 acres per year from 2000 to 2005. During this period, major export crops grew by an average of about 350 acres per year, while crops grown for the Hawai'i market declined by an average of about 190 acres per year.

b. Adjusted Supply of Land Available for the Growth of Diversified Crops

As discussed above, about 10,900 acres of farm land are available on O'ahu, and over 160,000 acres are available Statewide. Over time, a portion of this available land supply will be leased to the four agricultural operations that will have to relocated as a result of Ho'opili in combination with other land-use changes in 'Ewa, lower Kunia, and Central O'ahu. On O'ahu, this relocation will require about 2,900 to 3,600 acres, depending on whether Syngenta's O'ahu operation remains on O'ahu or relocates to Kaua'i. The adjusted supply of farm land that will remain available for diversified farming will total about 7,300 to 8,000 acres on O'ahu and over 156,000 acres Statewide.

This adjusted supply of available farm land far exceeds the amount of land that will be needed to accommodate the growth of diversified crops, whether demand is based on potential or recent trends. This indicates that the limiting factor to the growth of diversified crops will *not* be the *land supply*. Instead, growth will be limited by the *size of the market* for crops that can be grown *profitably* in Hawai'i.

c. Impact on the Growth of Diversified Crop Farming

The development of Ho'opili—in combination with other development projects in 'Ewa, Central O'ahu and elsewhere—involves the loss of too little good agricultural land to significantly affect the growth of diversified crop farming in Hawai'i. This conclusion is based on the above finding that ample land will remain available for diversified crops, with the available supply far exceeding the likely or potential demand.

However, as discussed previously, water-related improvements are needed to allow full use of some of the available farm lands on the North Shore. These improvements are the responsibility of the landowners and government agencies.

d. Mitigating Measures

In view of the negligible impact of the Project on the growth of diversified agriculture, mitigation measures for the loss of good agricultural land are not recommended beyond the measures addressed in Section 9.h above.

13. OFFSETTING BENEFITS

As previously mentioned, Ho'opili will commit about 1,554 acres of agricultural land to a non-agricultural use, of which about 1,375 acres are arable. In turn, Ho'opili—in combination with other private and State urban projects and changes in agriculture land use in Kunia—will require the the affected agricultural operations to relocate.

These adverse impacts to agriculture will be offset by the following benefits of the Project:

- About 11,750 homes for Hawai'i residents, along with business and commercial space, light-industrial space, parks and open space, and public facilities.
- For 'Ewa, relatively high housing densities which, in turn, will contribute to slower urbanization of agricultural land than would be the case with lower densities.
- Construction jobs provided by the development activity.
- At full development of the Project, on-site jobs provided by business, commercial, industrial, and home-service activities.
- Tax revenues (excise taxes, personal income taxes, corporate income taxes, property taxes, etc.) generated by the development activity.
- Tax revenues generated by the families and businesses that occupy the Project.
- Improved land and partial funding for schools, parks and other public facilities.

14. CONSISTENCY WITH STATE AND COUNTY POLICIES

a. Availability of Lands for Agriculture

The *Hawaii State Constitution*, the *Hawaii State Plan*, the *State Agriculture Functional Plan*, and the *General Plan of the City and County of Honolulu* call directly or implicitly for preserving the economic viability of plantation agriculture and promoting the growth of diversified crops. To accomplish this, an adequate supply of agriculturally suitable lands and water must be assured.

With regard to plantation agriculture, the Petition Area is no longer part of a sugar plantation since O'ahu Sugar Co. closed in 1995 for reasons unrelated to the Project.

With regard to diversified crops, development of the Petition Area will result in a loss of good farm land, and the farms on this land will have to relocate. However, this loss of agricultural land will not limit the growth of diversified crops since ample agricultural land is available on O'ahu and on other islands. This is due to the enormous supply of farm land that is now available following the contraction of plantation agriculture (Figure ES-1). However, improvements to the WWTP and the WIS will be needed to allow full use of the available farm lands on the North Shore.

b. Conservation of Agricultural Lands

In addition to the above, State policies call for conserving and protecting prime agricultural lands, including protecting agricultural lands from urban development.

However, these policies—which were written before the major contraction of plantation agriculture in the 1990s—assume implicitly that profitable agricultural activities eventually will be available to use all available agricultural lands. This has proven to be a questionable assumption in view of the enormity of the contraction of plantation agriculture, the abundant supply of land that came available for diversified agriculture, and the slow growth in the amount of land being used for diversified crops (see Figure ES-1).

Furthermore, discussions in the Agriculture portion of the *State Functional Plan* recognize that redesignation of lands from Agricultural to Urban should be allowed "... upon a demonstrated change in economic or social conditions, and where the requested redesignation will provide greater benefits to the general public than its retention in ...agriculture;" that is, when an "overriding public interest exists." In this regard, major changes in economic and social conditions have occurred as a result of:

- The on-going development of the City of Kapolei and the surrounding 'Ewa region as the second largest urban center in Hawai'i (see the policy discussion in the following subsection).
- Inadequate expansion in the supply of workforce housing which has contributed to high housing prices on O'ahu.
- The enormous contraction in plantation agriculture which has resulted in the supply of agricultural land far exceeding demand.

Moreover, development in the Petition Area will provide community benefits (about 11,750 homes and many on-site jobs) that far exceed those provided by agriculture (about 80 jobs after Syngenta is replaced by a new farm). In practice, however, development of the Petition Area is likely to have little or no impact on Statewide agricultural employment.

c. County 'Ewa Development Plan

The Petition Area is within the County's designated Urban Growth Boundary of the 'Ewa Development Plan in an area designated for residential development. Thus, the Project is consistent with the 'Ewa Development Plan in terms of future land use.

This Plan is part of a broader long-established County policy, with support from the State, to direct urban growth to 'Ewa, to portions of Central O'ahu, and to the primary urban center. In turn, the policy reduces development pressures on the outlying Districts of Ko'olau Loa, Ko'olau Poko, North Shore, and Wai'anae. The policy was designed to provide needed housing, jobs, and commercial and industrial space in compact areas; preserve agricultural lands and open space in Kunia, the North Shore, and outlying areas; preserve the "country" lifestyle of rural communities; and reduce the cost of providing government infrastructure and services.

Portions of the Project could be inconsistent with the phasing component of the currently approved 'Ewa Development Plan which indicates that urban expansion of the northern and eastern portions of the Petition Area is to occur after 2015. Such phasing in the current 'Ewa Development Plan would create nuisance issues by placing farm areas immediately upwind of the new Ho'opili homes. However, the 'Ewa Development Plan is in the process of being updated which, based on discussions with the County, is expected to reflect the removal of phasing from the Plan.

HO'OPILI:
IMPACT ON AGRICULTURE

1. INTRODUCTION[1,2]

D.R. Horton—Schuler Homes, LLC (dba D.R. Horton—Schuler Division) proposes to develop Ho'opili ("the Project"), a planned community to be located on 1,555.145 acres in the 'Ewa District, O'ahu. This area includes 1,553.844 acres that is referred to as the "Petition Area," plus another 1.301 acres in the State Urban District. Off-site drinking-water reservoirs and storm-water detention areas will add 45.120 acres, resulting in a total Project Area of 1,600.265 acres. The location of the Project, Tax Map Keys (TMKs), and the parcels and their acreages are shown in Figures 1, 2 and 3, respectively.

The Petition Area is designated for residential and related development in the City and County of Honolulu (County) 'Ewa Development Plan (see Figure 4), and is currently zoned "Agricultural." At the State level, the Petition Area is in the State Agricultural District (Figure 5). Thus, the Project will require a State Land Use District Boundary Amendment to Urban, and a change in County zoning. The conceptual land-use plan for the Project is shown in Figure 6.

This report addresses the impacts on agriculture of developing the Project. The material below gives the following information on the Project and its agricultural impacts: its location; a brief Project description; the agricultural conditions of the Petition Area, along with supporting Figures 7, 8 and 9; potential crops; locational advantages and disadvantages for crop production; surrounding land uses; historical agricultural uses; existing farm operations along with supporting Figure 10; for the affected farms, anticipated losses of farm land due to urban development and to other agricultural uses; anticipated changes in farming activity before the development of Ho'opili begins; availability of replacement farm land, along with supporting Figure 11; direct and cumulative impacts of the Project on affected farms; nuisance issues; the impact of the Project on the growth of diversified crop farming; benefits of the Project that will offset adverse agricultural impacts; and consistency of the Project with State and County agricultural policies.

Following the eleven figures at the end of the report, an Appendix provides a summary of State and County goals, objectives, policies and guidelines related to agricultural lands.

2. LOCATION OF THE PROJECT [2]

The Project is *makai* of the H-1 Freeway, *mauka* of 'Ewa Villages, west of Fort Weaver Road and Old Fort Weaver Road, and east of the planned University of Hawai'i West O'ahu (UHWO) campus and planned development by the Department of Hawaiian Home Lands (DHHL) (Figures 1 to 6). As shown in Figures 2 and 3, the Petition Area is identified by the following TMKs:

TMK	Parcel	Acres
9-1-18:04	A	52.289
9-1-18:01	B	447.592
9-1-17:04 (por), 59 & 72	C	1,053.963

3. PROJECT DESCRIPTION[2]

Ho'opili will include about 11,750 single- and multi-family homes; business and commercial space; light-industrial space; parks and open space; public facilities (e.g., schools); and associated infrastructure (e.g., roadways, an electrical system, a telephone system, a cable-TV system, Internet systems, a drinking water system, a non-drinking water system for irrigating landscaped areas, sewers, and drainage).

4. AGRICULTURAL CONDITIONS

a. Soil Types[3]

As shown in Figure 7, the Petition Area consists of 19 soil types plus former reservoir sites. The complete names of the soil types and their slopes are:

- EaB Ewa silty clay loam, 3 to 6 percent slopes
- FL Fill land, mixed
- HLMG Helemano silty clay, 30 to 90 percent slopes
- HxA Honouliuli clay, 0 to 2 percent slopes
- HxB Honouliuli clay, 2 to 6 percent slopes
- Kfb Kaloko clay, noncalcerous variant
- KlaB Kawaihapai stony clay loam, 2 to 6 percent slopes
- KlA Kawaihapai clay loam, 0 to 2 percent slopes
- KlbC Kawaihapai very stony clay loam, 0 to 15 percent slopes

- KmaB Keaau stony clay, 2 to 6 percent slopes
- KyA Kunia silty clay, 0 to 3 percent slopes
- KyB Kunia silty clay, 3 to 8 percent slopes
- KyC Kunia silty clay, 8 to 15 percent slopes
- MuB Molokai silty clay loam, 3 to 7 percent slopes
- MuC Molokai silty clay loam, 7 to 15 percent slopes
- WkA Waialua silty clay, 0 to 3 percent slopes
- W Water (former reservoir)
- WzA Waipahu silty clay, 0 to 2 percent slopes
- WzB Waipahu silty clay, 2 to 6 percent slopes
- WzC Waipahu silty clay, 6 to 12 percent slopes

Table 1 shows the estimated acreage of each soil type according to its quality as rated by the Natural Resources Conservation Service (NRCS), formerly known as the Soil Conservation Service.

As indicated, HxA, KyA and WzA are the predominant soil types, comprising about 63.5% of the Petition Area.

b. Soil Ratings

Three classification systems are commonly used to rate Hawai'i soils: (1) Land Capability Grouping, (2) Agricultural Lands of Importance to the State of Hawai'i, and (3) Overall Productivity Rating.

Land Capability Grouping (NRCS Rating)[3]

The 1972 Land Capability Grouping by the U.S. Department of Agriculture, NRCS rates soils according to eight levels, ranging from the highest classification level I to the lowest VIII.

Table 1 shows that about 1,045.6 acres (67.3%) of the Petition Area have soils that are rated I. Class I soils have few limitations that restrict their use.

About 226.9 acres (14.6%) have soils that are rated IIe. Class II soils have moderate limitations that reduce the choice of plants or require moderate conservation practices. The subclassification "e" indicates that the soils are subject to erosion.

Table 1. Ho'opili Petition Area: Soil Types and NRCS Ratings

Soil Types	Acres	%	NRCS Ratings[1]
Higher-quality			
HxA	243.9	15.7%	I
KlA	10.9	0.7%	I
KyA	411.6	26.5%	I
WkA	48.2	3.1%	I
WzA	331.0	21.3%	I
EaB	48.2	3.1%	IIe
HxB	14.0	0.9%	IIe
KlaB	4.7	0.3%	IIe
KyB	3.1	0.2%	IIe
MuB	76.1	4.9%	IIe
WzB	80.8	5.2%	IIe
Moderate-quality			
KyC	4.7	0.3%	IIIe
MuC	46.6	3.0%	IIIe
WzC	115.0	7.4%	IIIe
Kfb	15.5	1.0%	IIIw
KmaB	3.1	0.2%	IIIw
Lower-quality			
KlbC	4.7	0.3%	VIs
HLMG	68.4	4.4%	VIIe
FL	7.8	0.5%	n.r.
W (former reservoirs)	15.5	1.0%	n.r.
Total	1,553.8	100.0%	

1. Assuming all soils are irrigated.

Source: U.S. Department of Agriculture, Soil Conservation Service, *Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii*, August 1972.

About 166.3 acres (10.7%) have soils rated IIIe. Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

About 18.6 acres (1.2%) have soils rated IIIw. The subclassification "w" indicates that the soils have excess water (i.e., they are poorly drained).

About 4.7 acres (0.3%) have soils rated VIs. Class VI soils have severe limitations that make them generally unsuitable for cultivation and restrict their use largely to pasture. The subclassification "s" indicates that the soils are rocky or stony.

About 68.4 acres (4.4%) have soils rated VIIe. Class VII soils have very severe limitations that make them unsuitable for cultivation and restrict their use largely to pasture.

About 23.3 acres (1.5%) have soils that are not rated because it is fill land or land associated with former reservoirs.

Agricultural Lands of Importance in the State of Hawai'i (ALISH)[4]

ALISH ratings were developed in 1977 by the NRCS, the UH College of Tropical Agriculture and Human Resources, and the State of Hawai'i, Department of Agriculture. This system classifies land into three broad categories: (a) Prime agricultural land which is land that is best suited for the production of crops because of its ability to sustain high yields with relatively little input and with the least damage to the environment; (b) Unique agricultural land which is non-Prime agricultural land used for the production of specific high-value crops; and (c) Other agricultural land which is non-Prime and non-Unique agricultural land that is important to the production of crops.

About 1,317.1 acres (84.8%) of the Petition Area have soils that are rated Prime; about 155.4 acres (10%) are rated Other; and about 80.8 acres (5.2%) are unclassified (Figure 8).

Overall Productivity Rating (LSB Rating)[5]

In 1972, the University of Hawai'i Land Study Bureau (LSB) developed the Overall Productivity Rating, which classifies soils according to five levels, with A representing the class of highest productivity and E the lowest.

About 517.4 acres (33.3%) of the Petition Area have soils rated A, about 890.3 acres (57.3%) are rated B, about 7.8 acres (0.5%) are rated C, about 17.1

acres (1.1%) are rated D, about 87.0 acres (5.6%) are rated E, and about 34.2 acres (2.2%) are unrated (Figure 9).

Summary Evaluation of Soil Quality

These soil-rating systems suggest that about 1,340 ± 65 acres (86 ± 4%) of the Petition Area are comprised of higher-quality soils (I and II for the NRCS ratings, Prime for ALISH, and A and B for the LSB).

c. Soil Characteristics[3,5]

The better soils in the Petition Area exhibit a number of favorable characteristics: the soils are deep (over 30 inches); they have good machine tillability; they are well-drained; the erosion hazard is none to slight; and the slopes are gentle (see below). However, some of the soils (e.g., HxA) are very sticky and very plastic clay, and others (e.g., KyA) are medium to extremely acidic.

d. Arable Land[1]

Consistent with the above ratings, existing agricultural leases indicate that about 1,375 acres (88%) of the Petition Area are arable land. This assessment is based on the fact that the land classified as arable was once cultivated in sugarcane.

e. Elevations[6]

Elevations range from about 50 feet near the southeast corner of the property to about 220 feet near the 228' Elevation Reservoir (Figure 1).

f. Terrain[2,3]

Most of the Petition Area has flat or gently sloping land, with slopes ranging from 0% to 6%. The exception is Honouliuli Gulch which runs through the northeast corner of the Petition Area and separates Syngenta Seeds from Aloun Farms (Figure10).

g. Climatic Conditions

Like other areas in Hawai'i, the 'Ewa Plain has a mild *semi*tropical climate which is due primarily to three factors: (1) Hawai'i's mid-Pacific location near

the Tropic of Cancer, (2) the surrounding warm ocean waters that vary little in temperature between the Winter and Summer seasons, and (3) the prevailing northeasterly tradewinds that bring air having temperatures that are close to those of the surrounding waters.

Solar Radiation[7]

The 'Ewa Plain is one of the sunniest areas on O'ahu. It is semi-arid, with a relatively warm and dry climate and an average daily insolation ranging from about 470 to 500 calories per square centimeter.

Rainfall[8]

Rainfall in the Petition Area is low: averaging about 25 inches per year. Most of this rain occurs during the Winter rainy season (October through February), while the Summer months (May through September) are hot and dry. Monthly average rainfall is lowest at about 0.5 inch in August and highest at about 3 inches in January.

Temperatures[8]

Average low temperatures range from about 60° Fahrenheit in the Winter to about 69° in the Summer. Average high temperatures range from about 78° in the Winter to 87° in the Summer.

Winds and Storms[8,9]

Wind speeds average about 9.4 miles per hour (mph) in the Winter and about 13.1 mph in the Summer. Tradewinds blow from a northeasterly direction, but they tend to break down during the Fall, giving way to lighter, more variable wind conditions through the Winter and into early Spring. Storms are infrequent, occurring mostly from the south in the Winter months.

h. Irrigation Water[1]

The fields are irrigated with groundwater pumped from wells in the area. The lift is short, so pumping costs are relatively low. None of the fields are irrigated with water from Waiahole Ditch.

i. Road Access[6]

Access to the fields is provided by plantation roads that connect to Farrington Highway, Fort Weaver Road, and Palehua Road.

Palehua Road provides a route for farmers to drive their trucks under the H-1 Freeway between the Petition Area and their operations in Kunia without having to use public roads. Portions of this road, including the segment between the H-1 Freeway and Farrington Highway, will become the North-South Road that will cross the 'Ewa Plain and provide additional access to the H-1 Freeway (Figure 6).

j. Summary

Of the approximately 1,553.8 acres in the Petition Area, soil ratings indicate that about 1,340 ± 65 acres have <u>favorable</u> agronomic conditions for crop production. This area has high-quality soils, flat or gently sloping terrain, high solar radiation, low pumping costs for irrigation water, and good access. Because of the sunny conditions, the fields are well-suited for growing crops during the Winter months. This is consistent with existing agricultural leases which indicate that about 1,375 acres (88%) are <u>arable</u> land.

5. POTENTIAL CROPS[10-14]

Based on the above agronomic conditions, most of the Petition Area is well-suited for low-elevation crops, including but not limited to the following crops which are commercially grown in 'Ewa: apple banana, basil, bell peppers, broccoli, cabbages, canteloupes, chives, choy sum, cucumbers, daikon, green beans, green onions, honeydew, kai choy, leaf lettuces, long beans, pak choy, romaine, seed corn, string beans, sweet corn, sweet potatoes, sweet onion, taro leaves, tomatoes, watermelons, and zucchini,

6. LOCATIONAL ADVANTAGES AND DISADVANTAGES FOR CROP PRODUCTION

The Petition Area is well-located for serving the Honolulu consumer market and export markets. This is due to the short trucking distance to the Honolulu markets, the Honolulu International Airport, and Honolulu Harbor.

In the U.S. mainland market, farmers in Hawai'i must compete against farmers on the mainland and in Mexico, Central and South America, the Caribbean, Australia, New Zealand, Southeast Asia, etc. Most of the competing farm areas have lower production and delivery costs than Hawai'i does. Competing against Mexico is particularly difficult given the North America Free Trade Agreement (NAFTA) and Mexico's proximity to major U.S. markets.

7. SURROUNDING LAND USES[2]

Existing and planned land uses surrounding the Petition Area are shown in Figure 6. By direction, these uses are as follows:

- To the north (*mauka*) are the H-1 Freeway, agricultural fields in Kunia and grazing lands in the Kunia foothills. All of these Kunia lands were once owned by James Campbell Company LLC (JCC). But over the past few years, JCC sold some of them and is in the process of selling the remainder. These lands are expected to remain in agriculture with the exception of land near Schofield Barracks which was purchased by the U.S. Army.
- To the east are Fort Weaver Road, Old Fort Weaver Road, the West Loch Golf Course, and the residential communities of Waipahu, Honouliuli, and West Loch Estates
- To the south (*makai*) are the 'Ewa Villages and other residential communities.
- To the west are agricultural fields on land owned by the State. These lands are in the Urban District and are scheduled to be developed as part of UHWO campus and related residential and commercial development, DHHL East Kapolei residential projects, DHHL commercial center, and the Kroc Community Center on DHHL land (Figure 6).

As indicated, urban development has occurred or will occur to the east, south and west of the Petition Area. Homes to the west will be downwind of the Project.

8. HISTORIC AGRICULTURAL USES[1,15-18]

Following the Mahele of 1848, the Petition Area was part of a 43,250-acre grant which, from 1871 to 1877, was leased for cattle grazing. In 1877, James Campbell purchased most of the property (including the Petition Area) for cattle ranching.

In 1889, Campbell leased most of the 'Ewa Plain to Benjamin Dillingham who, in turn, subleased the land to the 'Ewa Plantation Company to cultivate sugarcane. The 'Ewa Plantation Company grew quickly and continued operating until 1970 when the O'ahu Sugar Company, Ltd. (OSCo) took over operations. Sugarcane cultivation continued on about 1,375 acres of the Petition Area until 1995 when OSCo closed.

Since the mid-1990s, the Petition area has been leased for diversified crop farming (that is, crops other than sugarcane or pineapple).

9. EXISTING AGRICULTURAL OPERATIONS

a. Agricultural Leases[I]

Currently, about 1,497 acres (96%) of the Petition Area are leased to three companies to grow diversified crops. As shown in Figure 10, these companies are:

- Aloun Farms, Inc. (about 1,100 acres)
- Sugarland Farms, Inc. (about 197 acres)
- Syngenta Seeds, Inc. (about 200 acres)

In addition, Fat Law's Farm subleases about 100 acres from Aloun Farms. These four farms are described below.

b. Aloun Farms, Inc.[I,II]

Since 1997, Aloun Farms has leased about 1,097 acres of the Petition Area, of which about 1,003 acres are considered arable. The original lease was with The Estate of James Campbell, now James Campbell Company, LLC (Campbell). The lease expires in 2013, but is subject to withdrawal rights by the landowner. In April 2007, lease rents were about $194 per acre per year for arable land, which is below current market rents for good agricultural land on O'ahu.

Aloun Farms leases an additional 3 acres of arable land for its major facilities, discussed below. The lease expires in 2017 and the landowner does not have withdrawal rights. In April 2007, lease rents were $150 per acre per year.

In addition to the lands in the Petition Area, Aloun Farms and a company affiliated with it (A.M. Enterprises, LLC) lease about 1,440 acres in 'Ewa, Kunia and Central O'ahu. Thus, Aloun Farms (with its affiliate) leases a total of about 2,540 acres. However, about 100 acres of its Ho'opili lands are subleased, resulting in a net of about 2,440 acres available to Aloun Farms. Nearly all of this

land is arable, and most of the fields are of high quality. Having fields in 'Ewa, Kunia and Central O'ahu allows Aloun Farms to maintain year-round production of certain crops by taking advantage of the climatic and seasonal differences between the planting areas.

Averaged over time, about 910 acres (37%) are in crop. They farm their 'Ewa fields less intensively than the average (about 33% of the land in crop), while the Kunia and Central O'ahu fields are farmed more intensively (about 50% of the land in crop).

The 3-acre parcel mentioned above has two buildings on it having a combined footprint of about 22,600 square feet. The buildings are used by Aloun Farms for its cooling plant, packing facilities, and some of its warehouse space. To the east side of this parcel and within the Petition Area, nine buildings having a combined footprint of about 26,900 square feet provide additional operating and storage space.

Aloun Farms with its affiliate is the second largest diversified fruit and vegetable operation in Hawai'i. It is managed by skilled entrepreneurs who have special expertise in Asian vegetables and melons and in Asian markets. In 2006, Aloun Farms provided about 140 full-time-equivalent (FTE) jobs, including about 20 jobs involved with managing the operations. Salaries average about $22,000 per year.

Crops grown by Aloun Farms for the Hawai'i and overseas markets include:[II]

- Vegetables: bean shoot, broccoli, camote leaf (potato leaf), choy sum, daikon (Chinese and Korean), green onion, Japanese cucumber, kabocha squash, kai choy, long beans, long eggplant, pak choy, paria leaf (bitter melon leaf, peppers, radish, romaine and leaf lettuces, saluyot, string beans, sweet corn, sweet onion, won bok (Chinese cabbage), and zucchini.
- Fruits and melons: apple banana, cantaloupe, honeydew, Korean melon, Thai watermelon (small variety seedless red, yellow, seedless yellow), and watermelon.
- Herbs and spices: basil, chives, lemongrass, mint, and parsley (American and Chinese).
- Seed crops: corn and potatoes.

About 30% of the crops are grown in specific locations that take advantage of the distinctive climatic and agronomic conditions found in 'Ewa, but could be grown in areas having similar conditions. For certain crops, a few seasons are required to determine the best location for the crop, the best variety for the location, the best time to plant, etc.

Table 2 summarizes the consultant's estimates of the 2007 economic activity generated by agricultural operations in the Petition Area, along with the assumed multipliers used in the calculations. As shown for Aloun Farms, the estimates are approximately $3 million per year in revenues, an average employment of 45 jobs, and about $1 million per year in payroll.

c. **Fat Law's Farm, Inc.**[1,11,12]

Fat Law's Farm subleases about 100 acres from Aloun Farms. Their fields are located in the southeast corner of the Aloun lands (see Figure 10), extending south along the lower half of Old Fort Weaver Road and continuing along Fort Weaver Road. The operators began farming at this location on a little over 61 acres in 1996. The lease is month-to-month, and lease rents in April 2007 were about $630 per acre per year for arable land. At any given time, about 60 acres (60%), on average, are in crop and about 40 acres are between crops.

The company farms no other land in Hawai'i. However, they market produce that is farmed by relatives and friends on about 120 to 150 acres. Also, they have leased 150 acres in Hainan, China were they plan to grow tropical fruits (e.g., papaya) and vegetables to be marketed in Hong Kong, mainland China and Japan.

Fat Law's Farm has two on-site structures (about 12,800 square feet under roof) which house their offices, cooling plant, and warehouse space.

Fat Law's Farm is one of Hawai'i's main producers of fresh herbs and vegetables. Its primary crops are basil (Thai, hot and sweet), cucumbers, long beans, malongai leaves, and taro (leaves and stem). Other crops (which the Farm grows itself or markets for other farmers) include betai leaf, bitter melon, chives, curry leaf, la lop, long squash, ngo gai, peppermint, and Thai ginger.

Hawai'i customers include farmers' markets, supermarkets, produce stores, restaurants and wholesalers. The operation also exports Thai basil, sweet basil, taro leaves, chives, curry leaves, and malongai leaves to at least 14 major cities across the United States. They are nicknamed the "King of Basils," due to the fact that they provide more than 60% of the basil exports from Hawaii to the mainland.

In 2006, the U.S. Small Business Administration honored them as Exporter of the Year for Hawai'i and the Western United States. Also, Fat Law's Farm has received many awards for their outreach efforts to help immigrant small-scale farmers. They have provided encouragement, advice on farming practices, marketing help, and other assistance.

Table 2. Economic Activity Generated by Agricultural Operations in the Petition Area: 2007
(approximate estimates by DAHI)

	Aloun Farms	Fat Law's Farm	Jefts Farms	Syngenta	TOTAL
Agricultural acreage					
Total	1,000[1]	100	197	200	1,497
Arable land	903[2]	100	192	177	1,372
Average land in crop					
Percentage in crop	33.3%	60%	33.3%	25%	
Acres in crop	301	60	64	44	469
Adjustments	—	—	10[3]	8[4]	18
Adjusted acres in crop	301	60	74	52	487
Revenues (average annual)					
Revenue per acre in crop (thousands)	$10	$30	$10	$17	
Total revenues (millions)	$3.0	$1.8	$0.7	$0.9	$6.4
Employment (average)					
Jobs per 100 acres in crop	15	33	10	25	
Total Jobs	45	20	7	13	85
Payroll (average annual)					
Salary per job (thousands)	$22	$22	$25	$25	
Total payroll (millions)	$1.0	$0.4	$0.2	$0.3	$1.9

1. Excludes 100 acres leased to Fat Law's Farm.
2. Excludes 3 acres used for facilities.
3. 30 acres of Syngenta land used by Jefts Farms, with an average of 33% in crop, and assuming no reduction in acreage farmed by Jefts Farms.
4. 30 acres of Jefts Farms land used by Syngenta, with an average of 25% in crop, and assuming no reduction in acreage farmed by Syngenta.

Source: Decision Analysts Hawai'i, Inc.

Fat Law's Farm sells about $3 million of fresh herbs and vegetables annually. Approximately 60% of the sales are derived from its own production, while the remainder comes from selling produce from other farms.

Employment averages about 20 FTE jobs, including six management positions. Workers earn about $6.75 to $7.25 per hour.

For the immediate future, about 5 acres will be converted to organic crops, followed by additional conversions if production proves profitable and demand is sufficient. Growing organic crops will increase revenues since they command higher prices, while the cost of chemicals will be reduced. However, the crops will have to be grown in plastic greenhouses to protect them from insects and wind.

Table 2 summarizes the consultant's estimates of the 2007 economic activity for Fat Law's Farm that takes place in the Petition Area. As shown, the estimates are approximately $1.8 million per year in revenues, an average employment of 20 jobs, and about $400,000 per year in payroll.

d. **Sugarland Farms, Inc. ("Jefts Farms")**[1,13,14]

Since late 1994, Sugarland Farms has leased about 197 acres in the Petition Area, of which about 192 acres are arable (see Figure 10). The original lease was with Campbell. The lease is year-to-year, and lease rents in April 2007 were about $231 per acre per year for arable land, which is slightly below current market rents for good agricultural land on O'ahu. In addition, Sugarland Farms and Syngenta have an arrangement that allows them to exchange between the two of them 30 acres at no charge. This enables Sugarland Farms to cultivate 30 additional acres in the Petition Area (see Figure 10). Thus, Sugarland Farms cultivates a total of about 227 acres in the Petition Area. The advantage to Syngenta is that it can more easily isolate seed plantings away from its other varieties to avoid cross-pollination.

Sugarland Farms is part of a larger group of family agricultural operations that collectively is referred to in this report as the "Jefts Farms." They include, but are not limited to: Larry Jefts Farms, LLC; Sugarland Farms, Inc.; Sugarland Distribution, Inc.; Waikele Farms, Inc.; and Akea Farms, Inc.

Jefts Farms comprises the largest diversified fruit and vegetable agricultural operation in Hawai'i, with agricultural lands estimated by the consultant at over 5,000 acres. Their fields are located in, but are not limited to, the following areas:

- 'Ewa fields in the Petition Area as noted above.
- Other 'Ewa fields that are sandwiched between the H-1 Freeway and Farrington Highway, and between and to the west of the Sugarland fields shown in Figure 10. These lands are leased from the State.
- Other 'Ewa fields east of Fort Weaver Road and within the Navy's Blast Zone for the West Loch Naval Magazine. Jefts Farms leases these lands from the U.S. Navy.
- Fields in Kunia north of the H-1 Freeway and west of Kunia Road. Jefts Farms leases some of this land from the State and, until recently, the remainder was leased from Campbell. However, most of the Campbell land in lower Kunia was sold to Pioneer Hi-Bred International and the Monsanto Company (Monsanto) for expanded seed-corn operations.
- Fields in Kunia to the north of the H-1 Freeway and east of Kunia Road. Jefts Farms leases most of these lands from Robinson Estate and the remainder from the State.
- Lands at Mokule'ia, O'ahu that are leased from Dole Food Company Hawai'i.
- Lands on Moloka'i.

The heart of Jefts Farms is the Kunia land that it leases from Robinson Estate. Jefts Farms main offices, cooling plant, packing facilities, warehouses, etc., are located in Kunia near the Hawai'i Country Club. These Robinson lands are outside the County's Urban Growth Boundary and, as such, will remain in agriculture for the foreseeable future.

Most of the Jefts Farms fields in Kunia and Central 'Ewa are of high quality. Averaged over time, about one-third of these lands is in crop. By having fields in both Kunia and 'Ewa, Jefts Farms is able to take advantage of the climatic and seasonal differences between the two planting areas to maintain year-round production of certain crops. For example, tomatoes and peppers are planted in Kunia during the Summer months, and in 'Ewa during the Winter months.

Principal crops grown by Jefts Farms include: bell peppers, cabbages, canteloupes, cucumbers, green beans, onions, sweet potatoes, tomatoes, and watermelons. Most of the produce is grown for the Hawai'i market, but some is exported. In addition to its own crops, about 150 acres are subleased each season to Syngenta for its seed-corn operation (see below)—this is in addition to the 30 acres discussed above that Jefts Farms exchanges with Syngenta.

Employment by Jefts Farms is estimated by the consultant to exceed 150 farmhands. Annual salaries range from about $16,600 ($8 per hour) to over $60,000 for about a dozen key managers and technical experts.

Table 2 summarizes the consultant's estimates of the 2007 economic activity generated by farming activity in the Petition Area. As shown, the estimates for Jefts Farms are approximately $700,000 per year in revenues, an average employment of 7 jobs, and about $200,000 per year in payroll. This estimate takes into account the 30 acres of Syngenta land farmed by Jefts Farms.

e. **Syngenta Seed, Inc.**[I,14]

Syngenta is a global agribusiness headquartered in Switzerland with roots going back to 1758. In 2005, company sales amounted to about $8.1 billion which was derived from selling seeds (corn, soybean, other field crops, vegetables, and flowers) and crop-protection products (herbicides, fungicides and insecticides).

In Hawai'i, Syngenta is one of five major seed companies that use conventional breeding practices and genetic engineering to create improved or new parent seed corn—that is, corn seeds that will provide high yields of quality corn from plants that tolerate droughts and resist diseases. Most of the world's commercially grown corn can be traced back to Hawai'i. Syngenta and other companies also conduct research on soybeans, and other seed companies conduct research on sunflowers, soy, wheat and cotton. These seed companies are expanding steadily in Hawai'i: from the 2000/01 to the 2005/06 crop year, the amount of land in seed crops increased from 3,100 acres to 4,220 acres, and the value of the crop increased from about $37.5 million to about $70.4 million. The primary advantage of operating in Hawai'i is the year-round growing conditions which allow faster development of new hybrids and varieties: three crops per year are possible in Hawai'i versus one crop per year on the mainland. Hawai'i also provides a stable political and economic environment relative to other regions having similar agronomic conditions.

Since 1995, Syngenta has leased about 200 acres in the Petition Area, of which about 177 acres are arable (see Figure 10). The original lease was between Campbell and Garst Seed Company. Syngenta took over the lease when it purchased Garst in 2004. The lease expires in 2008, but is subject to withdrawal rights by the landowner. In April 2006, lease rents were about $215 per acre per year for arable land, which is slightly below current market rents for good agricultural land on O'ahu.

On average, about 45 acres of Syngenta's land in the Petition Area are used for parent seed operations (i.e., operations that increase the supply of selected seed varieties). The corn is normally planted in patches with considerable separation from other corn varieties in order to control pollination of the plants. In addition to its own plantings, Syngenta has an arrangement that allows Jefts Farms to use about 30 acres of Syngenta land in the Petition Area for vegetable crops. In exchange, Syngenta has use of a similar amount of land from Jefts Farms.

In total, Syngenta leases or subleases about 740 acres on O'ahu for its seed operations, including:

- The approximately 200 acres mentioned above.
- About 360 acres in Kunia that are under a long-term lease, subject to cancellation clauses. These lands front the west side of Kunia Road below Waiahole Ditch. The fields are used to research corn varieties and, to a lesser extent, soybeans. Also, Syngenta's processing facilities, warehouse, and offices are located there.
- About 30 acres that are made available as part of a land exchange with Jefts Farms. Plantings can occur in 'Ewa or Kunia.
- About 150 acres that are subleased seasonally from Jefts Farms. Plantings occur in 'Ewa and Kunia.

Most of Syngenta's fields in Kunia and 'Ewa are of high quality. In addition to its O'ahu operations, Syngenta has about 3,000 acres on Kaua'i for its seed operations.

On O'ahu, Syngenta provides employment for about a dozen full-time workers, 15 to 20 part-time workers, and about 60 to 90 temporary workers during the peak Winter season. Corresponding figures for the parent-seed portion of their operation—which includes farming the 'Ewa fields—are about two full-time workers, four part-time workers, and 10 to 15 workers in surges. Wages range from $8.75 to $17 per hour.

Table 2 summarizes the consultant's estimates of the 2007 economic activity generated by agricultural operations in the Petition Area. As shown, the estimates for Syngenta are approximately $900,000 per year in revenues, an average employment of 13 jobs, and about $300,000 per year in payroll. This estimate takes into account the 30 acres of Jefts Farms land that is farmed by Syngenta.

f. **Summary of Economic Activity of Agricultural Operations in the Petition Area: 2007**

For all four agricultural operations, the consultant's estimates of the 2007 economic activity they generate in the Petition Area totals approximately $6.4 million per year in revenues (about $4,665 per acre on average), an average employment of about 85 jobs (about 6.2 jobs per 100 acres), and about $1.9 million per year in payroll (see Table 2).

10. Cumulative Loss of Land for the Affected Agricultural Operations

In addition to the leased and subleased lands that gradually will be lost as the Project is developed over a 20-year period, three of the four agricultural operations in the Petition Area will eventually lose agricultural lands to (1) other private and State urban projects in 'Ewa and Central O'ahu that are within the County's Urban Growth Boundary, and (2) other agricultural operations in Kunia. The cumulative loss of land for the affected agricultural operations is addressed in this section. The related cumulative impact on them is addressed in Section 13.

a. Overview[1,18,19-23]

For the affected agricultural operations, the approximate cumulative reductions in acreages are summarized in Table 3, and include the following:

— Urban Projects within the County's Urban Growth Boundary

- Ho'opili, Ewa: about 1,497 acres of farm land currently leased or subleased to the four farms in the Petition Area. Some of the land will used by the State Department of Transportation for the North-South Road.
- State projects, 'Ewa: about 945 acres currently farmed by Aloun Farms and Jefts Farms. State projects include (1) the UH West O'ahu campus and related residential and commercial development, and (2) a DHHL residential and commercial development (see Figure 6).
- Koa Ridge, Central Oahu: about 430 acres currently farmed by Aloun Farms. This is a proposed residential community by Castle & Cooke Homes Hawai'i.

— Changes in Agricultural Uses

- State Ag Park, Kunia: about 150 acres currently farmed by Jefts Farms.

Table 3. Cumulative Loss of Land for the Affected Agricultural Operations
(approximate acreage estimates by DAHI)

	Aloun Farms	Fat Law's Farm	Jefts Farms	Syngenta	TOTAL
Urban Projects					
Ho'opili, 'Ewa	1,000	100	197	200	1,497
State Projects, 'Ewa[1]	850	-	95	-	945
Koa Ridge, Central O'ahu	430	-	-	-	430
Agricultural Uses					
State Ag Park, Kunia	-	-	150	-	150
Monsanto Co., Kunia	-	-	220	360	580
Total	2,280	100	662	560	3,602

1. UHWO, DHHL and other State projects.
Source: Decision Analysts Hawai'i, Inc.

- Monsanto, Kunia: about 580 acres currently farmed by Jefts Farms and Syngenta. Monsanto is a major seed company that purchased land in 2007 in lower Kunia west of Kunia Road.

Altogether, the four agricultural operations in the Petition area are projected to lose about 3,600 acres of their leased land: about 2,870 acres to private and State urban projects located within the County's Urban Growth Boundary, and about 730 acres which will remain in agriculture but will be farmed by other operators. Syngenta's and Jefts Farms' losses of acreage to Monsanto (another agricultural operation) may occur within a few years. The agricultural land lost to urban projects is likely to begin in a few years and continue until as late as 2030.

b. **Aloun Farms**

Aloun Farms is expected to gradually lose about 2,380 acres to urban projects (see Table 3). This will leave Aloun Farms with just 160 acres of its current Kunia farm, assuming that the lease to this land is renewed. This is the only land leased by Aloun Farms that is outside the County's Urban Growth Boundary.

c. Fat Law's Farm

As shown in Table 3, Fat Law's Farm eventually will lose all of its 100-acre farm to Ho'opili.

d. Jefts Farms

Table 3 shows that Jefts Farms is projected to lose about 660 acres of good farm land: approximately 197 acres to Ho'opili, 95 acres to State urban projects, 150 acres for the State Ag Park in Kunia, and 220 acres to Monsanto's seed operation. Also, Jefts Farms will eventually lose access to Syngenta's 30 acres in 'Ewa since this is within the Petition Area. In addition, Jefts Farms lost about 230 acres of cultivated land in lower Kunia that Campbell sold to Pioneer Hi-Bred International (a seed company) in 2006.

Even with these acreage reductions, Jefts Farms will retain an estimated 4,000+ acres of farm land, and will remain the largest diversified fruit and vegetable farm operation in Hawai'i. On O'ahu, all of Jefts Farms remaining land is located outside the County's Urban Growth Boundary.

e. Syngenta

Syngenta is expected to lose about 560 of its 740 acres on O'ahu—this includes 360 acres purchased recently by Monsanto for its seed operations, and 200 acres in the Petition Area (see Table 3).

In addition to the direct acreage losses, Syngenta will no longer have use of the 30 acres on Jefts Farms leased land since Syngenta will no longer have land in 'Ewa to provide to Jefts Farms in exchange (see Section 9.d). Furthermore, inasmuch as Jefts Farm will have less land to sublease, Syngenta could lose access to some of the 150 acres that they sublease from Jefts Farms.

11. CHANGES TO AGRICULTURAL OPERATIONS BEFORE HO'OPILI IS DEVELOPED

a. Relocation of Syngenta

Monsanto's 2007 land purchase in lower Kunia includes all of the 360 acres in Kunia that comprise the core of Syngenta's operations on O'ahu. Because of this purchase, the consultant anticipates that Syngenta will relocate from Kunia to some other area. And because of termination clauses in the existing lease, it is likely that this relocation will occur within the next few years—with or without Ho'opili, and before Ho'opili construction even begins.

If Syngenta is to retain its same size after relocating, then they will require about 740 acres of replacement land—the approximate acreage that they now lease and sublease in Kunia and 'Ewa. Syngenta could relocate to Kaua'i where they already lease about 3,000 acres, although the North Shore of O'ahu is also a possibility.

If the company relocates to Kaua'i, then the demand for good farm land on O'ahu will decrease by about 740 acres while the demand on Kaua'i will increase by a similar amount (the acreage could be somewhat less than 740 acres if Syngenta farms their existing lands on Kaua'i more intensively). In this scenario, the economic activity for Syngenta's O'ahu operation would be transferred to Kaua'i. This would include about a dozen full-time workers, 15 to 20 part-time workers, and about 60 to 90 temporary workers during the peak Winter season.

b. Interim Agriculture on Land Vacated by Syngenta

After Syngenta vacates the 200 acres it now leases in the Petition Area, it is expected that the land will be leased to a farmer until construction on this site is ready to begin.

Future economic activity associated with diversified crop farming on the land to be vacated by Syngenta is estimated at about $600,000 per year in revenues (based on 177 arable acres with one-third in crop, and revenues of about $10,000 per acre per year); about six jobs (based on ten jobs per 100 acres in crop); and a payroll of about $150,000 per year (based on about $25,000 per job).

c. Reduction in Jefts Farms Operations

After Syngenta vacates its 'Ewa fields, Jefts Farms will lose the 30 acres it now farms there as part of its land exchange with Syngenta (unless Jefts Farms leases the entire 200 acres). Thus, the economic activity shown in Table 2 for Jefts Farms will decrease slightly: about $100,000 less in annual revenues, about one less job, and about $25,000 less in annual payroll.

d. Summary of Economic Activity of Agricultural Operations in the Petition Area: 2010

Table 4 shows the consultant's resulting estimate of the economic activity generated by farming in the Petition Area by about 2010 after Syngenta is replaced by some other farming operation but before the Ho'opili construction begins. As shown, projected economic activity includes approximately $6 million per year in revenues (about $4,373 per acre on average), an average employment of slightly less than 80 jobs (about 5.6 jobs per 100 acres), and about $1.7 million per year in payroll.

Table 4. Projected Economic Activity Generated by Agricultural Operations in the Petition Area: 2010
(approximate estimates by DAHI)

	Aloun Farms	Fat Law's Farm	Jefts Farms	Interim Farm	TOTAL
Farm acreage					
Total	1,000[1]	100	197	200	1,497
Arable land	903[2]	100	192	177	1,372
Average land in crop					
Percentage in crop	33.3%	60%	33.3%	33.3%	
Acres in crop	301	60	64	59	484
Revenues (average annual)					
Revenue per acre in crop (thousands)	$10	$30	$10	$10	
Total revenues (millions)	$3.0	$1.8	$0.6	$0.6	$6.0
Employment (average)					
Jobs per 100 acres in crop	15	33	10	10	
Total Jobs	45	20	6	6	77
Payroll (average annual)					
Salary per job (thousands)	$22	$22	$25	$25	
Total payroll (millions)	$1.0	$0.4	$0.15	$0.15	$1.7

1. Excludes 100 acres leased to Fat Law's Farm.
2. Excludes 3 acres used for facilities.

Source: Decision Analysts Hawai'i, Inc.

12. AVAILABILITY OF REPLACEMENT LAND

As discussed in Sections 10 and 11, the farms that operate within the Petition Area will lose land to Ho'opili and to other urban projects, and to changes in agricultural uses. The impact of this cumulative loss of land on the affected agricultural operations will depend on the amount and quality of replacement land that will be available to them in the future to offset their land losses. The availability of replacement land Statewide and on O'ahu is reviewed below.

a. Statewide

Statewide, a vast amount of land has been released from plantation agriculture: about 251,800 acres between 1968 and 2005, resulting in an average release of over 6,800 acres per year over a 37-year period (see Figure 11).[10,24] The 2006 Del Monte closure in Kunia increased this figure by another 4,400 acres, resulting in a total release of at least 256,200 acres from plantation agriculture between 1968 and 2007.[25,26] Over the 1968-to-2005 period, the demand for land for diversified crops increased by about 26,300 acres (about 10% of the land released from plantation agriculture).[10]

As the above figures indicate, the acreage released from plantation agriculture has far outpaced the demand for land for diversified crops. The net decrease in diversified crop land amounts to about 229,900 acres. While some of the released land has been converted or is scheduled to be converted to urban uses and tree plantations, an estimated 160,000+ acres remain available for diversified crops.[26] Because of the increased availability of agricultural land, a number of landowners report lower per-acre agricultural land rents on O'ahu and the Neighbor Islands compared to rents charged before the major contraction in plantation agriculture.[27]

If the Hawai'i Superferry is successful, cultivating crops on the Neighbor Islands for the Honolulu market, and vice versa, may become more economically feasible. For a full load carried in a large pick-up truck, the one-way fare will be about 2¢ per pound.[28] However, for some perishable crops, the ferry service may not be sufficiently frequent and/or delivery times may not be sufficiently rapid.

The above information indicates that considerable land is available in Hawai'i to accommodate the relocation of agricultural operations as well as the growth of diversified crop farming (see Sections 13 and 15).

b. O'ahu

On O'ahu, a similar release of plantation land occurred. Between 1968 and 2007, about 51,900 acres were released from plantation agriculture due to the contraction of five plantations and the closures of all but one of them.[10,26] About 32,700 acres were released after 1990. Much of this land remains available for agriculture, and most of it lies outside the County's Urban Growth Boundary.

The Kunia fields are considered to be among the best farm land in the State, based on the high solar radiation, high-quality soils, and the short trucking distance to the large Honolulu market, the airport, and Honolulu Harbor.[29] Except for lands recently released by Del Monte, all of the better Kunia fields have already been leased for diversified crop farming. However, on average, only about one-third of this land is in crop.[30] The large amount of fallowing reflects best management practices when farm land is abundant and land rents are relatively low. Fallowing increases soil fertility and helps control unwanted volunteer plants, weeds, insects and disease. When demand for farm land is strong and rents are high in response to a strong demand for agricultural products, then more intensive farming of the land may be warranted even if this increases farmers' costs for pest control and soil additives.

Of the estimated 4,400 acres of Kunia land recently farmed by Del Monte, about 3,200 acres remain available. The decrease was due to (1) Monsanto's land purchase in lower Kunia for seed crops, and (2) the U.S. Army's land purchase in upper Kunia for expanding Schofield Barracks. These two purchases involve considerable land, including about 640 acres and 580 acres, respectively, of former pineapple fields.[21,31]

Another possible land purchase could impact the future supply of farm land in Kunia. The Army Hawai'i Family Housing LLC (AHFH), a public/private partnership between the U.S. Army and Actus Lend Lease, plans to acquire about 2,520 acres in northern Kunia from Campbell, including about 1,570 acres of former pineapple land.[21,32] AHFH intends to "bank" the land for future needs, which will allow a portion it to be used for military housing if needed in the distant future. If and when AHFH proposes the land for development, the project will be subject to all State and County development approvals and permits, which could prove difficult since the development would be outside the County's existing Urban Growth Boundary. AHFH has indicated that if the land is purchased, it would remain in agriculture for the foreseeable future.

On the North Shore, various crops are being grown, but about 7,750 acres of the former sugarcane and pineapple lands remain fallow or are in a low-value use.[27,33]

In total, about 10,900 acres of former plantation land remain available on O'ahu for other crops, including about 3,150 acres of former pineapple land in Kunia plus the 7,750 acres on the North Shore. However, this excludes any adjustment for the farm land that is already leased for diversified crops but is not farmed intensively, some arable lands in the foothills that are used for grazing, and a portion of the 2,290 acres (about 1,600 acres arable) purchased by Monsanto that might remain available for crops other than seed crops.

Given the large release of land from plantation agriculture on O'ahu, the amount of available farm land that remains on O'ahu is lower than what might be expected. This is explained by: (1) farmers relocating to or expanding on these high-quality and favorably located lands, thereby reducing the amount of land farmed elsewhere on O'ahu and the Neighbor Islands; (2) extensive fallowing of fields that are under lease; (3) growth of seed operations on O'ahu; (4) transferring land in the foothills from farming to grazing because of the lower demand; (5) urbanization in 'Ewa and Central O'ahu; and (6) military use of some land.

Much of the available 10,900 acres have limitations for growing certain crops. Some limitations reflect permanent agronomic and other conditions. For example, the higher elevation fields in Kunia and on the North Shore have less solar radiation compared to 'Ewa: the average daily insolation is about 400 calories per square centimeter at higher elevations compared to as much as 500 calories in 'Ewa.[7] In addition, fields at higher elevations incur higher pumping costs, although rainfall reduces water requirements. Also, North Shore farmers encounter longer trucking distances to Honolulu markets, the airport, and the harbor.

Nevertheless, some limitations can be overcome with investment in improvements. For example, on the North Shore, portions of the water delivery systems need major repairs to address current leaks and to prevent future ones.[27,34] Because of the leaks, a number of mid-level and high-level fields on the North Shore can no longer be irrigated in the summer months. Also, the types of crops on fields irrigated with water from Wahiawa Reservoir (Lake Wilson) will be restricted as long as partially-treated wastewater continues to be discharged into the lake.[35] Water from the lake can be used to irrigate tree crops (e.g., papaya and coffee) and crops such as sugarcane that are processed sufficiently to kill pathogens. However, the water cannot be used to irrigate the wide variety of fresh vegetable crops that are now grown in 'Ewa and Kunia.

Regardless of the above difficulties, the available supply of farm land on O'ahu will be partially absorbed over time as island farmers expand production.

This expansion will reflect the advantages to them of farming fields near the large Honolulu markets, and near the State's primary transportation/distribution centers (i.e., Honolulu Harbor, Honolulu International Airport, and many companies involved in distributing goods inter-island and overseas).

13. DIRECT AND CUMULATIVE IMPACTS ON THE AFFECTED AGRICULTURAL OPERATIONS

a. Loss of Land for the Affected Agricultural Operations

The Project will result in a direct loss of about 1,497 acres currently being leased for various agricultural operations. In combination with land lost to other State and private urban projects and to other agricultural uses, the four agricultural operations in the Petition Area will incur a cumulative loss of about 3,600 acres of their leased land (Section 10 and Table 3). The amount of arable land will be somewhat less. However, as noted above, it is expected that Syngenta will relocate for reasons unrelated to and before the Ho'opili construction begins.

b. Required Replacement Land

If Syngenta remains on O'ahu, then about 3,600 acres of replacement land will be needed on O'ahu by the four the affected agricultural operations. But, if Syngenta relocates its O'ahu activities to Kaua'i where most of its operations are located, then the O'ahu demand will be reduced by 740 acres (see Section 9.3), resulting in a need for less than 2,900 acres of replacement land.

Desired physical characteristics of replacement lands include: large gently-sloping fields, good soils, high solar radiation, and affordable irrigation water of sufficient quality to use on any type of crop.

As summarized in the previous section, sufficient land is available on O'ahu and the Neighbor Islands. Nevertheless, major water-related improvements are required before all available agricultural lands on the North Shore of O'ahu will be suitable for growing diversified crops. Also, the available lands possess different agronomic conditions than those found in 'Ewa and lower Kunia.

c. Direct On-site Agricultural Impacts

In isolation, Ho'opili will result in the gradual on-site loss of all agricultural activity in the Petition Area, along with the related gradual loss of approximately $6 million per year in revenues, an average employment of slightly under 80 jobs and about $1.7 million per year in payroll.

In practice, however, most or all of the agricultural operations on the Ho'opili land are expected to relocate to other lands (see the next subsection).

d. Anticipated Changes in Agricultural Operations

Until 2030, the agricultural operations located in the Petition Area are likely to adjust to gradual acreage losses by implementing a combination of the following:

— Leasing replacement lands

As discussed in the previous section, replacement lands are available in Kunia and on the North Shore, subject to (1) water-related improvements on the North Shore, and (2) adjustments that will have to be made by farmers to their crops and farming practices (see below).

— Cultivating remaining lands more intensively

Some farmers may be able to partially offset their acreage losses by fallowing less and keeping more of their land in crop. However, this may increase their costs for pest control and soil additives.

— Reducing operations

If the above two adjustments are not sufficient to offset future acreage losses, then farmers will have to reduce the sizes of their operations.

By 2030, however, Aloun Farms will lose nearly all and Fat Law's Farm will lose all their leased lands, thereby necessitating relocation to Kunia and/or the North Shore.

Assuming that the affected lessees secure replacement lands, and assuming the necessary water improvements are made, then the affected agricultural operations could maintain about the same level of production, sales revenues, employment and payroll. However, major adjustments in their operations will be required since the replacement lands will have different agronomic conditions (e.g., soils, temperature, solar radiation, and rainfall). Adjustments will include growing varieties that are more suitable to the replacement lands, modifying cultivation practices (which will take a few crop cycles to optimize), and changing the mix of crops if suitable varieties are not available. Also, the lessees will incur additional expenses to prepare the soils and irrigation systems for their particular crops, and to move their offices, and cooling and packing facilities.

If the agricultural operations lease replacement lands in Kunia, their trucking costs will be about the same. If they lease on the North Shore, then they will incur higher costs for hauling produce into Honolulu—costs that would be similar to what North Shore farmers pay, but lower than what Kahuku farmers pay. At the same time, the higher trucking costs could be partially offset by lower land rents on the North Shore as compared to those in Kunia.

If sufficient replacement land is not available on O'ahu due to the unlikely possibility that it will be used to grow an energy crop (explained in Section 15.a), then one or more of the farms could turn to a Neighbor Island. Potential feasibility is illustrated by the fact that two of the lessees already have agricultural operations on Neighbor Islands, while many Neighbor Islands growers supply O'ahu markets. However, the affected companies which may move to the Neighbor Islands will incur higher transportation costs, and delivery times will be longer. The costs and delays will be similar to those that Neighbor Island farmers now incur to supply the Honolulu market. In the future, these costs and delays may be somewhat lower because of the Superferry and the planned improvements to interisland barge service. The disadvantages of a Neighbor Island location could be partially offset by lower rents. However, for some perishable crops, the ferry service may not be sufficiently frequent or travel may take too long.

e. Flexibility of Affected Agricultural Operations to Resize

Diversified crop farms such as those operating in the Petition Area generally can be flexible as to their size: profitability can be achieved with a farm that becomes smaller, stays about the same sizes, or becomes larger (provided the market can absorb additional product). This differs from the typical sugarcane plantation which relies on economies of scale to maintain economic viability.

Because the affected diversified crop operations can be flexible with regard to their sizes, it is anticipated that they will survive regardless of the amount of replacement land they lease in the future. More to the point, changes in available agricultural land due to the Project are not likely to threaten the survival of Aloun Farms, Fat Law's Farm, or Jefts Farms.

f. Statewide Impacts

From a Statewide perspective, the cumulative agricultural impact of the Project will be modest regardless of how the affected agricultural operations adjust to losing all, or portions of, their leased acreage. Their lost agricultural

production from the Petition Area and from other areas they now lease will be offset largely by (1) maintaining their current levels of operation and production by leasing replacement lands in Kunia and/or the North Shore, and possibly cultivating their remaining lands more intensively; (2) one or more of them relocating all or portions of their operations to a Neighbor Island; (3) other farmers on O'ahu and the Neighbor Islands increasing their production; or (4) some combination of the three.

Thus, it is likely that there will be little or no loss in Statewide agricultural production, revenues, employment or payroll.

g. Urbanization of Agricultural Lands

Reconfigurations of farms such a those described above are common and appropriate when agricultural operations lease land in the path of planned urban expansion. For the affected operations, much of the land they lease is located in areas that the County and, for much of the 'Ewa Plain, the State have designated for eventual expansion of Kapolei. Also, all current tenants entered into lease agreements with this knowledge and, except for Fat Law's Farm, have benefited from rents that are now below market.

For diversified crop farmers who supply nearby markets, locations on the edge of town can be ideal for them because of the lower trucking costs. And until these lands are urbanized, the best "temporary" use of them may be agriculture—a use that may last decades. For example, the affected operations have cultivated their acreage on the 'Ewa Plain for 10 years or more, and some of this land will probably remain available to them for agriculture until as late as 2030.

But when urbanization does occur, the operations will incur the expense and disruption of relocating all their operations or major portions of them to other lands. Since lessees only have temporary rights to the land, the costs of relocating falls on the farmers and are not an obligation of the landowners. If the costs were an obligation of the landowners, they would avoid leasing their land to crop farmers and put their land in a lower value agricultural use such as cattle grazing which has similar land-management and property-tax benefits.

h. Mitigating Measures

The mitigation measures recommended below will contribute to the successful relocation of the four agricultural operations that will be displaced by Ho'opili in combination with other land-use changes in 'Ewa, lower Kunia and Central O'ahu. They are designed to (1) address water issues that limit crop production on the North Shore where most available farm lands on O'ahu are located, and (2) provide sufficient time to make the necessary improvements and arrangements for relocating.

The recommended mitigation measures are categorized by those which may be best implemented by government, and those which are within the purview of D.R. Horton:

— Government

- Upgrade the Wahiawa Wastewater Treatment Plant (WWTP) to treat wastewater to the State's R-1 standard, or eliminate discharging wastewater into the Wahiawa Reservoir.

  This recommendation to the County is consistent with a 1998 Consent Decree with the U.S. Environmental Projection Agency (EPA). Its purpose is to allow farmers to use water from the Wahiawa Reservoir to irrigate any type of crop using any type of irrigation system.

  Until the quality of the reservoir water is improved, most of the available agricultural land on the North Shore cannot be used to grow the types of vegetable crops the farmers grow in 'Ewa and lower Kunia. In turn, one or more agricultural operations that will be displaced by Ho'opili and by other projects may not be able to fully relocate to the North Shore until the improvements are made (assuming that relocating to the North Shore is their best option).

- Repair the Wahiawa Irrigation System (WIS)

  Repairs to portions of the WIS are needed to address major and minor leaks and to prevent future leaks. Because of the leaks, a number of mid-level and high-level fields on the North Shore can no longer be irrigated in the summer months with water from Wahiawa Reservoir. Until these repairs are made and more fields can be irrigated reliably, one or more agricultural operations being displaced by Ho'opili and by other projects may not be able to fully relocate to the North Shore (assuming that relocating to the North Shore is their best option).

  Because of the high cost of the repairs, State and Federal funds may be required.

— D.R. Horton

- To the extent possible, coordinate the development of Ho'opili with the affect agricultural operators and with developers of adjacent lands so as to maintain farming in 'Ewa for as long as possible.

  The development of Ho'opili and of projects on adjacent State lands could continue until 2030. Until then, farming can continue in 'Ewa, provided that Ho'opili works with the agricultural operators and developers of adjacent land to: (1) maintain access to fields and irrigation water, and (2) phase development to minimize the potential for nuisance issues (discussed in the next section). This will allow more time for others to make the necessary improvements to the WWTP and the WIS.

- Continue to lease agricultural land at below-market rents.

  The affected agricultural operators will have to make frequent adjustments to their operations as development proceeds. These adjustments may include contracting their 'Ewa operations, rearranging water systems, building berms to reduce nuisance problems, etc.

  Continued below-market rents will allow the affected agricultural operators to retain more funds to help finance the required adjustments.

14. Nuisance Issues

a. Potential for Nuisance Issues

Nuisances arising from agricultural operations can become an issue for both residents and farmers. Residents who live close to and downwind from agricultural operations may complain about occasional noise, dust, chemical spraying, etc. In turn, the farmers may have to change their operations in order to address these complaints.

Regarding the existing homes that are located downwind of the agricultural operations in the Petition Area, they are buffered from nuisance problems by (1) farming activities on State land, (2) fallow fields on State land, and (3) the Kapolei Golf Course.

However, nuisance issues could arise during the 20 or so years while agricultural operations continue in portions of the Petition Area and homes are built and occupied nearby as part of Ho'opili or other projects on adjacent State lands.

Once Ho'opili and adjacent lands are fully developed, nuisance issues arising from agricultural activities will not occur since the lands will no longer be cultivated.

b. Mitigating Measures

To mitigate potential nuisance issues related to agricultural activities near newly built homes, the following mitigation measures are recommended:

- To the extent possible—and subject to transit alignment, water and other infrastructure improvements—phase the development of homes and coordinate agricultural leases to provide wide separations between homes and upwind agricultural activities.
- For each phase of development of Ho'opili and nearby projects, require farmers to provide a buffer of fallow fields and berms upwind of the homes before the homes are occupied.
- As necessary, limit agricultural activities (restricted hours of operation, restricted plowing and use of chemicals on windy days, etc.) so as to avoid or minimize nuisance problems.
- As long as agricultural operations continue in the Petition Area and on adjacent lands, inform home buyers in the area that they will be living near agricultural activities.

15. GROWTH OF DIVERSIFIED CROPS

The Project will commit about 1,554 acres of agricultural land to a non-agricultural use, of which about 1,375 acres are arable. The impact of this commitment on the growth of diversified crops is addressed below. The material covers the (1) amount of land required for the growth of diversified crops, (2) the adjusted supply of land available for the growth of diversified crops, (3) impact of the Project on the growth of diversified crop farming, and (4) mitigating measures.

a. Potential Acreage Requirements for Diversified Crops

Crops to Replace Imports of Fruits and Vegetables[36]

For low-elevation fruits and vegetables that have a history of profitable production in Hawai'i, potential land requirements in 2010 for 100% import substitution for the Hawai'i and O'ahu markets are estimated at 12,700 acres and 8,600 acres, respectively, plus additional acreage for fallowing land between crop plantings. When allowing for competition from imports, these estimates drop to about half. These estimates take into account estimated consumption, production trends, seasonal and annual market shares, yields, and the number of crops per year. Also, these figures are for acreage in crop—not harvested acreage as is typically reported in government publications.

For many crops grown in Hawai'i, market shares for Hawai'i growers are limited by the following factors: (1) local varieties are not perfect substitutes for all imports (e.g., premium-priced sweet Maui onions versus inexpensive storage onions); (2) some crops cannot be produced profitably in the Summer due to competition from low-cost imports of fruits and vegetables from California, other states, and Mexico; and (3) over-production must be avoided in order to maintain profitable price levels.

Since Hawai'i farmers already supply a portion of the Hawai'i market, land requirements for increased import substitution are a fraction of the above estimates.

Export Crops[10,37,38]

The potential market for export crops is far larger than the Hawai'i market. In 2005, the U.S. population was 296.41 million, compared to Hawai'i's resident-plus-visitor population of 1.45 million. To take advantage of this large potential, Hawai'i farmers are exploring various export crops on lands released from plantation agriculture. Over the next 20+ years, one or more of these crops may prove to be successful and may grow into a major export crop.

However, the history of agricultural efforts in Hawai'i reveals that the successful development of major new export crops requiring large amounts of land is difficult and infrequent. For example, over the past 50 years in Hawai'i, farmers have explored numerous possibilities for export crops, but they have developed overseas markets for just one diversified crop that requires more than 10,000 acres (macadamia nuts at 18,300 acres in 2005); one additional crop that requires more than 5,000 acres (coffee at 8,000 acres); and only five additional crops or crop categories that require more than 1,000 acres each (papaya at 2,395 acres, bananas at 1,145 acres, tropical specialty fruits at 1,230 acres, flowers/nursery products at 3,895 acres, and seed crops at 4,220 acres). Tropical specialty fruits include longan, lychee, mango, rambutan, star-fruit, etc.

At 4,220 acres in 2005 and growing at an average rate of 264 additional acres per year, the seed industry is expected to soon become only the third diversified crop that requires more than 5,000 acres. The fourth crop could be nursery and flower products: 3,895 acres and increasing at 235 acres per year.

Feed Crops[29]

If feed crops could be grown in Hawai'i and priced competitively against mainland imports, they could replace some of the grains and hay that are now being imported to the State. Unfortunately, a number of commercial attempts in Hawai'i to grow grains and alfalfa have been unsuccessful. The major problems have been (1) pests, particularly birds that eat the grains before they are harvested; (2) humidity that is too high for drying alfalfa properly; and (3) high production costs compared to those of mainland farms.

Biofuel Crops

Crops can be grown to produce biomass to fuel a boiler, or as feedstock to produce fuels. Examples of the latter include sugarcane, corn, or sorghum used to produce ethanol. In turn, the ethanol is used to produce E-10 gasohol (90% gasoline and 10% ethanol). Also, palm oil, soybean, sunflower, kukui nut, avocado, coconut, neem and other crops can be grown to produce biodiesel.[39]

In Hawai'i, the common practice has been to produce biomass as a by-product of some principal crop. For example, at HC&S on Maui and at Gay & Robinson on Kaua'i, the sugarcane by-product bagasse is burned to help fuel their respective power plants. In addition, the biofuel company Maui Ethanol plans to use the sugarcane by-product, molasses, from the two sugarcane plantations as feedstock to produce ethanol.[40,41] Using conventional technology, the sugar in the molasses will be fermented to produce ethanol, followed by distillation to extract the alcohol.

However, O'ahu Ethanol Corporation plans to build an ethanol plant at Campbell Industrial Park using conventional technology but, at least initially, using imported molasses as the feedstock.[40,42] The rated capacity will be 15 million gallons of ethanol per year. For the longer term, this company is exploring the economics of growing sweet sorghum to supply feedstock to its ethanol plant. The sorghum would have to be grown on O'ahu because it would be too expensive to ship the sorghum juice from a Neighbor Island to O'ahu. Sorghum juice is mostly water having a low concentration of sugar compared to molasses. Acreage requirements for a new sorghum biofuel plantation on O'ahu would range from about 6,000 acres for viability to 15,000 acres if juice from sorghum were to replace all imported molasses.[42] This acreage comprises a substantial share, if not all, of the estimated 10,900 acres of crop land that is available on O'ahu as of mid-2007. But it is a small share of the 160,000+ acres of crop land available Statewide (see Section 11.b).

Also, Imperium Renewables Hawai'i LLC is proposing to build by 2009 a biodiesel refinery on State land at Kalaeloa Harbor; it would produce about 100 million gallons of biodiesel annually.[43,44] Similarly, BlueEarth Maui Biodiesel LLC plans to build a similar refinery on Maui that would produce about 120 million gallons annually by 2011. Both will use imported palm oil from Malaysia and other countries as their feed stock, but would refine locally produced vegetable oil if available.

A number of substantial difficulties must be overcome in order to develop one or more biofuel plantations to supply feedstock for ethanol or biodiesel production, including:

— Long-term Leases

In many areas of the State, it will be difficult to lease the large amount of land required for a biofuel plantation at low lease rents for the 30 or so years required to capitalize the investment in a new plantation. Over time, other farmers and other users of land are likely to make higher offers to landowners of lease rents or land purchases. In view of this potential for landowners, the current market value of available farm lands is likely to be higher if landowners do not commit long-term to rents that are low enough to be affordable to a biofuel plantation.

— Capital

Substantial investment capital will be required to cover the cost of improvements and equipment such as: a mill to extract the juice from a biofuel crop; a generating plant to provide power; improvements and upgrades to irrigation systems that are in disrepair; trucks and equipment to harvest and haul harvested plants to the mill, and haul the extracted juice to an ethanol plan or the vegetable oil to a refinery, etc.

— Short-term Profitability

Annual revenues from selling the ethanol plus direct subsidies are estimated by the consultant at about $2,430 per acre (based on an estimated 900 gallons per acre per year of ethanol at about $2.70 per gallon). Even with subsidies, this is low compared to revenues from other crops in Hawai'i. Per-acre returns from biodiesel crops are even less.

Furthermore, the cost of importing molasses or palm oil for feedstock, or importing ethanol may prove to be less expensive than growing a biofuel crop in Hawai'i. For similar crops (such as feed crops), importing has proven to be less expensive than growing and processing crops locally. Also, the U.S. Department of Agriculture has found sorghum to be an expensive feedstock for producing ethanol—about 3.7 times more expensive than corn and 63% more expensive than molasses.[45]

As ethanol production increases on the mainland and in Hawai'i, there is a risk that the combined Federal and State subsidies for ethanol (over $2 per gallon) could be reduced, thereby compromising the profitability of a biofuel crop.

— Long-term Profitability

Over the long-term, emerging technology holds promise for a cheaper source of feedstock for ethanol than does growing a biofuel crop on a plantation.[46] Instead of producing ethanol using sugars from conventional sources (e.g., molasses, sugarcane, grains, fruits, etc.), the sugar would come from "cellulosic" sources. Using new technology that is in the early stages of commercialization, sugar that is locked in complex carbohydrates of plants is separated into fermentable sugars. Feedstock would include agricultural wastes, yard clippings, discarded paper, wood waste, etc.—i.e., the green waste that is now used for composting. This new technology promises (1) much higher ethanol yields per ton of biomass because the entire plant can be used as feedstock, and (2) lower costs—particularly if there are no growing costs when waste product is used, and if the operator is paid a fee to dispose of municipal and agricultural waste. Eventually, this less expensive source of feedstock could result in unprofitable biofuel plantations. In Hawai'i, this new technology is being explored by ClearFuels Technology Inc.

O'ahu's municipal waste could produce an estimated 160 million gallons of ethanol compared to the current annual consumption of about 400 million gallons of gasoline.

The above difficulties and risks suggest that the probability of successfully developing and sustaining a biofuel plantation in Hawai'i is low. The more likely scenario is that ethanol will be produced as a by-product of sugar and, over the long-term, it will be produced from green waste.

Recent Crop-acreage Trends[10]

For all diversified crops (i.e., all crops other than sugarcane and pineapple, including crops to replace imports and crops for export) Statewide land requirements grew as shown in Figure 11, with the annual growth by selected periods summarized as follows:[1,2]

— 1963 to 1979: about 839 acres per year.

— 1979 to 1983: about 3,450 acres per year.[1]

— 1983 to 2000: about 310 acres per year.[2]

— 2000 to 2005: about 160 acres per year.

As the above illustrates, growth in acreage of diversified crops has slowed over time.

Regarding major export crops and crop categories, acreage increased for four of them from 2000 to 2005: coffee up an average of 20 acres per year; tropical specialty fruits up 54 acres per year, flowers/nursery products up 235 acres per year, and seed crops up 264 acres per year. During this same period, acreage declined for three of the major export crops: macadamia nuts down an average of 20 acres year, papaya down 90 acres per year, and bananas down 113 acres per year. The net change was an average increase of 350 acres per year.

Regarding crops grown for the Hawai'i market, acreage declined by an average of 190 acres per year from 2000 to 2005.

In summary, the major growth in acreage for diversified crops from 2000 to 2005 came from just two crop categories: seed crops and flowers/nursery products.

These trends are consistent with advances in economic development, transportation and overseas trade. In essence, communities increase their standard of living by increasing their economic specialization and their trade with other communities.

1. In Figure 11, the rapid growth in diversified-crop acreage that occurred during the 1979-to-1983 period largely reflects (1) growth in macadamia-nut acreage which continued until about 1986 when tax-shelter advantages were terminated, and (2) a temporary increase in feed-crop acreage that declined after 1983 and offset the acreage gains in macadamia nuts. The growth in feed-crop acreage may reflect the situation addressed in Footnote 2.
2. In Figure 11, the temporary bump in diversified-crop acreage that occurred in the late 1990s reflects the fact that some former sugarcane fields were newly planted with grasses for future cattle grazing. After cattle grazing began in 2000, much of this acreage was recategorized by NASDA from crop land to grazing land.

Factors Limiting the Growth of Diversified Crops[36]

A great many crops can be grown in Hawai'i's year-round subtropical climate, and a number of them can be grown profitably in volumes that require a few hundred acres. However, the modest growth in land requirements for diversified crops reflects the fact that few crops can be grown profitably on a large scale. The primary factors that have limited the growth of diversified agriculture in Hawai'i are given below:

- Hawai'i's subtropical climate is not well-suited to the commercial production of major crops that grow better in the temperate mainland climates.
- For certain crops, special hybrids adapted to Hawai'i's subtropical climate are yet to be developed.
- Crop pests are more prevalent and more expensive to control in Hawai'i than they are on the mainland where the cold winters kill many pests.
- Fruit-fly infestations prevent exports of many crops, or require expensive treatment.
- Most soils in Hawai'i have low nutrient levels and therefore require high expenditures for fertilizer.
- Hawai'i suffers from high farm-labor costs, largely because the agriculture industry must compete against the visitor industry and related industries for its labor.
- Compared to many other farm areas that supply U.S. markets, the cost of shipping agricultural supplies and equipment to Hawai'i is high, as is the cost of exporting produce from Hawai'i to mainland markets. High shipping costs are a result of Hawai'i's remote location and to Federal regulations that require use of American-built ships and U.S. crews between U.S. ports.
- For a number of crops, consumption volumes in Hawai'i are too small to support large, efficient farms (i.e., the volumes are too small to realize economies of scale).
- On-going trends towards food suppliers purchasing produce that is certified as safe and towards buying from a single supplier of many food items favor large farms.
- Hawai'i farmers must compete against highly efficient mainland and foreign farms which, in a number of cases, can deliver produce to Hawai'i more cheaply than it can be produced locally. This is due to economies of scale and, in comparison to Hawai'i, low costs for land, labor, supplies, fertilizer, pest control, equipment, etc.

b. Adjusted Supply of Land Available for the Growth of Diversified Crops

As discussed Section 12, about 10,900 acres of farm land are available on O'ahu, and over 160,000 acres are available Statewide. Over time, a portion of this available land supply will be leased to the four agricultural operations that will have to relocated as a result of Ho'opili in combination with other land-use changes in 'Ewa, lower Kunia, and Central O'ahu. As discussed in Section 13, the relocation will require about 2,900 to 3,600 acres, depending on whether Syngenta's O'ahu operation remains on O'ahu or relocates to Kaua'i. The adjusted supply of farm land that will remain available for diversified farming will total about 7,300 to 8,000 acres on O'ahu and over 156,000 acres Statewide.

This adjusted supply of available farm land far exceeds the amount of land that will be needed to accommodate the growth of diversified crops, whether demand is based on potential or recent trends. This indicates that the limiting factor to the growth of diversified crops will *not* be the *land supply*. Instead, growth will be limited by the *size of the market* for crops that can be grown *profitably* in Hawai'i.

c. Impact on the Growth of Diversified Crop Farming

The development of Ho'opili—in combination with other development projects in 'Ewa, Central O'ahu and elsewhere—involves the loss of too little good agricultural land to significantly affect the growth of diversified crop farming in Hawai'i. This conclusion is based on the above finding that ample land will remain available for diversified crops, with the available supply far exceeding the likely or potential demand.

However, as discussed in Subsections 12.b and 13.h, water-related improvements are needed to allow full use of some of the available farm lands on the North Shore. These improvements are the responsibility of the landowners and government agencies.

d. Mitigating Measures

In view of the negligible impact of the Project on the growth of diversified agriculture, mitigation measures for the loss of good agricultural land are not recommended beyond the measures in Section 13.h.

16. Offsetting Benefits

As previously mentioned, Ho'opili will commit about 1,554 acres of agricultural land to a non-agricultural use, of which about 1,375 acres are arable. In turn, Ho'opili—in combination with other private and State urban projects and changes in agriculture land use in Kunia—will require the the affected agricultural operations to relocate.

These adverse impacts to agriculture will be offset by the following benefits of the Project:

- About 11,750 homes for Hawai'i residents, along with business and commercial space, light-industrial space, parks and open space, and public facilities.
- For 'Ewa, relatively high housing densities which, in turn, will contribute to slower urbanization of agricultural land than would be the case with lower densities.
- Construction jobs provided by the development activity.
- At full development of the Project, on-site jobs provided by business, commercial, industrial, and home-service activities.
- Tax revenues (excise taxes, personal income taxes, corporate income taxes, property taxes, etc.) generated by the development activity.
- Tax revenues generated by the families and businesses that occupy the Project.
- Improved land and partial funding for schools, parks and other public facilities.

17. Consistency with State and County Policies[47]

a. Availability of Lands for Agriculture

The *Hawaii State Constitution*, the *Hawaii State Plan*, the *State Agriculture Functional Plan*, and the *General Plan of the City and County of Honolulu* call directly or implicitly for preserving the economic viability of plantation agriculture and promoting the growth of diversified crops. To accomplish this, an adequate supply of agriculturally suitable lands and water must be assured.

With regard to plantation agriculture, the Petition Area is no longer part of a sugar plantation since O'ahu Sugar Co. closed in 1995 for reasons unrelated to the Project.

With regard to diversified crops, development of the Petition Area will result in a loss of good farm land, and the farms on this land will have to relocate. However, this loss of agricultural land will not limit the growth of diversified crops since ample agricultural land is available on O'ahu and on other islands. This is due to the enormous supply of farm land that is now available following the contraction of plantation agriculture (see Section 15 and Figure 11). However, improvements to the WWTP and the WIS will be needed to allow full use of the available farm lands on the North Shore.

b. Conservation of Agricultural Lands

In addition to the above, State policies call for conserving and protecting prime agricultural lands, including protecting agricultural lands from urban development.

However, these policies—which were written before the major contraction of plantation agriculture in the 1990s—assume implicitly that profitable agricultural activities eventually will be available to use all available agricultural lands. This has proven to be a questionable assumption in view of the enormity of the contraction of plantation agriculture, the abundant supply of land that came available for diversified agriculture, and the slow growth in the amount of land being used for diversified crops (see Section 15 and Figure 11).

Furthermore, discussions in the Agriculture portion of the *State Functional Plan* recognize that redesignation of lands from Agricultural to Urban should be allowed "... upon a demonstrated change in economic or social conditions, and where the requested redesignation will provide greater benefits to the general public than its retention in ...agriculture;" that is, when an "overriding public interest exists." In this regard, major changes in economic and social conditions have occurred as a result of:

- The on-going development of the City of Kapolei and the surrounding 'Ewa region as the second largest urban center in Hawai'i (see the policy discussion in the following subsection).
- Inadequate expansion in the supply of workforce housing which has contributed to high housing prices on O'ahu.
- The enormous contraction in plantation agriculture which has resulted in the supply of agricultural land far exceeding demand.

Moreover, development in the Petition Area will provide community benefits (about 11,750 homes and many on-site jobs) that far exceed those provided by agriculture (about 80 jobs after Syngenta is replaced by a new farm). In practice, however, development of the Petition Area is likely to have little or no impact on Statewide agricultural employment.

c. County 'Ewa Development Plan

As shown in Figure 4, the Petition Area is within the County's designated Urban Growth Boundary of the 'Ewa Development Plan in an area designated for residential development. Thus, the Project is consistent with the 'Ewa Development Plan in terms of future land use.

This Plan is part of a broader long-established County policy, with support from the State, to direct urban growth to 'Ewa, to portions of Central O'ahu, and to the primary urban center. In turn, the policy reduces development pressures on the outlying Districts of Ko'olau Loa, Ko'olau Poko, North Shore, and Wai'anae. The policy was designed to provide needed housing, jobs, and commercial and industrial space in compact areas; preserve agricultural lands and open space in Kunia, the North Shore, and outlying areas; preserve the "country" lifestyle of rural communities; and reduce the cost of providing government infrastructure and services.

Portions of the Project could be inconsistent with the phasing component of the currently approved 'Ewa Development Plan which indicates that urban expansion of the northern and eastern portions of the Petition Area is to occur after 2015. This area includes all the fields farmed by Aloun Farms that are between Farrington Highway and the H-1 Freeway, the eastern portion of Aloun lands that are subleased to Fat Law's Farm, and all the lands farmed by Syngenta (see Figure 10). Such phasing in the current 'Ewa Development Plan would create nuisance issues by placing farm areas immediately upwind of the new Ho'opili homes (see Section 14). However, the 'Ewa Development Plan is in the process of being updated which, based on discussions with the County, is expected to reflect the removal of phasing from the Plan.

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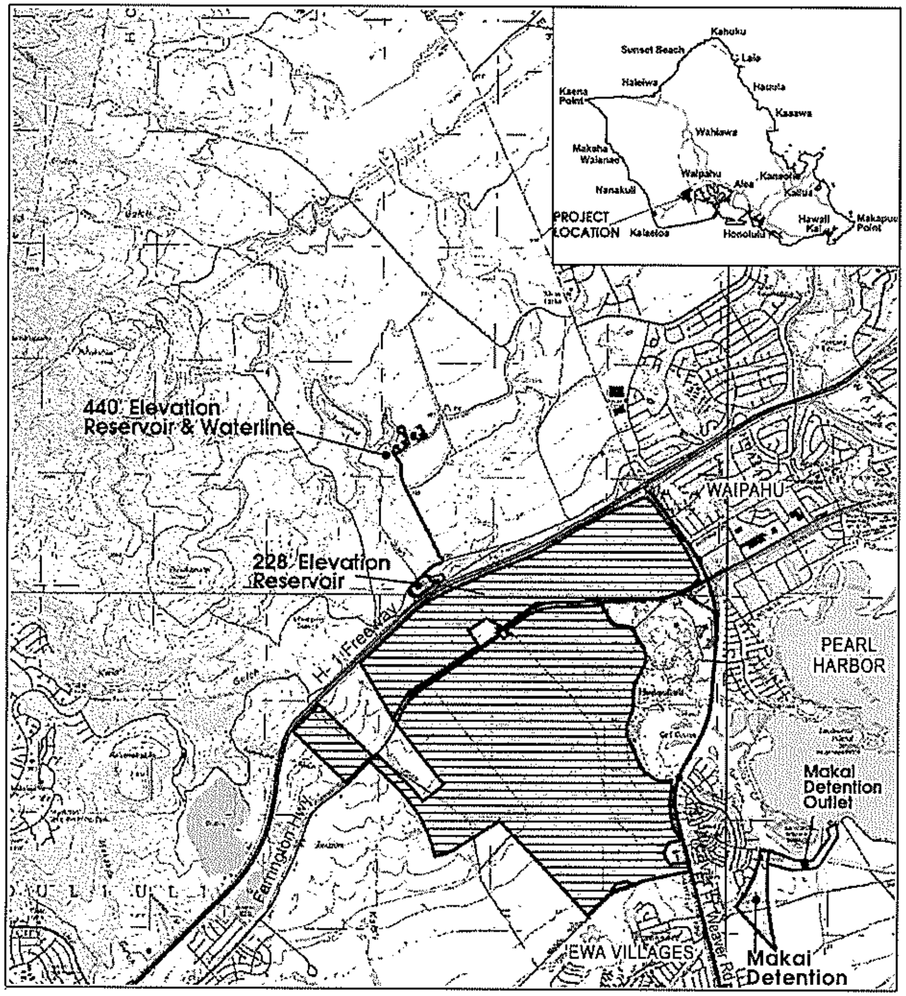
FIGURES



LEGEND

Project Site Boundary

Petition Area

Source: US Geological Survey
Disclaimer: This graphic has been prepared for general planning purposes only.

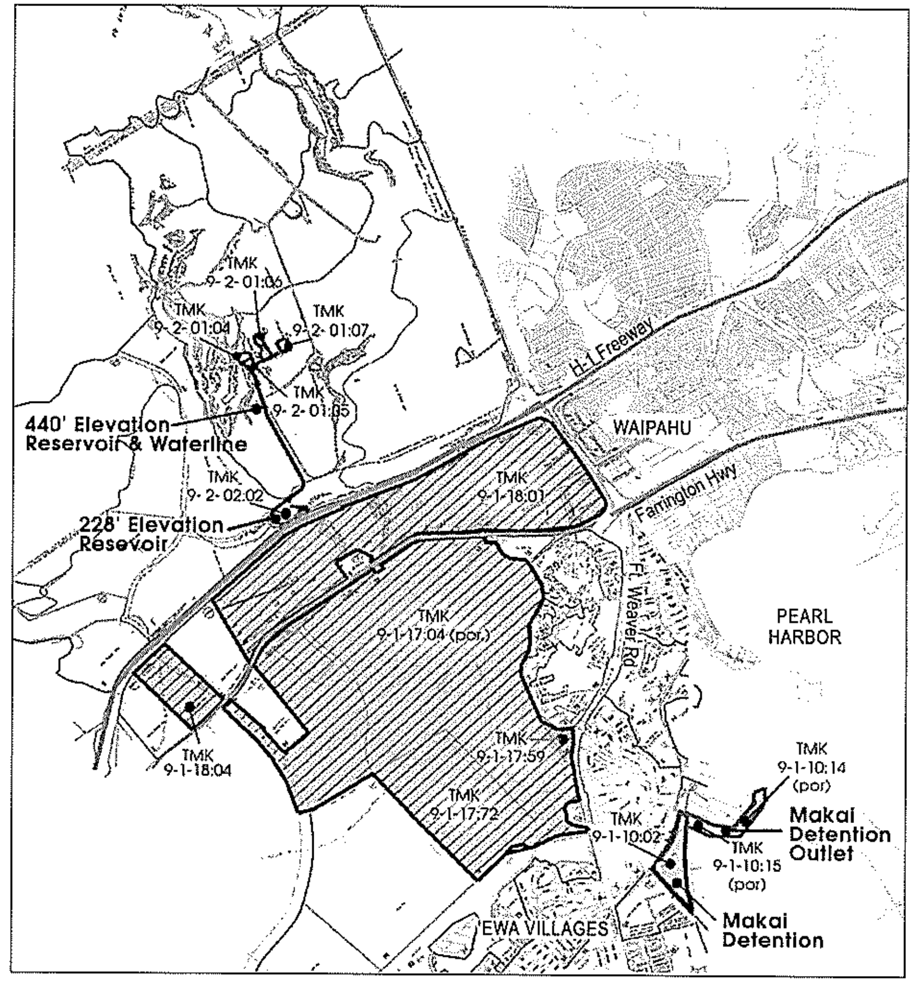
Figure 1: Location Map

HO'OPILI

O'ahu, Hawai'i

NORTH LINEAR SCALE (FEET) 0 3,500 7,000

PBR HAWAII & ASSOCIATES, INC.



LEGEND

Project Site Boundary

Petition Area

Source: Tax maps Zone 9, Sec. 1, Plats 10, 17 and 18
Zone 9, Sec. 2, Plat 1 and 2
Disclaimer: This graphic has been prepared for general planning purposes only.

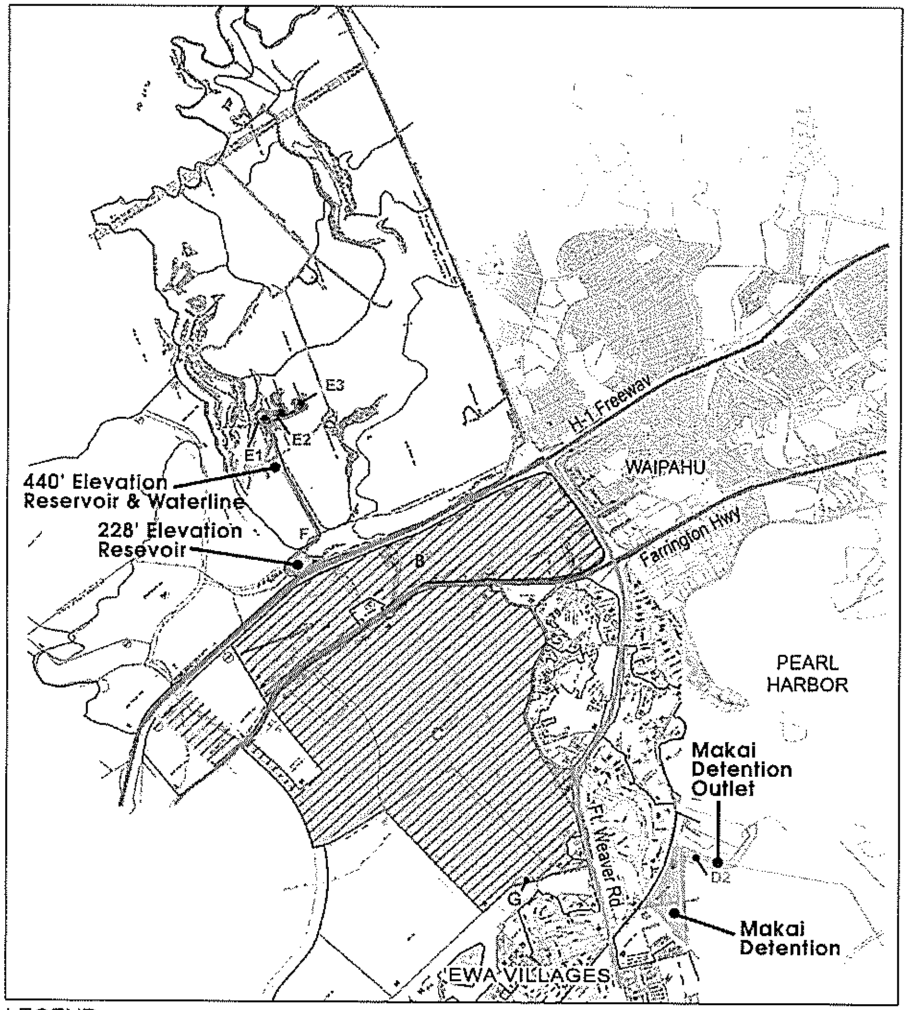
Figure 2: Tax Map Key

HO'OPILI

O'ahu, Hawai'i

NORTH LINEAR SCALE (FEET) 0 3,000 6,000

PBR HAWAII & ASSOCIATES, INC.



LEGEND

Petition Area
Parcel A: 52.289 Acres
Parcel B: 447.592 Acres
Parcel C: 1,053.963 Acres

Non-petition Area
Parcel D1: 30.825 Acres
Parcel D2: 4.5 Acres*

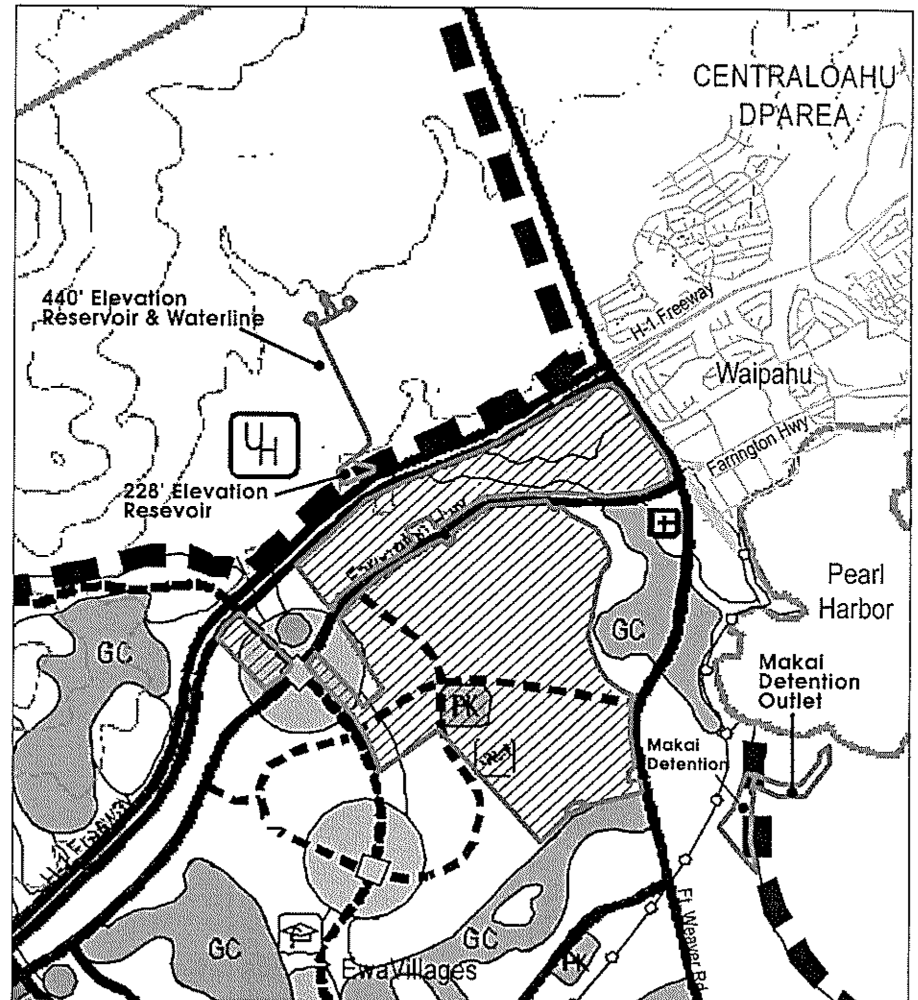
Parcel E1: .635 Acres
Parcel E2: 1.49 Acres*
Parcel E3: .359 Acres
Parcel F: 7.311 Acres
Parcel G: 1.301 Acres
* Approx Acres

Source: Tax Maps Zone 9, Sec. 1, Plats 10, 15,17 & 18 and Zone 9, Sec. 2, Plats 1 and 2
Disclaimer: This graphic has been prepared for general planning purposes only.

Figure 3: Parcels Map

HO'OPILI
O'ahu, Hawai'i

NORTH LINEAR SCALE (FEET) 0 3,000 6,000
PBR HAWAII & ASSOCIATES, INC.



LEGEND

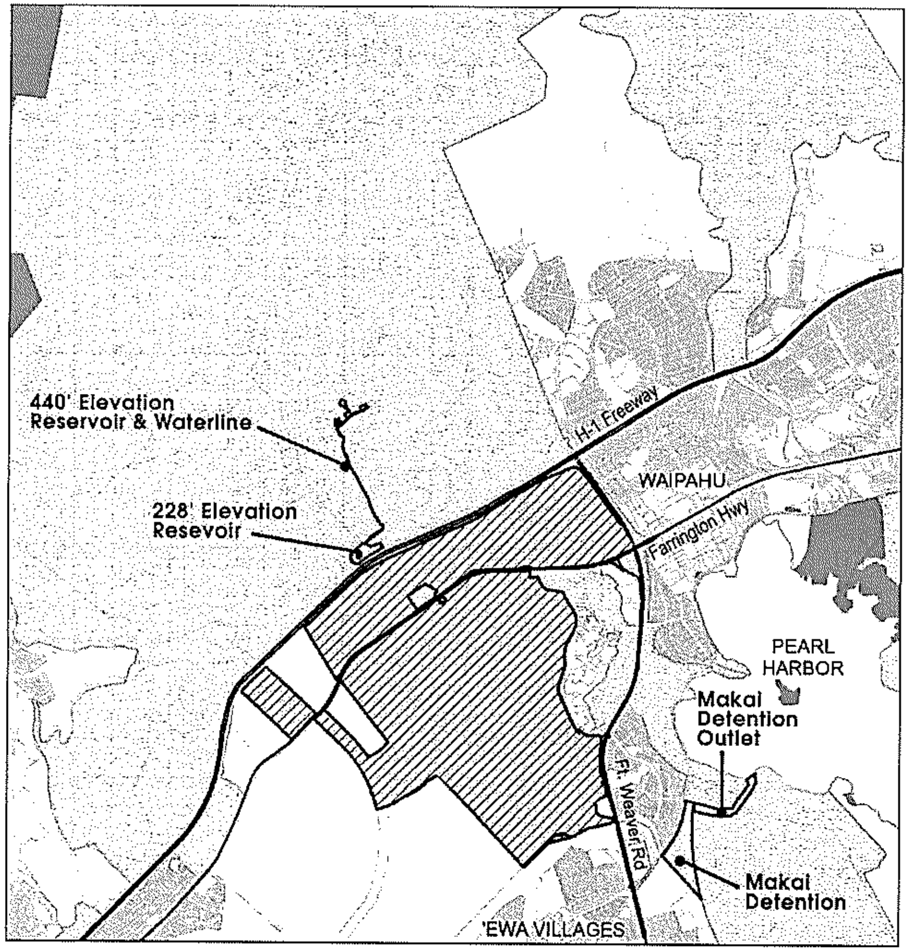
Project Site Boundary
Petition Area
Low & Medium Density Residential
High Density Residential
Community Commercial Center
Agricultural Land Preservation
Parks & Golf Courses
Transit Nodes/ High Density Residential & Commercial
Urban Growth Boundary

Source: City & County of Honolulu 'Ewa Development Plan Urban Land Use Map (1997)
Disclaimer: This graphic has been prepared for general planning purposes only

Figure 4: 'Ewa Development Plan Land Use Map

HO'OPILI
O'ahu, Hawai'i

NORTH LINEAR SCALE (FEET) 0 3,000 6,000
PBR HAWAII & ASSOCIATES, INC.



LEGEND

- Project Site Boundary
- Petition Area
- Agricultural
- Conservation
- Urban

Source: State Land Use Commission (2004)

Disclaimer: This graphic has been prepared for general planning purposes only.

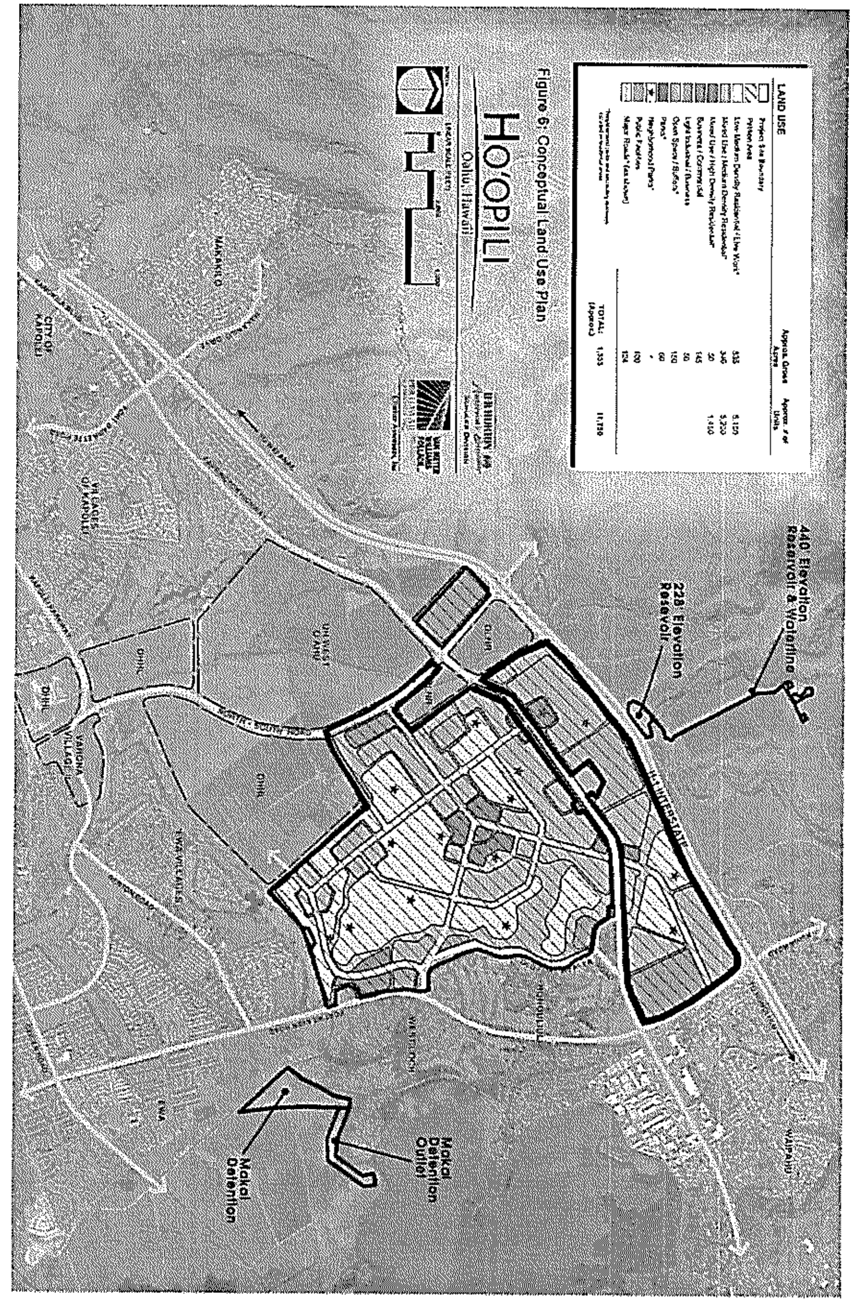
Figure 5: State Land Use District

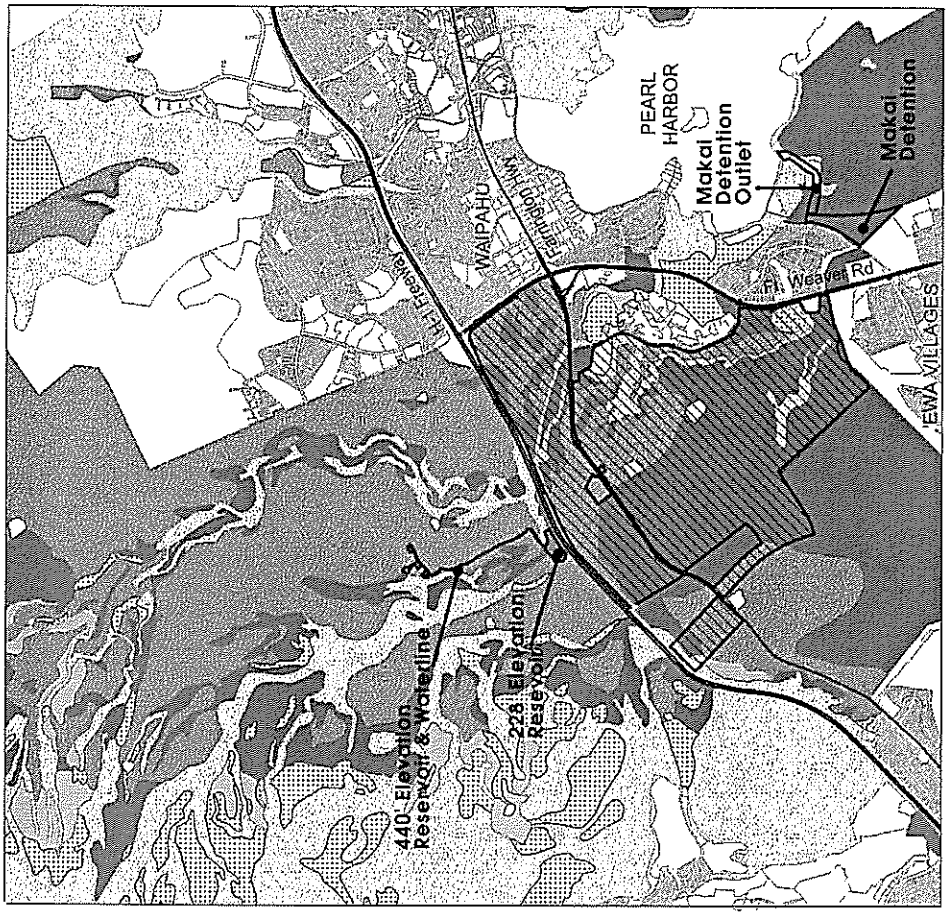
HO'OPILI

O'ahu, Hawai'i

NORTH LINEAR SCALE (FEET) 0 3,500 7,000

PBR HAWAII & ASSOCIATES, INC.





LEGEND

- Project Site Boundary
- Petition Area

Soil Classification

- A (Excellent)
- B (Good)
- C (Fair)
- D (Poor)
- E (Very Poor)
- Not Classified

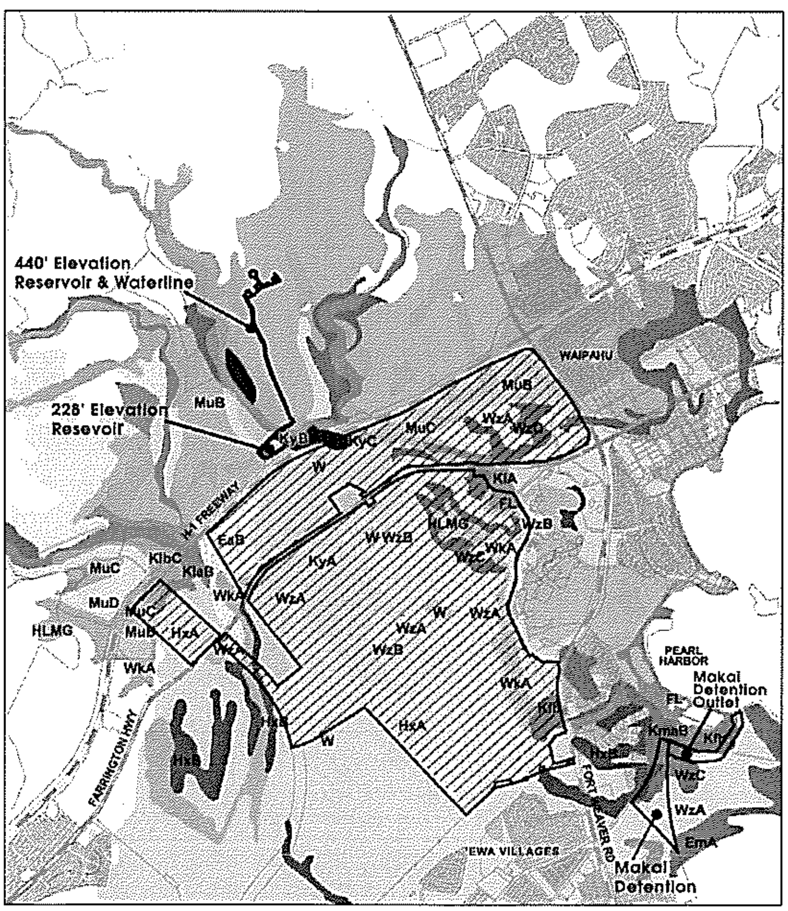
Source: Land Study Bureau (1967)
Disclaimer: This graphic has been prepared for general planning purposes only.

Figure 8: Land Study Bureau Land Classification

HO'OPILI
O'ahu, Hawai'i

NORTH LINEAR SCALE (FEET) 0 3,500 7,000

PBR HAWAII & ASSOCIATES, INC.



LEGEND

- Project Site Boundary
- Petition Area

Soil Types

- EaB: Ewa Silty Clay Loam, 3-6% Slopes
- EmA: Ewa Silty Clay Loam, Moderately Shallow, 0-2% Slopes
- FL: Fill Land Mixed
- HLMG: Helemano Silty Clay, 30-90% Slopes
- HxA: Honouliuli Clay, 0-2% Slopes
- HxB: Honouliuli Clay, 2-6% Slopes
- Kfb: Keloko Clay, noncalcareous Variant
- KlA: Kawaihapai Clay Loam, 0-2% Slopes
- KlaB: Kawaihapai Stony Clay Loam, 2-6% Slopes
- KlbC: Kawaihapai Very Stony Clay Loam, 0-15% Slopes
- KmaB: Keaau Stony Clay, 2-6% Slopes
- KyA: Kunia Silty Clay, 0-3% Slopes
- KyB: Kunia Silty Clay, 3-8% Slopes
- KyC: Kunia Silty Clay, 8-15% Slopes
- MuB: Molokai Silty Clay Loam, 3-7% Slopes
- MuC: Molokai Silty Clay Loam, 7-15% Slopes
- MuD: Molokai Silty Clay Loam, 15-25% Slopes
- rRK: Rock Land
- WkA: Waialua Silty Clay, 0-3% Slopes
- WzA: Waipahu Silty Clay, 0-2% Slopes
- WzB: Waipahu Silty Clay, 2-6% Slopes
- WzC: Waipahu Silty Clay, 6-12% Slopes
- W: Water

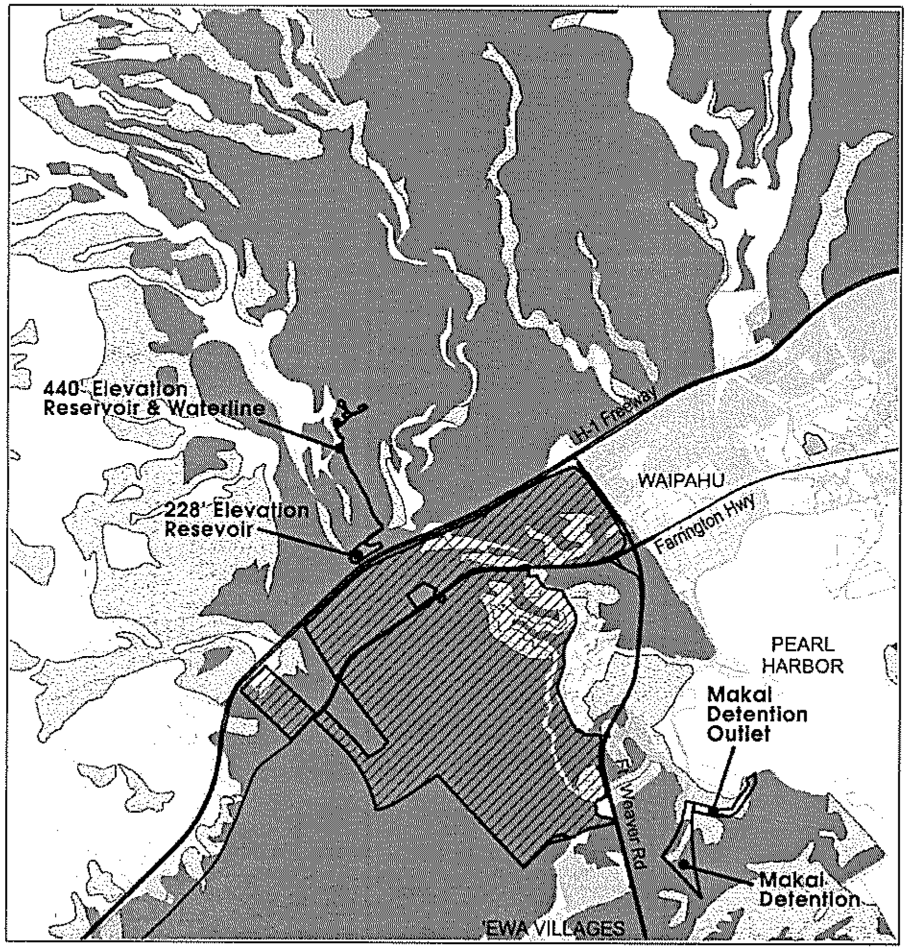
Source: U.S. Department of Agriculture Natural Resources Conservation Service (1995)
Disclaimer: This graphic has been prepared for general planning purposes only.

Figure 7: Natural Resources Conservation Service Soil Survey Map

HO'OPILI
O'ahu, Hawai'i

NORTH LINEAR SCALE (FEET) 0 3,000 6,000

PBR HAWAII & ASSOCIATES, INC.



LEGEND

- Project Site Boundary
- Petition Area
- Prime Agricultural Lands
- Unique Agricultural Lands
- Other Agricultural Lands
- Unclassified Agricultural Lands

Source: State Dept. of Agriculture (1977).
Disclaimer: This graphic has been prepared for general planning purposes only.

Figure 9: Agricultural Lands of Importance to the State of Hawaii (ALISH)

HO'OPILI

O'ahu, Hawai'i

PBR HAWAII & ASSOCIATES, INC.

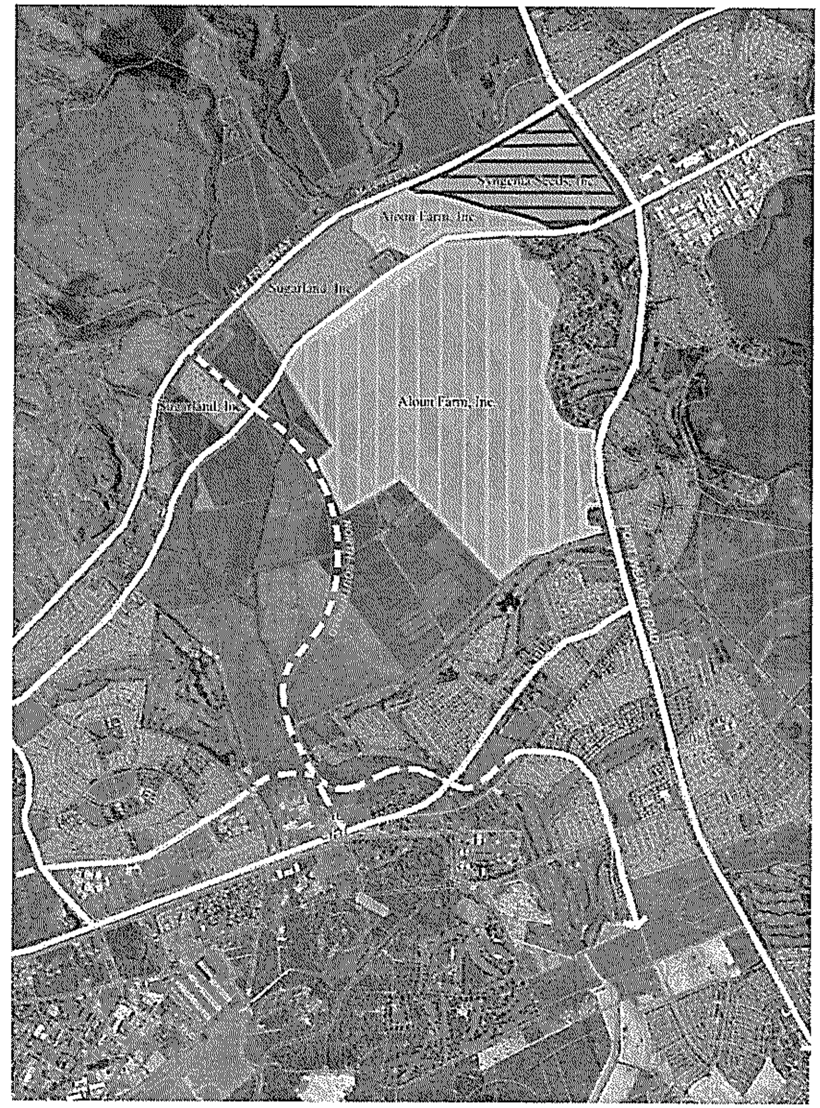
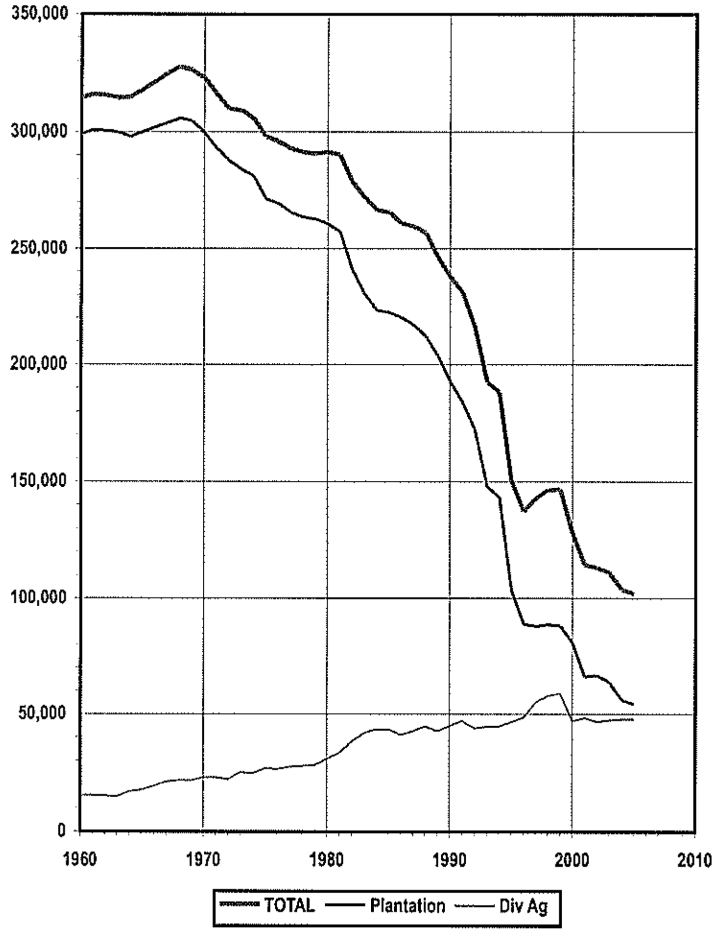


Figure 10: Farm Lease Map

D.R.Horton East Kapolei

Figure 11 - Statewide Acreage in Crop: 1960 to 2005



Appendix:
Selected State and County Goals, Objectives, Policies and Guidelines Related to Agricultural Lands

1. **Hawai'i State Constitution** (Article XI, Section 3):

   ...to conserve and protect agricultural lands, promote diversified agriculture, increase agricultural self-sufficiency and assure the availability of agriculturally suitable lands...

2. **Hawai'i State Plan** (Chapter 226, Hawaii Revised Statutes, as amended):[1,2]

Section 226-7 Objectives and policies for the economy--agriculture.

(a) Planning for the State's economy with regard to agriculture shall be directed towards achievement of the following objectives:

- (1) Viability in Hawaii's sugar and pineapple industries.
- (2) Growth and development of diversified agriculture throughout the State.
- (3) An agriculture industry that continues to constitute a dynamic and essential component of Hawaii's strategic, economic, and social well-being.

(b) To achieve the agricultural objectives, it shall be the policy of the State to:

- (2) Encourage agriculture by making best use of natural resources.
- (10) Assure the availability of agriculturally suitable lands with adequate water to accommodate present and future needs.
- (16) Facilitate the transition of agricultural lands in economically nonfeasible agricultural production to economically viable agricultural uses.

Section 226-103 Economic priority guidelines.

(c) Priority guidelines to promote the continued viability of the sugar and pineapple industries:

- (1) Provide adequate agricultural lands to support the economic viability of the sugar and pineapple industries.

(d) Priority guidelines to promote the growth and development of diversified agriculture and aquaculture:

- (1) Identify, conserve, and protect agricultural and aquacultural lands of importance and initiate affirmative and comprehensive programs to promote economically productive agricultural and aquacultural uses of such lands.
- (10) Support the continuation of land currently in use for diversified agriculture.

Section 226-104 Population growth and land resources priority guidelines.

(b) Priority guidelines for regional growth distribution and land resource utilization:

- (2) Make available marginal or non-essential agricultural lands for appropriate urban uses while maintaining agricultural lands of importance in the agricultural district.

Section 226-106 Affordable Housing

Priority guidelines for the provision of affordable housing:

- (1) Seek to use marginal or nonessential agricultural land and public land to meet housing needs of low- and moderate-income and gap-group households.

3. **Agricultural State Functional Plan** (1991)[3]

(Functional plans are guidelines for implementing the State Plan. They are approved by the Governor, but not adopted by the State Legislature.)

Objective H: Achievement of Productive Agricultural Use of Lands Most Suitable and Needed for Agriculture.

Policy H(2): Conserve and protect important agricultural lands in accordance with the Hawaii State Constitution.

Action H(2)(a): Propose enactment of standards and criteria to identify, conserve, and protect important agricultural lands and lands in agricultural use.

Action H(2)(c): Administer land use district boundary amendments, permitted land uses, infrastructure standards, and other planning and regulatory functions on important agricultural lands and lands in agricultural use, so as to ensure the availability of agriculturally suitable lands and promote diversified agriculture.

4. CITY AND COUNTY OF HONOLULU
GENERAL PLAN, Objectives and Policies (Resolution No. 87-211)[4]

Economic Activity

Objective C. To maintain the viability of agriculture on Oahu.

Policy 1. Assist the agricultural industry to ensure the continuation of agriculture as an important source of income and employment.

Policy 2. Support agricultural diversification in all agricultural areas on Oahu.

Policy 3. Support the development of markets for local products, particularly those with the potential for economic growth.

Policy 4. Provide sufficient agricultural land in Ewa, Central Oahu, and the North Shore to encourage the continuation of sugar and pineapple as viable industries.

Policy 5. Maintain agricultural land along the Windward, North Shore, and Waianae coasts for truck farming, flower growing, aquaculture, livestock production, and other types of diversified agriculture.

Policy 6. Encourage the more intensive use of productive agricultural land.

Policy 7. Encourage the use of more efficient production practices by agriculture, including the efficient use of water.

Policy 8. Encourage the more efficient use of nonpotable water for agricultural use.

5. CITY AND COUNTY OF HONOLULU
'EWA DEVELOPMENT PLAN[5]

3.1. Open Space Preservation and Development

3.1.1 General Policies

Open space will be used to:

- Provide long range protection for diversified agriculture on lands outside the Urban Growth Boundary.

6. REFERENCES

[1] State of Hawaii, Office of State Planning, Office of the Governor. *The Hawaii State Plan, 1991.* Honolulu, Hawaii. 1991.

[2] Act 25, S.B. No. 1158, April 15, 1993.

[3] Hawaii Department of Agriculture. *The Hawaii State Plan: Agriculture, State Functional Plan.* Honolulu, Hawaii. 1991.

[4] City and County of Honolulu, Department of General Planning. *General Plan Objectives and Policies.* Honolulu, Hawaii. 1992.

[5] City and County of Honolulu, Planning Department. *'Ewa Development Plan.* Honolulu, Hawaii. August 1997 (Revised May 2000).

APPENDIX B
Botanical Resources Assessment

BOTANICAL RESOURCES ASSESSMENT FOR THE HO'OPILI PROJECT HONOULIULI, OAHU

MAIN PARCELS

Prepared by:

Maya LeGrande
LeGrande Biological Surveys Inc
68-310 Kikou Street
Waialua HI 96791

Prepared for:

PBR HAWAII &
D.R. HORTON - SCHULER DIVISION

August 2006

INTRODUCTION

This report includes the findings of a botanical study conducted within the Honouliuli Region on the island of Oahu, Hawaii. LeGrande Biological Surveys Inc. carried out a botanical field survey of the above location on January18, 19, 23, 24, 30, and 31, and May 6 and 7, 2006, for a total of 8 field days. The primary objectives of the field studies were to:

1) provide a general description of the vegetation on the project site;
2) inventory the flora; and
3) search for threatened and endangered species as well as species of concern.

Federal and State of Hawaii listed species status follows U.S. Fish and Wildlife (USFWS) (1999a and 1999b, 2004) and Federal Register (2002).

GENERAL SITE DESCRIPTION

The area proposed for the Ho'opili Project in Ewa includes three main parcels (covered in this report) and two smaller "Off-Site" areas (separate reports). The main parcels covered in this report include: [A] a rectangular section to the west of Palehua Road, between H-1 Freeway and Farrington Highway (TMK 9-1-18:04);[B] a strip running east-west between H-1 Freeway (to the north) and Farrington Highway (to the south) (TMK 9-1-18:01); and [C] the largest parcel bordered by Farrington Highway to the north, Old Fort Weaver Road to the east, Mango Tree Road to the south, and Palehua Road and the new North-South Road to the west (TMK 9-1-17:04 (por.), 9-1-17:59, and 9-1-17:72). The entire area surveyed (and described in this report) encompasses approximately 1,555 acres

The majority of the surveyed area is either in active cultivation or cleared to bare dirt substrate. The edges of the agricultural fields along with a few small gulches harbor most of the plant diversity. Weedy plant species dominate all areas. The subject property ranges in elevation from near sea level to 250 ft. The Ho'opili parcels have been utilized for agriculture for some time, being planted in sugar cane in the past and now in diversified agriculture. Alteration of native plant habitat has been in place for some time and few of the natural plant elements remain.

SURVEY METHODS

Prior to undertaking the field studies, a search was made of the pertinent literature to familiarize the principal investigator with other botanical studies conducted in the general area. The 2004 Habitat Conservation Plan for *Abutilon menziesii* at Kapolei was reviewed for possible endangered plant locations within the survey area. Information from the Hawaii Biodiverstiy & Mapping Program database was reviewed. Topographic maps were examined to determine terrain characteristics, access, boundaries, and reference points.

A walk-through survey method was used. The boundaries of all five parcels were surveyed by foot. Roads through the subject property were driven and most were walked as well to survey for roadside plants. Transects on an average of 80 ft apart were surveyed on foot by 2 botanists for the parcel interiors, except in areas where active cultivation was in progress (i.e. cornfields were surveyed from the outer margins.). Special attention was paid to gulch areas and areas that contained scrub vegetation with native plant elements. Notes were made on plant associations and distribution, disturbances, topography, substrate types, exposure, drainage, etc. Plant identifications were made in the field. Plants that were not positively identified were collected for later determination, and for comparison with the recent taxonomic literature.

DESCRIPTION OF THE VEGETATION

The entire survey area is dominated by non-native plant species and agricultural crops. A total of 137 plant species were observed within the survey area. 133 are alien (introduced) and four are indigenous (native to the Hawaiian Islands and elsewhere). Therefore, 97% of the plant species observed were alien and only 3% native.

An inventory of all the plants observed within the five survey areas is presented in the species list at the end of the report.

<u>TMK 9-1-18:04 [A]</u>

This parcel is located between H-1 and Farrington Highway west of Palehua Road with Hunehune Gulch bordering the parcel to the west. The majority of the parcel is either cleared land or planted in corn. The edges of the parcel, including Palehua Road are dominated by weedy species such as, castor bean (*Ricinus* communis), lion's ear (*Leonotis nepetifolia*), partridge pea (*Chamaecrista nictitans*), and kikania (*Xanthium strumarium* var. *canadense*). A few kiawe (*Prosopis pallida*) and opiuma (*Pithecellobium dulce*) trees are scattered along the top of the gulch. Grass species throughout the parcel include natal redtop, sourgrass (*Digitaria insularis*), and swollen fingergrass (*Digitaria insularis*).

<u>TMK 9-1-18:01 [B]</u>

This parcel is a strip running east-west between H-1 Freeway (to the north) and Farrington Highway (to the south) with Fort Weaver Road bordering to the east. Aloun Farms baseyard is located within this section. The majority of this section consists of gently sloping agricultural fields planted with corn. Edges of fields and along roadsides were generally low-growing weedy shrubs dominated by koa haole, Christmas berry (*Schinus terebinthifolius*), sourbush (*Pluchea carolinensis*), castor bean, and guinea grass.

Honouliuli Gulch runs north-south through this section. The gulch is characterized by koa haole scrub at the northern (upper) sections. Along with koa haole and guinea grass as the dominant species several tall tree species reside in the gulch including kukui (*Aleurites moluccana*), kiawe, pride of India (*Melia azerdarach*), and autograph tree (*Clusia rosea*). Lower down the bottom of the gulch has been cleared for a banana (*Musa sp.*) patch that is currently in cultivation. At the lowest point of the gulch where it crosses Farrington Highway several morning-glory species were observed, koali ai (*Ipomoea cairica*), little bell (*I. Triloba*), and *I. obscura*. Primrose willow (*Ludwigia octovalvis*), love-in-a-mist (*Passiflora foetida*), and comb hyptis (*Hyptis pectinata*) were observed in the drainage.

The Aloun baseyard is planted with various cultivars including citrus (*Citrus sp.*), noni (*Morinda citrifolia*), kalo (*Colocasia esculenta*), yellow Poinciana (*Peltophorum pterocarpum*), sugarcane (*Saccharum officinarum*), and lemon grass (*Cymbopogon citratus*). The electric power substation has a hedge of tropical coral tree (*Erythrina variegata*) planted along the fenceline. Along Farrington Highway the vegetation is dominated by non-native grass species with kiawe, monkeypod (*Samanea saman*) trees and bougainvillea (*Bougainvillea sp.*) scattered along the length of the parcel.

<u>TMK 9-1-17:04, 9-1-17:59, & 9-1-17:72 [C]</u>

This is the largest section of the subject property, bordered by Farrington Highway to the north, Old Fort Weaver Road to the east, Mango Tree Road to the south, and Palehua Road and the new North-South Road to the west. The majority of this portion of the surveyed area is under cultivation or cleared to bare soil. Crops observed grown in this area include corn, melons (*Cucumis sp.*), basil (*Ocimum sp.*) and bananas. At the edges of planted areas and in fallow fields weedy species such as kili oopu (*cyperus rotundus*), wild spider flower (*Cleome gynandra*), and cheeseweed (*Malva parviflora*) were observed. There are several flumes running east-west through the property, they have a greater number of plant species due to the availability of water. The flumes are dominated by koa haole and guinea grass with other non-native plant species scattered within the site including, boerhavia (*Boerhavia coccinea*), Australian saltbush (*Atriplex semibaccata*), heliotrope (*Heliotropium procumbens*), coat buttons (*Tridax procumbens*), and slender mimosa (*Desmanthus pernambucans*). Along the flumes there are some larger woody species such as Christmas berry (*Schinus terebinthifolius*), fleabane (*Pluchea* x *fosbergii*), Chinese banyan (*Ficus microcarpa*), and a few mango (*Mangifera indica*) trees. The only indigenous plant species observed within the site are uncommon and include: ilima (*Sida fallax*) and scattered individuals of popolo (*Solanum americanum*) and uhaloa (*Waltheria indica*).

Between the fairly level agricultural fields and Old Fort Weaver Road, the property changes elevation quite drastically, there is a cliff approximately 20 to 30 feet high running the length of the eastern boundary. The majority of the cliff area is dominated by kiawe forest with an understory of guinea grass. Along the top of the cliff where the cultivated fields do not extend to the edge of the cliff, there are pockets of shrub vegetation that contain a few native plant species such as, ilima, uhaloa, and popolo. At the bottom of the cliff faces there are areas of flat land that extend to Old Fort Weaver Road. These areas are being utilized for various purposes including automobile parking, water pumping stations, baseyards, or farming. The area across from Kahi Mohala appears to be used for storing and parking large buses and shuttles. Several large trees were observed in this area including earpod tree (*Enterolobium cyclocarpum*), kiawe, African tulip, monkey pod, and Chinese banyan (*Ficus microcarpa*).

The southern section of the parcel between Old Fort Weaver Road and the cliff contain flat areas where there is active farming and equipment buildings. The farm is growing basil, cucumber (*Cucumis sativus*), and horseradish tree (*Moringa oleifera*). Coconut trees (*Cocos nucifera*), papaya (*Carica papaya*), and bamboo (*Bambusa sp.*) are some of the plants observed growing around the farm buildings.

DISCUSSION AND RECOMMENDATIONS

None of the plants which occur on the project site is a threatened or endangered species or a species of concern (U.S. Fish and Wildlife Service, 1999a, 1999b, 2004; Wagner et. al., 1999). HBMP (Hawaii Biodiversity & Mapping Program) supplied historical and present locations of known Threatened and Endangered plant species within the project area for review. The only rare plant mapped near the project area was the kooloaula (*Abutilon menziesii*) population at the southern end of North-South Road. There were no threatened or endangered plants mapped within the Ho'opili project area itself. *A. menziesii* is protected by both the federal Endangered Species Act of 1973, as amended, and Chapter 195D, HRS, as amended. *A. menziesii* is a shrub of the mallow family, growing six to eight feet tall, with coarsely toothed, silvery, heart-shaped leaves that are about one to three inches long. Flowers are medium red to dark red and less than an inch in diameter. It has been sold as an ornamental plant at local nurseries in the past under the name "Red ʻilima." Other extant populations of Kooloaula currently exist on Lānaʻi and Maui.

As part of the environmental planning for North-South Road and a portion of Kapolei Parkway, a "Habitat Conservation Plan for *Abutilon menziesii* at Kapolei" was finalized in March 2004. Mitigation measures have already been specified for these populations of *A. menziesii* related to construction of North-South Road. A concerted effort was made in surveying for *Abutilon menziesii* within the survey area. No plants of *A. menziesii* were observed during the survey.

No wetlands were encountered during either the January or May surveys. None of the three essential criteria for defining a federally recognized wetland were present within the study site. Those being hydrophytic vegetation, hydric soils, and wetland hydrology.

A follow up survey for wet season ephemeral plants was conducted in May following the heavy winter and spring rains. All parcels were resurveyed for additional plant species that may have been overlooked or died back during the January survey. No additional species were noted during this follow-up survey.

The proposed development of the surveyed area is not expected to have significant negative impacts on the botanical resources of the site or the general region.

Literature Cited

Evehuis, N.L. and L.G. Eldredge, editors. 1999-2002. Records of the Hawaii Biological Survey. Bishop Museum Occasional Papers Nos. 58-70.

Federal Register. 2002. Department of the Interior, Fish and Wildlife Service, 50 CFR 17. Endangered and Threatened Wildlife and Plants. Review of Species That Are Candidate or Proposed for Listing as Endangered or Threatened; Annual Notice of Findings on Recycled Petition; Annual Description of Progress on Listing Actions. *Federal Register*, 67 No. 14 (Thursday, June 13, 2002): 40657-40679.

Ohashi, Yukie. 2004. Habitat Conservation Plan for Abutilon menziesii at Kapolei. State of Hawaii Department of Transportation. Final HCP.

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Wagner, W.L. and D.R. Herbst. 1999. Supplement to the Manual of the flowering plants of Hawaii, pp. 1855-1918. In: Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1990. Manual of the flowering plants of Hawaii. Revised Edition. 2 vols. University of Hawaii Press and Bishop Museum Press, Honolulu.

PLANTS SPECIES LIST – Ho`opili, Oahu, Hawaii
MAIN PARCELS

The following checklist is an inventory of all the plant species observed within the three parcels of the survey site for the proposed Ho`opili project. The plant names are arranged alphabetically by family and then by species into two groups: Monocots and Dicots. The taxonomy and nomenclature of the flowering plants (Monocots and Dicots) are in accordance with Wagner *et al*. (1990), Wagner and Herbst (1999) and Staples and Herbst (2005). Recent name changes are those recorded in the Hawaii Biological Survey series (Evehuis and Eldredge, eds, 1999-2002).

For each species, the following name is provided:

1. Scientific name with author citation.
2. Common English and/or Hawaiian name(s), when known.
3. Biogeographic status. The following symbols are used:

   I= indigenous= native to the Hawaiian Islands and elsewhere.

   X=introduced or alien = all those plants brought to the Hawaiian Islands by humans, intentionally or accidentally, after Western contact, that is Cook's arrival in the islands in 1778.

HO`OPILI PLANT SPECIES LIST
MAIN PARCELS
AUGUST 2006

SCIENTIFIC NAME	COMMON NAME	STATUS
MONOCOTS		
AGAVACEAE		
Cordyline fruticosa (L.) A.Chev.	Ti, ki	X
ALOEACEAE		
Aloe vera (L.) N.L.Burm.	Aloe	X
ARACEAE		
Colocasia esculenta(L.) Schott	Kalo, taro	X
Dracaena sp. L.	dracaena	X
ARECACEAE		
Areca catechu L.	Betel nut palm	X
Cocos nucifera L.	coconut	X
Phoenix dactylifera L.	Date palm	X
CYPERACEAE		
Cyperus involucratus Roxb.	Ahuawa haole	X
Cyperus rotundus L.	Kili oopu	X
MUSACEAE		
Musa sp. L.	banana	X
POACEAE		
Bambusa sp. Schreber	bamboo	X
Brachiaria mutica (Forssk.) Stapf	California grass	X
Cenchrus ciliaris L.	Buffelgrass	X
Cenchrus echinatus L.	Common sandbur	X
Chloris barbata (L.) Sw.	Swollen fingergrass	X
Coix lachryma-jobi L.	Job's tears, puoheohe	X
Cymbopogon citratus (DC) Stapf	Lemon grass	X
Cynodon dactylon (L.) Pers	manienie	X
Digitaria insularis (L.) Mez ex Ekman	sourgrass	X
Eleusine indica (L.) Gaertn.	wiregrass	X
Eragrostis tenella (L.) P.Beauv. Ex Roem.&Schult.		X
Melinus repens (Willd.) Zizka	Natal redtop	X
Panicum maximum L.	Guinea grass	X
Paspalum dilatatum Poir.	Dallis grass	X

Paspalum urvillei Steud.	Vasey grass	X
SCIENTIFIC NAME	**COMMON NAME**	**STATUS**
Pennisetum purpureum Schumach.	Elephant grass	X
Saccharum officinarum L.	Sugar cane, ko	X
Setaria verticillata (L.) P.Beauv.	Bristly foxtail	X
Sorghum bicolor (L.) Moench	Sorghum	X
Sorghum halapense (L.) Pers.	Johnson grass	X
Zea mays L.	corn	X
DICOTS		
ACANTHACEAE		
Asystasia gangetica (L.) T. Anderson	Chinese violet	X
AIZOACEAE		
Trianthema portulacastrum L.		X
AMARANTHACEAE		
Achyranthes aspera L.		X
Alternanthera pungens Kunth	Khaki weed	X
Amaranthus spinosus L.	Spiny amaranth	X
Amaranthus viridis L.	Slender amaranth	X
ANACARDIACEAE		
Mangifera indica L.	mango	X
Schinus terebinthifolius Raddi	Christmas berry	X
ANNONACEAE		
Annona muricata L.	soursop	X
APOCYNACEAE		
Thevetia peruviana (Pers.) K.Schum.	Be-still tree	X
ARALIACEAE		
Schefflera actinophylla (Endl.) Harms	Octopus tree	X
ASCLEPIADACEAE		
Stapelia gigantea N.E.Br.	Zulu-giant	X
ASTERACEAE		
Bidens alba (L.) DC. var. *radiata* (Sch. Bip.) Ballard ex Melchert	Beggar tick	X
Bidens pilosa L.	Spanish needle	X
Conyza bonariensis (L.) Cronq.	Hairy horseweed	X
Crassocephalum crepidioides (Benth.) S.Moore	crassocephalum	X
Emilia fosbergii Nicolson	Red pualele	X

Lactuca serriola L.	Prickly lettuce	X
SCIENTIFIC NAME	**COMMON NAME**	**STATUS**
Pluchea carolinensis (Jacq.) G. Don	sourbush	X
Pluchea indica (L.) Less.	Indian fleabane	X
Pluchea x fosbergii Coopper. & Galang	fleabane	X
Sonchus oleraceus L.	pualele	X
Tridax procumbens (L.)	Coat buttons	X
Verbesina encelioides (Cav.) Benth. & Hook	Golden crown-beard	X
Xanthium strumarium L. var. *canadense* (Miller)	kikania	X
BIGNONIACEAE		
Spathodea campanulata P. Beauv.	African tulip	X
BORAGINACEAE		
Heliotropium curassavicum L.	kipukai	I
Heliotropium procumbens Mill. var. *depressum* (Cham.) Fosberg		X
BUDDLEIACEAE		
Buddleia asiatica Lour.	Dog tail	X
CACTACEAE		
Opuntia ficus-indica (L.) Mill.	panini	X
CAPPARACEAE		
Cleome gynandra L.	Wild spider flower	X
CARICACEAE		
Carica papaya L.	papaya	X
CASUARINACEAE		
Casuarina equisetifolia L.	ironwood	X
CHENOPODIACEAE		
Atriplex semibaccata R.Br.	Australian saltbush	X
Chenopodium murale L.	aheahea	X
CLUSIACEAE		
Clusia rosea Jacq.	Autograph tree	X
CONVOLVULACEAE		
Ipomoea cairica (L.) Sweet	Ivy leaved morning glory, koali ai	X
Ipomoea obscura (L.) Ker Gawl.		X
Ipomoea triloba L.	Little bell	X

Merremia aegyptia (L.) Urb.	Hairy merremia	X
SCIENTIFIC NAME	**COMMON NAME**	**STATUS**
CUCURBITACEAE		
Coccinea grandis (L.) Voigt	Ivy gourd	X
Cucumis dipsaceus ehrenb. Ex Spach	Hedgehog gourd	X
Cucumis melo L.	melon	X
Cucumis sativus L.	cucumber	X
Cucurbita sp. L.	Gourd, pumpkin	X
Momordica charantia L.	Balsam pear	X
EUPHORBIACEAE		
Aleurites moluccana (L.) Willd.	kukui	X
Chamaesyce hirta (L.) Millsp.	hairy spurge, garden spurge	X
Chamaesyce hypercifolia (L.) Millsp.	graceful spurge	X
Chamaesyce hyssopifolia (L.) Small		X
Euphorbia heterophylla L.	kaliko	X
Ricinus communis L.	Castor bean	X
FABACEAE		
Acacia farnesiana (L.) Willd.	Klu, aroma, kolu	X
Chamaecrista nictitans (L.) Moench	Partridge pea	X
Clitoria ternatea L.	Blue pea	X
Crotalaria incana L.	Fuzzy rattlepod	X
Crotalaria pallida Aiton	Smooth rattlepod	X
Desmanthus pernambucanus (L.) Thell.	Slender or virgate mimosa	X
Desmodium tortuosum (Sw.) DC	Florida beggarweed	X
Enterolobium cyclocarpum (N.Jacquin) Grisebach	Earpod	X
Erythrina variegata L.	Tropical coral tree	X
Indigofera hendecaphylla Jacq.	Creeping indigo	X
Indigofera suffritocosa Mill.	Iniko	X
Leucaena leucocephala (Lam.) de Wit	Koa haole	X
Macroptilium lathyroides (L.) Urb.	Wild bean	X
Peltophorum pterocarpum (A.P. de Candolle) K. Heyne	Yellow poinciana	X
Pithecellobium dulce (Roxb.) Benth.	opiuma	X
Prosopis pallida (Humb. & Bonpl. Ex Willd.) Kunth	Kiawe, algaroba	X
Samanea saman (Jacq.) Merr.	monkeypod	X
LAMIACEAE		
Hyptis pectinata (L.) Poit.	Comb hyptis	X
Leonotis nepetifolia (L.) R.Br.	Lion's ear	X

Ocimum basilicum L.	Sweet basil	X
SCIENTIFIC NAME	**COMMON NAME**	**STATUS**
Ocimum tenuifolium L.	Holy basil	X
MALVACEAE		
Abutilon grandifolium (Willd.) Sweet	Hairy abutilon	X
Abutilon incanum (Link.) Sweet	Hoary abutilon	X
Malva parviflora L.	Cheese weed	X
Malvastrum coromandelianum (L.) Garcke	False mallow	X
Sida ciliaris L.		X
Sida fallax Walp.	ʻilima	I
Sida rhombifolia L.		X
Sida spinosa L.	Prickly sida	X
MELIACEAE		
Melia azerdarach L.	Pride of India	X
MORACEAE		
Ficus microcarpa L.f.	Chinese banyan	X
Morus sp. L.	Mulberry	X
MORINGACEAE		
Moringa oleifera Lamark	Horseradish tree	X
MYRTACEAE		
Eucalyptus degulpta Blume	Painted gum	X
Psidium guajva L.	Common guava	X
Syzigium cumini (L.) Skeels	Java plum	X
NYCTAGINACEAE		
Boerhavia coccinea Mill.		X
Bougainvillea sp. A.L. Jussieu	bougainvillea	X
ONAGRACEAE		
Ludwigia octovalvis (Jacq.) Raven	Primrose willow	X
PASSIFLORACEAE		
Passiflora foetida L.	Love-in-a-mist	X
POLYGONACEAE		
Antigonon leptopus Hook&Arnott	Mexican creeper	X
PORTULACACEAE		
Portulaca oleracea L.	pigweed	X

SCIENTIFIC NAME	COMMON NAME	STATUS
RUBIACEAE		
Morinda citrifolia L.	noni	X
RUTACEAE		
Citrus xparadisi MacFadyen	grapefruit	X
Citrus sp. L.	citrus	X
SOLANACEAE		
Datura stramonium L.	Jimson weed	X
Nicandra physalodes (L.) Gaertn.	Apple of Peru	X
Nicotiana glauca R.C. Graham	Tree tobacco	X
Solanum americanum Mill.	Glossy nightshade, popolo	I
Solanum lycopersicum L. var. *cerasiforme* (Dunal) Spooner, G.J. Anderson & R.K. Jansen	Cherry tomato	X
Solanum torvum Sw.		X
STERCULIACEAE		
Waltheria indica L.	`uhaloa	I
VERBENACEAE		
Stachytarpheta jamaicensis (L.) Vahl	Jamaican vervain	X
ZYGOPHYLLACEAE		
Tribulus terrestris L.	Puncture vine	X

Appendix C

Survey of Avian & Mammalian Resources

A Survey of Avian and Mammalian Resources for the Ho'opili Development Project, 'Ewa District, O'ahu, Hawai'i.

-

Main Parcels

Prepared for:
PBR Hawaii
ASB Tower, Suite 650
1001 Bishop Street
Honolulu, Hawai'i 96813-3484

Prepared by:

Reginald E. David
Rana Productions, Ltd.
P.O. Box 1371
Kailua-Kona, Hawai'i 96745

February 11, 2008

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Figures & Tables

Introduction

D. R. Horton - Schuler Division is proposing to develop a residential community on approximately 1,555-acres of land in the 'Ewa District, O'ahu (Figure 1). This report summarizes the findings of the avian and mammalian surveys that were conducted on the subject property to determine the potential effects of the proposed development on biological resources present on the site and within the general project area.

A primary goal of the surveys was to determine if there were any avian or mammalian species currently listed as endangered, threatened, or proposed for listing under either Federal or State of Hawaii endangered species statutes. Listed species status follows species identified in the following referenced documents (Division of Land and Natural Resources (DLNR) 1998, Federal Register 2005, U. S. Fish & Wildlife Service (USFWS) 2005, 2006). Fieldwork was conducted on July 20, and 21, 2006.

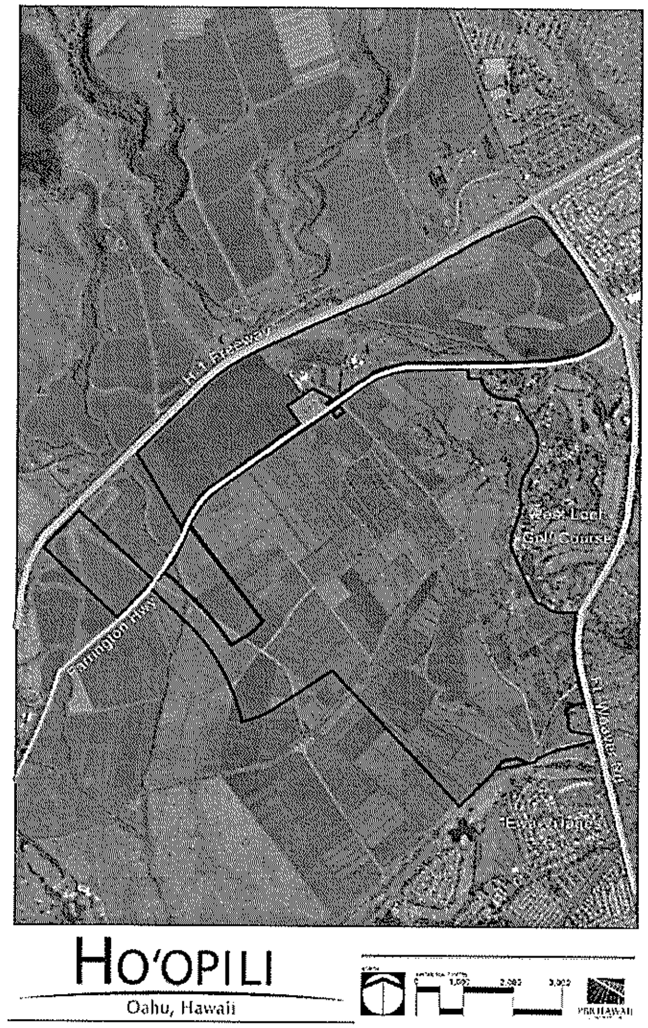
The avian phylogenetic order and nomenclature used in this report follows *The American Ornithologists' Union Checklist of North American Birds 7th Edition* (American Ornithologists' Union 1998), and the 42nd through the 47th supplements to *Check-list of North American Birds* (American Ornithologists' Union 2000; Banks et al. 2002, 2003, 2004, 2005, 2006). Mammal scientific names follow *Mammals in Hawaii* (Tomich 1986). Plant names follow *Manual of the Flowering Plants of Hawai'i* (Wagner et al. and Wagner and Herbst, 1990, 1999). Place names follow *Place Names of Hawaii* (Pukui et al. 1974).

Hawaiian and scientific names are italicized in the text. A glossary of technical terms and acronyms used in the document, which may be unfamiliar to the reader, are included at the end of the narrative text on Page 11.

General Site Description

The proposed Ho'opili Development includes five main parcels which are identified as (TMK: 9-1-17:04 (por.), 9-1-17:59 and 9-1-17:72, 9-1-18:01 and 9-1-18:04, and two smaller "off-site" parcels, which are covered in two separate reports (David 2008a, 2008b). This reports covers the approximately 1555-acres, which make up the main development area (Figure 1).

The project site is made up primarily of former sugar cane fields, most fallow now, though some are being farmed for various diversified agricultural crops. The site is bound to the north by the H-1 Freeway, to the east by Fort Weaver Road and to the west by additional former sugar cane lands. Farrington Highway transects the side from east to west (Figure 1). The terrain slopes gently from the north-to-south, from an elevation of approximately 200-feet above mean sea level (MSL) at the north corner of the site, adjacent to Fort Weaver Road and H-1 Freeway off ramp, down to approximately 60-feet MSL at the southwestern corner of the site located along Mango Tree Road (Figure 1).



Much of the site is made up of former sugar cane land, some of which is bare, (Figure 2), and some of which is under active cultivation of various diversified crops, such as corn, and bananas (Figure 3). Areas along roads and between fields are vegetated with a mix of predominantly alien ruderal species typical of disturbed former sugar fields on O'ahu (Figure 2). The vegetation present on the project site is almost completely dominated by alien species. The botanical surveys conducted on the site identified 137-plant species, four of which are considered indigenous, the remainder alien to the Hawaiian Islands (LeGrande 2006).

Mammalian Survey Methods

All observations of mammalian species were of an incidental nature. With the exception of the endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*), or *'ōpe'ape'a* as it is known locally, all terrestrial mammals currently found on the Island of O'ahu are alien species, and most are ubiquitous. Two hours were spent within the project area on the evenings of August 30 and 31, 2006 and again in the early morning hours of August 31, and September 1, 2006, in an attempt to detect Hawaiian hoary bats. The survey of mammals was limited to visual and auditory detection, coupled with visual observation of scat, tracks, and other animal signs. A running tally was kept of all vertebrate species observed and heard within the study area.

Mammalian Survey Results

Five mammalian species were detected within the project site. Numerous European house mice (*Mus musculus domesticus*) were seen at several locations during the course of this survey. A total of five domestic dogs (*Canis f. familiaris*) were seen within, or adjacent to the study area. Nine small Indian mongooses (*Herpestes a. auropunctatus*) were seen at various locations within the site, as were three cats (*Felis catus*). Many more dogs and cats were seen and or heard within existing developments located to the northeast and southeast of the proposed project site. Additionally, tracks, scat and sign of dog, mongoose, cat, and horse (*Equus c. caballus*) were observed in numerous locations within the project site.

The endangered Hawaiian hoary bat was not recorded during the course of this survey. This finding is not surprising given that this species has rarely been documented from the Island of O'ahu (Tomich 1986, USFWS 1998).

Avian Survey Methods

Twenty-seven avian count stations were sited along linear transects within the subject property. Six-minute point counts were made at each of the 27-count stations. Field observations were made using Leitz 10 X 42 binoculars and by listening for avian vocalizations. Counts took place between 06:30 a.m. and 11:00 a.m., the peak of daily bird activity. An additional two hours was spent within the project area on the evenings of August 30 and 31, 2006 and again in the early morning hours of August 31, and September 1, 2006 in an attempt to detect crepuscular and/or nocturnally flying seabirds and owls. Time not spent conducting station counts was used to search the subject property for species and habitats not detected during count sessions.

Figure 2 – Cleared former sugar cane fields and ruderal vegetation along road

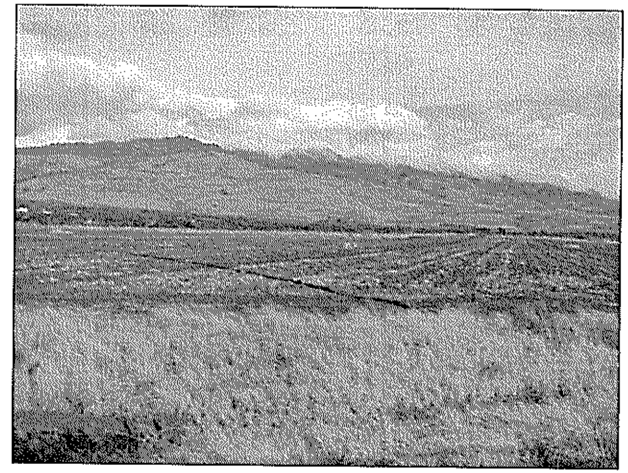


Figure 3 – Cornfields typical of diversified crops to the south of Farrington Hwy.

Avian Survey Results

A total of 831 individual birds, of 24 different avian species, representing 15 separate families were recorded during station counts. These results are summarized in Table 1. Two of the species recorded, Pacific Golden-Plover (*Pluvialis fulva*) and Ruddy Turnstone (*Arenaria interpres*), are indigenous migratory shorebird species. Both species breed in the high Arctic, and spend their winters in Hawai'i and the tropical Pacific. The remaining 22 species detected are considered to be alien to the Hawaiian Islands (Table 1).

Avian diversity and densities were relatively low, not surprising given the depauperate state of the habitat found on most of the site. Four species, Common Waxbill (*Estrilda astrild*), Red-vented Bulbul (*Pycnonotus cafer*), Common Myna (*Acridotheres tristis*), and Spotted Dove (*Streptopelia chinensis*) accounted for slightly less than 43% of the total number of individual birds recorded. Common Waxbills were the most frequently recorded species, accounting for more than 13% of the total number of individual birds recorded during station counts. We recorded an average of 23 birds per station count.

Table 1. Avian Species Detected Ho'opili Project – Main Sites

Common Name	*Scientific Name*	*ST*	*RA*
	GALLIFORMES		
	PHASIANIDAE - Pheasants & Partridges		
	Phasianinae - Pheasants & Allies		
Gray Francolin	*Francolinus pondicerianus*	A	0.15
Black Francolin	*Francolinus francolinus*	A	0.26
Erckel's Francolin	*Francolinus erckelii*	A	0.56
Ring-necked Pheasant	*Phasianus colchicus*	A	0.19
	CICONIIFORMES		
	ARDEIDAE - Herons, Bitterns & Allies		
Cattle Egret	*Bubulcus ibis*	A	0.74
	CHARADRIIFORMES		
	CHARADRIIDAE - Lapwings & Plovers		
	Charadriinae - Plovers		
Pacific Golden-Plover	*Pluvialis fulva*	IM	0.37
	SCOLOPACIDAE - Sandpipers, Phalaropes & Allies		
	Scolopacinae - Sandpipers & Allies		
Ruddy Turnstone	*Arenaria interpres*	IM	0.41

Common Name	*Scientific Name*	*ST*	*RA*
	COLUMBIFORMES		
	COLUMBIDAE - Pigeons & Doves		
Spotted Dove	*Streptopelia chinensis*	A	2.81
Zebra Dove	*Geopelia striata*	A	2.15
Mourning Dove	*Zenaida macroura*	A	0.15
	PASSERIFORMES		
	ALADIDAE - Larks		
Sky Lark	*Alauda arvensis*	A	1.63
	PYCNONOTIDAE - Bulbuls		
Red-vented Bulbul	*Pycnonotus cafer*	A	3.22
	ZOSTEROPIDAE - White-Eyes		
Japanese White-eye	*Zosterops japonicus*	A	2.41
	MIMIDAE - Mockingbirds & Thrushes		
Northern Mockingbird	*Mimus polyglottos*	A	2.89
	STURNIDAE - Starlings		
Common Myna	*Acridotheres tristis*	A	2.89
	EMBERIZIDAE - Emberizids		
Red-crested Cardinal	*Paroaria coronata*	A	0.70
	CARDINALIDAE - Cardinals Saltators & Allies		
Northern Cardinal	*Cardinalis cardinalis*	A	0.74
	FRINGILLIDAE - Fringilline And Cardueline Finches & Allies		
	Carduelinae - Carduline Finches		
House Finch	*Carpodacus mexicanus*	A	1.85
	PASSERIDAE - Old World Sparrows		
House Sparrow	*Passer domesticus*		0.67
	ESTRILDIDAE - Estrildid Finches		
	Estrildinae - Estrildine Finches		
Common Waxbill	*Estrilda astrild*	A	4.11
Red Avadavat	*Amandava amandava*	A	0.78
Nutmeg Mannikin	*Lonchura punctulata*	A	1.41
Chestnut Mannikin	*Lonchura atricapilla*	A	0.48
Java Sparrow	*Padda oryzivora*	A	1.04

KEY TO TABLE 1

- *ST* Status
- A Alien – introduced to the Hawaiian Islands by humans
- IM Indigenous Migrant – a native migratory species that winters in Hawai'i but breeds elsewhere
- *RA* Relative Abundance – number of birds detected divided by the number of count stations (27)

Discussion

Mammalian Resources

The findings of the mammalian survey are consistent with the findings of at least one other recent survey conducted on lands immediately adjacent to the subject property (David 2005a), as well as with several others faunal surveys conducted in the general vicinity of the subject property in the recent past (David 2000, 2001, 2005b, 2008a, 2008b, David and Guinther 2000, 2005, 2006, 2007).

As previously mentioned we did encounter several European house mice within the project site. It is also likely that the other three established *muridae* in Hawaii, roof rats (*Rattus r. rattus*), Norway rats (*Rattus norvegicus*), and possibly Polynesian rats (*Rattus exulans hawiiensis*), use resources present within the project site. These commensal species are all but ubiquitous on the island of O'ahu. All of these introduced rodents are deleterious to remaining native ecosystems and the native floral and faunal species that are dependant on them for their survival.

Avian Resources

The findings of the avian survey are consistent with the findings of at least one other recent avian survey conducted on lands immediately adjacent to the subject property (David 2005a), as well as with several others avian surveys conducted in the general vicinity of the subject property in the recent past (David 2000, 2001, 2005b, 2008a, 2008b, David and Guinther 2000, 2005, 2006, 2007).

Only two of the 24-avian species recorded during the course of this survey are native species. The two species in question, Pacific Golden-Plover, and Ruddy Turnstone are indigenous migratory shorebird species that breed in the high Arctic and spend the winter months in Hawai'i and the tropical Pacific. Both species are readily seen throughout the Hawaiian Islands between late July and the end of April each year. The remaining 22-species detected are considered to be alien to the Hawaiian Islands (Table 1).

Although not detected during this survey, it is likely that the Hawaiian endemic sub-species of the Short-eared Owl (*Asio flammeus sandichensis*), or *pueo* use resources within the general project area. This species is regularly seen along the Wai'anae coast from the Lualualei Naval Reservation to Waimānalo Gulch (David 2005c). The O'ahu population of the short-eared Owl is listed as an endangered species under the State of Hawai'i's endangered species program, though; it is not protected under the federal endangered species statutes (DLNR 1998).

From an avian and native mammalian perspective there is nothing unique about the subject property, and none of the study area is important habitat for any listed avian or mammalian species currently known from the Island of O'ahu.

Conclusions

It is not expected that the modification of the project area or the development of the site will have a negative impact on any avian or mammalian species currently listed as endangered, threatened, or any that are currently proposed for listing under either Federal or State of Hawai'i endangered species statutes.

Glossary

Alien - Introduced to Hawai'i by humans
Commensal - Animals that share human food such as rats and mice
Crepuscular – Twilight hours
Depauperate – Lacking in numbers or variety of species
Endangered – Listed and protected under the ESA as an endangered species
Endemic – Native and unique to the Hawaiian Islands
Indigenous - Native to the Hawaiian Islands, but also found elsewhere naturally
Muridae - Rodents, including rats, mice and voles, one of the most diverse families of mammals.
Nocturnal – Night-time, after dark
'ōpe'ape'a – Hawaiian hoary bat (*Lasiurus cinereus semotus*)
pueo – Hawaiian endemic cub-species of the Short-eared Owl (*Asio flammeus sandwichensis*)
Ruderal – Disturbed, rocky, rubbishy areas, such as old agricultural fields and rock piles
Threatened - Listed and protected under the ESA as a threatened species

DLNR – Hawaii State Department of Land & Natural resources
TMK – Tax Map Key
USFWS – U.S. Fish & Wildlife Service

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A Survey of Avian and Mammalian Resources for the Ho'opili Development Project, 'Ewa District, O'ahu, Hawai'i.

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Makai Detention Site

Prepared for:
PBR Hawaii
ASB Tower, Suite 650
1001 Bishop Street
Honolulu, Hawai'i 96813-3484

Prepared by:

Reginald E. David
Rana Productions, Ltd.
P.O. Box 1371
Kailua-Kona, Hawai'i 96745

February 11, 2008

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Figures & Tables

Introduction

D. R. Horton – Schuler Division is proposing to use a triangular parcel of land located to the east of Fort Weaver Road as a storm water retention basin for their proposed Ho'opili Development in East Kapolei, 'Ewa District, O'ahu (Figure 1). A portion of the site is currently being used as such by developments to the north and west of the site. This report summarizes the findings of the avian and mammalian surveys that were conducted within this site to determine the potential effects of the proposed development on biological resources present on the site and within the general project area (Figure 1).

A primary goal of the surveys was to determine if there were any avian or mammalian species currently listed as endangered, threatened, or proposed for listing under either Federal or State of Hawaii endangered species statutes present on, or close to the proposed project areas. Listed species status follows species identified in the following referenced documents (Division of Land and Natural Resources (DLNR) 1998, Federal Register 2005, U. S. Fish & Wildlife Service (USFWS) 2005, 2006). Fieldwork was conducted on August 15, 2006.

The avian phylogenetic order and nomenclature used in this report follows *The American Ornithologists' Union Checklist of North American Birds 7th Edition* (American Ornithologists' Union 1998), and the 42nd through the 47th supplements to *Check-list of North American Birds* (American Ornithologists' Union 2000; Banks et al. 2002, 2003, 2004, 2005, 2006). Mammal scientific names follow *Mammals in Hawaii* (Tomich 1986). Plant names follow *Manual of the Flowering Plants of Hawai'i* (Wagner et al. and Wagner and Herbst, 1990, 1999). Place names follow *Place Names of Hawaii* (Pukui et al. 1974).

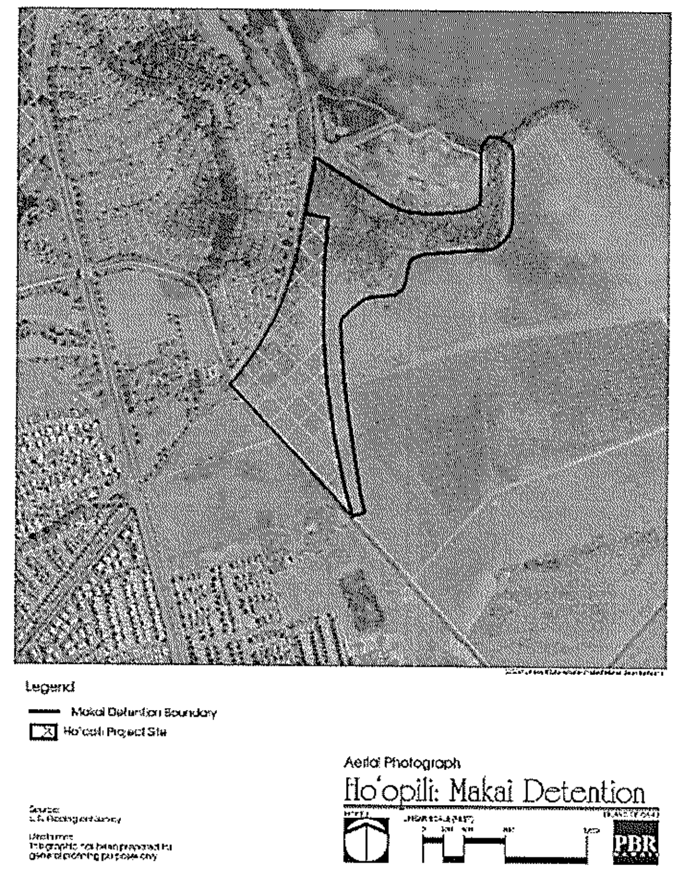
Hawaiian and scientific names are italicized in the text. A glossary of technical terms and acronyms used in the document, which may be unfamiliar to the reader, are included at the end of the narrative text on Page 9.

General Site Description

The proposed Ho'opili Development includes five main parcels, which are covered in a separate report, and two smaller "off-site" parcels, which are covered in two separate reports (David 2008a, 20008b). This report covers a proposed storm water detention basin which is to be located to the east of Fort Weaver Road, and south of the Honouliuli Unit of the Pearl Harbor National Wildlife Refuge (Figure 1). The site is transected by the former OR&L railway line. A corridor running from the original detention site to Pearl Harbor was not surveyed, as we were unable to secure access to the area, which is controlled by the U. S. Navy.

The project site is made up of an approximately 2-acre detention basin on the northern third of the site. The southern third of the site is in active cultivation of corn (*Zea mays*) and tomatoes (*Solanum lycopersicum*). The vegetation present on the project site is almost completely dominated by alien species. The botanical surveys conducted on the site identified 73-plant species, three of which are considered indigenous, the remainder being alien to the Hawaiian Islands (LeGrande 2006).

Figure 1 – Ho'opili Makai Detention Site



Mammalian Survey Methods

All observations of mammalian species were of an incidental nature. With the exception of the endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*), or *'ōpe'ape'a* as it is known locally, all terrestrial mammals currently found on the Island of O'ahu are alien species, and most are ubiquitous. The survey of mammals was limited to visual and auditory detection, coupled with visual observation of scat, tracks, and other animal sign. A running tally was kept of all vertebrate species observed and heard within the study area.

Mammalian Survey Results

Three mammalian species were detected within the project site. Three small Indian mongooses (*Herpestes a. auropunctatus*) were seen at various locations within the site. Several dogs (*Canis f. familiaris*) were heard barking from within existing developments located to the northwest of the site. Tracks, scat and sign of mongoose cat (*Felis catus*) and dog were encountered in several locations within the site. The endangered Hawaiian hoary bat was not recorded during the course of this survey. This finding is not surprising given that this species has rarely been documented from the Island of O'ahu (Tomich 1986, USFWS 1998).

Avian Survey Methods

Five avian count stations were sited along two linear transects running the length of the site. Stations were sighted approximately 300-meters apart. Six-minute point counts were made at each of the nine-count stations. Field observations were made using Leitz 10 X 42 binoculars and by listening for avian vocalizations. Counts took place between 06:30 a.m. and 11:00 a.m., the peak of daily bird activity. Time not spent conducting station counts was used to search the subject property for species and habitats not detected during count sessions.

Avian Survey Results

A total of 170 individual birds, of 20-different avian species, representing 13-separate families were recorded during station counts. These results are summarized in Table 1. One of the species recorded, Black-crowned Night-Heron (*Nycticorax nycticorax hoactli*), is a resident indigenous breeding species. Two others, Pacific Golden-Plover (*Pluvialis fulva*) and Ruddy Turnstone (*Arenaria interpres*), are indigenous migratory shorebird species. Both of which breed in the high Arctic, and spend their winters in Hawai'i and the tropical Pacific. The remaining 17-species detected are considered to be alien to the Hawaiian Islands (Table 1).

The survey results were in keeping with the habitat present on the site, and it's location on the Island of O'ahu. Three species, Common Waxbill (*Estrilda astrild*), Zebra Dove (*Geopelia striata*), and Spotted Dove (*Streptopelia chinensis*), accounted for more than 45% of the total number of individual birds recorded. Common Waxbills were the most frequently recorded species, accounting for more slightly less that 19% of the total number of individual birds recorded during station counts. We recorded an average of 20 birds per station count.

Table 1. Avian Species Detected Ho'opili Project - Makai Detention Site

Common Name	*Scientific Name*	*ST*	*RA*
	GALLIFORMES		
	PHASIANIDAE - Pheasants & Partridges		
	Phasianinae - Pheasants & Allies		
Red Junglefowl	*Gallus gallus*	D	0.80
	CICONIIFORMES		
	ARDEIDAE - Herons, Bitterns & Allies		
Cattle Egret	*Bubulcus ibis*	A	1.40
Black-crowned Night-Heron	*Nycticorax nycticorax hoactli*	IR	0.20
	CHARADRIIFORMES		
	CHARADRIIDAE - Lapwings & Plovers		
	Charadriinae - Plovers		
Pacific Golden-Plover	*Pluvialis fulva*	IM	0.80
	SCOLOPACIDAE - Sandpipers, Phalaropes & Allies		
	Scolopacinae - Sandpipers & Allies		
Wandering tattler	*Tringa incana*	IM	0.20
Ruddy Turnstone	*Arenaria interpres*	IM	0.60
	COLMBIFORMES		
	COLMBIDAE - Pigeons & Doves		
Rock Pigeon	*Columba livia*	A	1.60
Spotted Dove	*Streptopelia chinensis*	A	300
Zebra Dove	*Geopelia striata*	A	6.00
	PASSERIFORMES		
	PYCNONOTIDAE - Bulbuls		
Red-vented Bulbul	*Pycnonotus cafer*	A	0.40
	ZOSTEROPIDAE - White-Eyes		
Japanese White-eye	*Zosterops japonicus*	A	2.40
	STURNIDAE - Starlings		
Common Myna	*Acridotheres tristis*	A	1.60
	EMBERIZIDAE - Emberizids		
Red-crested Cardinal	*Paroaria coronata*	A	1.00
	CARDINALIDAE - Cardinals Saltators & Allies		
Northern Cardinal	*Cardinalis cardinalis*	A	0.40

Common Name	Scientific Name	ST	RA
	FRINGILLIDAE - Fringilline And Cardueline Finches & Allies		
	Carduelinae - Carduline Finches		
House Finch	*Carpodacus mexicanus*	A	1.00
	PASSERIDAE - Old World Sparrows		
House Sparrow	*Passer domesticus*	A	1.40
	ESTRILDIDAE - Estrildid Finches		
	Estrildinae - Estrildine Finches		
Common Waxbill	*Estrilda astrild*	A	6.40
Nutmeg Mannikin	*Lonchura punctulata*	A	1.00
Chestnut Munia	*Lonchura atricapilla*	A	1.00
Java Sparrow	*Padda oryzivora*	A	2.80

KEY TO TABLE 1

ST Status
D Domesticated Species – Not currently considered to be established on the Island of O'ahu
A Alien – introduced to the Hawaiian Islands by humans
IM Indigenous Migrant – a native migratory species that winters in Hawai'i but breeds elsewhere
RA Relative Abundance – number of birds detected divided by the number of count stations (5)

Discussion

Mammalian Resources

The findings of the mammalian survey are consistent with the findings of several others faunal surveys conducted in the general vicinity of the subject property in the recent past (David 2000, 2001, 2005a, 2005b, 2007, 2008a, 2008b, David and Guinther 2000, 2005, 2006, 2007).

Although none of the four established *muridae* were detected during the course of this survey, it is likely that, European house mice (*Mus musculus domesticus*), Hawai'i, roof rats (*Rattus r. rattus*), Norway rats (*Rattus norvegicus*), and possibly Polynesian rats (*Rattus exulans hawaiiensis*), use resources present within the project site. These commensal species are all but ubiquitous on the island of O'ahu. All of these introduced rodents are deleterious to remaining native ecosystems and the native floral and faunal species that are dependant on them for their survival.

Avian Resources

The findings of the avian survey are consistent with the findings of several others avian surveys conducted in the general vicinity of the subject property in the recent past (David 2000, 2001, 2005a, 2005b, 2007, 2008a, 2008b, David and Guinther 2000, 2005, 2006, 2007).

Three of the 20-avian species recorded during the course of this survey are native species. Black-crowned Night-Herons are an indigenous resident breeding species. They are regularly seen in

and around just about any kind of standing or running water present on O'ahu. The other two native species recorded, Pacific Golden-Plover and Ruddy Turnstone, are indigenous migratory shorebird species that breed in the high Arctic and spend the winter months in Hawai'i and the tropical Pacific. Both species are readily seen throughout the Hawaiian Islands between late July and the end of April each year. The remaining 17-species detected are considered to be alien to the Hawaiian Islands (Table 1).

Four waterbird species that are currently listed as endangered under both the Federal and State of Hawai'i's endangered species statutes, Hawaiian Duck x Mallard hybrids (*Anas wyvilliana x platyrhynchos*), Common Moorhen (*Gallinula chloropus sandvicensis*), Hawaiian Coot (*Fulica alai*), and Black-necked Stilt (*Himantopus mexicanus knudseni*), are present within the general project area, although there currently is no suitable habitat within the project site for them. All four species breed within the Honouliuli unit of the Pearl Harbor National Wildlife Refuge, which is located some 250-meters north of the proposed site. They are also regularly encountered on the golf course located to the northwest of the project site. At such time as the detention basin is enlarged, and when water ponds within it, it is likely that one or more of these species may start to use resources present within the expanded detention basin. According to the projects' civil engineer, Bills Engineering Inc. this is likely to happen very infrequently.

Although not detected during this survey, it is likely that the Hawaiian endemic sub-species of the Short-eared Owl (*Asio flammeus sandwichensis*), or *pueo* use resources within the general project area occasionally. This species is regularly seen along the Wai'anae coast from the Lualualei Naval Reservation to Waimānalo Gulch (David 2005c). I have also seen them within the Honouliuli unit of the Pearl Harbor National Wildlife Refuge upon occasion (David 2007e). The O'ahu population of the short-eared Owl is listed as an endangered species under the State of Hawai'i's endangered species program, though; it is not protected under the federal endangered species statutes (DLNR 1998).

From an avian and native mammalian perspective there is nothing unique about the habitat present within the *makai* detention site. None of the habitat present on the project site is important habitat for any listed avian or mammalian species currently known from the Island of O'ahu.

Conclusions

It is not expected that the modification of the habitat currently found within the proposed makai detention site will result in any deleterious impacts to any avian or mammalian species currently listed as endangered, threatened, or any that are currently proposed for listing under either Federal or State of Hawai'i endangered species statutes.

Glossary

Alien - Introduced to Hawai'i by humans
Commensal - Animals that share human food such as rats and mice
Crepuscular – Twilight hours
Endangered – Listed and protected under the ESA as an endangered species
Endemic – Native and unique to the Hawaiian Islands
Indigenous - Native to the Hawaiian Islands, but also found elsewhere naturally
makai – Down-slope, towards the ocean
mauka – Upslope, towards the mountains
Muridae - Rodents, including rats, mice and voles, one of the most divers families of mammals.
Nocturnal – Night-time, after dark
'ōpe'ape'a – Hawaiian hoary bat (*Lasiurus cinereus semotus*)
pueo – Hawaiian endemic sub-species of the Short-eared Owl (*Asio flammeus sandwichensis*)
Ruderal – Disturbed, rocky, rubbishy areas, such as old agricultural fields and rock piles
Threatened - Listed and protected under the ESA as a threatened species

ESA – Endangered Species Act of 1973, as amended
DLNR – Hawaii State Department of Land & Natural resources
USFWS – U.S. Fish & Wildlife Service

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A Survey of Avian and Mammalian Resources for the Ho'opili Development Project, 'Ewa District, O'ahu, Hawai'i.

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New 440 Tank, Transmission Line and New 228 Tank

Prepared for:
PBR Hawaii
ASB Tower, Suite 650
1001 Bishop Street
Honolulu, Hawai'i 96813-3484

Prepared by:

Reginald E. David
Rana Productions, Ltd.
P.O. Box 1371
Kailua-Kona, Hawai'i 96745

February 11, 2008

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Figures & Tables

Introduction

D. R. Horton – Schuler Division is proposing to develop two new potable water tanks (440 and 228) as well as approximately 5600-feet of waterline to service their proposed Ho'opili Development which is to be located *makai* of the water infrastructure in the 'Ewa District, O'ahu (Figure 1). This report summarizes the findings of the avian and mammalian surveys that were conducted along the proposed waterline routes and on the proposed water tank sites, to determine the potential effects of the proposed development on biological resources present on the site and within the general project area (Figure 1).

A primary goal of the surveys was to determine if there were any avian or mammalian species currently listed as endangered, threatened, or proposed for listing under either Federal or State of Hawaii endangered species statutes present on, or close to the proposed project areas. Listed species status follows species identified in the following referenced documents (Division of Land and Natural Resources (DLNR) 1998, Federal Register 2005, U. S. Fish & Wildlife Service (USFWS) 2005, 2006). Fieldwork was conducted on July 20, and 21, 2006.

The avian phylogenetic order and nomenclature used in this report follows *The American Ornithologists' Union Checklist of North American Birds 7th Edition* (American Ornithologists' Union 1998), and the 42nd through the 47th supplements to *Check-list of North American Birds* (American Ornithologists' Union 2000; Banks et al. 2002, 2003, 2004, 2005, 2006). Mammal scientific names follow *Mammals in Hawaii* (Tomich 1986). Plant names follow *Manual of the Flowering Plants of Hawai'i* (Wagner et al. and Wagner and Herbst, 1990, 1999). Place names follow *Place Names of Hawaii* (Pukui et al. 1974).

Hawaiian and scientific names are italicized in the text. A glossary of technical terms and acronyms used in the document, which may be unfamiliar to the reader, are included at the end of the narrative text on Page 10.

General Site Description

The proposed Ho'opili Development includes five main parcels, which are covered in a separate report, and two smaller "off-site" parcels, which are covered in two separate reports (David 2008a, 20008b). This reports covers two proposed above ground reservoir sites and associated water transmission line routes, all of which are located *mauka*, or north of the H-1 Freeway (Figure 1 and 2).

The project site is made up primarily of a dirt road, which extends some 4000-feet *mauka* from the H-1 Freeway. The proposed 228 water tank site is located on a previously graded pad, immediately adjacent to an existing Board of Water Supply (BWS) water tank just *mauka* of the H-1 Freeway. The proposed 440 water tank is located adjacent to yet another BWS water tank in a former pineapple field, which was fallow at the time of this survey. The proposed water transmission line will be located parallel to the existing BWS transmission line which currently runs along the dirt road between the two existing tanks (Figure 1).

Figure 1 – New 440 Tank, Transmission Line and New 228 Tank Schematic

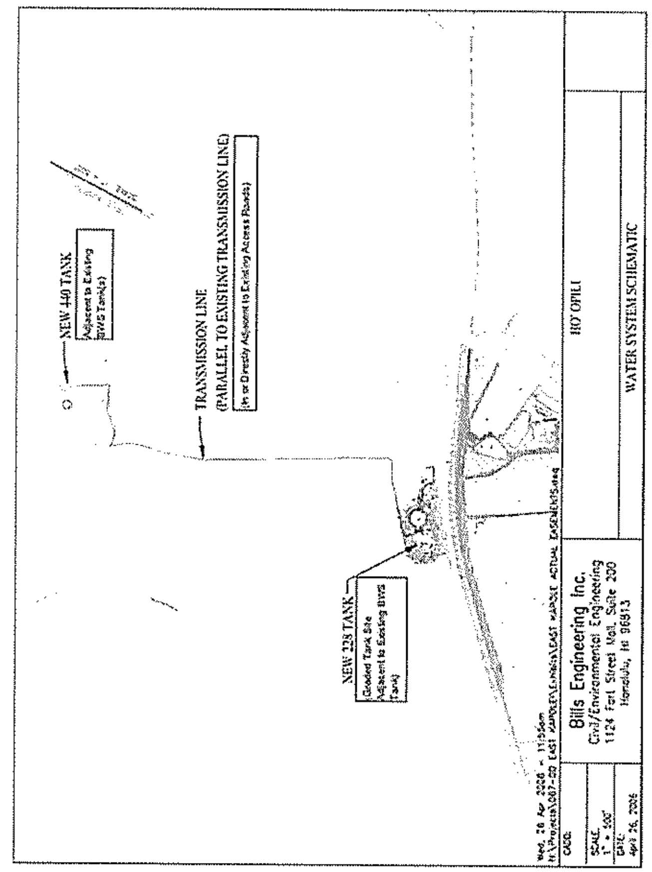
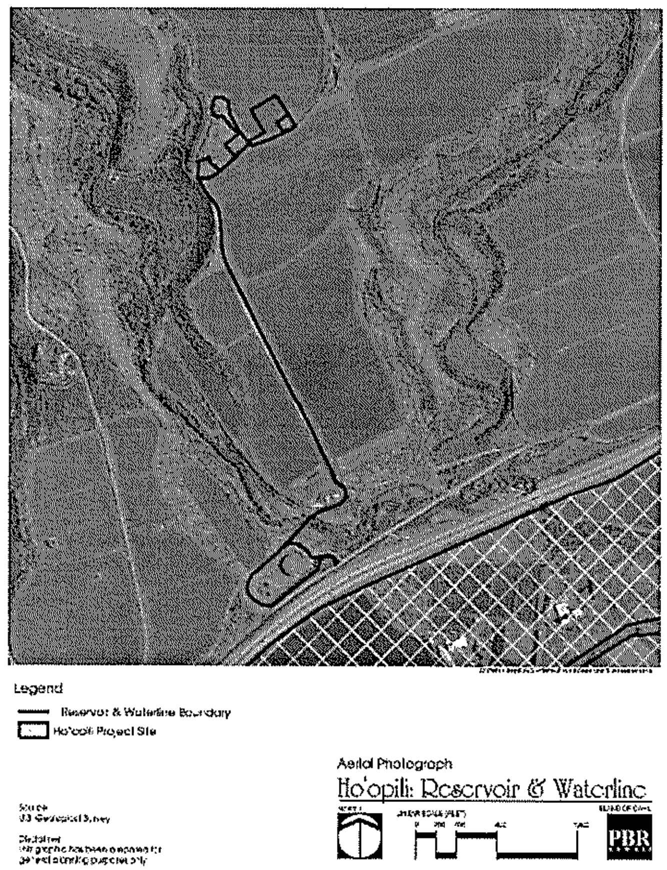


Figure 2
Habitat Present New Transmission Line and New Tank Sites



The terrain on the project site slopes from north-to-south, from an elevation of approximately 440-feet above mean sea level (MSL) at the northern terminus of the site, down to approximately 200-feet MSL along the H-1 Freeway (Figure 1).

As can clearly be seen in Figure 2 the habitat present within the general project site is made up of former sugar cane lands, some of which have in recent years been used to grow various diversified agricultural crops. The new 440 tank site is located on a relatively flat parcel of land formerly used to grow pineapple. The entire project site has been heavily disturbed by agricultural activities and the existing water supply infrastructure. The vegetation present on the project site is almost completely dominated by alien species. The botanical surveys conducted on the site identified 56-plant species, two of which are considered indigenous, the remainder alien to the Hawaiian Islands (LeGrande 2006).

Mammalian Survey Methods

All observations of mammalian species were of an incidental nature. With the exception of the endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*), or *'ōpe'ape'a* as it is known locally, all terrestrial mammals currently found on the Island of O'ahu are alien species, and most are ubiquitous. Two hours were spent within the project area on the evening of July 20, 2006 and again in the early morning hours of July 21, 2006, in an attempt to detect Hawaiian hoary bats. The survey of mammals was limited to visual and auditory detection, coupled with visual observation of scat, tracks, and other animal sign. A running tally was kept of all vertebrate species observed and heard within the study area.

Mammalian Survey Results

Three mammalian species were detected within the project site. Several small Indian mongooses (*Herpestes a. auropunctatus*) were seen at various locations along the dirt road and close to the Hawaiian Electric Companies switching station located at the *mauka* end of the site. We also encountered tracks, scat and sign of dog (*Canis f. familiaris*), cat (*Felis catus*), and mongoose at several locations along the dirt road.

The endangered Hawaiian hoary bat was not recorded during the course of this survey. This finding is not surprising given that this species has rarely been documented from the Island of O'ahu (Tomich 1986, USFWS 1998).

Avian Survey Methods

Seven avian count stations were sited along a linear transect running the length of the dirt road and extending east from the *mauka* water tank site. Stations were sighted approximately 900-feet apart. Six-minute point counts were made at each of the seven-count stations. Field observations were made using Leitz 10 X 42 binoculars and by listening for avian vocalizations. Counts took place between 06:30 a.m. and 11:00 a.m., the peak of daily bird activity. An additional two hours was spent within the project area on the evening of July 20, 2006 and again in the early morning hours of July 21, 2006, in an attempt to detect crepuscular and/or nocturnally flying seabirds and owls. Time not spent conducting station counts was used to search the subject property for species and habitats not detected during count sessions.

Avian Survey Results

A total of 152 individual birds, of 13 different avian species, representing 11-separate families were recorded during station counts. These results are summarized in Table 1. One of the species recorded, Pacific Golden-Plover (*Pluvialis fulva*), is an indigenous migratory shorebird species. Pacific Golden-Plover breed in the high Arctic, and spend their winters in Hawai'i and the tropical Pacific. The remaining 12 species detected during the course of this survey are considered to be alien to the Hawaiian Islands (Table 1).

Avian diversity and densities were relatively low, not surprising given the depauperate state of the habitat found on most of the site. Three species, Common Waxbill (*Estrilda astrild*), Zebra Dove (*Geopelia striata*), and Japanese White-eye (*Zosteropus japonicus*) accounted for slightly less than 41% of the total number of individual birds recorded. Common Waxbills were the most frequently recorded species, accounting for more than 15% of the total number of individual birds recorded during station counts. We recorded an average of 22 birds per station count.

Discussion

Mammalian Resources

The findings of the mammalian survey are consistent with the findings of at least two other recent surveys conducted on lands immediately adjacent to the subject property (David 2005a, 2007a), as well as with several others faunal surveys conducted in the general vicinity of the subject property in the recent past (David 2000, 2001, 2005b, 2008a, 2008b, David and Guinther 2000, 2005, 2006, 2007).

Although we did not record any of the four muridae species currently considered to be established on O'ahu, it is likely that, European house mouse (*Mus musculus domesticus*) Hawai'i, roof rat (*Rattus r. rattus*), Norway rat (*Rattus norvegicus*), and possibly Polynesian rats (*Rattus exulans hawaiiensis*) use resources present within the project site. These commensal species are all but ubiquitous on the island of O'ahu. All of these introduced rodents are deleterious to remaining native ecosystems and the native floral and faunal species that are dependant on them for their survival.

Avian Resources

The findings of the avian survey are consistent with the findings of at least two other recent avian surveys conducted on lands immediately adjacent to the subject property (David 2005a, 2007a), as well as with several others avian surveys conducted in the general vicinity of the subject property in the recent past (David 2000, 2001, 2005b, 2008a, 2008b, David and Guinther 2000, 2005, 2006, 2007).

Table 1. Avian Species Detected Ho'opili Project; Offsite Reservoirs and Waterline Routes

Common Name	*Scientific Name*	*ST*	*RA*
	GALLIFORMES		
	PHASIANIDAE - Pheasants & Partridges		
	Phasianinae - Pheasants & Allies		
Gray Francolin	*Francolinus pondicerianus*	A	0.86
	CICONIIFORMES		
	ARDEIDAE - Herons, Bitterns & Allies		
Cattle Egret	*Bubulcus ibis*	A	0.57
	CHARADRIIFORMES		
	CHARADRIIDAE - Lapwings & Plovers		
	Charadriinae - Plovers		
Pacific Golden-Plover	*Pluvialis fulva*	IM	0.43
	COLUMBIFORMES		
	COLUMBIDAE - Pigeons & Doves		
Spotted Dove	*Streptopelia chinensis*	A	1.71
Zebra Dove	*Geopelia striata*	A	2.86
	PASSERIFORMES		
	PYCNONOTIDAE - Bulbuls		
Red-vented Bulbul	*Pycnonotus cafer*	A	2.14
	ZOSTEROPIDAE - White-Eyes		
Japanese White-eye	*Zosterops japonicus*	A	2.71
	STURNIDAE - Starlings		
Common Myna	*Acridotheres tristis*	A	2.29
	EMBERIZIDAE - Emberizids		
Red-crested Cardinal	*Paroaria coronata*	A	1.00
	CARDINALIDAE - Cardinals Saltators & Allies		
Northern Cardinal	*Cardinalis cardinalis*	A	0.57
	FRINGILLIDAE - Fringilline And Carduelinc Finches & Allies		
	Carduelinae - Carduline Finches		
House Finch	*Carpodacus mexicanus*	A	2.43
	ESTRILDIDAE - Estrildid Finches		
	Estrildinae - Estrildine Finches		
Common Waxbill	*Estrilda astrild*	A	3.29
Red Avadavat	*Amandava amandava*	A	0.86

KEY TO TABLE 1

ST Status
A Alien – introduced to the Hawaiian Islands by humans
IM Indigenous Migrant – a native migratory species that winters in Hawai'i but breeds elsewhere
RA Relative Abundance – number of birds detected divided by the number of count stations (7)

Only one of the 13-avian species recorded during the course of this survey, Pacific Golden-Plover, is a native species. Pacific Golden-Plover are an indigenous migratory shorebird species that breed in the high Arctic and spends the winter months in Hawai'i and the tropical Pacific. This species is readily seen throughout the Hawaiian Islands between late July and the end of April each year. The remaining 12-species detected during the course of this survey are considered to be alien to the Hawaiian Islands (Table 1).

Although not detected during this survey, it is likely that the Hawaiian endemic sub-species of the Short-eared Owl *(Asio flammeus sandwichensis)*, or *pueo* use resources within the general project area occasionally. This species is regularly seen along the Wai'anae coast from the Lualualei Naval Reservation to Waimānalo Gulch (David 2005c). The O'ahu population of the short-eared Owl is listed as an endangered species under the State of Hawai'i's endangered species program, although it is not protected under the federal endangered species statutes (DLNR 1998).

From an avian and native mammalian perspective there is nothing unique about the project area or within the reservoir site, and none of the habitat present within the study area is important habitat for any listed avian or mammalian species currently known from the Island of O'ahu.

Conclusions

It is not expected that the modification of the project area will have a deleterious impact on any avian or mammalian species currently listed as endangered, threatened, or any that are currently proposed for listing under either Federal or State of Hawai'i endangered species statutes.

Glossary

Alien - Introduced to Hawai'i by humans
BWS – Board of Water Supply
Commensal - Animals that share human's food such as rats and mice
Crepuscular – Twilight hours
Endangered – Listed and protected under the ESA as an endangered species
Endemic – Native and unique to the Hawaiian Islands
Indigenous - Native to the Hawaiian Islands, but also found elsewhere naturally
makai – Down-slope, towards the ocean
mauka – Upslope, towards the mountains
Muridae - Rodents, including rats, mice and voles, one of the most diverse families of mammals.
Nocturnal – Night-time, after dark
'ōpe'ape'a – Hawaiian hoary bat (*Lasiurus cinereus semotus*)
pueo – Hawaiian endemic sub-species of the Short-eared Owl (*Asio flammeus sandwichensis*)
Ruderal – Disturbed, rocky, rubbishy areas, such as old agricultural fields and rock piles
Threatened - Listed and protected under the ESA as a threatened species

BWS – Honolulu Board of Water Supply
ESA – Endangered Species Act of 1973, as amended
DLNR – Hawaii State Department of Land & Natural resources
TMK – Tax Map Key
USFWS – U.S. Fish & Wildlife Service

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APPENDIX D
Archaeological Inventory Survey

An Archaeological Inventory Survey for the East Kapolei Project, Honouliuli Ahupua'a, 'Ewa District, Island of O'ahu TMK: (1) 9-1-010:002, 9-1-017:004, 059, 072; 9-1-018:001, 004; 9-2-001:001

Prepared for

D. R. Horton – Schuler Division

Prepared by

Constance O'Hare, B.A.,

D.W. Shideler, M.A.,

and

Hallett H. Hammatt, Ph.D.

Cultural Surveys Hawai'i, Inc.

Kailua, Hawai'i

(Job Code: HONO 75)

February 2006

O'ahu Office
P.O. Box 1114
Kailua, Hawai'i 96734
Ph.: (808) 262-9972
Fax: (808) 262-4950

www.culturalsurveys.com

Maui Office
16 S. Market Street, Suite 2N
Wailuku, Hawai'i 96793
Ph: (808) 242-9882
Fax: (808) 244-1994

Management Summary

Reference	An Archaeological Inventory Survey For the East Kapolei Project, Honouliuli Ahupua'a, 'Ewa District, Island of O'ahu, TMK: (1) 9-1-010:001, 9-1-017:004, 059, 072; 9-1-018:001, 004, 9-2-001:001, by Constance R. O'Hare, David W. Shideler, and Dr. Hallett H. Hammatt
Date	February 2006
Project Number (s)	CSH Job Code: HONO 75
Investigation Permit Number	CSH completed the inventory survey fieldwork under state archaeological permit No. 0508 issued by the State Historic Preservation Division, per Hawai'i Administrative Rules (HAR) Chapter 13-13-282.
Project Location	The main project area comprises TMK:(1) 9-1-017:004, 059, 072; 9-1-018:001, 004. The main project area is generally bound on the north by the H-1 Interstate (I H-1), on the south by Mango Tree Road (a dirt road along the Ewa Villages Golf Course), Pelehua Drive on the west, and Old Fort Weaver Road on the east. There are two non-contiguous parcels, one on the east side of new Fort Weaver Road (TMK 9-1-010:002, and one north of the H-1 Interstate around a reservoir (TMK 9-2-001:001).
Land Jurisdiction	The James Campbell Estate, owner
Agencies	State Historic Preservation Division / Department of Land and Natural Resources (SHPD/DLNR)
Project Description	The landowner plans to develop the area into a mixed residential, commercial, and recreational property.
Project Acreage	2625 acres
Area of Potential Effect (APE)	For the purposes of this study the area of potential effect (APE) and the project area are considered one and the same.
Historic Preservation Regulatory Context	The client, D.R. Horton-Schuler Division proposed development of James Campbell Estate East Kapolei lands constitutes a project requiring compliance with and review under State of Hawai'i historic preservation review legislation (Hawai'i Revised Statutes (HRS) Chapter 6E-42 and Hawai'i Administrative Rules (HAR) 13-284). At the request of D.R. Horton-Schuler Division, CSH completed an archaeological inventory survey investigation, per the requirements of HAR Chapter 13-13-276, of the subject 2625-acre parcel. This archaeological inventory survey report was prepared to support the proposed property's historic preservation review and any other project-related historic preservation consultation
Fieldwork Effort	Constance R. O'Hare, B.A., Owen O'Leary, M.A., Guadalupe Ochoa, B.A., Brad Garrett, M.A., and Jon Tulchin, B.A., under the general direction of Hallett H. Hammatt, Ph.D. conducted surface survey and subsurface testing in the project area. Field work was conducted on November 21, 22, 28, on December 8 and 9, 2005, and January 13, 2006..
Number of Historic Properties Identified	Five sites had been previously identified in a 1990 CSH survey (Hammatt and Shideler 1990). One of these sites (50-80-12-4344) was used to denote Ewa Sugar Plantation scattered infrastructure features. Three features (Features A-C) were recorded for this site during the 1990 survey. During the recent 2005 surface survey, four additional sugar plantation features were recorded. These will be considered additional features (Features D-F) of Site -4344.

Historic Properties Recommended Eligible to the Hawai'i Register of Historic Places (Hawai'i Register)	Sites 50-80-12-4344 (plantation infrastructure), -4345 (railroad berm), -4346 (northern pumping station), -4347 (central pumping station), and -4348 (southern pumping station) have been previously determined during a 1990 survey to be significant under Criteria C and D. Sites -4345 through- 4348 were also recommended for preservation. No further work or preservation was recommended for -4344. All five sites were revisited during the recent 2005 survey; four additional features were added to Site -4344, however, the original three features (Features A-C) have been destroyed since 1990. The significance and recommendations of these five sites remains the same.
Historic Properties Recommended Ineligible to the Hawai'i Register	Four areas of historic habitation (Honouliuli Taro Lands, Kapalani Catholic Church, PipeLine Village, and Drivers/Stable Village) were identified during the 1990 survey of a portion of the project area. No site designations were given, since there were no surface remains found during the survey. During the recent 2005 backhoe testing for the current project, no subsurface remains for these four habitation loci were found in the project area. No site designations are needed.
Mitigation Recommendation	Although no subsurface remains for four habitation loci were found during the recent backhoe testing of the four areas, it is recommended that a program of on-site/on-call monitoring be conducted during any future development of these four specific areas.

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Section 1 Introduction

1.1 Project Background

At the request of D.R. Horton-Schuler Division (828 Fort Street Mall, 4th Floor, Honolulu, HI 96813), Cultural Surveys Hawai'i, Inc. (CSH) has completed this Inventory Survey Report for the East Kapolei Project, Honouliuli Ahupua'a, 'Ewa District, O'ahu Island ([1] 9-1-010:002; 9-1-017:004, 059, 072; 9-1-018:001, 004; 9-2-001:001) (Figures 1 and 2). The main project area is generally bound on the north by the H-1 Interstate (I H-1), on the south by Mango Tree Road (a dirt road along the Ewa Villages Golf Course), Pelehua Drive on the west, and Old Fort Weaver Road on the east. There are two non-contiguous sections, a parcel on the east side of West Loch Estates and a parcel north of the H-1 Interstate, surrounding a reservoir. In all, the project area is approximately 2625 acres. The landowner, the James Campbell estate, plan to develop this area into a mixed residential, commercial, and recreational property (Figure 3).

CSH previously worked on the eastern 546-acres of these lands back in 1990 in association with what was then known as the West Loch Bluffs project (Hammatt and Shideler 1990). In the course of this study, we were able to determine that the eastern lands of the present project area contain more historic resources than one might guess, including such features as:

- A northern pumping station;
- a central pumping station complex;
- a southern pumping station;
- the former site of PipeLine Village;
- the former site of Drivers and Stable Villages;
- the former site of Hawaiian Land Commission Awards and former Hawaiian Homesteads;
- the former site of the Honouliuli "Kapalani" Roman Catholic Church;
- a well preserved portion of the Ewa Plantation Company railroad berm; and,
- the site of the first artesian well in Hawai'i.

Based on the presence of these sites and presumably others, CSH recommended an inventory survey that includes both surface and subsurface investigation. Based on the known data, subsurface testing with a backhoe is needed during the inventory survey. Backhoe testing will focus on locating and evaluating subsurface deposits, such as buried cultural layers, artifacts, and possibly burials that could not be located by surface pedestrian inspection. Backhoe testing will be conducted in four areas, at the site of the nineteenth century Kapalani Church, the area of Hawaiian Land Commission Awards, the location of Drivers/Stable Village, and the location of PipeLine Village, with its associated church.

The archaeological inventory survey and its accompanying report will document all historic properties within the subject parcel. The prepared inventory survey will be in compliance with state standards and will be submitted for review and approval to the State Historic Preservation Division/Department of Land and Natural Resources (SHPD/DLNR).

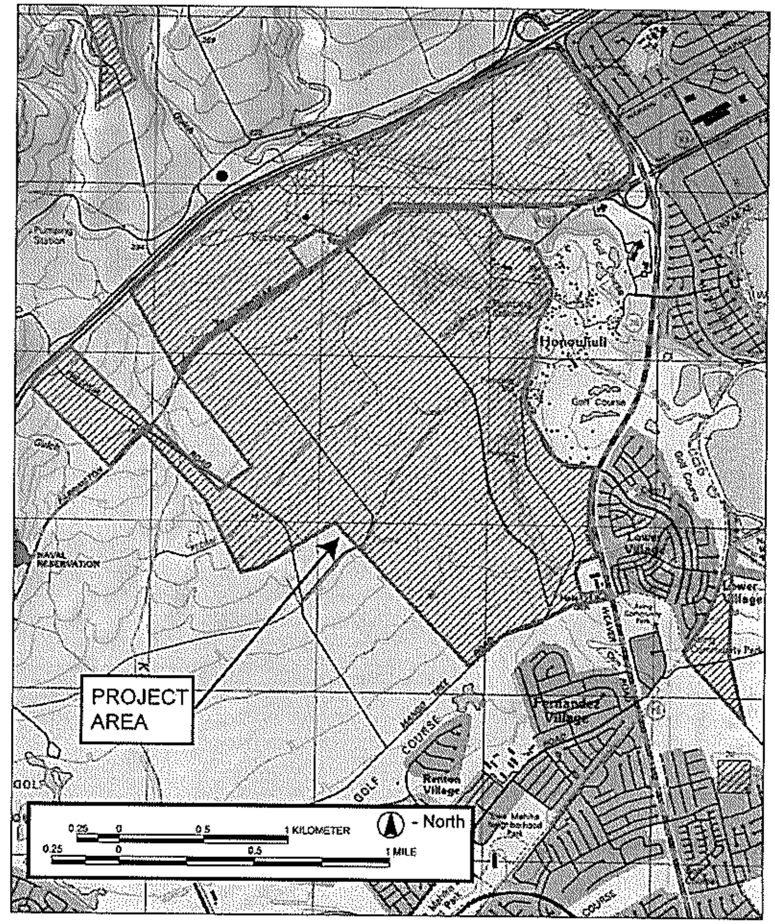

Figure 1. US Geological Survey map (1998), Waipahu and Ewa quadrangles, showing project area (hatched area)

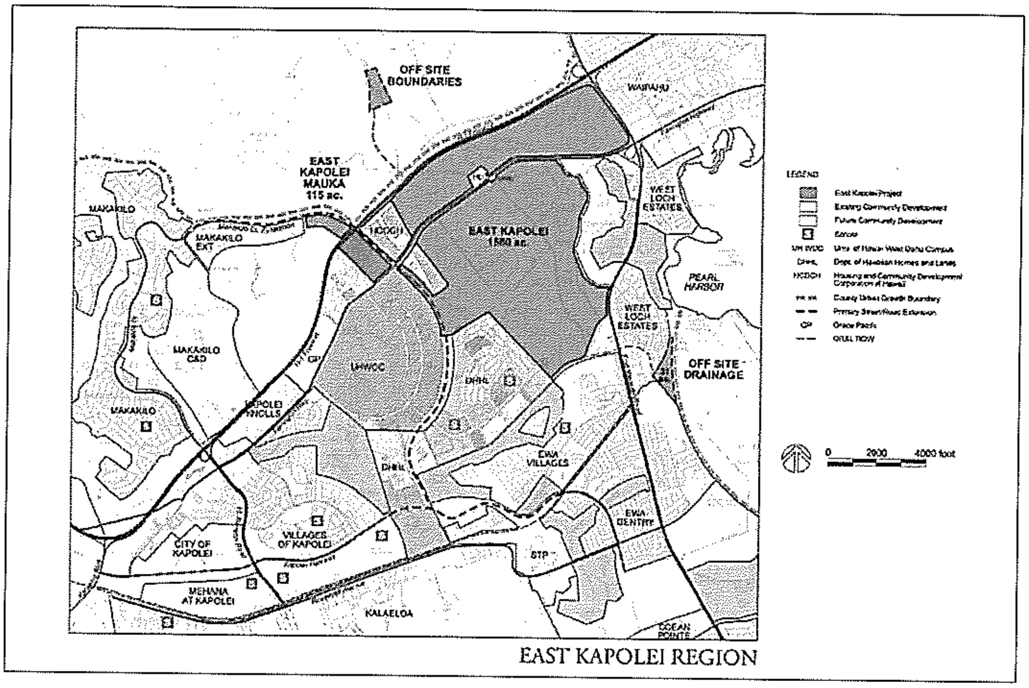

Figure 3. Planned Development for the East Kapolei Region

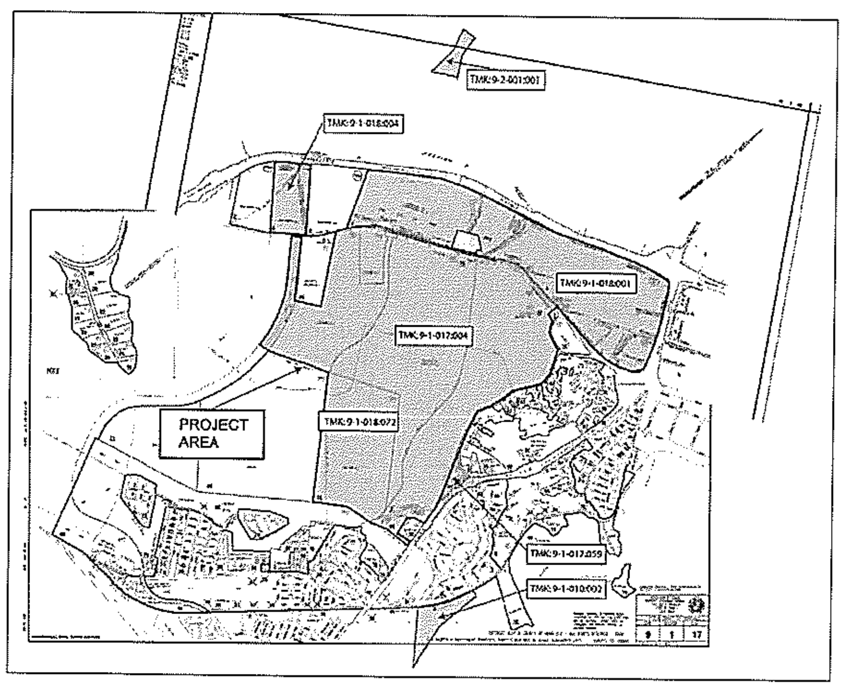

Figure 2. Tax Maps 9-1-010, 9-1-017, 9-1-018, and 9-2-001, showing project area (shaded red)

1.2 Scope of Work

The following archaeological inventory survey scope of work will satisfy the State and County requirements:

1. State rules have recently been established which require consultation with community members as part of the inventory survey process. This consultation requires contacting knowledgeable members of the community and requesting information on historic and cultural issues related to the property.
2. A complete ground survey of the entire project area for the purpose of site inventory. All sites would be located, described, and mapped with evaluation of function, interrelationships, and significance. Documentation will include photographs and scale drawings of selected sites and complexes. All sites will be assigned State site numbers.
3. Subsurface testing to determine if subsurface deposits are located in the project area, and, if so, evaluate their significance. If appropriate samples from these excavations are found, they will be analyzed for chronological and paleoenvironmental information.
4. Research on historic and archaeological background, including search of historic maps, written records, and Land Commission Award documents. This research will focus on the specific area with general background on the *ahupua'a* and district and will emphasize settlement patterns.
5. Preparation of a survey report which will include the following:
   a. A topographic map of the survey area showing all archaeological sites and site areas;
   b. Results of consultation with knowledgeable community members about the property and its historical and cultural issues.
   c. Description of all archaeological sites with selected photographs, scale drawings, and discussions of function;
   d. Historical and archaeological background sections summarizing prehistoric and historic land use as they relate to the archaeological features;
   e. A summary of site categories and their significance in an archaeological and historic context;
   f. Recommendations based on all information generated that will specify what steps should be taken to mitigate impact of development on archaeological resources - such as data recovery (excavation) and preservation of specific areas. These recommendations will be developed in consultation with the client and the State agencies.

This scope of work also includes full coordination with the State Historic Preservation Division (SHPD), and County relating to archaeological matters. This coordination takes place after consent of the owner or representatives.

Part of the SHPD mandated scope of work for an archaeological inventory survey includes specific documentation of located historic properties. If cultural deposits are located, it is required that appropriate data are collected from them. This includes recording their geographic location on project area maps, general written descriptions, sampling, and section drawings, plan views, and photographs as appropriate. For traditional Hawaiian deposits, this can include analysis of recovered artifacts and midden. It often also includes radiocarbon dating of samples from cultural contexts. If historic-era deposits are located then analysis of associated historic artifacts is sometimes required.

1.3 Environmental Setting

1.3.1 Natural Environment

Honouliuli Ahupua'a is the largest traditional land unit on O'ahu, extending from the West Loch of Pearl Harbor in the east, to the border of Nānākuli Ahupua'a at Pili o Kahe in the west. Honouliuli Ahupua'a includes approximately 19 km (kilometers), or 12 mi (miles) of open coastline from One'ula westward to Pili o Kahe. The *ahupua'a* extends *mauka* (inland) from West Loch nearly to Schofield Barracks in Wahiawā; the western boundary is the Wai'anae Mountain crest running north as far as Pu'u Hāpapa (or to the top of Ka'ala Mountain, according to some).

Topographically, the southern (south of Farrington Highway) project area is most notable for a scarp feature, typically 50 ft (15 m) high, which runs roughly north/south through the southeastern portion of the project area. This scarp is a Pleistocene fossil sea bluff. In the northern section, the land is generally flat, except along Honouliuli Gulch, which runs through the center of this project area section.

Lying in the lee of the Wai'anae mountain range, the project area is one of the driest areas of O'ahu with most of the area averaging about 18 inches of rainfall annually (Juvik and Juvik 1998:56). Temperatures range between 60° to 90° through the year; the highest temperatures are in August and September (Armstrong 1973). Elevation in the project area ranges from 40 ft (feet) AMSL (above mean sea level) to 240 ft, or 12 to 73 m (meters). The project area is located on the 'Ewa Plain, which is a Pleistocene (>38,000 years old) reef platform overlain by alluvium from the southern end of the Wai'anae Mountain Range. This alluvium supported commercial sugar cane cultivation for over a century. Honouliuli Stream extends (roughly northwest to southeast) through the center of the northern section (between I H-1 and Farrington Highway) of the main project area.

In pre-contact Hawai'i the project area would have been mostly lowland dry shrub and grassland, dominated by species such as *wiliwili* (*Erythrina sandwicensis*), *lama* (*Diospyros ferrea*), sandalwood (*Santalum* sp.), *'a'ali'i* (*Dodonea eriocarpa*), scrub *'ōhi'a* (*Metrosideros collina*) and *pili* grass (*Heteropogon contortus*). Today the non-cultivated portions of the project area are dominated by introduced species such as *kiawe* and *koa haole*. Understory plants include *'ilima ku kula* (*Sida cordifola*), cayenne vervain (*Stachytarpheta urticaefolia*), *ko'oko'olau* (*Bidens pilosa*), and morning glory (*Ipomoea indica*) (Moore and Kennedy 2002:3). The vast majority of the project area consists of plowed fields, with crops of pumpkins, squash, cucumbers, bananas, beans, and other vegetable products.

A total of ten soil series are found in the project area (Figure 4). The Ewa Series consists of well-drained soils in basins and on alluvial fans, developed in alluvium derived from basic igneous rock. They are nearly level to moderately sloping. These soils are used for sugarcane, truck crops, and pasture. The Helemano series consists of well-drained soils on alluvial fans and colluvial slopes on the sides of gulches, which developed in alluvium and colluvium derived from basic igneous rock. They are steep to extremely steep. These soils are used for pasture, woodland, and wildlife habitat. The Honouliuli series consists of well-drained soils on coastal plains; the soils developed in alluvium derived from basic igneous material. They are nearly level and gently sloping. These soils are used for sugarcane, truck crops, orchards, and pasture. The Kaloko Series consists of poorly drained soils on coastal plains. These soils developed in alluvium derived from basic igneous rock; the alluvium has been deposited over marly lagoon deposits. The soils are nearly level. These soils are used for irrigated sugarcane and pasture. The Kawaihapai Series consists of well-drained soils in drainageways and on alluvial fans on the coastal plains. The soils formed in alluvium derived from basic igneous rock in humid uplands. These soils are used for sugarcane, truck crops, and pasture. The Keaau Series consists of poorly drained soils on coastal plains, which developed in alluvium deposited over reef limestone or consolidated coral sand. They are nearly level and gently sloping. These soils are used for sugarcane and pasture. The Kunia Series consists of well-drained soils on upland terraces and fans; the soils developed in old alluvium. They are nearly level to moderately sloping. These soils are used for sugarcane, pineapple, homesites, and military reservations. The Molokai Series consists of well-drained soils on uplands, formed in material weathered from basic igneous rock. They are nearly level to moderately steep. These soils are used for sugarcane, pineapple, pasture, wildlife habitat, and homesites. The Waialua Series consists of moderately well drained soils on alluvial fans; these soils developed in alluvium weathered from basic igneous rock. They are nearly level to steep. These soils are used for sugarcane, truck crops, orchards, and pasture (Foote et al. 1972).

Four sections of the project area were selected for backhoe testing. Honouliuli clay, 0 to 2 percent slopes (HxA) is found adjacent to Old Fort Weaver Road where seven trenches were placed to test for the remains of a nineteenth century Catholic Church (Kapalani Church) and where one trench was placed to test for the remains of a early twentieth century plantation village (Drivers/Stable Village). This soil occurs in the lowlands along the coastal plains. Waialua silty clay, 0 to 3 percent slopes (WkA) is found adjacent (and west) of the HxA soils in the Kapalani Church testing area. This soil is found on smooth coastal plains. Waipahu silty clay, 0 to 2 percent slopes (WzA) is the dominant soil on the top of the scarp. Two areas selected for backhoe testing, the remains of PipeLine Village, and the Honouliuli Taro Lands, had this soil type. This soil is nearly level and occurs on dissected terraces near the ocean. Waipahu silty clay, 2 to 6 percent slopes (WzB) also occurred in the Honouliuli Taro Lands backhoe testing area.

1.3.2 Built Environment

In the post-contact period the project area has been mainly used as pastureland and for sugar cane irrigation and cultivation. Recently (since the 1990 survey of the project) the area has been used for produce farming.

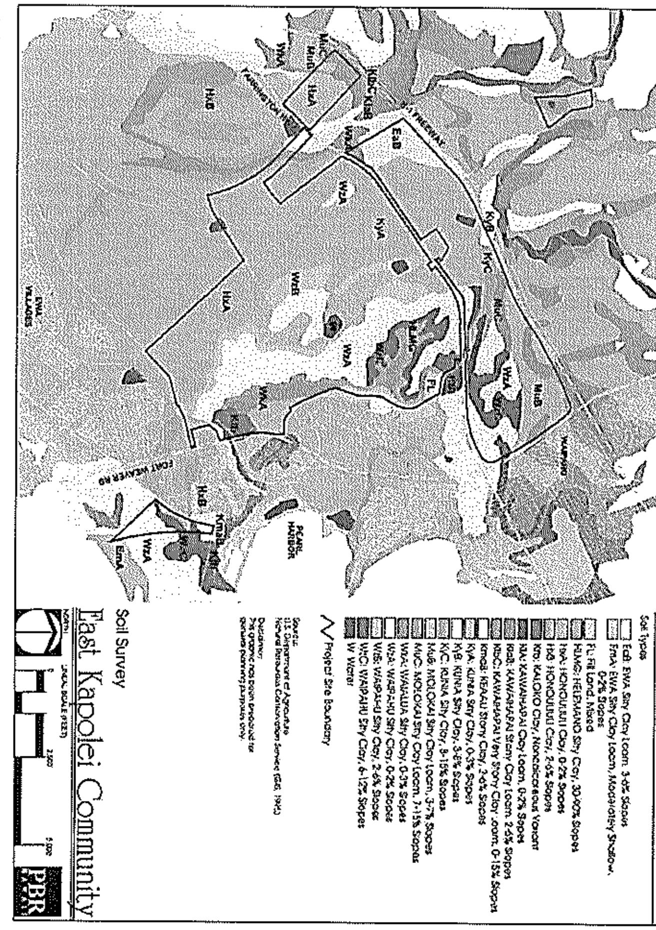

Figure 4. Soil Map of East Kapolei Community Project Area

Section 2 Methods

Background research included a review of previous archaeological studies on file at the State Historic Preservation Division, and a review of geology and cultural history documents at Hamilton Library at the University of Hawai'i, the Hawai'i State Archives, the Hawai'i Public Library, and the Archives of the Bishop Museum. Further research included a study of historic photographs at the Archives of the Bishop Museum and a study of historic maps at the Survey Office of the Department of Accounting and General Services. Information on LCAs was accessed through Waihona 'Āina Corporation's Māhele Data Base (www.waihona.com).

2.1 Field Methods

The pedestrian inspection of the main project area was conducted on November 21 and 22, 2005 with four Cultural Surveys Hawai'i staff archaeologists, Constance R. O'Hare, B.A., Owen O'Leary, M.A., Guadalupe Ochoa, B.A., and Brad Garrett, M.A., under the general direction of Hallett H. Hammatt, Ph.D. On January 13, 2006, the two small non-contiguous parcels of the project were surveyed (Figures 5 and 6). At least 75% of the project area has been denuded of all natural vegetation and has been recently plowed and planted with pumpkins, squash, and other vegetables (Figure 7). There are a few areas marked off for other crops, such as bananas and beans. All areas outside plowed fields were surveyed on foot. In the northern section of the project area (north of Farrington Highway) the northwest corner and a larger area to the east of Honouliuli Gulch was surveyed by pedestrian sweeps. Honouliuli Gulch was surveyed by a team of three archaeologists, one sweep moving downstream on one bank and a second sweep moving upstream on the opposite bank (Figure 8). In the southern section, the non-plowed areas surrounding the underground pipelines were surveyed. Sites previously identified during the 1990 CSH survey (Hammatt and Shideler 1990) of the eastern 546-acre parcel were revisited and additional notes were taken on their construction and their current condition.

All significant historic properties encountered were recorded and documented with a brief written field description, a sketch map, and photographs. Each site was also located using GPS survey technology. In total, in addition to the five previously identified sites found during the CSH 1990 survey (Hammatt and Shideler 1990; see Introduction section), four new features, all found along Honouliuli Gulch, were recorded. All features were initially given CSH temporary numbers (CSH 1-4), and were later given feature designations as part of a previously designated site, 50-80-12-4344, a site number used for sugar cane plantation infrastructure features.

Sub-surface testing was conducted in four specific portions of the project area; areas that could potentially contain buried cultural layers or artifacts. This testing was conducted on November 28, and December 8 and 9, 2005 by CSH archaeologists Constance R. O'Hare, B.A., Owen O'Leary, M.A., Guadalupe Ochoa, B.A., Brad Garrett, M.A., and Jon Tulchin, B.A., under the general direction of Hallett H. Hammatt, Ph.D. Subsurface testing consisted of the excavation of 19 backhoe trenches. These trenches were excavated to a total depth of 2.0-3.0 m. A 70 cm (centimeter) wide bucket was used on the backhoe, and one-bucket width trenches were dug. All excavations were closely monitored by CSH personnel. Trenches were placed to test for subsurface deposits in four specific former habitation loci, as well as to provide adequate coverage of these four areas.

Figure 5. Non-contiguous parcel east of Fort Weaver Road (TMK 9-1-001:002), showing koa haole on western half and low grass on eastern half

Figure 6. Non-contiguous parcel north of the H-1 interstate, showing bulldozed reservoir area

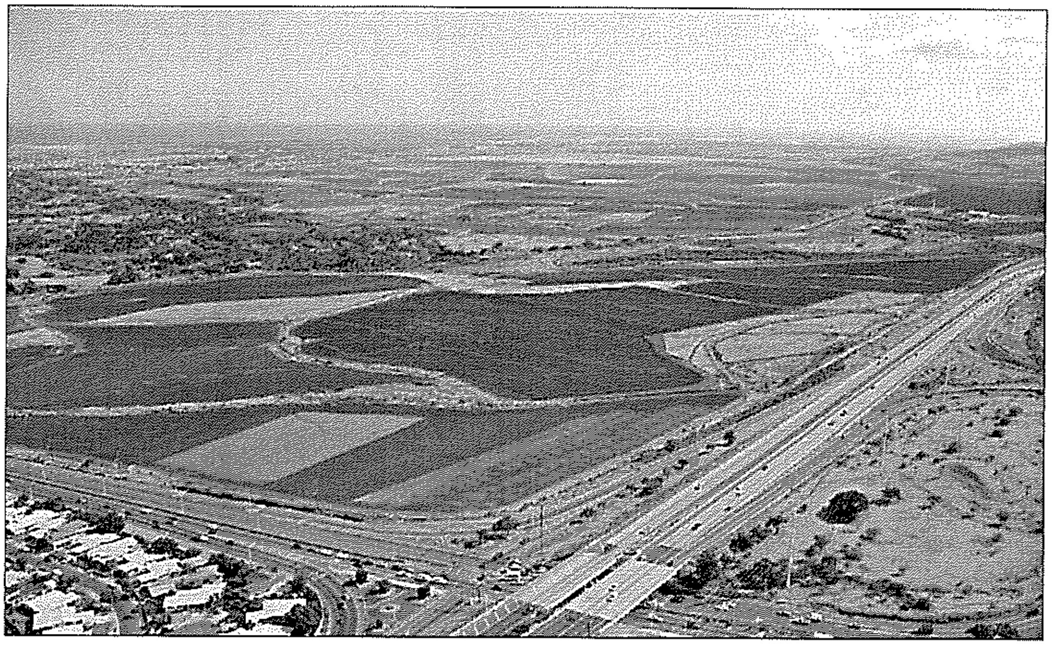

Figure 8. Aerial photograph of northern section of the project area taken near the intersection of H-1 Interstate and Fort Weaver Road; plowed fields in foreground, Honouliuli Gulch in background (shown by the alignment of trees)

Figure 7. 2000 Aerial photograph of main project area (TMK 9-1-017, 9-1-018), showing plowed fields

The stratigraphy of one profile wall was drawn and photographed; sediments were described for each of the 19 trenches. Sediment descriptions include Munsell color, texture, consistence, structure, plasticity, cementation, origin of sediments, descriptions of inclusions, lower boundary distinctiveness and topography, and other general observations. Fieldwork was conducted under state archaeological fieldwork permit No. 0508 issued by SHPD, per Hawai'i Administrative Rules (HAR) Chapter 13-13-282. The field effort, the surface pedestrian survey (2 days with a crew of 3-4 people), and the subsurface testing with a backhoe required 23 person-days to complete.

2.2 Laboratory Methods

Because no archaeological artifacts were discovered, no laboratory work was undertaken.

2.3 Consultation

As partial fulfillment for the Scope of Work (SOW), consultation with organizations and the community are currently being conducted to identify *kūpuna* and other individuals with knowledge of the history of the project area and its surroundings. The results of these interviews will be presented in a companion report for this project, titled "Cultural Impact Assessment for the East Kapolei Project." The on-going consultation with organizations include the Office of Hawaiian Affairs, the O'ahu Island Burial Council, 'Ahahui Siwila Hawai'i O Kapolei Hawaiian Civic Club, 'Ewa Task Force, 'Ewa Neighborhood Board, Hawaii Plantation Village, and Immaculate Conception Church in 'Ewa. A table of informants that will be contacted is presented below:

Table 1.Contact List of Community Members and Organizations for a Cultural Impact Assessment

Name	Affiliation
Aila, William	Hui Malama
Alexander, Jeff	'Ewa Neighborhood Board Member
Bautista, Gary	'Ewa Neighborhood Board Member (Chair)
Cayan, Coochie	O'ahu Island Burial Council
Eaton, Arline	*Kūpuna* at Iroquois Elementary School
Hirata, Richard	President of Hawaii Plantation Village; he was raised at the 'Ewa Plantation
Kane, Shad	Makakilo, Kapolei, Honokai Hale Neighborhood Board Member
Malama, Tesha	Former 'Ewa Neighborhood Board member
Nāmu'o, Clyde	Administrator at Office of Hawaiian Affairs
Oshiro, Richard	Former 'Ewa Plantation employee
Paishon, Frank	Raised in Tenney Village
Ramos, Rodolfo	Chair of 'Ewa Task Force
Sato, Melvin	Raised in Ewa Plantation "C" Village
Serrao, Mary	President of Pu'uloa Outrigger Canoe Club
Soma, Millie	Raised in 'Ewa Plantation Tenney Village
Soma, Kenneth	Former 'Ewa Plantation Employee and resident
Quintal, Leti	Raised in 'Ewa Plantation Secretary for the Immaculate Conception Church

Section 3 Background Research

3.1 Mythological and Traditional Accounts

The traditions of Honouliuli Ahupua'a have been compiled by several authors, in studies by Sterling and Summers (1978), Hammatt and Folk (1981), Kelly (1991), Charvet-Pond and Davis (1992), Maly (1992), and Tuggle and Tomonari-Tuggle (1997). Some of the traditional themes associated with this area include connections with Kahiki, the traditional homeland of Hawaiians in central Polynesia. There are several versions of the chief Kaha'i leaving from Kalaeloa for a trip to Kahiki; on his return to the Hawaiian Islands he brought back the first breadfruit (Kamakau 1991a:110) and planted it at Pu'uloa, near Pearl Harbor in 'Ewa (Beckwith 1940:97). Several stories associate places in Honouliuli to the gods Kāne and Kanaloa, with the Hawaiian pig god Kamapua'a and the Hina family, and with the sisters of Pele, the Hawaiian volcano goddess, all of who have strong connections with Kahiki (Kamakau 1991a:111; Pukui et al. 1974:200). The locations of traditional places names for Honouliuli are illustrated in Figure 9.

3.1.1 The Naming of 'Ewa and Honouliuli

Honouliuli is the largest *ahupua'a* in the *moku* (district) of 'Ewa. One translation of the name for this district is given as "unequal" (*Saturday Press* Aug. 11, 1883). Others translate the word as "strayed" and associate it with the legends of the gods, Kāne and Kanaloa.

> When Kane and Kanaloa were surveying the islands they came to Oahu and when they reached Red Hill saw below them the broad plains of what is now Ewa. To mark boundaries of the land they would throw a stone and where the stone fell would be the boundary line. When they saw the beautiful land lying below them, it was their thought to include as much of the flat level land as possible. They hurled the stone as far as the Waianae range and it landed somewhere, in the Waimanalo section. When they went to find it, they could not locate the spot where it fell. So Ewa (strayed) became known by the name. The stone that strayed [Told to E.S. by Simeon Nawaa, March 22, 1954; cited in Sterling and Summers 1978:1].

Honouliuli means "dark water," "dark bay," or "blue harbor" and was named for the waters of Pearl Harbor (Jarrett 1930:22), which marks the eastern boundary of the *ahupua'a*. The Hawaiians called Pearl Harbor, Pu'uloa (*lit.* long hill). Another explanation for the names comes from the "Legend of Lepeamoa", the chicken-girl of Pālama. In this legend, Honouliuli is the name of the husband of the chiefess Kapālama and grandfather of Lepeamoa (Thrum 1923:164-184). "Her grandfather gave his name, Honouliuli to a land district west of Honolulu . . ." (Thrum 1923:170). Westervelt (1963:209) gives an almost identical account.

It seems likely the boundaries of the western-most *ahupua'a* of 'Ewa were often contested with Wai'anae people. The 'Ewa people could cite divine sanction that the dividing point was between two hills at Pili o Kahe:

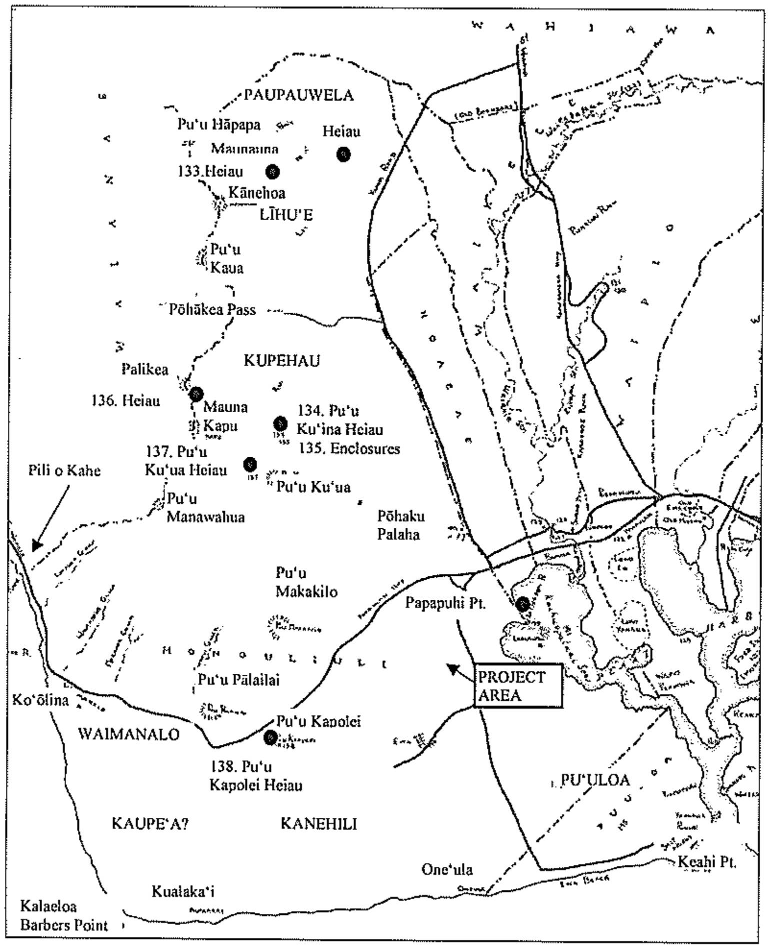

Figure 9. Place Names of Honouliuli (map adapted from Sterling and Summers 1978)

Eventually the stone was found at Pili o Kahe. This is a spot where two small hills of the Wai'anae Range come down parallel on the boundary between Honouliuli and Nānākuli ('Ewa and Wai'anae). The ancient Hawaiians said the hill on the 'Ewa side was the male and the hill on the Wai'anae side was female. The stone was found on the Waianae side hill and the place is known as Pili o Kahe.

> (Pili=cling to, Kahe=flow). The name refers, therefore, to the female or Waianae side hill. And that is where the boundary between the two districts runs [Told to E.S. by Simeon Nawaa, March 22, 1954; cited in Sterling and Summers 1978:1].

3.1.2 Pu'u o Kapolei and the Plains of Kaupa'e

Pu'uokapolei is a prominent hill at the *mauka* edge of the coastal 'Ewa Plains and was the primary landmark for travelers on the trail that ran from Pearl Harbor west to Wai'anae ('Ī'ī 1959:27, 29; Nakuina 1992:54; E.M. Nakuina 1904, in Sterling and Summers 1978:34).

3.1.2.1 Pu'u o Kapolei, Astronomical Marker and Heiau

Pu'u means hill and Kapolei means "beloved Kapo," a reference to the sister of the Hawaiian volcano goddess, Pele. Samuel Kamakau (1976:14) says that ancient Hawaiians used Pu'uokapolei as an astronomical marker to designate the seasons. Samuel Kamakau (1870 *Mo'olelo Hawai'i* Vol. I, Chap. 2, p. 23) relates:

> . . . the people of O'ahu reckoned from the time when the sun set over Pu'uokapolei until it set in the hollow of Mahinaona and called this period Kau [summer], and when it moved south again from Pu'uokapolei and it grew cold and the time came when young sprouts started, the season was called from their germination (*'ōilo*) the season of Ho'oilo [winter, rainy, season].

A *heiau* was once on Pu'uokapolei, but had been destroyed by McAllister's (1933:108) survey of the island in the early 1930s. The hill was used as a point of solar reference or as a place for such observations (Fornander 1919, Vol. VI, Part 2:292). Pu'uokapolei may have been regarded as the gate of the setting sun, just as the eastern gate of Kumukahi in Puna is regarded as the rising sun; both places are associated with the Hawaiian goddess Kapo (Emerson 1915:41). This somewhat contradicts some Hawaiian cosmologies, in which Kū was the god of the rising sun, and Hina, the mother of Kamapua'a was associated with the setting sun. Fornander (Fornander 1919, Vol. VI, Part 2:292) states that Pu'uokapolei may have been a jumping off place (also connected with the setting sun) and associated with the wandering souls who roamed the plains of Kaupe'a and Kāne-hili, *makai* of the hill.

3.1.2.2 Pu'u o Kapolei and the Plains of Kaupe'a and Kāne-hili

Hi'iaka sang this bitter chant addressed to Lohiau and Wahine-oma'o, which uses the association of the Plains of Kaupe'a as a place for the wandering of lost souls:

> *Ku'u aikana i ke awa lau o Pu'uloa,*
> *Mai ke kula o Pe'e-kaua, ke noho oe,*
> *E noho kaua e kui, e lei i ka pua o ke kauno'a,*

I ka pua o ke akuli-kuli, o ka wili-wili;
O ka iho'na o Kau-pe'e i Kane-hili,
Ua hili au; akahi no ka hili o ka la pomaika'i;
E Lohiau ipo, e Wahine-oma'o,
Hoe 'a mai ka wa'a i a'e aku au.

We meet at Ewa's leaf-shaped lagoon, friends;
Let us sit, if you will on this lea
And bedeck us with wreaths of Kauno'a,
Of akuli-kuli and wili-wili,
My soul went astray in this solitude;
It lost the track for once, in spite of luck,
As I came down the road to Kau-pe'a.
No nightmare dream was that which tricked my soul.
This way, dear friends; turn the canoe this way;
Paddle hither and let me embark
[Emerson 1915:162-163].

Several other Honouliuli places are mentioned in this chant, including Pe'e-kaua, which may be a variation of Kau-pe'e or Kaupe'a, and the plains of Kānehili, the last of which again refers to wandering, as the word *hili* means "to go astray" (Emerson 1915:162). In the chant, Hi'iaka is moving downhill from Kaupe'a, probably the plains adjacent to Pu'uokapolei, toward the coast, the plain of Kānehili.

3.1.2.3 The plains of Kaupe'a and Pu'u Kapolei and the Realm of Homeless Souls

There are several places on the 'Ewa coastal plain that are associated with *ao kuewa*, the realm of the homeless souls. Samuel Kamakau (1991b:47-49) explains the Hawaiian beliefs in the afterlife:

> . . . There were three realms (*ao*) for the spirits of the dead. . . There were, first, the realm of the homeless souls, the *ao kuewa*; second, the realm of the ancestral spirits, the *ao 'aumakua*; and third, the ream of Milu, *ke ao o Milu* . . .
>
> The *ao kuewa*, the realm of homeless souls, was also called the *ao 'auwana*, the realm of wandering souls. When a man who had no rightful place in the *'aumakua* realm (*kanaka kuleana 'ole*) died, his soul would wander about and stray amongst the underbrush on the plain of Kama'oma'o on Maui, or in the *wiliwili* grove of Kaupe'a on Oahu. If his soul came to Leilono [in Halawa, 'Ewa near Red Hill], there he would find the breadfruit tree of Leiwalo, *ka 'ulu o Leiwalo*. If it was not found by an *'aumakua* soul who knew it (*i ma'a mau iaia*), or one who would help it, the soul would leap upon the decayed branch of the breadfruit tree and fall down into endless night, *the pō pau 'olo o Milu*. Or, a soul that had no rightful place in the *'aumakua* realm, or who had no relative or friend (*makamaka*) there who would watch out for it and welcome it, would slip over the flat lands like a

> wind, until it came to a leaping place of souls, a *leina a ka 'uhane*. . . . [Kamakau 1991b:47].
>
> On the plain of Kaupe'a beside Pu'uloa [Pearl Harbor], wandering souls could go to catch moths (*pulelehua*) and spiders (*nanana*). However, wandering souls could not go far in the places mentioned earlier before they would be found catching spiders by 'aumakua souls, and be helped to escape. . . . [Kamakau 1991b:49].

The breadfruit tree Leilono was said to have been located on the 'Ewa-Kona border, above Āliamanu. In another section of his account of the dead, Kamakau calls the plain of wandering souls the "plain at Pu'uokapolei."

> There are many who have died and have returned to say that they had no claim to an 'aumakua [realm] (*kuleana'ole*). These are the souls, it is said, who only wander upon the plain of Kama'oma'o on Maui or on the plain at Pu'uokapolei on Oahu. Spiders and moths are their food [Kamakau 1991b:29].

This association of Pu'u Kapolei and Kānehili with wandering souls is also illustrated in a lament on the death of Kahahana, the paramount chief of O'ahu, who was killed by his father, Kahekili, after Kahahana became treacherous and killed the high priest Kaopulupulu.

Go carefully lest you fall dead in the sun,	*E newa ai o hea make i ka la,*
The god that dwells on Kapolei hill.	*Akua noho la i Puuokapolei.*
The sun is wailing on account of the women of Kamao,	*E hanehane mai ana ka la i na wahine o Kamao,*
A hiding god, blossoming ohai of the banks,	*Akua pee, pua ohai o ke kaha,*
Contented among the stones-	*I walea wale i ke a-*
Among the breadfruit planted by Kahai.	*I ka ulu kanu a Kahai.*
Thou wast spoken of by the oo-	*Haina oe e ka oo-*
By the bird of Kanehili.	*E ka manu o Kanehili.*
[Fornander 1919, Vol. VI, Part 2:297]	

Fornander provides some notes on this lament. The god dwelling at Kapolei is the god Kahahana, stating that this is where his soul has gone. Kamao is one of the names of the door to the underworld. This lament draws an association with wandering souls and the place where the first breadfruit tree was planted by Kahai at Pu'uloa (Fornander 1919, Vol. VI, Part 2:304).

Pukui (1983:180) offers this Hawaiian saying, which places the wandering souls in a *wiliwili* grove at Kaupe'a.

> *The wiliwili grove of Kaupe'a* Ka wiliwili of Kaupe'a.
> In 'Ewa, O'ahu. Said to be where homeless ghosts wander among the trees.
> [Pukui 1983:#1666].

Beckwith (1940:154) has stressed that "the worst fate that could befall a soul was to be abandoned by its *'aumakua* and left to stray, a wandering spirit (*kuewa*) in some barren and desolate place." These wandering spirits were often malicious, so the places that they wandered were avoided.

3.1.2.4 The Plain of Pukaua

The Hawaiian language newspaper *Ka Loea Kālai'āina*, (January 13, 1900) relates that near Pu'uokapolei, on the plain of Pukaua, on the *mauka* side of the road, there was a large rock. This legend suggests that the plain around Pu'u o Kapolei was called Pukaua. The legend is as follows:

> If a traveler should go by the government road to Waianae, after leaving the village of gold, Honouliuli, he will first come to the plain of Puu-ainako and when that is passed, Ke-one-ae. Then there is a straight climb up to Puu-o-Kapolei and there look seaward from the government road to a small hill, That is Puu-Kapolei. . . . You go down some small inclines, then to a plain. This plain is Pukaua and on the mauka side of the road, you will see a large rock standing on the plain. . . . There were two supernatural old women or rather peculiar women with strange powers and Puukaua belonged to them. While they were down fishing at Kualaka'i [near Barbers Point] in the evening, they caught these things, *'a'ama* crabs, *pipipi* shellfish, and whatever they could get with their hands. As they were returning to the plain from the shore and thinking of getting home while it was yet dark, they failed for they met a one-eyed person [bad omen]. It became light as they came near to the plain, so that passing people were distinguishable. They were still below the road and became frightened lest they be seen by men. They began to run - running, leaping, falling, sprawling, rising up and running on, without a thought of the *'a'ama* crabs and seaweeds that dropped on the way, so long as they would reach the upper side of the road. They did not go far for by then it was broad daylight. One woman said to the other, "Let us hide lest people see us," and so they hid. Their bodies turned into stone and that is one of the famous things on this plain to this day, the stone body. This is the end of these strange women. When one visits the plain, it will do no harm to glance on the upper side of the road and see them standing on the plain [*Ka Loea Kālai'āina*, January 13, 1900, translation in Sterling and Summers 1978:39].

In another version of this story, the two women met Hi'iaka as she journeyed toward the 'Ewa coast. The women were *mo'o* (supernatural beings) and were afraid that Hi'iaka would kill them, so they changed into their lizard form. One of the lizards hid in a little space on a stone beside the coastal trail, and the other hid nearby (*Ka Hōkū o Hawai'i*, February 15, 1927, translated in Maly 1997:19). From that time on the stone was known as *pe'e-kāua*, meaning "we two hidden." Hi'iaka greeted the two women but did not harm them, and passed on.

When she reached Pu'u o Kapolei, she also greeted two old women who lived at a *'ohai* grove on the hill. These women were named Pu'uokapolei and Nāwaineokama'oma'o (*Ka Hōkū o Hawai'i*, February 22, 1927, translated in Maly 1997:19). As she continued her travels, she looked to the ocean and saw the canoe carrying Lohi'au.

My man on the many harbored sea of Pu'uloa	*Ku'u kāne i ke awa lau o Pu'uloa*
As seen from the plain of Pe'ekāua	*Mai ke kula o Pe'ekāua ke noho*
Let us dwell upon the 'ōhai covered shore	*E noho kāua i ke kaha o ka 'ōhai*

Where the noni blossoms are twisted together	*I ka wiliwili i ka pua o ka lau noni*
Descending along Kānehili	*O ka ihona i Kānehili la*
I am winding along	*Ua hili ho'i au-e*

[*Ka Hōkū o Hawai'i*, February 22, 1927, translated in Maly 1997:20].

3.1.2.5 Pu'u Kapolei and Kamapua'a

Pu'uokapolei's was the home of Kamapua'a's grandmother, Kamaunuaniho, who was one of the three migrants from Kahiki that were ancestors to the people of O'ahu (Fornander 1919, Vol. V, Part 2:318; Kahiolo 1978:81, 107). Kamapua'a, the Hawaiian pig god, once lived in Kaluanui on the windward side, but escaped to 'Ewa when he was pursued by the chief Olopana.

> Kamapua'a subsequently conquered most of the island of O'ahu, and, installing his grandmother [Kamaunuaniho] as queen, took her to Pu'uokapolei, the lesser of the two hillocks forming the southeastern spur of the Wai'anae Mountain Range, and made her establish her court there. This was to compel the people who were to pay tribute to bring all the necessities of life from a distance, to show his absolute power over all [Nakuina 1904:50-51].

Emma Nakuina goes on to note: "A very short time ago [prior to 1904] the foundations of Kamaunuaniho's house could still be seen at Pu'uokapolei." Another account (*Ka Loea Kālai'āina* January 13, 1900, from Sterling and Summers 1978:34) speaks of Kekeleaiku, the older brother of Kamapua'a, who also lived on Pu'uokapolei.

3.1.2.6 The Strife at Honouliuli; Kūali'i unites Hawai'i nei (Mo'olelo o Kūali'i)

The celebrated chief, Kūali'i, is said to have led an army of twelve thousand (*'ekolu mano*) against the chiefs of Ko'olauloa with an army of twelve hundred (*'ekolu lau*) upon the plains of Keahumoa (Fornander 1917 Vol. IV, Part 2:364-401). Perhaps because the odds were so skewed the battle was called off and the *ali'i* of Ko'olau ceded (*ha'awi a'e*) the districts of Ko'olauloa, Ko'olaupoko, Waialua and Wai'anae to Kūali'i. When the *ali'i* of Kaua'i heard of this victory at Honouliuli they gave Kaua'i to Kūali'i as well and thus he became possessed of all the islands (*a lilo a'e la nā moku a pau ia Kūali'i mai Hawai'i a Ni'ihau*). The strife at Honouliuli was the occasion of the recitation of a song for Kūali'i by a certain Kapa'ahulani (*Ka Pule Ana a Kapa'ahulani*). This *mele* compares the king to certain places and objects in the islands, in this instance to the first breadfruit planted by Kahai at Pu'uloa, and a pig and a woman on Pu'u Kapolei, possibly a reference to Kamapua'a and his grandmother.

Not like these art thou, Ku.	*Aole I like Ku.*
Not like the pig	*Aole I like i ka puaa,*
Discerning the progeny of the god;	*I ka weke lao a ke akua,*
[Or] The breadfruit planted by Kahai.	*Ka ulu kanu a Kahai;*
Truly, have you not known	*Oi ole ka oe i ike,*
The woman with the dyed garment,	*Ka wahine pau mao*
On the top of Puuokapolei?	*I ka luna o Puuokapolei-la?*

[Fornander 1917, Vol. IV, Part 2:392-393].

A later section of this *mele* also refers to Pu'u o Kapolei and makes mention of the famous blue poi of Honouliuli.

O Kawelo! Say, Kawelo!	*O Kawelo-e, e Kawelo-e,*
Kawelokiki, the sharp-pointed hill,	*O Kaweloiki puu oioi,*
Hill of Kapolei.	*Puu of Kapolei-e-*
Blue is the poi which appeases [the hunger] of Honouliuli.	*Uliuli ka poi e piha nei-o Honouliuli;*

[Fornander 1917, Vol. IV, Part 2:400-401].

3.1.3 Pearl Harbor (Pu'uloa) and West Loch (Kaihu o pala'ai)

3.1.3.1 The "Silent Fish" of Pearl Harbor

Pearl Harbor was called Pu'uloa or *ke-awa-lau-o-Pu'uloa*, the many harbored-sea of Pu'uloa (Pukui 1983:#1686) by the Hawaiians. An alternate name was Awawa-lei, or "garland (*lei*) of harbors" (Handy and Handy 1972:469). Pukui (1983:#1126] also uses the name *Awalua* for Pearl Harbor, as in the saying "*Huhui na 'ōpua i Awalau*, The clouds met at Pearl Harbor. Said of the mating of two people." Emerson (1915:167) interprets Awalau as "leaf-shaped lagoon."

John Clark (1977:70) says that its English name came from the name Waimomi, or "water of the pearl," an alternate name for the Pearl River (Pearl Harbor). The harbor was named Pearl Harbor after the pearl oysters of the family Pteriidae (mainly *Pinctada radiata*), which were once abundant on the harbor reefs, but were later decimated by over-harvesting. This oyster was supposedly brought from Kahiki, the Hawaiian ancestral lands, by a *mo'o* (lizard or water spirit) named Kane-kua'ana (Handy and Handy 1972:470).

Kanekua'ana was the *kia'i* (food guardian) for 'Ewa. When food was scarce, the descendants of Kanekua'ana built *waihau heiau* (a *heiau* for *mo'o*) for her and lit fires to plead for her blessings. For 'Ewa, the chief *i'a* (marine food) blessing was the famous *pipi*, or pearl oyster. Samuel Kamakau describes the *pipi* of Honouliuli.

> That was the oyster that came in from deep water to the mussel beds near shore, from the channel entrance of Pu'uloa to the rocks along the edges of the fishponds. They grew right on the *nahawele* mussels and thus was this *i'a* obtained. Not six months after the *hau* branches [that placed a *kapu* on these waters until the *pipi* should come up] were set up, the *pipi* were found in abundance-enough for all 'Ewa-and fat with flesh. Within the oyster was a jewel (*daimana*) called a pearl (*momi*), beautiful as the eyeball of a fish, white and shining; white as the cuttle fish, and shining with the colors of the rainbow-reds and yellow and blues, and some pinkish white, ranging in size from small to large. They were of great bargaining value (*he waiwai kumuku'ai nui*) in the ancient days, but were just "rubbish" (*'opala*) in 'Ewa [Kamakau 1991b:83].

This oyster, the *pipi*, was sometimes called "the silent fish," or *i'a hamau leo o 'Ewa*, 'Ewa's silent sea creature (Handy and Handy 1972:471), since the collectors were supposed to stay quiet while harvesting the shells, as in the sayings:

> The fish of 'Ewa that silences the voice. *Ka ka'a hāmau leo o 'Ewa.*
> The pearl oyster, which has to be gathered in silence [Pukui 1983:#1331].
>
> 'Ewa is disturbed by the Moa'e wind. *Haunāele 'Ewa i ka Moa'e.*
> Used about something disturbing, like a violet argument. When the people of 'Ewa went to gather the *pipi* (pearl oyster), they did so in silence, for if they spoke, a Moa'e breeze would suddenly blow across the water, rippling it, and the oysters would disappear [Pukui 1983:5#493].
>
> Hush, lest the wind rise. *E hāmau o makani mai auane'i.*
> Hold your silence or trouble will come to us. When the people went to gather pearl oysters at Pu'uloa, they did so in silence, for they believed that if they spoke, a gust of wind would ripple the water and the oysters would vanish [Pukui 1983:#274].
>
> The gesturing fish of 'Ewa. *Ka i'a kuhi lima o 'Ewa.*
> The *pipi*, or pearl oyster. Fishermen did not speak when fishing for them but gestured to each other like deaf-mutes [Pukui 1983:#1357].

Sereno Bishop, an early resident of O'ahu, wrote, of his time in the area around 1836, of the pearl oyster, the *pipi*, and another edible clam, identified by Margaret Titcomb (1979:351) as probably *Lioconcha heiroglyphica*.

> The lochs or lagoons of Pearl River were not then as shoal as now. The subsequent occupation of the uplands by cattle denuded the country of herbage, and caused vast quantities of earth to be washed down by storms into the lagoons, shoaling the water for a long distance seaward. No doubt the area of deepwater and anchorage has been greatly diminished. In the thirties, the small oyster was quite abundant, and common on our table. Small pearls were frequently found in them. No doubt the copious inflow of fresh water favored their presence. I think they have become almost entire extinct, drowned out by the mud. There was also at Pearl River a handsome speckled clam, of a delicate flavor which contained milk white pearls of exquisite luster and perfectly spherical. I think the clam is still found in the Ewa Lochs [Bishop 1901:87].

Older Hawaiians believed that the *pipi* disappeared around the time of the smallpox epidemic of 1850-1853, because Kanekua'ana became displeased at the greed of some *konohiki* (overseer).

> The people of the place believe that the lizard was angry because the konohikis imposed kapus [bans], were cross with the women and seized their catch of oysters. So this "fish" was removed to Tahiti and other lands. When it vanished a white, toothed thing grew everywhere in the sea, of Ewa, which the natives of Ewa had named the pahikaua (sword). It is sharp edged and had come from Kauai-helanai, according to this legend [Manu 1885:50].

Pahikaua is the Hawaiian name for the mussel, *Brachidontes crebristriatus* (Mytilidae), which was also a popular clam eaten by the residents of Pearl Harbor.

A clarification of the story of Kanekua'ana and the pearl oysters of Pearl Harbor is given, in which it seems an overseer had set a ban on the *pipi* for several months a year so that they could increase. A poor widow, a relation of the *mo'o*, took some of the *pipi* and hid them in a basket. The *konohiki* found the hidden shells, and took them from her, emptying them back into the sea, which was proper. However, after this he followed the woman home and also demanded that she pay a stiff fine in cash, which she did not have. The *mo'o* thought this was unjust and the next night she took possession of a neighbor who was a medium.

> . . . After the overseer had gone back to Palea the lizard goddess possessed her aged keeper [a woman of Ewa] and said to those in the house, "I am taking the pipi back to Kahiki and they will not return until all the descendants of this man are dead. I go to sleep. Do not awaken my medium until she wakes of her own accord." The command was obeyed and she slept four days and four nights before she awoke. During the time that she slept the pearl oysters vanished from the places where they were found in great numbers, as far as the shore . . . .The few found today are merely nothing . . . [*Ka Loea Kālai'āina*, June 3, 1899, translation in Sterling and Summers 1978:49-50].

3.1.3.2 Kāne and Kanalao and the Fish Ponds of West Loch

According to an account in the Hawaiian newspaper *Ka Loea Kālai'āina* (June 10, 1899), several of the fishponds in the Pu'uloa area were made by the brother gods, Kāne and Kanaloa. A fisherman living in Pu'uloa, named Hanakahi, prayed to unknown gods, until one day two men came to his house. They revealed to him that they were the gods to whom he should pray. Kāne and Kanaloa then built fishponds at Ke'ana-pua'a, but were not satisfied. Then they built the fishpond, Kepo'okala, but were still not satisfied. Finally they made the pond Kapākule, which they stocked with all manner of fish. They gifted all of these fishponds to Hanakahi and his descendants (Handy and Handy 1972:473; *Ka Loea Kālai'āina*, July 8, 1899).

According to Mary Pukui (1943:56-57), who visited Kapākule fishpond when she was young, the pond was built by the legendary little people of Hawai'i, the *menehune*, under the direction of the gods Kāne and Kanaloa. Pukui describes several unique aspects of this pond:

> On the left side of the pond stood the stone called Hina, which represented a goddess of the sea by that by that name. Each time the sea ebbed, the rock became gradually visible, vanishing again under water at high tide. Ku, another stone on the right, was never seen above sea level. This stone represented Ku'ula, Red Ku, a god for fish and fishermen. From one side of the pond a long wall composed of driven stakes of hard wood, ran toward the island [Laulaunui] in the lochs. When the fish swam up the channel and then inside of this wall, they invariably found themselves in the pond. A short distance from the spot where the pond touched the shore was a small koa or altar composed of coral rock. It was here that the first fish caught in the pond was laid as an offering to the gods [Pukui 1943:56].

The fishpond contained many fish, especially the *akule* (scad fish, *Trachurops crumenophthalmus*), thus its name, "the enclosure for *akule* fish" (Pukui 1943:56-57). The pond was destroyed when the channel to Pearl Harbor was dredged in the early twentieth century. The

caretaker of the pond took the stones Kū and Hina to a deep place in the ocean and sunk them so "none would harm or defile them." Cobb (1903:733) says it was used to catch the larger *akule* (goggler), *opelu* (mackeral scad), *weke* (goat fish), *kawakawa* (bonito), and sharks; it was unusual for having walls made of coral. This contradicts much of the legendary material that says that sharks were not killed within Pearl Harbor; however, Kamakau does relate that Kekuamanoha and Kauhiwawaeono, two conspirators against Kamehameha I, lived at Pu'uloa. The chief Kauhiwawaeono was known to murder people and use their bodies as shark bait (Kamakau 1961:182, 232).

Samuel Kamakau adds more information on the pond Kapākule, and a second one called Kepo'okala.

> At Pu'uloa on Oahu were two unusual ponds [fish traps]—Kapakule and Kepoolala. Kapakule was the better one. The rocks of its walls, *kuapa*, could be seen protruding at high tide, but the interlocking stone walls (*pae niho pohaku*) of the other pond were still under water at high tide. . . . It [Kapakule] was said to have been built by the *'e'epa* people [mysterious people] at the command of Kane ma . . .
>
> This is how the fish entered the pond. At high tide many fish would go past the mauka side of the pond, and when they returned they would become frightened by the projecting shadows of the trunks, and would go into the opening. The fish that went along the edge of the sand reached the seaward wall, then turned back toward the middle and entered the *anapuna* (the arched portion of the trap) A man ran out and placed a "cut-off" seine net (*'omuku lau*) in the opening, and the fish shoved and crowded into it. The fish that were caught in the net were dumped out, and those not caught in the net were attacked with sharp sticks and tossed out, or were seized by those who were strong [Kamakau 1976:88].

3.1.3.3 The Story of Kaihuopala'ai Pond, Honouliuli (Ka'ao no Maikohā)

In the Legend of Maikohā (Fornander 1917, Vol. V, Part 2:270-271), a sister of Maikohā, a deified hairy man who became the god of *tapa* makers, named Kaihuopala'ai, journeys to O'ahu:

> Kaihuopala'ai saw a goodly man by the name of Kapapaapuhi who was living at Honouliuli, 'Ewa; she fell in love with him and they were united, so Kaihuopala'ai has remained in 'Ewa to this day. She was changed into that fishpond in which mullet are kept and fattened, and that fish pond is used for that purpose to this day
>
> *'Ike aku la o Kaihuopala'ai i ka maikai o Kapapaapuhi, he kāne e noho ana ma Honouliuli ma 'Ewa. Moe iho la lāua, a noho iho la o Kaihuopala'ai i laila a hiki i kēia lā. 'Oia kēlā loko kai e ho'opuni ia nei i ka 'anae, nona nā i'a he nui loa, a hiki i kēia kākau ana* [Fornander 1919, Vol. V, Part 2:270].

The name of Maikohā's sister, Kaihu o pala'ai, which means "the nose of Pala'ai" (Pukui et al. 1974:68) is also the name the Hawaiians used for the west loch of Pearl Harbor, adjacent to the current study area. McAllister recorded that other Hawaiians say there never was a fishpond by that name. Beckwith (1918) says that Kaihuopala'ai changed into the fishpond near Kapapapuhi, which means "the eel flats." This is identified on old maps as the point northeast of the current study area (sometimes spelled Kapapa'apuhi) that juts into the loch; early Hawaiian settlement was focused on this area.

There is also a famous *pōhaku*, or rock, associated with the traveling mullet of Pearl Harbor.

> . . . I . . . asked the person sitting on my left, "What place is this?" Answer – "This is Pearl City." It was here that mullets were bred in the ancient times and that flat stone there was called Mullet Rock or Pōhaku Anae. It lies near the beach by Ewa mill [*Ka Nūpepa Kū'oko'a*, Oct. 2, 1908, from Sterling and Summers 1978:53].

3.1.3.4 The Traveling Mullet of Honouliuli (Fish Stories and Superstitions)

The story of Kaihuopala'ai, or Ihuopala'ai, is also associated with the tradition of the *anae-holo*, the traveling mullet of Pearl Harbor (Thrum 1998:270-272):

> The home of the *'anae-holo* is at Honouliuli, Pearl Harbor, at a place called Ihuopala'ai. They make periodical journeys around to the opposite side of the island, starting from Pu'uloa and going to windward, passing successively Kumumanu, Kalihi, Kou, Kālia, Waikīkī, Ka'alāwai, and so on, around to the Ko'olau side, ending at Lā'ie, and then returning by the same course to their starting point [Thrum 1998:271].

In Thrum's account, Ihupala'ai is a male who possesses a Kū'ula or fish god that supplied the large mullet known as "*anae*." His sister lived in Lā'ie, and there came a time when there were no fish to be had. She sent her husband to visit Ihupala'ai, who was kind enough to send the fish following his brother-in-law on his trip back to Lā'ie.

This story is associated with a proverb or poetical saying identified with Honouliuli:

> The fish fetched by the wind. *Ka I'a hali a ka makani*
> The *'anaeholo*, a fish that travels from Honouliuli, where it breeds, to Kaipāpa'u, on the windward side of O'ahu. It then turns about and returns to its original home. It is driven closer to shore when the wind is strong [Pukui 1983:#1330].

Pukui et al. (1974:68) gives the name of the husband in this story as Lā'ie and the name of the wife as Pala'ai, which ties into the name of the west loch of Pearl Harbor, called Ka-ihu o Pala'ai, "the nose of Pala'ai." Another version has a woman named Awawalei (an alternate version for the name of Pearl Harbor), who had a brother named Laniloa (the point on Lā'ie at which the mullet stops its migration and makes its way back to Pearl Harbor), and another brother (a mullet) who lived with an eel named Papa-puhi, which relates to the name of the fishpond in the tale called Kapapapuhi (*Ka Loea Kālai'āina*, Oct. 21, 1899). On historic maps, Kapapapuhi is a point of land that juts into West Loch and was a focus for habitation, taro cultivation, and fishpond maintenance in the early post-Contact (and probably earlier) period.

3.1.3.5 The Caves of Pu'uloa

'Ewa was famous for the many limestone caves formed in the uplifted coral. Some of these caves, called *ka-lua-ōlohe* were inhabited by the *ōlohe*, a type of people that looked like other humans but had tails like dogs (Beckwith 1940:343). These people were skilled in wrestling and bone-breaking and often hid along narrow passes to rob travelers; they were also reputed to be cannibals. The famous cannibal king, Kaupe, who lived in Līhu'e in upland Honouliuli, was an *ōlohe*.

There was once a cave named Kapuna on Waipi'o peninsula that was associated with a famous riddle. *No Kapuna kane hale noho ia e ke kai*, or "To Kapuna belongs the house, the sea dwells in it."

> This cave is on the Waipio side and a sea passage separates Waipio and Waikele and Waikele and Honouliuli. The passage is obstructed by three small islands, a middle one and Manana and Laulaunui. These small islands in the middle of the passage to Honouliuli and inside and outside of these small islands is the sea of Kaihuopalaai [Hawaiian name for West Loch] where mullet lived till they whitened with age [*Ka Loea Kālai'āina*, Oct. 7, 1899, translation in Sterling and Summers 1978:24].

Another famous cave of the area was Keanapua'a [in Halawa opposite Waipi'o peninsula], which means "the pig's cave," so named because Kamapua'a once slept there (Pukui et al. 1974:103). This cave was one of the places where the high king of O'ahu, Kahahana, hid after he had killed the priest Kaopulupulu, thus angering the high chief of Maui, Kahekili (Kahahana's father).

> Upon the arrival here at Oahu of Kahekili, Kahahana fled, with his wife Kekuapoi, and friend Alapai, and hid in the shrubbery of the hills. They went to Aliomanu, Moanalua, to a place called Kinimakalehua; them moved along to Keanapuaa and Kepookala, at the lochs of Puuloa, and then from there to upper Waipio; thence to Wahiawa, Helemano, and on to Lihue; thence the came to Poohilo, at Honouliuli, where they first showed themselves to the people and submitted themselves to their care.
>
> Through treachery, Kahahana was induced to leave Po'ohilo, Honouliuli and was killed on the plains of Hō'ae'ae [Thrum 1906:213-214].

The place Pō'o Hilo was somewhere on the border between Honouliuli and Hō'ae'ae (north of the current study area). In the "Legend of the Sacred Spear-point" (Kalākaua 1990:209-225) is a reference to the Hawai'i Island chief, Hilo-a-Lakapu. Following his unsuccessful raid against O'ahu "he was slain at Waimano, and his head was placed upon a pole near Honouliuli for the birds to feed upon"(Kalākaua 1990:224). This place was called Pō'o Hilo, which literally means "the head of Hilo."

The caves of Pu'uloa were sometimes used as burial caves. In 1849, Keali'iahonui, son of Kaua'i's last king, Kaumuali'i, died. He had once been married to the chiefess Kekau'ōnohi, who had stayed with him until 1849. She wanted to bury her ex-husband at sea.

> It seems that by Kekauonohi's orders, the coffin containing her late husband's remains was removed to Puuloa, Ewa, with the view of having it afterwards taken out to sea and there sunk. It was temporarily deposited in a cavern in the coral limestone back of Puuloa, which has long been used for a burial place, and has lately been closed up [Alexander 1907:27].

After some initial objections by the niece of Kealai'iahonui, the body was removed from the outer coffin, the rest was sunk, and the coffin was later buried somewhere in Pu'uloa.

3.2 Historic Background

3.2.1 Pre-Contact and Early Post-Contact Period

By ca. A.D. 1320, 'Ewa, along with Kona, and Ko'olaupoko were the dominant polities, ruled by the sons of a chief named Māweke (Cordy 2002:21). 'Ewa at this time included the traditional districts of 'Ewa, Wai'anae, and Waialua (Fornander 1880:48). Around A.D. 1400, the entire island was ruled by King La'akona; chiefs within his line, the Māweke-Kumuhonua line, reigned until about A.D. 1520-1540, with their major royal center in Līhu'e, in 'Ewa. (Cordy 2002:24). Haka was the last chief of the Māweke-Kumuhonua line; he was slain by his men at the fortress of Waewae near Līhu'e (Kamakau 1991a:54-54; Fornander 1880:88). Power shifted between the chiefs of different districts from the 1500s until the early 1700s, when Kūali'i achieved control of all of O'ahu by defeating the Kona chiefs, then the 'Ewa chiefs, and then expanding his control on windward Kaua'i. Peleiholani, the heir of Kūali'i, gained control of O'ahu ca. 1740, and later conquered parts of Moloka'i. He was ruler of O'ahu until his death in ca. 1778 when Kahahana, of the 'Ewa line of chiefs was selected as the ruler of O'ahu (Cordy 2002:24-41).

After Kamehameha's O'ahu victory, he gave the *ahupua'a* of Honouliuli to Kalanimōkū as part of the *panalā'au*, or conquered lands, with the right to pass the land on to his heirs rather than having it revert to Kamehameha (Kame'eleihiwa 1992:58, 112). Kalanimōkū subsequently gave the *ahupua'a* to his sister, Wahinepi'o.

Various Hawaiian legends and early historical accounts indicate that the *ahupua'a* (land division) of Honouliuli was once widely inhabited by pre-Contact populations, including the Hawaiian *ali'i* (chiefly class). This would be attributable for the most part to the plentiful marine and estuarine resources available at the coast, along which several sites interpreted as permanent habitations and fishing shrines have been located. Other attractive subsistence-related features of the *ahupua'a* include irrigated lowlands suitable for wetland taro cultivation, as well as the lower forest area of the mountain slopes for the procurement of forest resources. Handy and Handy (1972:429) report:

> The lowlands, bisected by ample streams, were ideal terrain for the cultivation of irrigated taro. The hinterland consisted of deep valleys running far back into the Ko'olau range. Between the valleys were ridges, with steep sides, but a very gradual increase of altitude. The lower part of the valley sides were excellent for the cultivation of yams and bananas. Farther inland grew the 'awa for which the area was famous.

In addition, breadfruit, coconuts, *wauke* (paper mulberry; *Broussonetia papyrifera*), bananas, and *olona* (*Touchardia latifolia*) and other plants were grown in the interior. 'Ewa was known as one of the best areas to grow gourds and was famous for its *mamaki*. It was also famous for a rare taro called the *kai o 'Ewa*, which was grown in mounds in marshy locations (Handy and Handy 1972:471). The cultivation of this prized and delicious taro led to the saying:

> He has eaten the Kāī-koi taro of 'Ewa. *Ua 'ai i ke kāī-koi o 'Ewa.*
> Kāī is O'ahu's best eating taro; one who has eaten it will always like it. Said of a youth of a maiden of 'Ewa, who, like the Kāī taro, is not easily forgotten [Pukui 1983:#2770].

The lochs of Pearl Harbor were ideal for the construction fishponds and fishtraps. Forest resources along the slopes of the Wai'anae Range probably acted as a viable subsistence alternative during times of famine and/or low rainfall (Handy 1940:211; Handy and Handy 1972:469-470). The upper valley slopes may have also been a resource for sporadic quarrying of basalt used in the manufacturing of stone tools. At least one probable quarrying site (SIHP site 50-80-12-4322) is present in Maka'īwa Gulch at 152 m (500 ft) above mean sea level (Hammatt, Robins, et al. 1990).

John Papa 'Ī'ī describes a network of Leeward O'ahu trails (Figure 10), which in historic times encircled and crossed the Wai'anae Range, allowing passage from Lualualei to Honouliuli by three different trails ('Ī'ī 1959:96-98). The coastal trail skirted Pearl Harbor, passing by Pu'u o Kapolei; this would have been the nearest of three Honouliuli trails to the current project area. Following 'Ī'ī's description, a portion of this trail network would have passed close to the existing Farrington Highway, near the north border of the project area, as seen in an 1825 map (Figure 11) map of the south coast of O'ahu by Charles Malden of the British ship the *Blonde*.

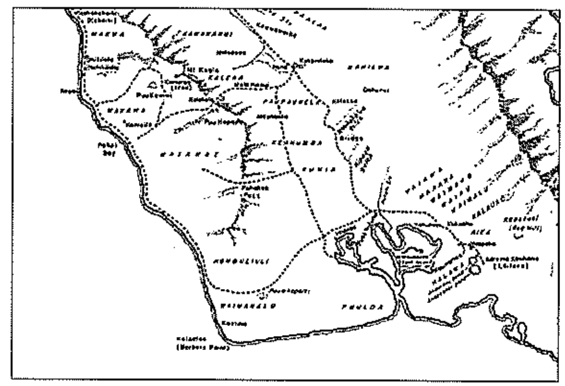

Figure 10. Trails of Leeward Oahu. Map by Paul Rockwood. ('Ī'ī 1959:96) Mid- to late-1800s

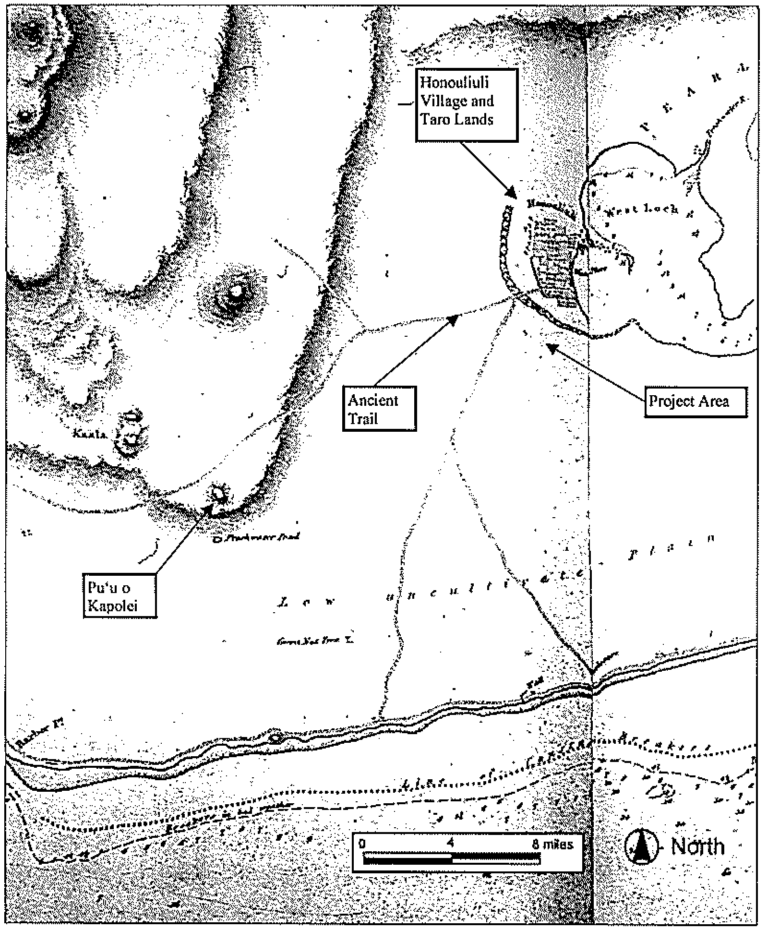

Figure 11. Portion of 1825 Map of the South Coast of Woahoo (O'ahu) and Honolulu by Lieut. C.R. Malden from the British ship the *Blonde*

The trail is described by 'Ī'ī as:

> The trail went down to the stream and up again, then went above the taro patches of Waiau, up to a *makai* field, to Waimano, to Manana, and to Waiawa; then to the stream of Kukehi and up to two other *maika* fields, Pueohulunui and Haupuu. At Pueohulunui was the place where a trail branched off to go Waialua and down to Honouliuli and on to Waianae. As mentioned before, there were three trails to Waianae, one by way of Pu'u o Kapolei, another by way of Pohakea, and the third by way of Kolekole ['Ī'ī 1959:97].

Early historical accounts of the general region typically refer to the more populated areas of the 'Ewa district, where missions and schools were established and subsistence resources were perceived to be greater. However, the presence of archaeological sites along the barren coral plains and coast of southwest Honouliuli Ahupua'a, indicate that prehistoric and early historic populations also adapted to less inviting areas, despite the environmental hardships.

3.2.2 Observations of Early Explorers and Foreign Residents

Captain Vancouver sailed by Kalaeloa (Barbers Point) in 1792, and recorded his impression of the small coastal village of Kualaka'i and the arid Honouliuli coast.

> The point is low flat land, with a reef round it . . . Not far from the S.W. point is a small grove of shabby cocoa-nut trees, and along these shores are a few struggling fishermen's huts [Vancouver 1798, Vol. I:167].

> . . . from the commencement of the high land to the westward of Opooroah [Pu'uloa], was composed of one very barren rocky waste, nearly destitute of verdure, cultivation or inhabitants, with little variation all the way to the west point of the island . . . [Vancouver 1798, Vol. II:217].

> . . . This tract of land was of some extent but did not seem to be populous, nor to possess any great degree of fertility; although we were told that at a little distance from the sea, the soil is rich, and all necessaries of life are abundantly produced . . . [Vancouver 1798, Vol. III:361-363].

Archibald Campbell, an English seamen who was given some land in Waimano Ahupua'a by King Kamehameha in 1809, described his land around Pearl Harbor:

> In the month of November the king was pleased to grant me about sixty acres of land, situated upon the Wymummee [traditional Hawaiian name for Pearl River], or Pearl-water, an inlet of the sea about twelve miles to the west of Hanaroora [Honolulu]. . . . We passed by footpaths, winding through an extensive and fertile plain, the whole of which is in the highest state of cultivation. Every stream was carefully embanked, to supply water for the taro beds. Where there was not water, the land was under crops of yams and sweet potatoes [Campbell 1967:103-104].

> Pearl and mother of-pearl shells are found here in considerable quantity. Since the king has learned of their value, he has kept the fishing to himself, and employs divers for the purpose [Campbell 1967:114-115].

Subsequent to western contact in the area, the landscape of the 'Ewa plains and Wai'anae slopes was adversely affected by the removal of the sandalwood forest, and the introduction of domesticated animals and new vegetation species. Domesticated animals, including goats, sheep and cattle, were brought to the Hawaiian Islands by Vancouver in the early 1790s, and allowed to graze freely about the land for some time after. It is unclear when the domesticated animals were brought to O'ahu; however, L.A. Henke reports the existence of a longhorn cattle ranch in Wai'anae by at least 1840 (Frierson 1972:10). During this same time, perhaps as early as 1790, exotic vegetation species were introduced to the area. These typically included vegetation best suited to a terrain disturbed by the logging of sandalwood forest and eroded by animal grazing. Within the current project area, the majority of the (non-cultivated) vegetation is comprised of introduced species, mainly grasses.

At contact, the most populous *ahupua'a* on the island was Honouliuli, with the majority of the population centered on Pearl Harbor. In 1832, a missionary census of Honouliuli recorded the population as 1,026. Within four years the population was down to 870 (Schmitt 1973:19, 22). In 1835, there were eight to ten deaths for every birth (Kelly 1991:157-158). Between 1848 and 1853, there was a series of epidemics of measles, influenza, and whooping cough that often wiped out whole villages. In 1853, the population of 'Ewa and Wai'anae combined was 2,451 people. In 1872, it was 1,671 (Schmitt 1968:71). The inland area of 'Ewa was probably abandoned by the mid-nineteenth century, due to population decline and consolidation of the remaining people in the town of Honouliuli (at Papapuhi Point, northeast of the project area). A detailed discussion of the historic population counts in the 'Ewa District has been presented by Charvet-Pond and Davis (1992).

The first mission station in Ewa was established in 1834 at Kalua'aha near Pearl Harbor. Charles Wilkes, of the U.S. Exploring Expedition visited the missionary enclave at Honouliuli town in 1840.

> At Ewa, Mr. Bishop has a large congregation. The village comprises about fifty houses, and the country around is dotted with them. . . . The natives have made some advance in the arts of civilized life; there is a sugar-mill which, in the season, makes two hundred pounds of sugar a day. . . . In 1840, the church contained nine hundred members, seven hundred and sixty of whom belonged to Ewa, the remainder to Waianae; but the Catholics have now established themselves at both these places, and it is understood are drawing off many from their attendance on Mr. Bishop's church [Wilkes 1970:80-81].

The earliest detailed map of the area (Alexander 1873; Figure 12) shows no habitation closer than the western edge of West Loch in the vicinity of Papapuhi Point. A Monsarrat survey map of 1878 documents substantial settlement at the "Honouliuli Taro Land" in the Papapuhi Point area, and it seems clear that in early historic times, this was the focus of the population of Honouliuli. The amenities of the area - including fishponds, taro *lo'i*, abundant shellfish, and salt pans - would have focused population there in pre-Contact times as well.

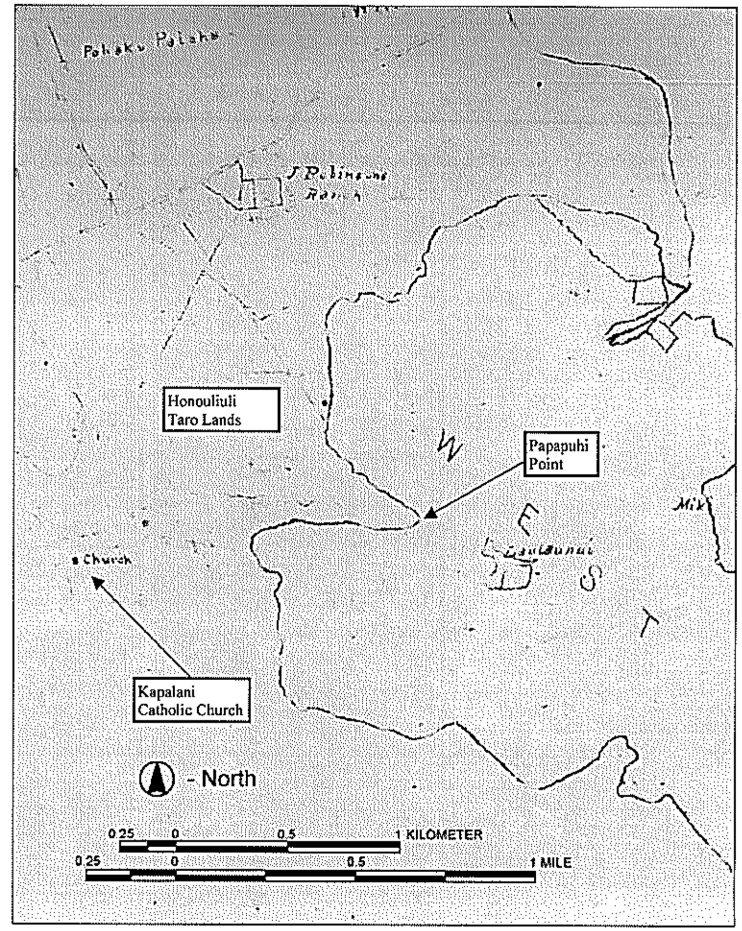

Figure 12. Portion of 1873 W.D. Alexander map of Honouliuli, showing location of Papapuhi Point (habitation symbols are illegible); also note location of Kapalani Catholic Church

3.2.3 Mid-Nineteenth Century and the Māhele

The Organic Acts of 1845 and 1846 initiated the process of the *māhele* - the division of Hawaiian lands, which introduced private property into Hawaiian society. In 1848 the crown and the *ali'i* (chiefly class) received their land titles. The common people received their *kuleana* (individual parcels) in 1850.

During the *Māhele* of 1848, 72 individual land claims in the *ahupua'a* of Honouliuli were registered and awarded by King Kamehameha III (Tuggle and Tomonari-Tuggle 1997:34). The 72 *kuleana* awards were almost all made adjacent to Honouliuli Gulch, which contained fishponds and irrigated taro fields. Kepa Maly (1997, Table 3: 38-42) provides a table recording information on each award, including awardee, *'ili*, and land use of the *'āpana* (lot). A summary of the information on houses, fields, and boundary landmarks noted for each *'ili* is given below in Table 2 and *'ili* locations are shown on Figure 13.

3.2.4 Project Area Māhele Awards

A comparison of project area maps with an 1878 map surveyed by M.D. Monsarrat (Figure 14) clearly show that all or portions of certain land claims belonging to Kelia (LCA 763), Pue (LCA 869), Leleiupa (LCA 1699) and Kua (LCA 5653) lie within the project area. These LCAs were once located on the east side of the main road along Honouliuli town, but now portions lay west of the current alignment of Old Fort Weaver Road. In addition, a portion of the former site of a Catholic church, called Kapalani Catholic Church, also now lies on the west side of the current road alignment, although the church itself was probably covered by the new road itself. This church and associated school house is believed to have been the site of the ministry of a particularly notable person, Kepelino Keauokalani. A brief review of the four known LCAs within the project area follows (see Figure 13 for *'ili* locations):

<u>Kelia's *'Āpana* (*'Āp.*) 1 (LCA 763)</u>

Kelia's claimed this land situated in the *'ili* of Poohilo and Uani for his houses. His witnesses agreed with his claim, but there was a dispute over whether there were 3 or 4 houses within the parcel. All agreed Kelia has one house there and that his father, Pueeu had two. The west or Wai'anae boundary was described variously as the "*pali* of Makaaku," "a ravine" or "a cliff." The claimant received his house lot from his father Pueeu and "has accepted it ever since 1836."

<u>Pue *'Āpana* 1 and *'Āpana* 2 (LCA 869)</u>

Pue claimed four parcels in the *'ili* of Maui at Honouliuli, 'Ewa. One parcel was a houselot and had two houses on it, one for himself and one for Puali who was his father-in-law. The western side was bounded by the land of Koi, the *luna* (overseer), who gave Pue's family their land in 1842. The other parcel within the project area was *kula*, pasture land to the east of the houselot.

<u>Leleiupa *'Āpana* 1 and *'Āpana* 2 (LCA 1699)</u> '

Leleiupa 'Āpana 1 and 2 were claims for two parcels situated in the *'ili* of Maui. 'Āpana 1 was bordered on the west by the land of Koi, the overseer.

Table 2. Summary of land use and boundary landmarks recorded in Honouliuli LCA awards

'Ili	Land Use and Boundary Landmarks
Hiwalalo	*kou* trees
Ka'aumakua	houselots, *kalo* (taro) patches; *kula* (pasture/dryland agriculture), two fishponds called Mokumeha; landmarks - *kula ālialia* (salt plains), land division wall, Pānāhāhā *loko* (fishpond), Kalahu fishpond, Naholowaa pond, Honouliuli Stream (called stream of Makai'i), or *'aka'akai* (bulrush growth) of Kamo'okahi
Kaihuopala'ai	*mo'i* (arable land in a long strip); on lot bounded by *'auwai* (irrigation ditch) called Panaenui
Ka'ilikahi	houselot and *kalo* patches; landmarks – highway, Kauhipuna cliff, *lapalapa* (*panax*) thickets, meeting house
Kamilomilo	houselot and *kalo* patches
Kamoku	fenced *mo'o kalo*, *lo'i* (irrigated fields) *kalo*, houselot; landmarks – Kauhipuna pali
Kamo'okahi	bulrushes
Kapāpahi	houselots, *kalo* patches; bounded by ponds of Healani
Kapapapūhi	houselots, vineyard, *kula*, pond, trails, hog pens, and salt beds
Ka'ula'ula	*mo'o* next to Kaulaula (cliff) with a houselot and a wall
Loloulu	*kalo* patches, 1/3 of a fishpond (in land of Kahakuli'ili'i), hala grove, pig pens, breadfruit, bulrushes
Maka'u	houselot and *kalo* patches
Maui	*kalo* patches, *kula*, houselots, bounded by *pā'āina a ke Aupini* (land division wall of the government)
Mokumeha	2 fishponds, salt beds (western one called Kohumakahou)
Niuke'e	*kalo* patches, *kula*, potato field, houselots; landmarks - *loko kalo* (taro/ fishpond) of Nihola, Loko'eli pond, Kehewanakawalu pond, Kalokoiki pond, *pali* of Kihewamakawela; Ka'akau *pali*; Ka'akau community, meeting house, prison plot, cattle fences
Polapola	*kalo* patches; houselots, school house, prison plot; some bounded by *pā'āina a ke Aupini*, or high road from the sea, or Catholic Chapel yard
Pō'ohilo	*kula*, *kalo* patches, *loko kalo*, houselots; landmarks - *pā'āina*, Ka'aimanō fishpond, *kula* of Kahakai, *loko kalo* of Kalokoloa, Aimea Pond, Waianu pond, Kahui pond, Ka'aimano fishpond, *pupulu* cave (wet cave?), prison plot, Makaakua pali, Puehuehu Stream, Puehuehu road
Pua'alu'u	*lo'i*, houselot
Pu'uloa	houselots; boundaries include the sea, a *kula* called Waioipu, and the plain of Kaluanohu

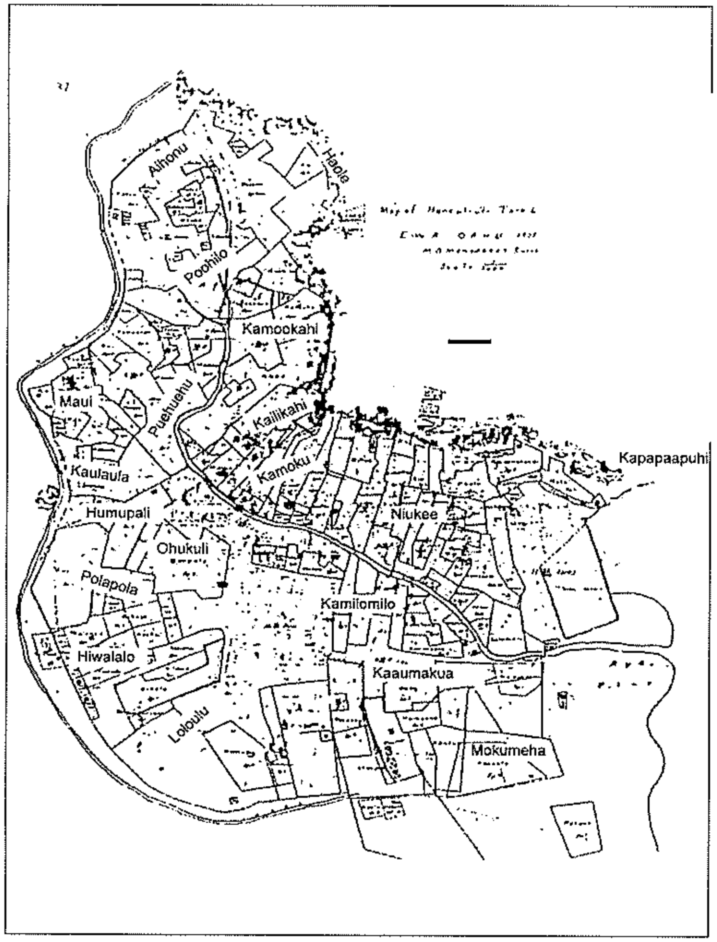

Figure 13. 1878 Map of Honouliuli Taro Lands (LCAs) by M.D. Monsarrat, with inserted *'ili* names

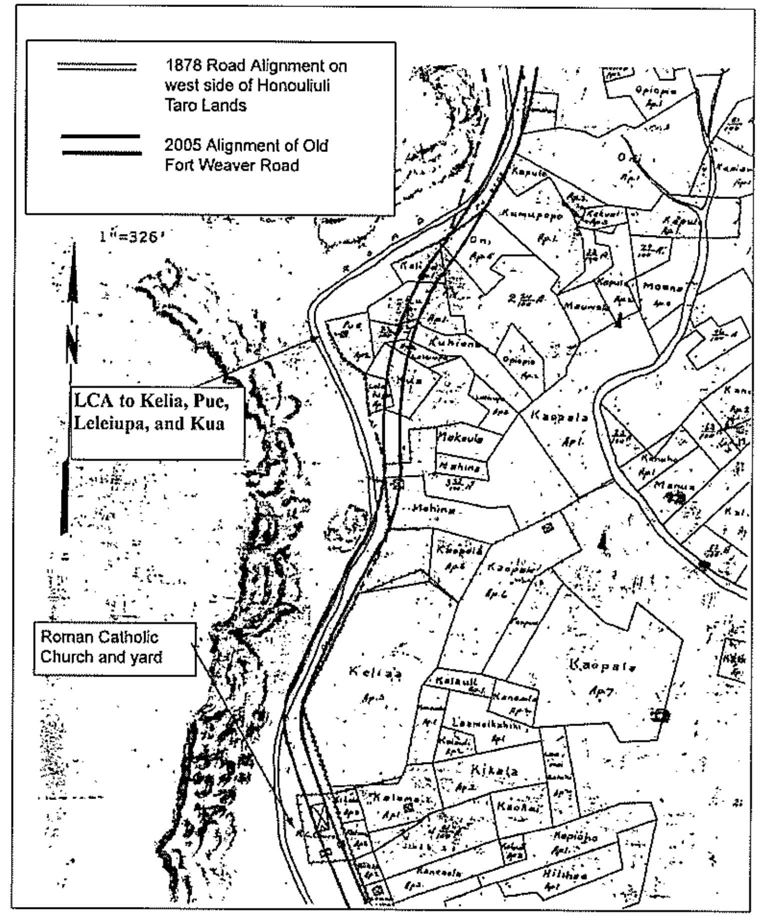

Figure 14. Portion of 1878 Monsarrat map, showing portion of Honouliuli Taro Lands in Relation to current alignment of Old Fort Weaver Road (eastern boundary of the project area)

Kua (LCA 5623)

Kua claimed two taro patches and a *kula* land called Kahui in the *'ili* of Maui. Of note was the sworn testimony of Maakuia on the Land Court Application for Mahina (LCA 749), which stated that the western boundary of Mahina's land was [Kaulaula] Pali, which had a wall on its top.

3.2.5 The Catholic Church

There are two land applications that make reference to a Catholic Church near the town of Honouliuli. Kaohai in April of 1850 (LCA 5670B) claimed a house site in the *'ili* of Polapola "adjoining the Catholic Chapel yard." Hilinae (LCA 1720) in November of 1847 made a houselot claim in the *'ili* of Polapola bounded on the west by the Kapalani Church. Little is known about the Kapalani Roman Catholic Church. It is clearly annotated on Monsarrat's 1878 map (see Figure 14) and is the lone "church" pictured on an 1873 map of the Honouliuli district by Alexander (Figure 15). Even the name is uncertain, as Kapalani probably means "the Frenchmen's" church. Efforts to found a Catholic Mission in Hawai'i were initially met with hostility until the issuing of an edict of toleration in 1839. The establishment of the Catholic Mission in Hawai'i in May of 1849 initiated an active period of building churches and schools. The Kapalani church (and school house) cited in the Land Court Application of Hilinae in November of 1847 must have been constructed within the previous seven years. Father Raymond Delande was pastor of the Leeward District of the church from 1857-1885 and, operating out of Honouliuli, he covered an area extending as far as Makaha and Waialua. "Up to 1877, he had baptized 600 children and adults, all living along the SW coast of Oahu" (Schoofs 1978:110).

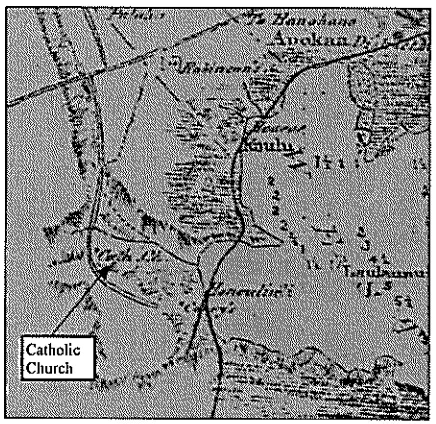

Figure 15. Portion of 1881 Hawai'i Government Survey Map (Alexander) showing location of the Catholic Church

Of particular interest is the association with this church of Kahoali'ikumaieiwakamoku Kepelino (Zepherino) Keauokalani, whose name means "to-be-the-chief-of-the-nine-districts" (Beckwith 1978:4). His father was Namiki, of the lineage of the high priest Pa'ao and his mother, Kahiwa Kaneikopulei, was a daughter of Kamehameha I. They had two children, the son Kepelino, and a daughter named Puahau. Namiki was the "old savage" whose narratives were collected by Jules Remy as "Contributions of a Venerable Savage to the Ancient History of the Hawaiian Islands" during his travels in the islands between 1851 and 1855. In a note on a section concerning the priest Pā'ao, the author talks about Namiki's son, who he met in 1853.

> The old historian Namiki, an intelligent man, and well versed in the secrets of Hawaiian antiquity, has left precious unedited documents, which have fallen into our hands. His son, Kuikauai, a school-master at Kailua, one of the true historico-sacerdotal race, has given us a genealogy of his ancestors which ascends without break to Paao [Remy 1857, in Nordhoff 1974:253].

The family was of Kailua, Kona, Hawai'i and converted to Catholicism very quickly after the arrival of Fathers Walsh and Ernest Herutel of the Catholic Mission to Kona in 1840. His parents sent him to Catholic school in Honolulu in 1845 to become a teacher. Father Ernest writes:

> Father Martial writes me about our little Zepherin, telling me that he has been received as teacher but that because they have no school to give him as yet, he has not received his diploma. Father Desire wants to keep him to send to the High School; but when will you have a High School? Perhaps not so soon. I think therefore that Zepherin would be more useful here as we lack teachers [cited in Beckwith 1978:4].

As noted above, Remy claims that at some point, Kepelino was a school teacher in Kailua; although Remy is believed to have met Kepelino in 1853, his teaching position at Kailua could have dated to an earlier period, possibly around 1845, when Father Ernst suggested that he return to the island of Hawai'i from Honolulu. At some point he attended the Catholic High School at Ahuimanu (established in 1846), where he is said "to have acquired English, French, Latin, and Greek" (Beckwith 1978:5). In 1847, at the age of 17, he was sent briefly with Father Ernest to Tahiti to help establish a Catholic mission. He developed a reputation for his pranks and was sent back to his parents (Beckwith 1978:5).

Controversial letters under the name of Z. Kahoali'i, addressed from the town of Honouliuli on O'ahu, were published in Catholic newspapers from 1860-1869. A letter in the Public Instruction Correspondence filed and dated 11/26/1851, written by a school teacher name Naheona to the Minister of Public Education, state his reasons for the rejection of a teacher "Kepilina" and accuses Kepilina of "dancing and thieving while employed as teacher of Honouliuli School and of general improper conduct." The letter also mentions "Catholic priests in the area who have been among the people for a while who do not recommend retaining Kepilina" (In Silva 1987:A8). It seems quite probable that Kepelino lived at Honouliuli from 1851 into the 1870s and that as a devout Catholic and teacher that he taught at the school house next to Kapalani Church.

Detailed biographic information on Kepelino is not readily available, which is probably due in part to the fact that he was "controversial" for the Catholics and for the government. He went on to become Queen Emma's secretary (by at least 1874) and was one of the most important documenters about Hawaiian beliefs and traditions. He supported Queen Emma as the heir of King Lunalilo over David Kalākaua, and wrote letters to the king of Italy and the queen of England, asking for warships to support Queen Emma's cause. In 1874, the newly elected King Kālakaua had him tried for high treason and sentenced him to hanging, but the sentence was commuted and he was released from prison in 1876; he died in 1878 (Day 1984:77).

"The Honouliuli church . . . had by the 1880s outlived its usefulness and become dilapidated. It was therefore abandoned and replaced by a simple structure close, too close to the mill" [at 'Ewa Village, south of the project area] (Schoofs 1978:111). However, "in 1891 Honouliuli was still important enough to acquire its own Catholic cemetery" (Schoofs 1978:110). Whether this cemetery or any other Catholic cemetery was on the grounds of the Kapalani Church in unknown. In the late 1920s, Bishop Alencastre exchanged land at Honouliuli with Campbell Estate for land at 'Ewa Village to establish a new church.

3.2.6 Honouliuli Māhele Awards to *Ali'i*

In 1855 the Land Commission awarded all of the unclaimed lands in Honouliuli, 43,250 acres, to Miriam Ke'ahikuni Kekau'ōnohi (Royal Patent #6971 in 1877; Parcel #1069 in the Land Court office), a granddaughter of Kamehameha I, and the heir of Kalanimōkū, who had been given the land by Kamehameha after the conquest of O'ahu (Indices of Awards 1929; Kame'eleihiwa 1992). Kekau'ōnohi was also awarded the *ahupua'a* of Pu'uloa, but she sold this land in 1849 to Isaac Montgomery, a British lawyer.

Kekau'ōnohi was one of Liholiho's (Kamehameha II's) wives, and after his death, she lived with her half-brother, Luanu'u Kahalai'a, who was governor of Kaua'i (Hammatt and Shideler 1990:19-20:20). Subsequently, Kekau'ōnohi ran away with Queen Ka'ahumanu's stepson, Keli'iahonui, and then became the wife of Chief Levi Ha'alelea. Upon her death on June 2, 1851, all her property was passed on to her husband and his heirs. A lawsuit (Civil Court Case No. 348) was brought by Ha'alelea in 1858, to reclaim the fishing rights of the Pu'uloa fisheries from Isaac Montgomery, and the court ruled in Ha'alaea's favor. In 1863, the owners of the *kuleana* lands deeded their lands back to Ha'alelea to pay off debts owed to him (Frierson 1972:12). In 1864, Ha'alelea died, and his second wife, Anadelia Amoe, transferred ownership of the land to her sister's husband John Coney (Yoklavich et al 1995:16).

3.2.7 Early Ranching in on the 'Ewa Plain

John Coney rented the land to James Dowsett and John Meek in 1871, who used the land for cattle grazing. In 1877, the land, except for the *'ili* of Pu'uloa, was sold to James Campbell. He drove off 32,237 head of stock belonging to Dowsett and Meek and to James Robinson and constructed a fence around the outer boundary of his property (Bordner and Silva 1983:C-12). He let the land rest for one year and then began to restock the ranch, so that he had a head of 5,500 head after a few years (Dillingham 1885, cited in Frierson 1972:14)

In 1880-81, the Honouliuli ranch was described as:

> . . . Acreage, 43,250, all in pasture, but possessing fertile soils suitable for agriculture; affords grazing for such valuable stock. The length of this estate is no

> less than 18 miles. It extends to within less than a mile of the sea coast, to the westward of the Pearl River inlet. . . . There are valuable fisheries attached to this estate . . . . [Bowser 1880:489].
>
> From Mr. Campbell's veranda, looking eastward, you have one of the most splendid sights imaginable. Below the house there are two lochs, or lagoons, covered with water fowl, and celebrated for their plentiful supply of fish, chiefly mullet. . . . Besides Mr. Campbell's residence, which is pleasantly situated and surrounded with ornamental and shade trees, there are at Honouliuli two churches and a school house, with a little village of native huts [Bowser 1880:495].

Most of Campbell's lands in Honouliuli were used exclusively for cattle ranching. At that time, one planter remarked "the country was so dry and full of bottomless cracks and fissures that water would all be lost and irrigation impracticable" (Ewa Plantation Co. 1923:6-7). In 1879, Campbell brought in a well-driller from California to search the 'Ewa plains for water, and the well, drilled to a depth of 240 feet near Campbell's home in 'Ewa, resulted in ". . . a sheet of pure water flowing like a dome of glass from all sides of the well casing" (The Legacy of James Campbell n.d., cited in Pagliaro 1987:3). Following this discovery, plantation developers and ranchers drilled numerous wells in search of the valuable resource. A Hawai'i Visitor Bureau, marker, located in the southwestern portion of the project area, bears the inscription "Site of First Artesian Well in the Hawaiian Islands drilled by James Ashley for James Campbell owner of Honouliuli Ranch brought in on Sept. 22, 1879." Kuykendall (1967:III, 67) states that this well was "near Campbell's ranch house" but Campbell's ranch house, which is shown on Monsarrat's 1878 map, was located outside the project area.

3.2.8 History of the Ewa Sugar Plantation

3.2.8.1 General History of the Plantation

In 1886, Campbell and B. F. Dillingham put together the "Great Land Colonization Scheme," which was an attempt to sell Honouliuli land to homesteaders (Thrum 1886:74). This homestead idea failed, but with the water problem solved by the drilling of artesian wells, Dillingham decided that the area could be used instead for large-scale cultivation (Pagliaro 1987:4). During the last decade of the nineteenth century, the railroad would reach from Honolulu to Pearl City in 1890, to Wai'anae in 1895, to Waialua Plantation in 1898, and to Kahuku in 1899 (Kuykendall 1967:100). This railroad line eventually ran across the center of the 'Ewa Plain at the lower boundary of the sugar fields.

To attract business to his new railroad system, Dillingham subleased all land below 200 ft to William Castle, who in turn sublet the area to the newly-formed Ewa Plantation Company (Frierson 1972:15). Dillingham's Honouliuli lands above 200 ft that were suitable for sugar cane cultivation were sublet to the Oahu Sugar Company (Figure 16). Throughout this time, and continuing into modern times, cattle ranching continued in the area, and Honouliuli Ranch - established by Dillingham was - the "fattening" area for the other ranches (Frierson 1972:15).

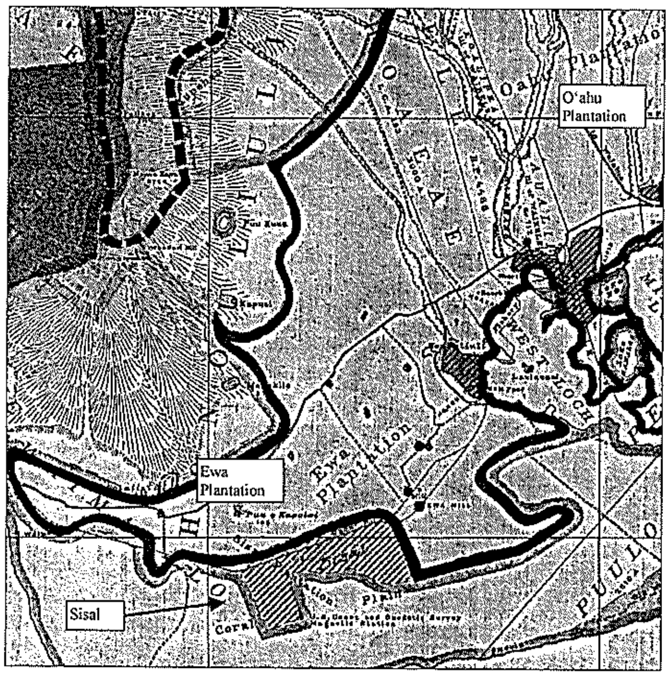

Figure 16. 1902 map showing relationship of Ewa Plantation and the Oahu Sugar Co. plantation; also note location of sisal growing area

Ewa Plantation Company (Figure 17) was incorporated in 1890 for sugar cane cultivation. The first crop, 2,849 tons of sugar, was harvested in 1892 at the Ewa Plantation. Ewa was the first all-artesian plantation, and it gave an impressive demonstration of the part artesian wells were to play in the later history of the Hawaiian sugar industry (Kuykendall 1967:69). As a means to generate soil deposition on the coral plain and increase arable land in the lowlands, the Ewa Plantation Company installed ditches running from the lower slopes of the mountain range to the lowlands. When the rainy season began, they plowed ground perpendicular to the slope so that soil would be carried down the drainage ditches into the lower coral plain. After a few years, about 373 acres of coral wasteland were reclaimed in this manner (Immisch 1964). It is uncertain if there was also a deliberate effort to induce erosion on the scarp (called Evans Bluff by the Campbell Estate), near the eastern boundary of the project area, but it would have been easy to do and probably very effective. By the 1920s, Ewa Plantation was generating large profits and was the "richest sugar plantation in the world" (*Paradise of the Pacific*, Dec. 1902:19-22, cited in Kelly 1985:171).

Just north of 'Ewa Plantation was the equally sprawling O'ahu Sugar Company which "covered some 20 square miles . . . ranging in elevation from 10 feet at the Waipio Peninsula . . . to 700 feet at the Waiahole Ditch" (Condé and Best 1973:313) (see Figure 16). The Oahu Sugar

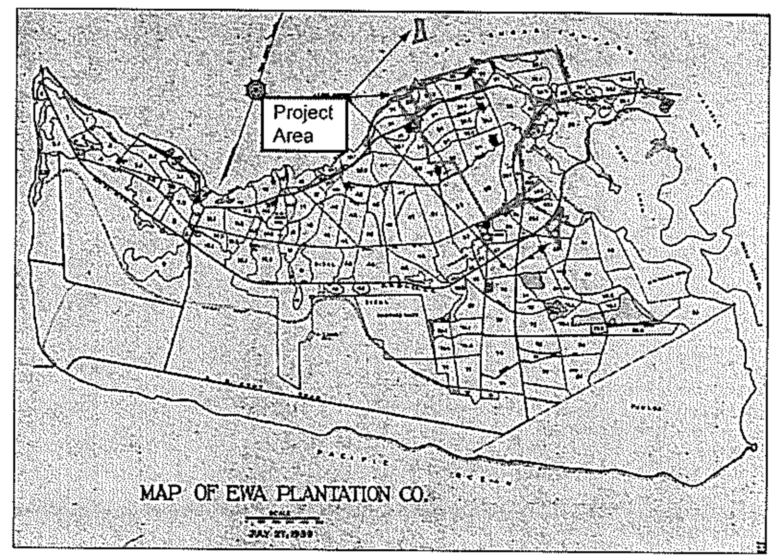

Figure 17. 1939 map of the Ewa Plantation Co. lands, showing project area

Company was incorporated in 1897. Prior to commercial sugar cultivation, the lands occupied by the Oahu Sugar Company were described as being "of near desert proportion until water was supplied from drilled artesian wells and the Waiahole Water project" (Condé and Best 1973:313). The Oahu Sugar Company took control of the Ewa Plantation lands in 1970 and continued operations until 1995, when they decided to shut down sugar cane production in the combined plantation area (Dorrance and Morgan 2000:45, 50).

3.2.8.2 History of PipeLine Village

During the twentieth century, the Ewa Plantation would continue to grow and, by the 1930s, would encompass much of the eastern half of Honouliuli Ahupua'a. This growth impelled the creation of plantation villages to house the growing immigrant labor force working the fields. In the decade of the 1890s, the plantation built 72 houses, cottages or dwellings; in the first decade of this century, 536; in the second decade, 132; in the 1920s, 285; in the 1930s, 168; and, in the 1940s, only 35. Censuses of the Ewa Plantation population record 4,967 persons in 1928, 4,477 in 1929, and 4,100 in 1932. After the outbreak of World War II, which siphoned off much of the plantation's manpower, along with the changeover to almost complete reliance on mechanical harvesting in 1938, there was little need for the large multi-racial (Japanese, Chinese, Okinawan, Korean, Portuguese, Spanish, Hawaiian, Filipino, European) labor force that had characterized most of the early history of the plantation.

It is to be noted that in the history of construction, buildings were moved, demolished, and replaced all the time. As early as 1899, the plantation moved "the lower camp of thirty houses [believed to be duplexes built in 1890] to a position on the bluffs nearby . . . principally for sanitary reasons" (Ewa Plantation Company Annual Report for 1890).

The original location of these thirty houses is unknown. They probably were not in the area later known as "Lower Camp" and may have been in the Honouliuli Taro lands. It is also unknown where they moved to "on the bluffs," but it seems probable that they were moved to what became the west central portion of PipeLine Village near the present water pumping station in that vicinity. A 1908/1913 U.S. Army Fire Control map shows 47 houses in the area of PipeLine Village (Figure 18).

PipeLine Village was a major plantation community that lay in the central southern portion of the present project area and is shown in detail in a 1928 USGS map (Figure 19), which documents the location of about 160 houses, a church and a school. This was probably the great extent of PipeLine Village. An entry in the 1931 Annual Report of Ewa Plantation Company records that "The PipeLine Village of 162 cottages built in 1906" was dismantled and that "other cottages near [near the factory, south of the project area] were erected using the reclaimed lumber from the PipeLine Villages. Photos (Bishop Museum Visual Collection) dated 1906 (Figure 20) show what appears to be brand new single family residences at PipeLine Village, but the Annual Report for 1906 documents the construction of only 47 houses and many of there were probably not built in PipeLine Village. Photos dated 1907 (Figure 21) show houses at PipeLine village with very well established garden and tall banana, papaya, and many mango trees, suggesting that they are significantly older. Another photo dated January 1910 (Figure 22) shows a line of ten new cottages with the caption "Pipe Line Village (Family houses built

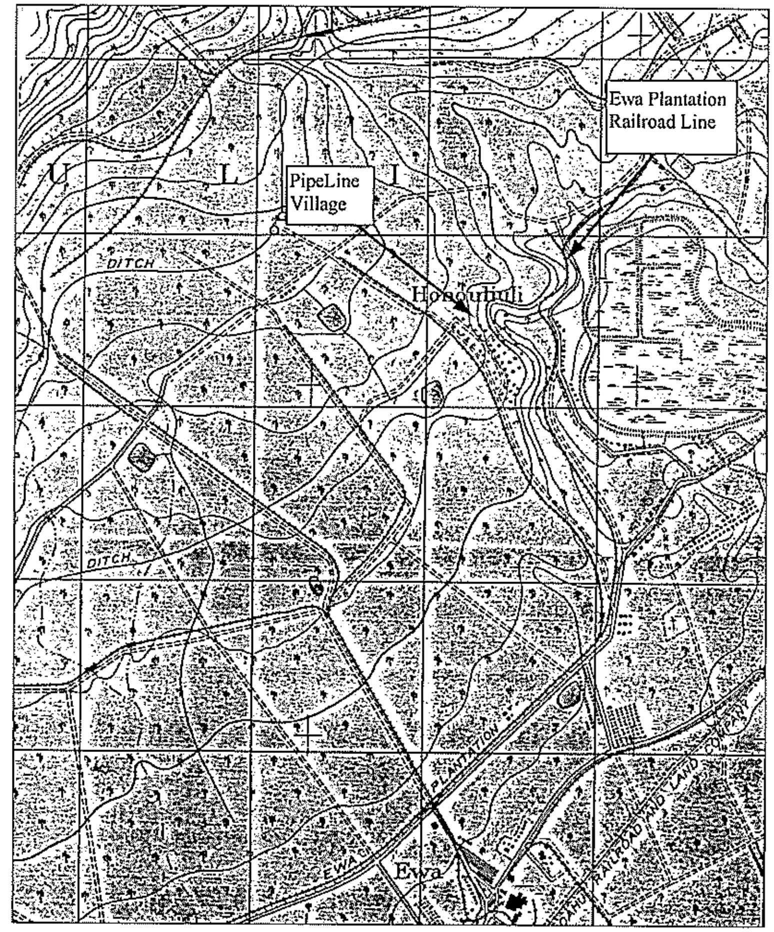

Figure 18. Portion of an 1908/1913 U.S. Army Fire Control map, showing 47 houses in PipeLine Village; map also shows the alignment for the Ewa Plantation railway

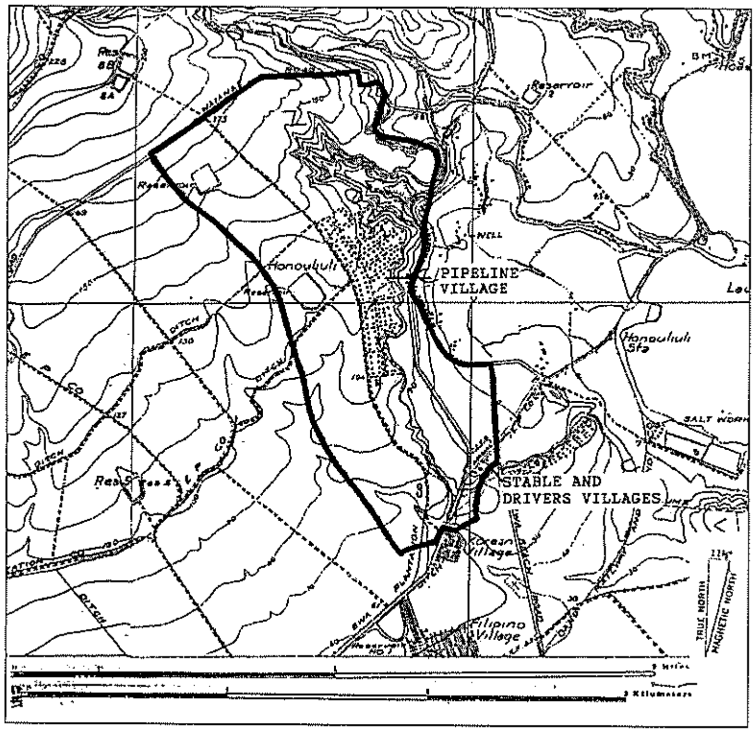

Figure 19. 1927/1928 US Geological Survey map, showing location of PipeLine Village, Stable Village, Driverss Village, and other Ewa Plantation structures

Figure 20. Portuguese family residence at PipeLine Village 1906

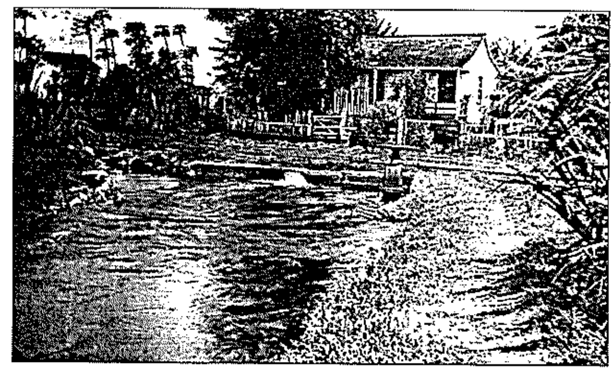

Figure 21. Discharge Pump No. 5, PipeLine Village 1907

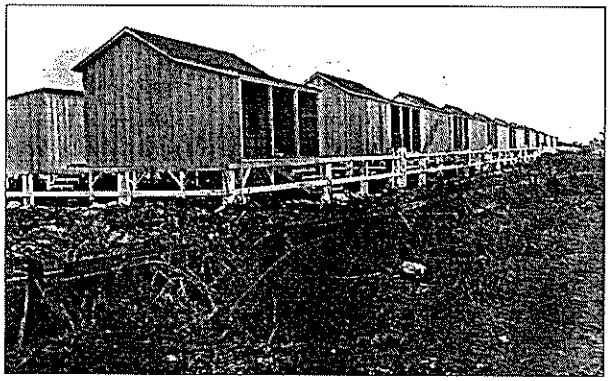

Figure 22. PipeLine Village, famly houses built in 1909, photograph taken on January 1910

Figure 23. PipeLine Village, April 7, 1907; forno at center of photograph

during 1909)." A 1907 photo (Figure 23) shows blocks of houses separated by wooden fences, and a *forno*, a brick Portuguese bread oven in the center. One hundred and twenty-nine cottages were built for married laborers in that year and they include the majority of the houses at PipeLine Village. In 1911 "60 new houses, principally for Spanish and Portuguese workmen with families" were erected. Thus, it seems highly probable that PipeLine village was largely constructed between 1906 and 1911, but may have incorporated a number of relocated structures dating to 1890. The demolition of 1931 was probably quite thorough, and not a trace of the structures was found on later maps.

3.2.8.3 History of Stable Village and Drivers Village

The Ewa Plantation housing located in the southeastern corner of the project area, just north of the present Hale o Ulu School, is not well-documented. It appears that there were at least two small villages located here: "Stable Village" and "Drivers Village." The Ewa Plantation Company Annual Report for 1931 states that "The Drivers Village, located near the main stable was in such a bad location that it was decided to move all the fourteen cottages down to 'B' village near the factory." Drivers Village doubtlessly corresponds to the site of the 14 houses shown on the 1927/1928 map (see Figure 19), with Stable Village probably referring to the structures just to the south across the street. The date of construction of these villages is unknown. No houses are shown in this area on the 1908/1913 Fire Control map (see Figure 18). The villages were probably built in that flurry of construction in the first decade of this century. All of the structures of Stable Village and Drivers Village are shown on the War Department Map of 1943, but this map may be another example of a lack of military intelligence regarding the Pearl Harbor area; records indicate that the houses were probably all demolished around 1931.

3.2.8.4 Other Enterprises in Campbell Lands

As noted above, part of Mr. Campbell's lands were also used to grow rice. By 1885, 200 acres in Honouliuli were used for rice and 50 acres were used to grow bananas (article in *Pacific Commercial Advertiser*, August 15, 1885, summarized in Silva 1987:A-12). These rice fields were planted in former taro fields or in undeveloped swamps, such as those near the project area in the former Honouliuli Taro lands. The rice fields in 1882 were described by Frank Damon, during a tour of the area.

> . . . Towards evening we reached Honouliuli, where the whole valley is leased to rice planters . . . This was one of the largest rice plantations we visited. Sometimes two or three men only, have a few fields which they cultivate for themselves, and we often too came upon houses where there were eight or ten men working their own land. But the larger plantations are owned by merchants in Honolulu, who have a manager acting for them. . . . [Damon 1882:37].

In 1890, Dillingham leased all land below 200 ft to William Castle, who used most of the land for sugar cane, but also leased some lands for rice cultivation, pasture, wood lots, bee-keeping, garden crops, and quarries. Some land above 650 ft was also leased for the cultivation of canaigre, which may be a word used for pineapple (Frierson 1972:15-16).

An additional agricultural trial was conducted in the Honouliuli area for the cultivation of sisal, a plant used to make fibers for rope and other material. Some sisal was planted before 1898 and production continued until the 1920s (Frierson 1972:16). This was grown mainly on the coastal plain of Honouliuli in Kānehili, just *mauka* of Kualaka'i Beach (now Nimitz Beach). An article in the *Paradise of the Pacific* in 1902 described this venture in glowing terms.

> . . . The venture was made and a tract of land containing a large percentage of disintegrated coral, in the neighborhood of Ewa Plantation, where nothing else would grow, was chosen for the planting. . . . The Hawaiian Fiber Co., which Mr. Turner organized, and of which he is now manager, has 755 acres under fence, two and a half miles of which is stone wall with good gates at convenient places. . . . In a large field containing 130 acres, mauka of the Oahu Railway & Land Co. track, the first harvest is to be gathered in a few months. . . . Out of this section of 130 acres the company has figured on securing 50 tons of clean fiber, for which it is offered eight cents per pound in Honolulu or nine cents per pound in San Francisco . . . . [*Paradise of the Pacific* March 1902:17].

Although many of the fishponds at Pearl Harbor deteriorated from lack of care and lack of people to maintain them in the early nineteenth century, there was some action to reclaim these areas in the later part of the century. Some were converted to rice fields, but others were maintained as fish ponds or duck ponds. Records of the Minister of Public Instruction (1848) show that some ponds were maintained by local teachers and students, with the funds generated used for the upkeep of the school system. Some ponds as early as 1848 were also maintained by prisoners, possibly from the women's prison located at Honouliuli. In 1852, however, Levi Ha'alelea reasserted his claims to these neglected lands, when he claimed all of the mullet from this area be reserved to him (Hawaii Kingdom files, cited in Silva 1987:A-7 to A-9). During James Campbell's tenure of the land, fish ponds and Pu'uloa fishing rights were leased out to various entrepreneurs (Kelly 1985:175).

Into the early twentieth century, some Hawaiian families continued to live in Honouliuli and preserve the traditional lifestyle, including at the fishing village of Kualaka'i. One resident, Mrs. Eli Williamson, recalled:

> In the Honouliuli area the train stopped among the *kiawe* (algaraboa) trees and *malina* (sisal) thickets. We disembarked with the assorted food bundles and water containers. Some of the Kualaka'i '*ohana* (family) met us to help carry the '*ukana* (bundles) along a sandstone pathway through the *kiawe* and *malina*. The distance to the frame house near the shore seemed long. When we departed our '*ukana* contained fresh lobsters, *limu* (algae), fish and *i'a malo'o* (dried fish) . . . [Williamson in Kelly 1985:160].

3.2.9 The Military and Modern Developments

In 1891, Russian explorer Otto Von Kotzebue tried to observe Pearl River, but his group could not obtain a canoe. What he was told, however, led him to speculate on the possible importance of Pearl Harbor to the future.

> In the mouth of this river are several islands; it is so deep, that the greatest ship of the line can lie at anchor a few fathoms from the shore; and so broad, that a hundred vessels can conveniently find room in it. The entrance into the Pearl Rivers is in the same situation as the harbour of Hana-rura; but the windings between the reefs are, however, said to render a passage more difficult. If this place were in the hands of the Europeans, they would certainly employ means to make this harbour the finest in the world [Von Kotzebue 1821:338-348].

The early missionary Levi Chamberlain was able to take an outrigger canoe trip to Pearl River, and noted the difficulty of access for larger ships.

> Kawaa took passage in our canoe to go down the harbor to a place where oysters are abundant to give orders to his people to gather a mess. The sail down the harbor was delightful . . . The passage down the creek for a number of miles was very pleasant till we got down near the reef and our course altered. We then could sail no longer as the wind was against us. The sail was lowered the mast taken down and secured across the outrigger and the rowers plied their paddles [Journal of Levi Chamberlain 1822-1849, Hawaiian Mission Schools, Storage Case 4, p. 899, from Sterling and Summers 1978:51].

The first foreign attempt to survey Pearl Harbor was made in 1840 during the U.S. Exploring Expedition, led by Charles Wilkes.

> In this district is a large inlet of the sea, into which the river Ewa empties; at the entrance of this inlet is the village of Laeloa (at Kalaeloa Point): the shore is known by the name of Pearl River or harbour, from the circumstance that the pearl oyster is found here; and it is the only place in these islands where it occurs.
>
> The inlet has somewhat the appearance of a lagoon that has been partly filled up by alluvial deposits. At the request of the king, we made a survey of it: the depth of water at its mouth was found to be only fifteen feet; but after passing this coral bar, which is four hundred feet wide, the depth of water becomes ample for large ships, and the basin is sufficiently extensive to accommodate any number of vessels. If the water upon the bar should be deepened, which I doubt not can be effected, it would afford the best and most capacious harbour in the Pacific. . . . [Wilkes 1970:79].

Although Wilkes was impressed by the harbor, he was not at this time thinking of how this survey could benefit the American government in the future. In fact, Wilkes (1970:79) concluded, "As yet there is no necessity for such an operation, for the port of Honolulu is sufficient for all the present wants of the islands, and the trade that frequents them."

This had changed in less than 30 years, however. The U.S. military had tried to make a coaling station on Midway Island in 1869 by blasting through the coral reef to make a harbor; this plan failed. In 1873, General Schofield presented a confidential report to the U.S Secretary of War, recommending that Pearl Harbor should be available to the U.S. Navy. Schofield wrote:

> In case it should become the policy of the Government of the United States to obtain the possession of this harbor for naval purposes, jurisdiction over all the waters of Pearl River with the adjacent shores to the distance of 4 miles from any anchorage should be ceded to the United States by the Hawaiian Government. . . .
>
> The cession of Pearl River could probably be obtained by the United States in consideration of the repeal of the duty of Sandwich Island sugar. Indeed, the sugar –planters are so anxious for a reciprocity treaty, or so anxious rather for free trade in sugar with the United States, that many of them openly proclaim themselves in favor of annexation of these islands of the United States [Sen. Ex. Docs, 52nd Cong. 2nd Sess. No. 77, pp. 150-154, reproduced in Judd 1971:Appendix 3].

This reciprocity treaty was concluded in 1876 with the provision that Hawai'i would not "lease or relinquish sovereignty to another country or any harbor, etc." In 1887, the treaty was renewed and amended and allowed the United States the "exclusive right to enter the harbor of Pearl River, in the Island of Oahu, to establish and to maintain there a coaling and repair station for the use of vessels of the United States" (Judd 1971:128).

After annexation of the islands to the United States in 1899, development began in order to make a Pacific base that could be used as a staging area for the Spanish-American War (Coletta 1985:433). Dredging of the harbor began in 1901, and additional dredging to deepen and widen the channel was conducted in 1908 and again in the 1920s. Money for the funding of the construction of dry docks and other support facilities was approved in 1908. In 1931 the Navy built an ammunition depot at West Loch on a 213-acre parcel that it had bought from the Campbell Estate. Construction of a new depot in Lualualei Valley and at West Loch Harbor began in 1931.

In the early 1930s, the U.S. Navy leased 700 acres of the Campbell Estate to build Ewa Field, a base with a mooring mast for Navy dirigibles. Although the mast was completed, the program was abandoned before the *Akron*, the designated airship for the mast, was built. In 1937, 18 miles of roads were built in the coastal Honouliuli area, and in 1939-1940 the U.S. bought 3,500 acres of land in this area (Landrum et al 1997:62-67), to build several other military camps and installations, including Barbers Point Naval Air Station, at the site of the old mooring mast.

On December 7, 1941 the Japanese Navy launched the devastating surprise attack on the United States base at Pearl Harbor and other military facilities. Although the major battle damage to the US Pacific Fleet was at its base at Ford Island in the Middle Loch of Pearl Harbor, Honouliuli did not escape unscathed.

> The Waipahu and Ewa sugar plantation, next to Pearl Harbor and the town of Wahiawa, adjoining Schofield Barracks, saw more action than did Honolulu.
>
> At Waipahu, machine gun bullets, shrapnel, and shells started two cane fires, riddled the sugar mill, hit the plantation hospital in four places, went through the roof of the company store, exploding in an electric supply warehouse, and narrowly missed many houses. In nearly all of the fields of tall cane, many of which contained terrified women and children, shells buried themselves-dozens of

> them in some concentrated areas-blasting holes in the ground the size of barrels, and flattening cane for several square yards.
>
> At Ewa, after bombing the nearby Marine airfield [at Barbers Point], enemy planes machine-gunned the plantation's main street, the mill and power plant and some 30 houses and started two cane fires [Allen 1999:20].

The attack had consequences not only for the military, but also for the civilians, mostly Japanese, who lived around West Loch.

> Two permanent local evacuations were ordered in the first month of the war, partly to remove civilians from areas which might be dangerous in event of further attack and partly to protect installations from possible sabotage or espionage activities. On a Thursday less than two weeks after the bombing, farmers adjacent to West Loch at Pearl Harbor were ordered to leave their farms by sundown. The order was modified to allow two days to prepare and the men were permitted to return to their farms during daylight until livestock could be moved and crops harvested. The displaced farmers, who had only recently been established at West Loch by the Farm Security Administration were forced to seek temporary housing with friends and relatives at Ewa plantation. Since they had invested in the enterprises practically all of their life's savings and considerable money borrowed from the FSA as well, several suffered heavy losses [Allen 1999:122].

Section 4 Previous Archaeological Research

4.1 Early Archaeological Surveys

All archaeological projects conducted in Honouliuli and Pu'uloa are listed in Table 1. Two archaeological features, a boundary *pōhaku* or rock and a *hōlua*, or sledding site, are recorded only in the Boundary Commission Reports establishing the division lines between the *ahupua'a* of Honouliuli and Hō'ae'ae (to the east). The surveyor wrote of the southern point of this boundary:

> In regard to Hoaeae . . . the point of commencement is Pōhaku Palahalaha, a well known rock, now marked by an arrow and the name "Honouliuli" on one side and "Hoaeae" on the other, which I have made the initial point of the survey . . . [Boundary Commission Vol. 1:243].

This rock is shown on the Sterling and Summer map (see Figure 9) as Pōhaku Palaha. In another boundary survey, the *pōhaku* is called a "large, flat rock" (Boundary Commission Vol. 1:249), which may indicate the origin of the name from the Hawaiian word *pālaha*, which means "flattened, wide" (Pukui and Elbert 1986:307). As the surveyor continued to walk the Honouliuli/Hō'ae'ae boundary, he marked the northern point of the division as:

> The Kamaaina took me to the corner of Pauhala (?)-Hoaeae and Honouliuli – there is an ancient holua or sleding [*sic*] place near this – which is agreed for the ancient corner. . . [Boundary Commission Vol. 1:243].

The earliest attempt to record archaeological remains in Honouliuli Ahupua'a was made by Thrum (1906:46). He reported the existence of a *heiau* located on Pu'uokapolei, west of the present study area. In a second monograph on *heiau*, Thrum (1917) called this *heiau* Palole'i (Kapolei). Emory mapped and photographed these structures in 1933 (field notes), but they were dismantled and destroyed sometime before McAllister's survey of the islands in the 1930s. According to legend, Pu'u Kapolei was the location on which Kamapua'a, the pig-god, resided with his grandmother, Kamaunuahihio (McAllister 1933:108).

In his surface survey of the 1930s, archaeologist J. Gilbert McAllister recorded the specific locations of important sites, and the general locations of less important sites (at least at Honouliuli). McAllister recorded seven specific sites at Honouliuli (numbered 133-139; McAllister 1933:107-108) (see Figure 9), and these became the first seven sites in the Bishop Museum's Site Numbering System (OA-B6-1 through OA-B6-7).

The first six sites are in the upland section of Honouliuli, *mauka* of the 'Ewa coral plain and Pu'u o Kapolei. Site 133 is a possible *heiau*, a small enclosure at the foot of Pu'u Kānehoa. It was still standing during McAllister's day, and local residents informed him of its sacred nature. Site 134 is Pu'u Kuina Heiau, located in a gulch at the foot of Mauna Kapu. Only traces of a large terrace remained. Site 135 is a series of enclosures *makai* of Pu'u Kuina Heiau. McAllister believed that the walls marked *kuleana* lots. Site 136 is a small platform near Mauna Kapu, a sacred site, possibly an altar. Site 137 is Pu'u Ku'ua Heiau, plotted on a ridge near Pu'u Ku'ua; it

Table 3. Previous archaeological work in Honouliuli and Pu'uloa

Author	Report Type	Location
Thrum 1906	Heiau study	Hawaiian Islands
McAllister 1933	All island survey	O'ahu Island
Kikuchi 1959	Site letter report	Barbers Point
Bowen and Soehren 1962	Burial Discovery	Barbers Point
Soehren 1964	Site letter report	Waimanalo Gulch
Lewis 1970	Reconnaissance survey	Barbers Point (harbor area)
McCoy 1972	Survey	Pu'uloa Elementary School Site
Hommon 1973	Survey and Excavations	Honouliuli
Barrera 1975	Reconnaissance survey	Barbers Point (harbor area)
Clark and Connolly 1975	Reconnaissance survey	Barbers Point (harbor area)
Oshima 1975	Reconnaissance survey	Barbers Point
Sinoto 1976	Cultural resources survey	Barbers Point (harbor area)
Bordner 1977a	Reconnaissance survey	Kalo'i Gulch
Bordner 1977b	Reconnaissance survey	Makaiwa Gulch
Clark 1977	Reconnaissance survey	Puu O Kapolei
Connolly and Clark 1977	Reconnaissance survey	Puu O Kapolei
Davis 1978	Scholarly paper	Barbers Point (harbor area)
Davis and Griffin 1978	Archaeological Survey	Barbers Point (harbor area)
Hawai'i Marine Research Inc. 1978	Geoarchaeological reconnaissance	Barbers Point (harbor area)
Kirch 1978	Land snail study	Barbers Point (harbor area)
Sinoto 1978a	Reconnaissance Survey and Burial Salvage	NAVMAG -West Loch
Sinoto 1978b	Archaeological & Paleontological salvage	Barbers Point (harbor area)
Barrera 1979	Archaeological Survey	West Beach
Clark 1979	Reconnaissance survey	Barbers Point (harbor area)
Cleghorn 1979	Reconnaissance survey	Barbers Point
Davis 1979a	Emergency excavations	Barbers Point (harbor area)
Davis 1979b	Emergency excavations	Barbers Point (harbor area)
Davis 1979c	Emergency excavations	Barbers Point (harbor area)
Jourdane 1979	Reconnaissance Survey	'Ewa Marina Community
Komori and Dye 1979	Archaeological testing	West Beach
Sinoto 1979	Cultural resources survey	Barbers Point (harbor area)
Ahlo 1980	Reconnaissance survey	Solid Waste Processing Facility
Davis 1980	Research design	Barbers Point
Kirch and Christensen 1980	Land snail study	Barbers Point (harbor area)
Christensen and Kirch 1981	Land snail study	Barbers Point (harbor area)
Hammatt and Folk 1981	Archaeological and Paleontological	Barbers Point (harbor area)
Davis 1982	Academic paper	Barbers Point
McCoy et al. 1982	Proposal for investigations	Barbers Point (harbor area)
Neller 1982	Scholarly study	Barbers Point
Ahlo and Hommon 1983	Reconnaissance survey	Barbers Point (harbor area)
Bordner and Silva 1983	Reconnaissance survey	Waimānalo Gulch
Davis 1983	Archaeological & Paleontological Excavations	Barbers Point
Ahlo and Hommon 1984	Test excavations	Barbers Point (harbor area)

Author	Report Type	Location
Hammatt 1984a	Reconnaissance survey	Kahe Point
Hammatt 1984b	Reconnaissance survey	Ewa Marina Community
Haun and Kelly 1984	Research design	Naval Air Station
Tuggle 1984	Survey report	Naval Air Station
Barrera 1985	Survey report	West Beach
Neller 1985	Review and evaluation	West Beach
Barrera 1986	Archaeological Investigations	West Beach
Davis and Haun 1986	Intensive survey and test excavations	West Beach
Davis et al. 1986a, b	Research design	West Beach
Haun 1986a	Reconnaissance survey	Kapolei Town
Haun 1986b	Reconnaissance survey	Kapolei Town
Athens & Pietrusewsky 1987	Burial documentation	Iroquois Point
Davis and Haun 1987	Intensive survey & test excavations	West Beach
Dicks et al. 1987	Reconnaissance survey	West Loch
Rosendahl 1987a	Reconnaissance survey	Kapolei Town
Rosendahl 1987b	Reconnaissance survey	Ko Olina Resort
Rosendahl 1987c	Reconnaissance survey	West Loch
Rosendahl 1987d	Reconnaissance survey	Kapolei Golf Course
Welch 1987	Reconnaissance survey	Naval Air Station
Davis 1988a	Subsurface Survey	'Ewa Gentry
Davis 1988b	Reconnaissance survey	Barbers Point HECO
Kennedy 1988a	Reconnaissance survey	'Ewa Gentry
Kennedy 1988b	Field Report	Waiau-Campbell Industrial Park
Rosendahl 1988	Reconnaissance survey	Camp Malakole
Sinoto 1988a	Reconnaissance survey	'Ewa Golf Course
Sinoto 1988b	Reconnaissance survey	Makakilo Golf Course
Bath 1989a	Petroglyph study	Waimānalo Gulch
Bath 1989b	Burial documentation	Kahe
Bath 1989c	Burial documentation	West Loch – Hō'ae'ae Point
Burgett and Rosendahl 1989	Subsurface archaeological testing	North of O.R.&L.
Hammatt and Shideler 1989a	Archaeological assessment	Barbers Point (harbor area)
Hammatt and Shideler 1989b	Reconnaissance survey	Kahe Point
Carlson and Rosendahl 1990	Inventory survey	Kaomi Loop Subdivision
Cleghorn and Davis 1990	Archaeological and paleontological	Barbers Point (harbor area)
Collin and Kennedy 1990	Burial documentation	Pu'uloa Golf Course
Davis 1990a	Archaeological and paleontological study	Barbers Point (harbor area)
Davis 1990b	Archaeological and paleontological	Barbers Point (HECO area)
Davis et al. 1990	Survey and Test Excavations	Ewa Marina Community
Hammatt and Shideler 1990	Inventory survey	West Loch Bluffs
Hammatt, Robins, et al. 1990	Inventory survey	Makaiwa Hills
Hammatt, Shideler, et al. 1990	Inventory Survey	'Ewa Villages
Kawachi 1990	Inadvertent Burial find	Campbell Industrial Park
Miller 1990	Inadvertent Burial find	Barbers Point, Nimitz Beach
Rosendahl 1990a	Letter report	Kapolei Golf Course
Rosendahl 1990b	Archaeological Survey and Test Excavations	'Ewa Marina Community
Davis and Burtchard 1991	Inventory Survey	NAVMAG-West Loch
Dunn et al. 1991	Inventory Survey and Test Excavations	'Ewa Marina Community

Author	Report Type	Location
Folk 1991	Reconnaissance Survey	Kapolei Town
Goodman and Cleghorn 1991	Surface Survey	Laulani Fairways Housing
Kennedy 1991	Subsurface testing	Pu'u o Kapolei
Hammatt 1991	Reconnaissance Survey	Honouliuli Livestock Park
Hammatt and Shideler 1991a	Archaeological assessment	Barbers Point (harbor area)
Hammatt and Shideler 1991b	Inventory Survey	St. Francis Medical Center West
Haun et al. 1991	Survey report	Naval Air Station
Burgett and Rosendahl 1992	Inventory survey	Barbers Point (harbor area)
Charvet-Pond and Davis 1992	Data Recovery	West Beach
Cleghorn and Anderson 1992	Inventory survey	Kahe Point
Hammatt and Folk 1992	Subsurface testing	Barbers Point (harbor area)
Erkelens 1992	Archaeological survey	Naval Air Station
Folk 1992	Subsurface Testing	Barbers Point
Hammatt 1992	Inventory Survey	Palikea
Jayatilaka et al. 1992	Survey and Test Excavations	Hawai'i Prince Golf Course
Kennedy et al. 1992	Inventory Survey	Pu'uloa Golf Course
Shideler et al. 1992	Assessment	Kahe Point
Trembly et al. 1992	Burial documentation	West Beach
Davis 1993	Archaeological and paleontological	Barbers Point (harbor area)
Glidden et al. 1993	Data recovery excavations	Paradise Cove
Goodman et al. 1993	Reconnaissance Survey	20-acre Commercial Project
Jones 1993	Fossil coral reefs study (Ph.D. dissertation)	Hawaiian Islands
Landrum and Schilz 1993	Reconnaissance and subsurface testing	Naval Air Station
Miller et al. 1993	Data recovery	Barbers Point (harbor area)
Nakamura et al. 1993	Inventory survey	Makakilo
Pantaleo and Sinoto 1993	Inventory survey	Ewa Gentry
Hammatt and Shideler 1994	Archaeological assessment	Barbers Point (harbor area)
Hammatt et al. 1994	Inventory survey	Barbers Point (harbor area)
Tuggle 1994	Inventory survey	Barbers Point
Davis et al. 1995	Archaeological & Paleontological Investigations	Barbers Point (harbor area)
Dye 1995	Burial documentation	Barbers Point
Franklin 1995	Data Recovery	Ewa Marina Community
Hammatt and Shideler 1995	Data recovery plan	Barbers Point (harbor area)
Jourdane 1995	Burial documentation	Paradise Cove
Yoklavich et al. 1995	CRM Overview	Barbers Point
Corbin et al. 1996	Reconnaissance Survey	Laulaunui Island
O'Hare et al. 1996	Intensive survey and testing	Naval Air Station
Spear 1996	Archaeological Survey	Honouliuli Treatment Plant
Athens et al. 1997	Cultural resources, paleoenvironmental	'Ewa Plain; Naval Air Station
Schilz and Landrum 1996	Test Excavations	Barbers Point
Spear 1996	Reconnaissance Survey	Kapolei Town
Borthwick 1997	Assessment	Palehua, Honouliuli
Hammatt 1997	Inventory survey	Pu'uloa
Hammatt and Chiogioji 1997	Reconnaissance Survey	Corridor in Honouliuli
Jensen and Head 1997	Reconnaissance Survey	NAVMAG-West Loch
Tuggle 1997a	Cultural resource inventory	Naval Air Station
Tuggle 1997b	Synthesis	'Ewa Plain

Author	Report Type	Location
Tuggle and Tomonari 1997a,b	Cultural resource inventory survey	Naval Air Station
Wickler and Tuggle 1997	Cultural resources, Inventory Survey	Naval Air Station
Wolforth and Wulzen 1997	Data Recovery	West Loch Estates
Wulzen and Rosendahl 1997	Data Recovery	Barbers Point Nimitz Beach
Goodfellow et al.	1998	West Loch
Hammatt and Shideler 1999	Inventory survey	Waimanalo Gulch
Magnuson 1999	Reconnaissance Survey	Farrington Hwy.
McDermott et al. 2000	Data recovery	Barbers Point (harbor area)
Elmore et al. 2001	Honouliuli	Pu'u Kapolei/Fort Barrette
Ostroff *et al.* 2001	Inventory survey	Pu'uokapolei
Tulchin et al. 2001	Inventory survey	'Ewa Shaft Renovation
McIntosh and Cleghorn 2003	Inventory survey	'Ewa Gentry Makai
Cordy and Hammatt 2003	Archaeological assessment	Barbers Point, North of O.R.&L.
O'Hare et al. 2005	Field Check	Kapolei Property
O'Hare et al. 2004	Documentation of Plantation Infrastructure	North of O.R.&L.
Terry et al. 2004	Archaeological Inventory Survey of Two	North of O.R.&L.
Hoffman et al. 2004	Archaeological inventory Survey	Between OR&L and Barbers Point

had been modified for use as a cattle pen; some areas had been cleared for pineapple cultivation or planted with ironwoods. Site 138 is Pu'u Kapolei Heiau, which had been on the *makai* side of the hill before it was destroyed. The stones of the structure had been crushed in a nearby rock crusher. McAllister was also told that there was once a cave on the hill, in which Kamapua'a and his grandmother lived (McAllister 1933:107-108).

The remaining eight sites recorded by McAllister are adjacent to Pearl Harbor or the coast. Site 139 is Kalanamaihiki Ko'a (fishing shrine) at Kapapapuhi Point (north of the current study area). McAllister described it as "two large rough stones about 2.5 feet in size, with six or seven smooth stones averaging 1 foot in size in a small pile adjoining the larger stones." Site 140 is a 4-5 acre fishpond on Laulaunui Island in West Loch, opposite Kapapapuhi Point. McAllister recorded the entire West Loch of Pearl Harbor as Site 141, Kaihuopala'ai. Although some versions of the legend of the traveling mullet (see Section 3.1, Mythological and Traditional Accounts) say that there was a fishpond called Kaihuopala'ai, McAllister recorded that local informants said there was never a fishpond by that name here; rather it was the name for the loch. Site 142 is Kapamuku, or Pamoku fishpond, a 3-acre fishpond, located south of the current study area, opposite the tip of Waipi'o peninsula. Site 143 is 'Oki'okiolepe fishpond, south of Loko Pamoku. The walls of this 6-acre fishpond were made of coral.

McAllister records Site 144 as the location of fish traps and a fishing shrine described by Stokes in his study of the fishtraps of Pearl Harbor. This is the location of the fishtraps Kapākule (Pākule) and Kepo'okala, as described by Samuel Kamakau (1976:88). McAllister listed Site 145 as Pu'uloa, a legendary site where the first breadfruit was planted. It is not known whether Pu'uloa referred to is the '*ili* of Pu'uloa or the harbor of Pu'uloa, or an area within the '*ili* near the harbor. Site 146 covers the entire 'Ewa coral plain. This includes historic features, such as cattle walls and the walls near the Pu'uloa Salt Works, pre-Contact sites such as habitation,

agricultural, and fishpond sites recorded by early European explorers, and paleontological sites, where in recent years many fossil bird bones have been discovered (McAllister 1933:108-110).

Between McAllister's 1930s study and the flurry of work that began in 1969, there are only a few sporadic pieces of research, which are not well documented. In 1933, Dr. Kenneth P. Emory recorded a well-preserved house site and a possible *heiau* (later destroyed by sugar cane cultivation) in the western part of the coral plains (Sinoto 1976:1). In 1959, William Kikuchi removed a number of burials from a burial cave site (Bishop Museum Site OA-B6-10) at the Standard Oil Refinery, which was subsequently destroyed (Barrera 1975:1). Kikuchi recovered 12-16 incomplete primary and/or secondary burials cached in a sinkhole or crevice exposed during construction activities near the big bend in Malakole Road (Kikuchi 1959; Davis 1990b: 146, 147). In 1960, Yoshi Sinoto and Elspeth Sterling visited a house site (BPBM. Site OA-B6-8) within 'Ēkaha Nui Gulch. "Around this elevation (1200 feet), along the sides of the stream, were seen remains of many terraces and some house sites" (Sterling and Summers 1978:37). In 1962, Lloyd Soehren recorded another secondary human burial in a sinkhole at the Barbers Point Naval Air Station (Davis 1990a:147). In 1966, Lloyd Soehren carried out salvage excavations at a possible fishing shrine (BPBM. Site # 50-OA-B6-13). The site was reported as destroyed by construction (Barrera 1975:1), but Davis relocated the shrine and performed additional excavations in 1982 (Davis 1990a:148).

4.2 Previous Archaeological Work near Honouliuli town

Beginning in the late 1970s, archaeological research has been conducted in Honouliuli in the general vicinity of the present study area (Figure 24). Work has been focused on the West Loch Estates (east of the current project area), Pearl Harbor Naval Magazine (NAVMAG) – West Loch (east of the current project area), the 'Ewa Gentry project (south of the current study area), and 'Ewa Villages (south of the project area).

4.2.1 West Loch Estates

An archaeological reconnaissance survey (Rosendahl 1987c) was conducted in association with the development of the 232-acre "West Loch Estates" Residential Increments I and II (golf course and parks) project, which lies to the east of the present study area, in the section of the Honouliuli Taro lands adjacent to Pearl Harbor. This project covered portions of the old town of Honouliuli, the focus of population in the early historic period (and possibly earlier). This study identified a modern cemetery (Site 3319) with a remnant pre-Contact deposit, two historic sites of minimal integrity with some possible pre-Contact deposits (Site 3318 and 3320) at Kapapapuhi Point, a significant pre-Contact deposit with trash pits, fire pits and at least one human burial (Site 3321), a buried fishpond (Site 3322), an historic fishpond (Site 3323) built in the 1890s during the construction of the OR& L railroad, and a buried pond field system (Site 3324) (Rosendahl 1987c:7, 9). It was noted that some artifacts "indicate the possibility of pre-1900 occupation" (Rosendahl. 1987c:8). As noted in the final reconnaissance survey report (Dicks et al. 1987:28) for the surface and subsurface reconnaissance survey, an effort was also made to relocate McAllister's Site 139, Kalanamaihiki Ko'a (fishing shrine). The archaeologists

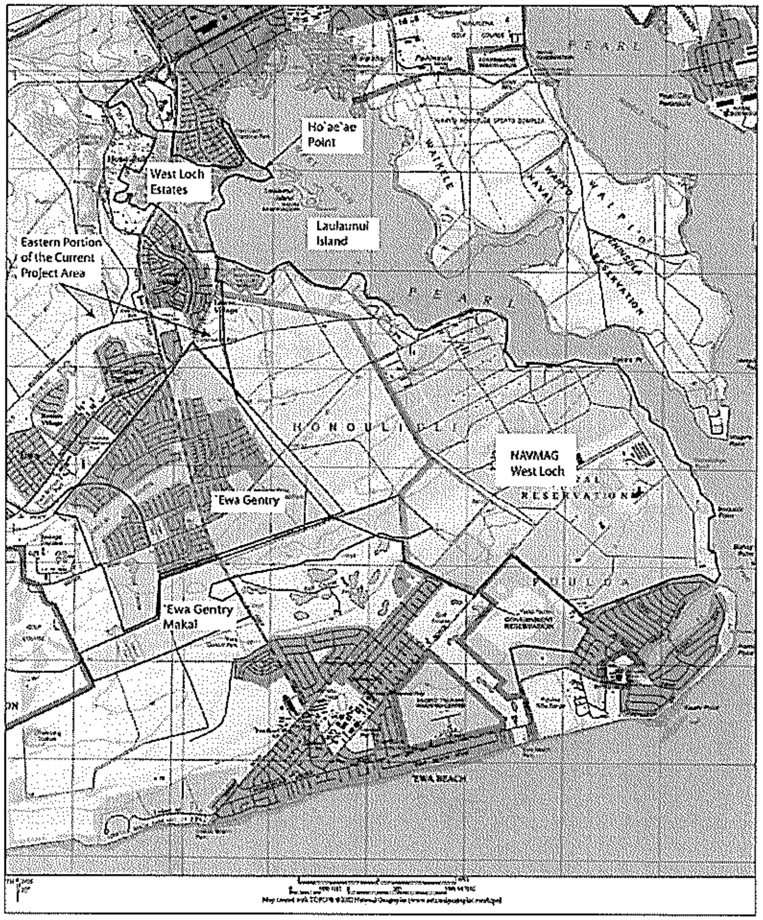

Figure 24. U.S. Geological Survey topographic map, showing previous archaeological project areas near the current study area

found a small boathouse and dock in the area and concluded that the shrine had been destroyed since McAllister's survey in the 1930s.

A total of 21 radiocarbon dates were determined; at Site 3321, the cultural deposit, the age of a lower cultural deposit was dated to A.D. 540-880, while an upper deposit was dated to A.D. 1327-1640. For the buried fishpond (Site 3322), ages ranged from A.D. 70-610 in the lowest layer to A.D. 1160-1410 in the upper layer. For the buried pond field systems (Site 3324), ages ranged from B.C. 400-A.D. 240 (interpreted as the original surface of the upper valley) in the lowest layers to A.D. 1430-1952 in the upper layers of upper valley area and A.D. 1020-1280 in lower valley area. In summary, the authors (Dicks et al. 1987:78-79) concluded that agricultural use of the Honouliuli Stream floodplain for pondfield cultivation of taro may have begun in the lower valley segment as early as A.D. 1000, while cultivation of the upper valley pondfields may have begun as early as the thirteenth and fourteenth centuries. Site 3321in the upper valley may have been a habitation locus established as early as the mid-sixth to mid-ninth century (Wolforth et al. 1998).

In 1989, a burial was found on Ho'ae'ae Point (formerly called Papapuhi Point), when someone was digging under a mango tree on a residential property. There is no follow-up report (Bath 1989) to whether the bones were left in place or disinterred. The burial was given the site designation 50-80-13-4816.

4.2.2 NAVMAG – West Loch

In 1978, Sinoto conducted an archaeological reconnaissance survey on a 32-acre portion of NAVMAG-West Loch. A sinkhole 200 m inland and northwest of 'Oki'okiolepe Fishpond was found, containing ten human burials (Site 50-80-13-2310). Historic artifacts were found in the pit, enough to determine that the pit was probably used by the Chinese in the historic period as a family crypt (Sinoto 1978a).

Davis and Burtchard (1991) conducted an archaeological inventory survey of a 36-acre lot for a proposed housing area in the Pu'uloa portion of NAVMAG-West Loch in 1991. No archaeological sites were found. They concluded that extensive alteration to the landscape due to military land disturbance had erased all surface traces of pre-Contact habitation.

In 1992, a crew from Archaeological Consultants of Hawai'i, Inc. (ARCH) conducted an archaeological inventory survey with subsurface testing, and later data recovery at the proposed Pu'uloa Golf Course (Kennedy et al. 1992). A total of 72 sites were identified, 47 from the pre-Contact/early historic period and 25 sites associated with ranching, military training, and modern quarrying. Radiocarbon dates of these habitation, agricultural, and ceremonial sites indicate that traditional Hawaiian use extended from A.D. 1090 to 1695.

An overview survey of the NAVMAG Lualualei was completed by Ogden Environmental and Energy Services in 1977 (Landrum et al. 1977). A total of ten sites had been previously recorded in the West Loch project area, three in the Honouliuli section, one within Pearl Harbor (Site 140, Laulaunui Island), five on Waipi'o peninsula, one in both (salt works), and one encompassing all lands (Pearl Harbor Navy Base). In Honouliuli, the sites were Site 141, Kaihuopala'ai (West Loch), Site 142, Loko Pamoku or Kapamuku, Site 143, 'Oki'okiolepe Fishpond, and salt works at Honouliuli (no site designation). NAVMAG-West Loch is considered part of the Pearl Harbor Navy Base (Site 50-80-13-9992) due to its importance during World War II. The site was listed as a National Historic Landmark in 1966, on the National Register of Historic Places (NRHP) in 1966, on the State Inventory of Historic Places (SIHP), in 1971, and on the State Register of Historic Places in 1971 (Landrum et al. 1977:160).

In 1996, a crew from Paul H. Rosendahl, Ph.D., Inc. (PHRI) completed a Phase I archaeological reconnaissance survey of the 1,483 acres of land at the U.S. Naval Magazine – West Loch Branch (Jensen and Head 1997). This survey covered the southern section of Waipi'o peninsula on the east side of West Loch, Laulaunui Island, the Naval Reservation on the west side of West Loch, and the West Loch Outleased Cultivated Lands, which included the National Wildlife Refuge. Only 25% of the outleased lands were actually surveyed. The PHRI crew found that most of the outleased area had been bulldozed for sugarcane cultivation. Only a small strip adjacent to West Loch was unmodified. In the West Loch Outleased Lands, eight features were recorded; all but one was associated with military use of the area. The seven military sites consisted of six concrete slabs (Sites 50-80-13-5040, 5080, 5081, 5133, 5134), a metal container (5080), and a pressure tank (5133). The one non-military site (4971) was a cave with a partially blocked (blocked with roof fall) entrance that the crew members believed should be investigated in the future to see if it at one time was used as a pre-Contact or historic burial site (Jensen and Head 1997:85).

In 1996, a field reconnaissance of Laulaunui Island and fishpond was conducted by the State Historic Preservation Division (Corbin et al. 1996) to determine if restoration of the fishpond was possible and if the site would be a good candidate to be used as an educational tool. The crew simply walked to the island from the West Loch Waterfront Park; water depth varied from one to four ft. Five concrete structures, probably built by the military, were observed. The fishpond was surrounded by mangroves and was silted in; portions of a coral wall (about 500 ft long) around the pond were still intact, and a concrete gate allowed water to circulate into the pond.

4.2.3 'Ewa Villages

In 1990, Cultural Surveys Hawaii conducted an archaeological reconnaissance survey of a 616-acre area, which included three extant plantation villages, (Renton, Tenney, and Varona Village), the sites of three former plantation villages (C Village, Mill Village, Middle Village), and other sites associated with the 'Ewa Plantation infrastructure (Hammatt, Shideler, et al. 1990:i). The survey found no evidence of any pre-Contact activity within the project area and recommended further documentation of some of the ruined plantation structure sites.

In 1996, Scientific Consultant Services (Spear 1996) conducted an archaeological survey in an area west of the Tenney and Varona plantation villages and north of the Honouliuli Treatment Plant. No archaeological sites were identified.

4.2.4 'Ewa Gentry Project

In the initial reconnaissance (Kennedy 1988a) of the 1,016 acre 'Ewa Gentry project area, no surface evidence of potentially significant pre-Contact remains was found. The old OR&L railroad bed/right of way (Site 50-80-12-9714) did form a portion of the *mauka* boundary. According to historic maps, a Filipino Camp for sugarcane workers once existed near the

intersection of the OR&L bed and a cane road near Ft. Weaver Road, but the archaeologists could find no surface remains for this camp.

A subsequent subsurface exploration was undertaken. Eighteen backhoe trenches were excavated; however, "no evidence of past in situ cultural activity was found anywhere in the Ewa Gentry project area" (Davis 1988).

An inventory survey was conducted in 1993 by Aki Sinoto Consulting (ASC) (Pantaleo and Sinoto 1993) for the 'Ewa Gentry Off-Site Drainage System. This proposed drainage project area is a narrow strip that extends along the western boundary NAVMAG West Loch, and is adjacent to the southern non-contiguous parcel (TMK 9-1-010:002) for the current study. An 1897 map of Pearl Harbor indicated that the OR&L railroad, salt pans, and a fishpond were within this project area; only the railroad bed was found during the ASC survey. Iron flumes and concrete culverts (one with an inscribed date of July 1935) used for sugarcane irrigation were found bulldozed to the edge of the sugar cane fields near the dropoff to the shoreline of Pearl Harbor. These were not considered historically significant due to the absence of structural and locational integrity. No further archaeological work was recommended for this project prior to commencement of construction of the drainage system.

In 2003, Pacific Legacy (McIntosh and Cleghorn 2003) conducted an archaeological survey of the proposed 'Ewa Gentry Makai Development project area, which is adjacent to the southern (*makai*) boundary of the 'Ewa Gentry project area for the 1988 surface and subsurface inventory surveys (Kennedy 1988a; Davis 1988).

4.2.5 Previous Archaeology in the Current Project Area

As noted previously, and as discussed in more detail in the next section, a 546-acre portion of the current project area (the southeastern section) was previously surveyed in 1990 by a crew from Cultural Surveys Hawai'i. In 2005, a field assessment was conducted over the entire current project area by archaeologists from the firm Archaeological Consultants of the Pacific, Inc. (Elison and Kouneski 2005). The archaeologists found one "stone-faced hill" in the northern section of the project area (north of Farrington Highway), but did not describe it further. The report presents recommendations for field work in the different sections of the project area, concluding that the majority of the project area is farm land and did not need to be surveyed. Only the area around Honouliuli Gulch, and other areas of natural vegetation in the northern section needed to be surveyed.

4.3 Background Summary and Predictive Model

4.3.1 Honouliuli Settlement Patterns

The *ahupua'a* of Honouliuli is the largest traditional land unit on the island of O'ahu. Honouliuli includes all the land from the western boundary of Pearl Harbor (West Loch) westward to the 'Ewa/Wai'anae District Boundary with the exception of the west side of the harbor entrance, which is in the *ahupua'a* of Pu'uloa (the 'Ewa Beach/Iroquois Point area). This comprises approximately 12 miles of open coastline from One'ula westward to Pili O Kahe. The *ahupua'a* extends *mauka* (almost pie-shaped) from West Loch nearly to Schofield Barracks, and the western boundary is the Wai'anae Mountain crest running *makai* to the east ridge of Nānākuli Valley.

Not only is there a long coastline fronting the normally calm waters of leeward O'ahu, but there are also four miles of waterfront along West Loch. The land immediately *mauka* of the Pacific coast consists of a flat karstic raised limestone reef forming a level nearly featureless "desert" plain marked in pre-Contact times (previous to alluviation caused by sugar cultivation) by a thin or non-existent soil mantle. The microtopography is notable in containing countless sinkholes in some areas caused by chemical weathering (dissolution) of the limestone shelf.

Along the eastern flank of the Wai'anae Mountains, numerous gulches have contributed to the alluvial deposits over the coastal limestone shelf. The largest of the gulches is Honouliuli Gulch, which drains into West Loch. The gulches are generally steep-sided in the uplands and generally of a high gradient until they emerge onto the flat 'Ewa plain. The alluvium they have carried has spread out in delta fashion over the *mauka* portions of the plain, which comprises a dramatic depositional environment at the stream gradient change. These gulches are generally dry, but during seasonal Kona storms carry immense quantities of runoff onto the plain and into the ocean. As typical drainages in arid slopes they are either raging uncontrollably, or are dry and, as such, do not form stable water sources for traditional agriculture in their upper reaches. The Honouliuli gulches generally do not have valleys suitable for extensive irrigated agriculture; however, this lack is more than compensated for by the rich watered lowlands near West Loch.

Honouliuli Ahupua'a, as a traditional land unit, had abundant and varied resources available for exploitation by early Hawaiians. The "karstic desert" and marginal characterization of the limestone plain, which is the most readily visible terrain, does not do justice to the *ahupua'a* as a whole. The richness of this land unit is marked by the following available resources:

1) 12 miles of coastline with continuous shallow fringing reef, which offered rich marine resources.

2) Four miles of frontage on the waters of West Loch, which offered extensive fisheries (mullet, *awa*, shellfish), as well as frontage suitable for development of fishponds.

3) The lower portion of Honouliuli Valley in the 'Ewa plain offered rich level alluvial soils with plentiful water for irrigation from the stream as well as abundant springs. This land would have stretched well up the valley.

4) A broad limestone plain, which because of innumerable limestone sinkholes, offered a nesting home for a large population of avifauna. This resource may have been one of the early attractions to human settlement.

5) An extensive upland forest zone extending as much as 12 miles inland from the edge to the coastal plain. As Handy and Handy (1972:469) have pointed out, the forest was much more distant from the lowlands here than it was on the windward side, but on the leeward side was more extensive. Much of the upper reaches of the *ahupua'a* would have had species-diverse forest with *kukui*, *'ōhia*, sandalwood, *hau*, *ti*, banana, etc.

Within this natural setting, archaeological and traditional sources show a general pattern of three main areas of settlement within the *ahupua'a*: a coastal zone, the Honouliuli taro lands, and inland settlement at Pu'u Ku'ua.

4.3.2 The Coastal Zone - Kalaeloa (Barbers Point), Ko'ōlina (West Beach)

Kalaeloa (Barbers Point)

Archaeological research at Barbers Point has focused on the areas in and around the newly constructed Deep Draft Harbor (Barrera 1975; Davis and Griffin, 1978; Hammatt and Folk, 1981, McDermott et al. 2000). Series of small clustered shelters, enclosures and platforms show limited but recurrent use at the shoreline zone for marine-oriented exploitation. This settlement covers much of the shoreline with more concentrated features around small marshes and wet sinks. Immediately behind the shoreline, under a linear dune deposit, is a buried cultural layer believed to contain some of the earliest habitation evidence in the area.

The attraction of the area to early Hawaiians was the plentiful and easily exploited bird population. Particular evidence for taking of petrels occurs at Site -2763 (Hammatt and Folk, 197:213). Initial heavy exploitation of nesting seabirds and other species in conjunction with habitat destruction probably led to early extinction. There is some indication of limited agriculture in mulched sinkholes and limited soil areas. Considering rainfall, this activity would have been limited, but probably involved tree crops and roots (sweet potatoes). The archaeological content of the sites indicates a major focus on marine resources.

Davis and Griffin (1978) distinguish functional classes of sites, based on surface area size and argues that the Barbers Point settlement consists of functionally integrated multi-household residence groups. Density contours of midden (by weight) and artifacts (by numbers) plotted for residence sites by Hammatt and Folk (1981) generally indicate narrowly defined spatial foci of discard, possibly indicating continuous use, or at least with no refurbishing or additions to the structures through time (Hammatt and Folk 1981). The focus is small habitation sites, typically lacking the full range of features found in large permanent residence complexes such as high platforms, complex enclosures, and ceremonial sites.

Ko'ōlina (West Beach)

There are three available studies on the Ko'ōlina project area (Davis et a. 1986a; Davis et al. 1986b; and Davis and Haun 1987).

Davis documents around 180 component features at 48 sites and site complexes consisting of habitation sites, gardening areas, and human burials. Chronologically the occupation covers the entire span of Hawaiian settlement, in what Davis and Haun describe as "one of the longest local sequences in Hawaiian prehistory" (Davis and Haun 1987:37). The earliest part of the sequence relates to the discovery of an inland marsh, and early dates were also obtained for the beachfront site and an inland rock shelter.

4.3.3 Honouliuli Taro Lands

Centered around the west side of Pearl Harbor at Honouliuli Stream and its broad outlet into the West Loch are the rich irrigated lands of the *'ili* of Honouliuli, which give the *ahupua'a* its name. The major archaeological reference to this area is Dicks, Haun, and Rosendahl (1987) who documented remnants of a once-widespread wetland system (*lo'i* and fishponds) as well as dryland cultivation of the adjacent slopes. The current study area is within this environmental zone.

The area bordering West Loch was clearly a major focus of population within the Hawaiian Islands, and this was a logical response to the abundance of fish and shellfish resources in close proximity to a wide expanse of well-irrigated bottomland suitable for wetland taro cultivation. The earliest detailed map (Malden 1825) shows all the roads of southwest O'ahu coalescing and descending the *pali* (cliff) as they funnel into the locality (i.e. Honouliuli Village). Dicks et al. (1987:78-79) conclude, on the basis of 19 carbon isotope dates and 3 volcanic glass dates that "Agricultural use of the area spans over 1,000 years." Undoubtedly, Honouliuli was a locus of habitation for thousands of Hawaiians. Pre-Contact population estimates are a matter of some debate but it is worth pointing out that in the earliest mission census (Schmitt 1973:19) 1831-1832, the land (*'āina*) of Honouliuli contained 1026 men, women, and children. It is not clear whether this population relates to Honouliuli Village or the entire *ahupua'a*, but the village probably contained the vast majority of the district's population. The nature of the reported population structure for Honouliuli (less than 20% children under 12 years of age) and the fact that the population decreased more than 15% in the next 4 years (Schmitt 1973:22) suggests that the prehistoric population of Honouliuli Village may well have been significantly greater than it was in 1831-1832. A conservative estimate would be that tens of thousands of Hawaiians lived and died at Honouliuli Village.

4.3.4 Pu'uku'ua: Inland Settlement

Documentation of inland settlement in Honouliuli Ahupua'a is more problematic in that there are relatively few documented archaeological sources. However, it is probable that the area around Pu'uku'ua, on the east side of the Wai'anae Ridge seven miles inland of the coast, was a Hawaiian place of some importance.

In 1899, Hawaiian Newspaper *Ka Loea Kālai'āina* relates a story of Pu'uku'ua as "a place where chiefs lived in ancient times" and a "battle field," "thickly populated." The article summarizes:

> There were two important things concerning this place. (1) This place was entirely deserted and left uninhabited and it seems that this happened before the coming of righteousness to Hawai'i Nei. Not an inhabitant is left. (2) The descendants of the people of this place were so mixed that they were all of one class. Here the gods became tired and returned to Kahiki [*Ka Loea Kālai'āina*, July 8, 1899, translated in Sterling and Summers 1978:33].

McAllister recorded three sites in this area, two *heiau* (134, 137) (Pu'u Kuina and Pu'uku'ua, both destroyed) and a series of enclosures in Kukuilua which he called "kuleana sites" (McAllister 1933). On the opposite side of the Wai'anae range, along the trail to Pōhākea Pass, Cordy (2002:36) states "Kākuihihewa was said to have built (or rebuilt) Nōi'ula, a *pō'okanaka heiau* (1,300 sq. m.) in Hālona in upper Lualualei, along the trail to Pōhākea Pass leading into 'Ewa, ca. A.D. 1640-1660" (Cordy 2002:36). There is no direct archaeological evidence available to the authors' knowledge that intensive Hawaiian settlement occurred here, but it is considered as a place of high probability, based on the above indications. John Papa 'Ī'ī (1959)

described a journey that Liholiho took which led him and an entourage through inland Honouliuli and over Pōhākea Pass. Geographically, the area receives sufficient quantities of water and would have had abundant locally available forest resources.

4.3.5 Summary

On the basis of archaeological studies, informed by historic records, the following may be concluded:

1) There are three areas of Hawaiian settlement in the *ahupua'a*; two are well-documented and one is problematic:
    a. the extensive limestone plain with recurrent use habitations for fishermen and gatherers and sometime gardeners;
    b. the rich cultivated lands of Honouliuli 'ili for extensive wetland taro and clearly the *ahupua'a* population center; and,
    c. the uplands around Pu'uku'ua associated with *kauwā* residence but probably used for agriculture and forest resources.
2) Honouliuli is designed as a unit to contain all the geographic elements of a typical Hawaiian valley *ahupua'a*, except they are arranged geomorphically in an atypical relationship. The *ahupua'a* is not organized around a single drainage network but shares the west portions of Waikele drainage in its upper reaches. A typical and highly advantageous characteristic for human subsistence is included in a vast coastline and fringing reef, an extensive limestone plain which would support only limited agriculture but would be excellent for bird catching in early times, and a huge expanse of sloping forest land. The richest forest land for foraging for wood, birds, feathers, etc. would have been the east slope of the Wai'anae Range. The surveys by Bordner (1983) and Hammatt and Shideler (1999) at Waimānalo Gulch indicated no evidence of Hawaiian occupation, but the gulch has been impacted in modern times (Bordner 1983).
3) The *makai* slope was not a major thoroughfare. We can see some very limited evidence of part-time agriculture in and around gulches and two foci of sparse habitation. The first is limited to *makai* portions of gulches and lava flats. This habitation is considered a *mauka* component or continuing of the Ko'ōlina coastal settlement rather than an independent focus. The second focus, separated from the first by a barren zone, is generally above the 800-foot elevation. This *mauka* habitation which could have been supported by seasonal dry land planting and forest foraging may be the lower portion of a thinly scattered, but widespread zone of settlement which stretches eastward and northeast along the east Wai'anae Range slopes and may increase in intensity along the more watered lands forming the *mauka* western boundary of Honouliuli.
4) There is to date no archaeological evidence of high status residence in Honouliuli. Large residential structures are not present along the Pacific shoreline where they would be expected. The late prehistoric occurrence of chiefs' houses is not apparent, perhaps because the ocean shoreline, although rich in marine resources, is uninviting for sport and

unsuitable for fishponds. The chiefly focus of 'Ewa District was Waipi'o. Whatever activities of this class occurred in Honouliuli would have been in or near the rich lands fronting West Loch (the *'ili* of Honouliuli). Concerning status associations with Honouliuli, it is interesting to note the connection of the Pu'uku'ua settlement with slaves (*kauwā*), the lowest class of Hawaiians (Sterling and Summers 1978:33).

5) The focus of population and agriculture within the *ahupua'a* of Honouliuli was the *'ili* of Honouliuli. There is good reason to assume, given the lack of intensive agricultural resources in other prehistoric times, all other habitation zones were economically and socially co-dependent.

Section 5 Results of Fieldwork

5.1 1990 Survey Findings of the West Loch Bluffs Project Area

In 1990, the southeastern portion of the project area (a 546-acre parcel south of Farrington Highway then called West Loch Bluffs) was surveyed by CSH members (Hammatt and Shideler 1990). Five sites were recorded and given SIHP permanent site numbers (Figures 25-29). In addition, four areas of historical importance were researched. For the recent survey, these five previously identified sites were revisited and notes were made on their current condition. In addition, during the recent inventory survey, backhoe testing was conducted in the four areas identified in the 1990 CSH report as possibly containing important historical deposits or artifacts. Table 4 summarizes the findings of the 1990 survey and Figure 25 shows the location of sites and historically documented areas from the 1990 CSH survey.

Table 4. Sites Previously Identified during the 1990 CSH survey

SIHP 50-80-12-	Description	Function	Age
4344	Plantation infrastructure; 3 pipe features (destroyed sometime between 1990 and 2005)	Sugar cane cultivation and irrigation	Ewa and Oahu Plantation operated from 1890 to 1995
4345	Stone-faced Berm	Ewa Plantation Railroad Berm	The Ewa Plantation Railroad operated from 1890 to 1947
4346	Stone-lined Well & Associated Features	Pumping Station (Northern)	Pre-1928 to present
4347	Stone-lined Well & Associated Features	Pumping Station (Central)	Pre-1928 to present
4348	Stone-lined Well & Associated Features	Pumping Station (Southern)	ca. 1928 to present
No SIHP numbers were assigned to the next four areas since there were no surface remains			
	Land Court Awards (LCAs) in Honouliuli Taro Lands	Habitation and Agriculture	Documented in 1848; surviving to at least 1890 (founding of Ewa Plantation)
	Kapalani Catholic Church	Church, School, Residence; possibly cemetery	Built between 1840 and 1847 and destroyed between 1885 and 1890
	PipeLine Village	Plantation Camp for Portuguese and Puerto Rican workers; also a school and church	Some houses possibly built in 1890; main construction phase of 162 houses from 1906 to 1911; demolished in 1931
	Drivers and Stable Villages	Plantation Camp	Drivers Village probably built between 1900 and 1910; it was moved to a new location (outside the project area) in 1931; Stable Village seems to have consisted of only four houses

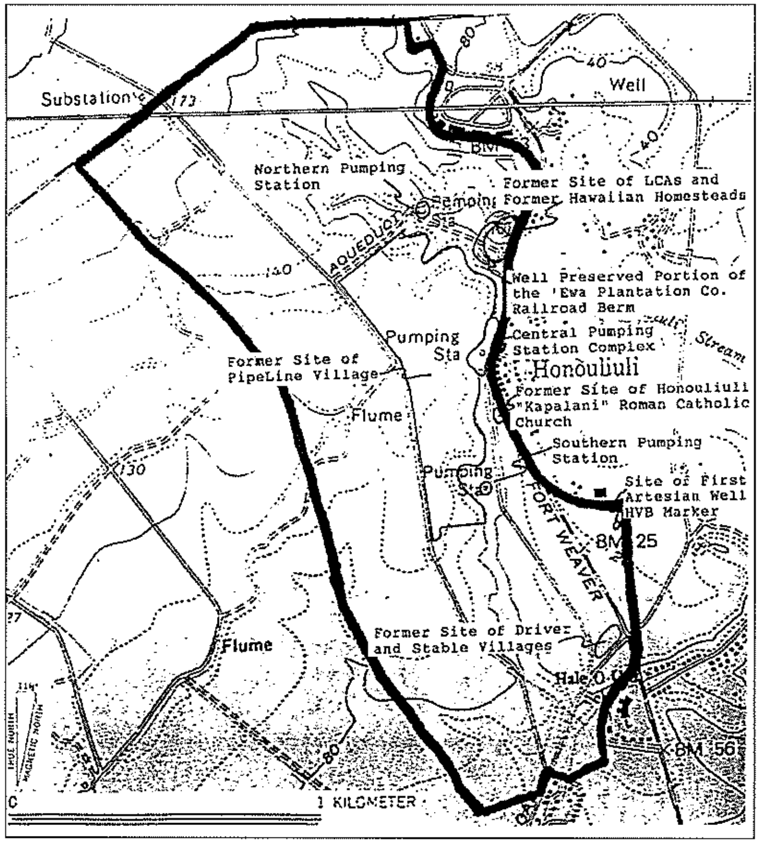

Figure 25. Map of sites and historically documented areas of interest identified during the 1990 CSH survey of a 546-acre parcel of the current project area

Figure 26. Site 50-80-12-4345, Stone-faced berm for Ewa Plantation railroad, view to the north

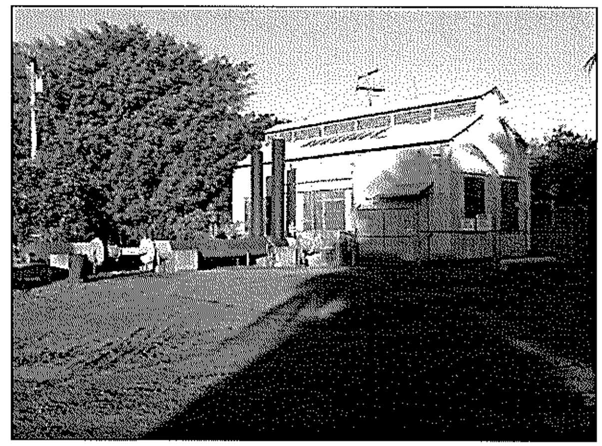

Figure 27. Site 50-80-12-4346, northern pumping station, view to the northwest

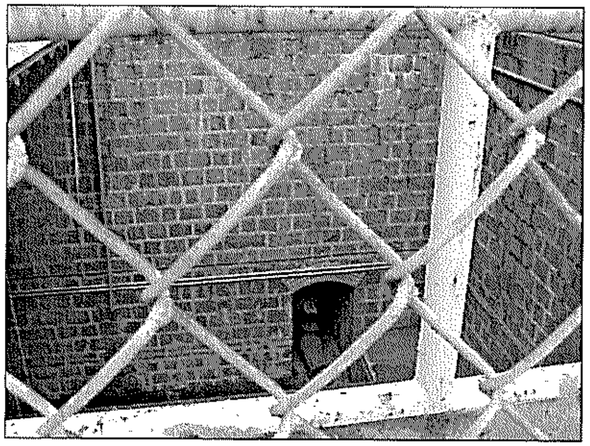

Figure 28. Site 50-80-12-4347, well wall of central pumping station, view to the north

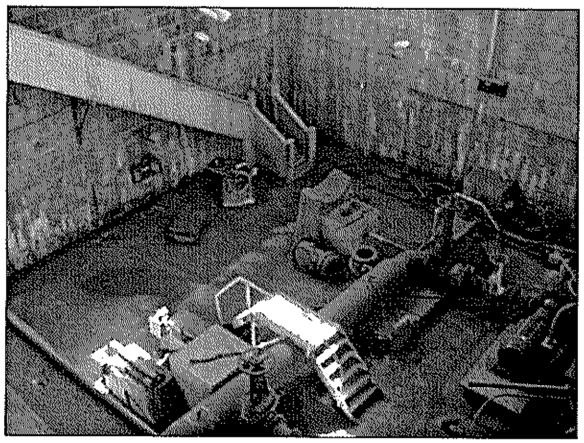

Figure 29. Site 50-80-12-4348, interior well of southern pumping station, view to the west

5.1.1 Sites Recorded during the 1990 Survey

There are three pumping stations within the project area, all which feature rectangular stone faced pits 9 m deep. The northern two (but not the southern one) appear on the 1927/28 USGS map. The southern one was built before 1946. A photo (Bishop Museum Visual Collection) dated 1923 shows what appears to be a brand new "Riedlier Steam Pump Driven by Triple Expansion Corlis Engine" in one of these large stone-faced rectangular wells.

An important part of life within the camps of the project area was the Ewa Plantation Company Railroad, which operated from 1890-1947. Near its peak in 1931, the Plantation Railway system included 18.95 miles of 36" gauge permanent track, 8 miles of portable track, seven oil-burning Baldwin locomotives, and 705 cars (Conde and Best 1974:283). Permanent rail lines ran from the southwest to the northeast up through the middle of the project area along the present can-haul road alignment and also near the eastern margin of the project area. In 1947, the rails were sold for scrap.

During the subsequent decades of the twentieth century, sugar cane operations in 'Ewa phased out and, more recently, former cane lands have been rezoned for residential development. Structures in the area of the former plantation villages have fallen into disrepair or have been demolished. However, portions of the area - including Varona Village, Tenney Village, and Renton Village - have been designated the 'Ewa Villages Historic District (State site 50-80-12-9786), which has been nominated for National Historic Landmark status. Additionally, the still-extant OR&L rail line through Honouliuli has been placed on the National Register of Historic Places (Site 50-80-12-9714).

5.1.1.1 Ewa Plantation Infrastructure (Site 50-80-12-4344)

In the immediate vicinity of the site of Drivers and Stable Villages, the 1990 CSH survey found three iron pipe features, including a tall metal post and two welded pipe constructions. These were collectively given SIHP number 50-80-12-4344, because they were tangible features, which by appearance and location, appeared to be more than 50 years old. The significance of these constructions is thought to exist only in so far as further determination of their age and function elucidate out record of Ewa Plantation life. During the recent CSH 2005 inventory survey, these features could not be refound; the area of their former location had been bulldozed and they had been destroyed.

5.1.1.2 Ewa Plantation Railroad (Site 50-80-12-4345)

The Ewa Plantation Co. ran a private railroad for the primary purpose of hauling cane; it included nearly 30 miles of permanent track. The railroad operated from 1890 to 1947, but most of the permanent track was in place by 1910 (Conde and Best 1973:280). It has been the policy of the Historic Sites section of the SHPD to encourage the retention of particularly good section of railroad berm. While many kilometers of permanent track ran through the project area, a particularly good example is only to be found in the northeastern portion of the project area in the mouth of the dry stream valley, in the traditional *'ili* of Maui. This stretch of the Ewa Plantation Railway was given SIHP number 50-80-12-4345. The railroad berm on either side of the valley access road features well-preserved facings commonly 2 m high. It is recommended that if the railroad berm in this area can be incorporated into development plans and preserved, that this be done. If development plans require the demolition of a portion of this stretch of railroad berm then mitigation should be worked out with the State Historic Preservation Office in advance.

5.1.1.3 Ewa Plantation Pumping Stations (Sites 50-80-12-4346, -4347, and- 4348)

There are three pumping stations within the project area, all of which feature a deep rectangular basalt block, faced wall. The northern two (Sites -4346 and -4347) are thought to pre-date 1928 and the southern well (Site -4348) is thought to date to shortly thereafter. All three are still extant in the project area. The wells are very impressive structures and are of particular importance to the history of 'Ewa. It is recommended that these wells be preserved. If these wells are deemed a hazard or these area are required by development plants, it might be possible to fill, mark, and cover the wells. All three of the site designations for these wells include adjacent structures. In the case of the northernmost (Site -4346) and the southernmost (Site -4348) wells, the adjacent structure is limited to a single pump house, which has an exterior or corrugated sheet metal panel construction. Evaluation of possible historic significance of these structures is beyond our area of expertise, and it is recommended that issues of significance and proper historic documentation be resolved with the SHPD office in advance of any development of these areas to avoid adverse impacts.

The case of the Central Pump house (Site -4347) is more complicated, in that there are eight features related to the well. In addition, there are a number of small architectural and/or industrial features in the immediate vicinity of the well. In some cases, the age and exact function of these features in unclear. We recommend preservation of at least portions of this site. The significance of the area of Site -4347 would be evaluated after an assessment of the significance of its architectural features and the assessment of the significance of the Ewa Village area. If development of this area is desired, mitigation should be discussed with the SHPD Office.

5.1.2 Historically Documented Areas Identified during the West Loch Bluffs Project

Background research for the West Loch Bluffs report (Hammatt and Shideler 1990) also highlighted four other areas of concern:

5.1.2.1 Hawaiian Land Court Awards in the Honouliuli Taro Lands

An area along the northern portion of Old Fort Weaver Road that was once called the *'ili* of Maui. It contained house sites and taro patches tended by native Hawaiians, according to 1848 Māhele LCA testimony.

A house site (belonging to Pue) is shown on Monsarrat's map of 1878, and the presence of several more house sites in this area is clearly indicated in land records circa 1848. It seems very likely that any stones from pre-contact or early historic foundations would have been removed to facilitate cane cultivation and possibly for used in the construction of the adjacent Ewa Plantation railway berm. Is seems highly probably that plowing associated with pre-drip irrigation cane cultivation has badly disturbed sediments to a depth of nearly a meter (36 inches). However, it was thought possible that slope wash from induced erosion had sealed and protected these deposits and had thus insulated these deposits from the impact of subsequent plowing.

There many be intact gravels or other cultural deposits associated with this area. Thus it was recommended in the 1990 survey report that subsurface testing take place in this area before development.

5.1.2.2 Kapalani Catholic Church

There is an area along the southern portion of Old Fort Weaver Road that once had a Roman Catholic Church, shown on the Monsarrat map of 1878 as a fenced area enclosing three structures believed to include a church, a school, and a residence. This church (Kapalani Church) was built between 1840 and 1847 and is believed to have been destroyed between 1885 and 1890. From old survey maps, it appears that part or all of the site of the church structure is directly under Old Fort Weaver Road. However, this area is still of archaeological concern for its association with an important person in the history of Hawai'i and because there may be associated historic graves.

It seems highly probable that the Honouliuli Roman Catholic church site within the project area was a major focus of the life of Kahoaliikunaiewakamoku Kepelino (Zepherino) Keauokalani, who is best known by the name Kepelino. Kepelino was a major historian and the author of four fascicles that appeared from 1858-1860, called Hooiliili Hawaii "Hawaiian Collection" and his Mo'olelo Hawaii "Traditions of Hawaii" in 1868 (Valeri 1985:xxv-xxvi). He is of particular importance because he came from a family of high priests, he was a grandson of Kamehameha, he was Queens Emma's secretary, and he was the only major Hawaiian historic of the time who was not a pupil of the Lahainaluna School. Letters to Catholic newspapers dated 1860-1869, under the name Z. Kahoali'i place him in Honouliuli, and it seems probable that he lived in Honouliuli from 1851 into the 1870s. As he was known as an ardent Catholic and a school teacher, it seems likely that he taught for many years at the school within the Roman Catholic Church compound at Honouliuli (now covered by Old Fort Weaver Road).

Another issue regarding the Roman Catholic Church site area is that of graves. A history of the Roman Catholic Church in Hawai'i (Schoofs 1978:110) reports that, after the abandonment of the church, "in 1891 Honouliuli was still important enough to acquire its own Catholic cemetery." We know of only on Roman Catholic Church property in Honouliuli, and that is the church property within and adjacent to the project area. It is possible, therefore, that this cemetery was adjacent or on these church grounds. While the site of the Honouliuli church has been under sugar cane cultivation for many decades, the 36-inch plow zone many not have disturbed any historic interments, if present. Because no trace of this church was found on the surface during the CSH 1990 survey, no site number was given, however, additional background research into this church and subsurface backhoe testing before any development was recommended (Hammatt and Shideler 1990:55).

5.1.2.3 Ewa Plantation PipeLine Village

PipeLine Village was a substantial community including 162 houses (some duplexes), a school, and a church. PipeLine Village was also known as Spanish Camp because its residents were largely of Puerto Rican and Portuguese ancestry. Most of the structures in PipeLine Village are believed to have been built between 1906 and 1911, but it seems highly probably that there were a few older structures, possibly including some of the oldest structures of Ewa Plantation, dating to 1890. The village is believed to have been completely demolished in 1931.

All of the many photos of PipeLine Village houses (Figure 30, Figure 31, Figure 32, and Figure 33) show house foundations consisting of wood posts resting on small light colored blocks (tofu block construction). Thus, there would be virtually no trace of a building footprint after the building was dismantled. The only archaeological remains associated with this village that would be likely to survive 60 years of subsequent cane cultivation would probably be related to the privies, which were typically detached outhouses. If these were pit privies, there should be more than 160 discernible pits with associated durable artifacts, which might include bottles, coins, and personal effects. Some plantation privies had detachable compartments, which would be periodically emptied. If this type of privy was utilized, there would probably be no trace left. It is believed that refuse collection was highly organized by the plantation from early times and this disposal was outside of the present project area. There could however, be small trash pits.

The Ewa Plantation Company Annual Report for 1923 states that "coral roads were laid through villages" and it may well be that the grid of streets shown on the 1928 USGS map could be determined on the ground once the cane was cleared. There are also photos of Portuguese bread ovens (*forno*), which appear to be constructed of brick and plaster, but these were probably all demolished and completely removed. There may have been building slabs or other more durable features to the schoolhouse and church, but there are believed to have been bulldozed as well. It is anticipated that with the possible exception of privy pits and associated artifacts, that the thoroughness of demolition, the light nature of construction, and the sixty years of continuous cane cultivation would have removed almost all other traces of PipeLine Village.

Subsurface reconnaissance of the site of PipeLine Village was recommend in this area for the purpose of gaining further data regarding the layout of the village and for the recovery of artifacts, which might be useful in the study of ethnicity and the interpretation of Ewa Plantation village life. In the absence of any identifiable intact surface cultural features, no site number during the 1990 CSH survey was given to the former site of PipeLine Village.

5.1.2.4 Drivers and Stable Villages

Drivers Village and Stable Village were small communities previously located in the southeastern corner of the project area. Little is known about these villages. A 1931 Ewa Plantation Report states "The Drivers Village, located near the main stables was in such a bad location that it was decided to move all the fourteen cottages . . ." It seems highly probable that Drivers Village consisted of the fourteen structures shown on the 1928 map, that it was constructed between 1900 and 1910 and that it was moved in 1931. Stable Village seems to refer to the few structures just across the street to the south. As with PipeLine Village, the 1990 CSH report recommended reconnaissance after the removal of sugar cane and subsurface testing for the purpose of gaining further data regarding the layout of the village and the recovery of artifacts, which might be useful in the study of ethnicity and in the interpretation of Ewa Plantation village life. No site number were assigned to these village in the absence of any tangible clearly-related remains.

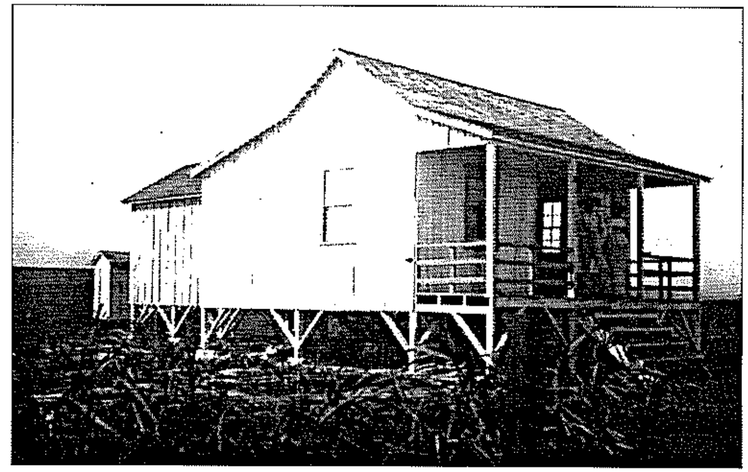

Figure 30. 1907 photograph of residence at PipeLine Village

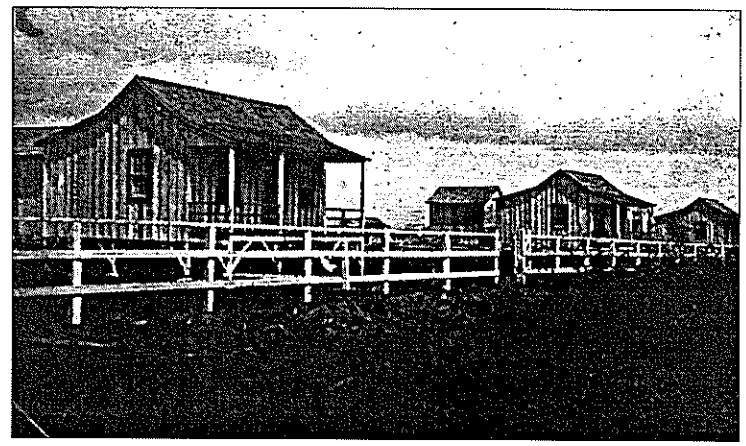

Figure 31. Undated photo of PipeLine Village, showing rows of houses

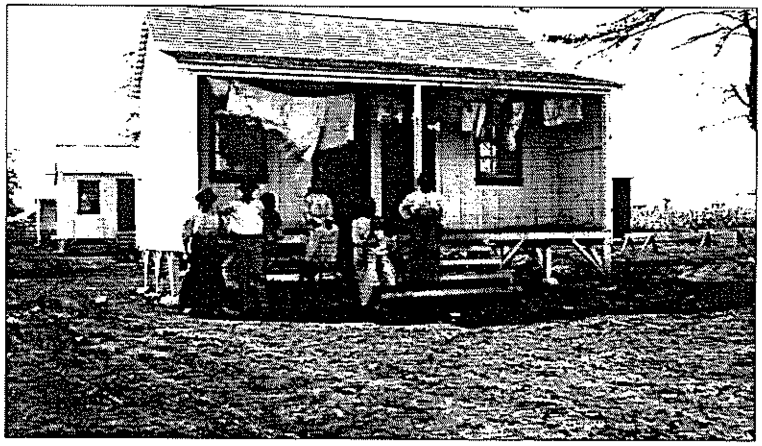

Figure 32. 1910 photograph of Puerto Rican family in PipeLine Village

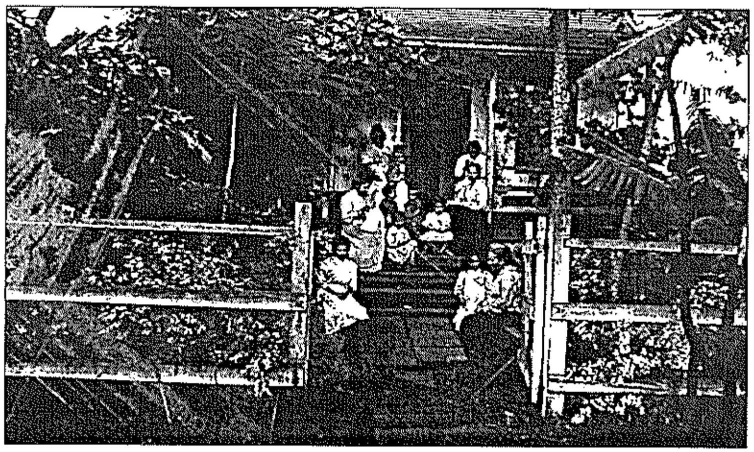

Figure 33. 1907 photograph of Portuguese family at PipeLine Village

5.2 2005 Surface Inventory Survey Findings

A surface pedestrian survey was conducted in the main project area on November 21 and 22, 2005 and January 13, 2006. Approximately 75% of the project area consists of plowed fields with low vegetation (pumpkins, squash and other ground vegetables). All roads surrounding these plowed fields were surveyed by car or by foot. In the southwestern section of the project area (south of Farrington Highway), only a linear corridor along an irrigation ditch had some (natural) weedy vegetation. This area was surveyed by foot. The southeastern section of the project area is a 546-acre parcel that was previously surveyed by CSH in 1990. Those areas with previously identified sites and areas selected for backhoe testing were revisited and additional notes were taken on the present condition of sites and areas. In the northern section of the project area (between I H-1 and Farrington Highway), larger sections of the project area were traversed on foot. Both banks of the Honouliuli Gulch were surveyed, the entire project area east of the gulch was surveyed, and a small weedy area in the northwestern corner of the project area was surveyed. The remaining portions of the main project area are plowed fields planted in crops or land covered with farm buildings.

Two non-contiguous parcels were surveyed by foot on January 13, 2006. The southern parcel (TMK 9-1-010:002) consisted of a triangular area bounded by a residential area, the West Loch Estates, on the west and Plantation Road on the west and south. The east side is bounded by the proposed Ewa Gentry Drainage Ditch, which was surveyed in 1993 (Sinoto and Pantaleo 1993). It is bisected by Arizona Road. The section south of Arizona Road is plowed fields; the northern section is covered with low grass and *koa haole* trees; the ground is extremely hummocky, as if it has been recently bulldozed (see Figure 5). Based on historic maps, Sinoto and Pantaleo (1993) thought they might find the remains of a portion of the OR&L track and sugar cane irrigation flumes in their project area. They found part of the OR&L roadbed berm, and also found the remains of metal flumes and concrete culverts, but these had been bulldozed into piles near the West Loch shoreline. These remains were not considered significant due to the absence of structural and locational integrity. During the recent CSH survey of the area, only a few concrete culverts, bulldozed into a ditch along the western border of the parcel, were found. The northern non-contiguous parcel (TMK 9-2-001:001) surrounds a reservoir north of the H-1 Interstate. This area has also been extensively bulldozed; the reservoir has been filled (is level with the surrounding ground) and a berm has been constructed around the former rim. There were no structural remains found in this area.

Four new features were recently identified in the project area. All four were found in the northern portion of the main project area along Honouliuli Gulch (Figure 34 and Figure 35). During the 1990 inventory survey of the West Loch Bluffs (southeastern 546-acre parcel), three sugar cane plantation infrastructure features (three pipe features) were grouped into Site 50-80-12-4344. Since all four new features found during the recent 2005 inventory survey are also related to sugar cane plantation infrastructure, these features have been subsumed into the same site designation. In this portion of the project area, Honouliuli Stream extends generally from the northwest to the southeast, but one portion is oriented east-west.

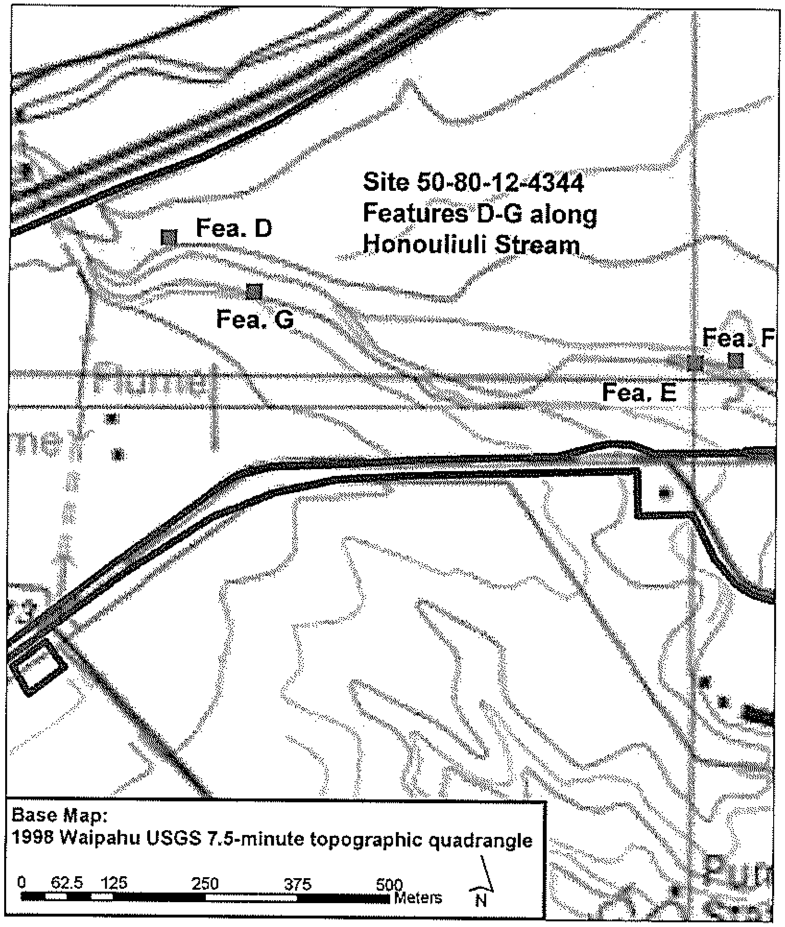

Figure 34. US Geological Survey map, showing location of Features D-F of Site 50-80-12-4344 along Honouliuli Stream

Figure 35. Typical vegetation in Honouliuli Gulch, view to the south

Site 50-80-12-4344, Features D-G

Feature D is a linear wall built against (parallel) to the east (or north) bank of Honouliuli Gulch (Figure 36 and Figure 37). It is 16 m long, 90 cm wide, 1.1 m high, and is oriented at a 77/277° angle. The wall is at the rim of the gulch. It is constructed of subangular basalt cobbles and boulders, 30-60 cm in diameter, stacked five to six courses high. One side abuts the gulch rim and the other side is faced; in some cases, the rocks have been split with metal tools, so that the outer side has a vertical face. Based on the location and construction, the wall functioned for erosion control.

Feature E is a linear wall on the west (or south) bank of Honouliuli Stream (Figure 38 and Figure 39). It is built perpendicular to the orientation of the gulch and is built on a slightly sloping terrace area near the top rim of the gulch. The wall is 4.5 m high, 55 cm wide, and 50 cm high. It is a core-filled wall, with basalt boulders 30-60 cm in diameter on the sides, and smaller cobbles in the interior. The function is unknown, but core-filled walls are usually historic in age. Its location near Honouliuli Gulch suggests it functioned for water or erosion control.

Feature F is a stone-faced berm on the west (south) bank of Honouliuli Stream at the top of the gulch rim (Figure 40 and Figure 41). It is constructed perpendicular to the orientation of the stream. The berm is faced with stones (some cut with metal tools to make a vertical face) on the northern side, stacked 6 to 8 courses high. The wall is not vertical, but slopes outward at the base. The construction is somewhat unusual in that the largest stones (up to 70 cm in diameter) are placed in the middle courses, not at the base, as is usual. The top of the berm is not particularly even and slopes down towards the gulch. The construction of this berm suggests it was constructed as some type of loading area, so that some type of vehicle could be parked or structure could be constructed on top of the berm, possible for loading or storing sugar cane or water.

Feature G consists of a concrete ditch and a concrete masonry catchment basement on the west (or south) bank of Honouliuli Gulch (Figure 42 and Figure 43). A metal pipe at the base of the flume and basin extends underground towards Honouliuli Gulch down a 45° slope at a due north/south orientation. The ditch is rectangular and 5.5 m long, 40 cm wide and 30 cm deep. The top of the ditch is covered with concrete slab lids, 90 cm long, 40 cm wide and 7 cm thick. The ditch itself is made with separate Waialua-type modal concrete units, which were made at the Ewa Plantation for their irrigation projects. The basin is C-shaped, constructed of rocks and mortar. The basin is 1.35 m long north/south, 1.3 m wide, 90 cm deep, with walls 28 cm thick. The outer side has an inset area that may once have had some type of sign or plaque. The ditch was used for irrigation or water control by the Ewa Plantation Company.

Figure 36. Feature D, Linear Wall abutting gulch rim, view to the north (upslope)

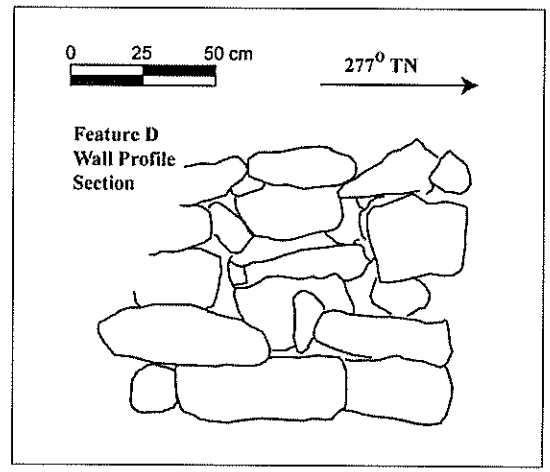

Figure 37. Feature D, Linear Wall, profile of 1.0 meter section

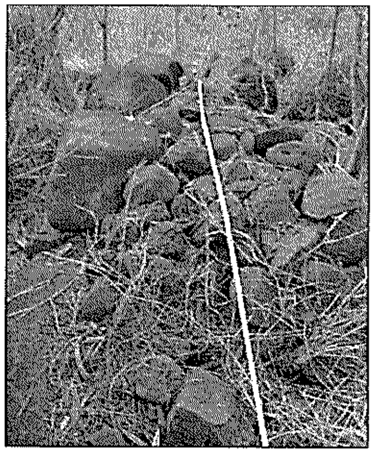

Figure 38. Feature E, Linear Wall, built perpendicular to orientation of Honouliuli Gulch, view to the east (upslope)

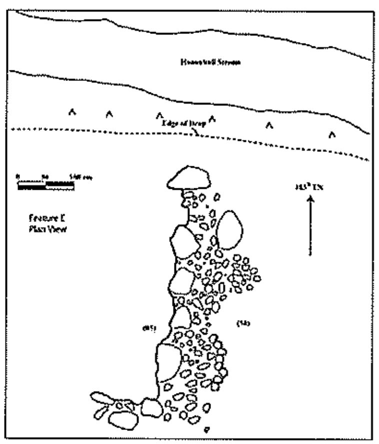

Figure 39. Feature E, Linear Wall, plan view

Figure 40. Feature F, Stone-faced berm, built perpendicular to orientation of Honouliuli Stream, view to the west (downlsope)

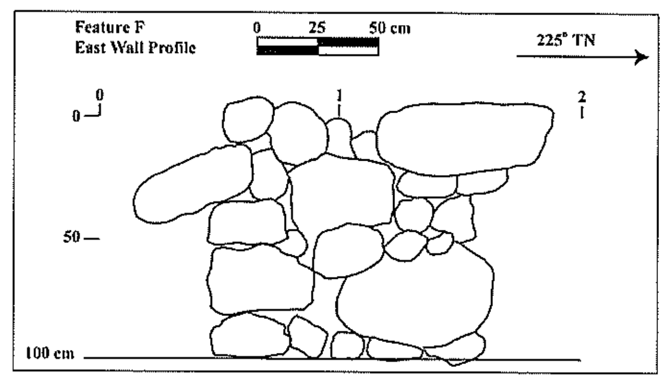

Figure 41. Feature F, Linear Wall of Berm, profile of 1.0 m faced wall section

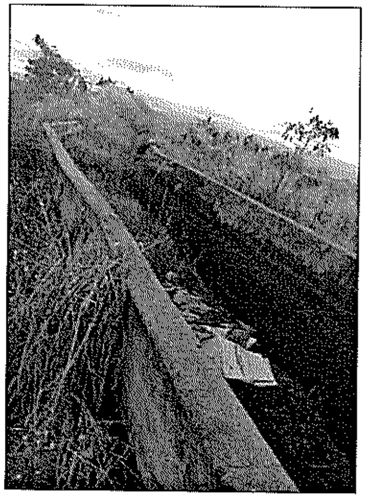

Figure 42. Feature G, concrete ditch, view to the west (upslope)

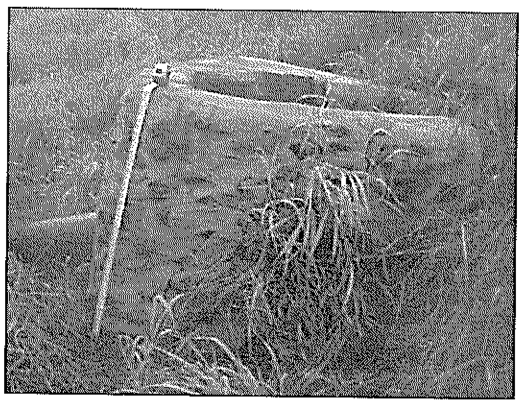

Figure 43. Feature G basin, showing steel pipe extending downslope to Honouliuli Stream, view to the south

5.3 2005 Backhoe Test Excavations Findings

Backhoe testing was conducted in four selected portions of the project area on November 28 and December 7 and 8, 2005. A total of 19 trenches were excavated in the project area in four specific areas (Figure 44 and Figure 45), the Honouliuli Taro Lands (5 trenches) adjacent to the northern portion of Old Fort Weaver Road, the probable location of the Kapalani Catholic Church (7 trenches) adjacent to the southern portion of Old Fort Weaver Road, the former site of Drivers and Stable Villages (1 trench) near the southeastern corner of the project area, and the former site of PipeLine Village (6 trenches) in the south-central section of the project area.

5.3.1 Roman Catholic Churchyard

Seven trenches (BHT 1-6, BHT 19) were excavated around the probable site of the Roman Catholic churchyard. As noted previously, a comparison of modern and nineteenth century maps indicates that the church building itself was once located under the present alignment of Old Fort Weaver Road. Only a small portion of the churchyard extended on the west side of the present road. There are fenced-in fields in this portion of the project area where staked beans are planted. There is only a small portion of open ground between this fenced-in area and a tall berm along the road. The seven trenches were placed around the sides of the fenced field and between the fields and the road berm. No shaped stones, mortar, cultural layers, or artifacts were found in any of the seven trenches.

Trenches 1-3, on the north side of the bean field, had complex stratigraphies with several silty loam or silty clay layers, probably deposited during flooding episodes. An old roadbed was present as the upper stratum of Trenches 4, 5, 6, and 19 (along the east side of the field adjacent to Old Fort Weaver Road). This is probably the old alignment of Fort Weaver Road, thus the yard of the Roman Catholic Road was probably located east of our trench placement. Either it was located under the present alignment of Old Fort Weaver Road, under the shoulder of the road, or under the earth berm adjacent to the road shoulder. Trench 4 had modern black plastic fragments (used for weed control in the gardens) at a depth of 210 cm. Another trench (Trench 3) had coral cobbles or boulders at depths of 150 cmbs, indicating a significant amount of soil disturbance in these trenches adjacent to the road.

Stratigraphic profiles for these seven trenches are illustrated in Figure 46 to Figure 52, with the stratigraphic soil descriptions following.

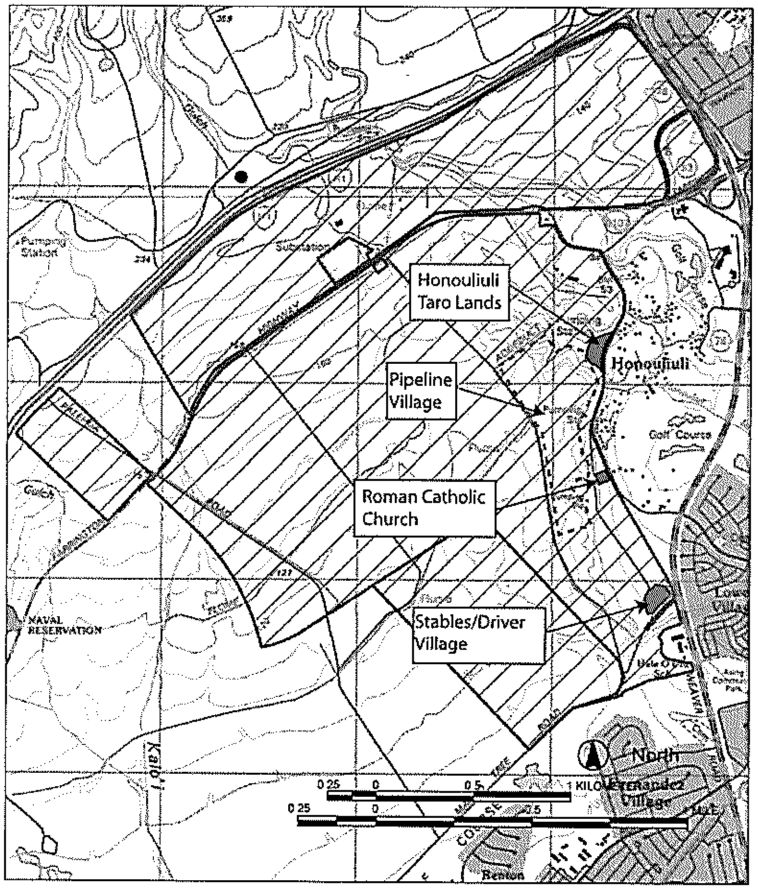

Figure 44. US Geological Survey map, showing four areas selected for backhoe testing

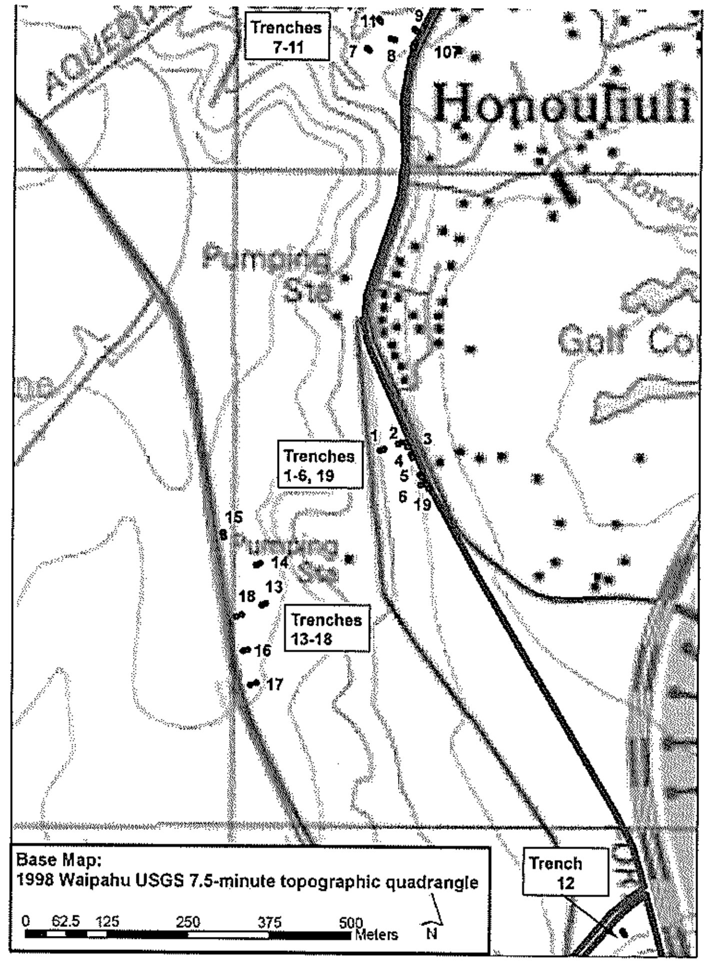

Figure 45. US Geological Survey map, showing location of Backhoe Trenches 1-19

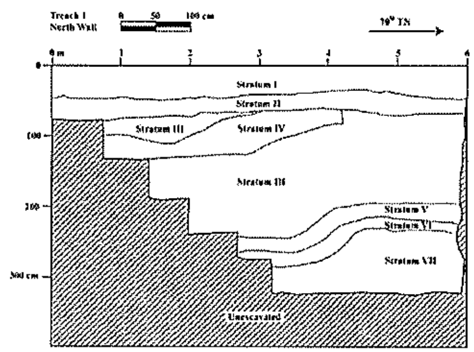

Figure 46. Backhoe Trench 1, north wall profile

Backhoe Trench 1
Stratum-Depth

I	0-60 cmbs	Very dark grayish brown (10YR3/2) silty clay loam; weak, fine, subangular blocky structure; very firm when moist, very sticky and moderately plastic consistence; terrestrial origin; abrupt, smooth boundary;
II	60-70 cmbs	Brown (10YR4/3) silty clay loam; moderate, medium subangular blocky structure; very hard when dry, slightly sticky and slightly plastic consistence; terrestrial origin; abrupt, smooth boundary;
III	60-240 cmbs	Very dark gray (10YR3/1) clay loam; strong, coarse, angular blocky structure; extremely hard when moist, slightly sticky and slightly plastic consistence; terrestrial origin; very abrupt, wavy boundary;
IV	65-120 cmbs	Gray (10YR6/1) ashy silt; structureless; slightly hard when moist; very sticky and slightly plastic consistence; terrestrial origin; abrupt, wavy boundary; stratum is between two Stratum III layers;
V	240-260 cmbs	Dark yellowish brown (10YR3/4) silty loam; structureless; loose when moist; slightly sticky and moderately plastic; terrestrial origin; very abrupt, wavy boundary;
VI	260-290 cmbs	Dark reddish brown (5YR3/2) silty loam; structureless; soft when dry, slightly sticky and moderately plastic; terrestrial origin; very abrupt, wavy boundary;
VII	290-330+ cmbs	Dark brown (10YR3/3) silty clay; moderate, medium angular blocky structure; hard when dry, slightly sticky and plastic; terrestrial origin; excavation arbitrarily terminated at 330 cmbs.

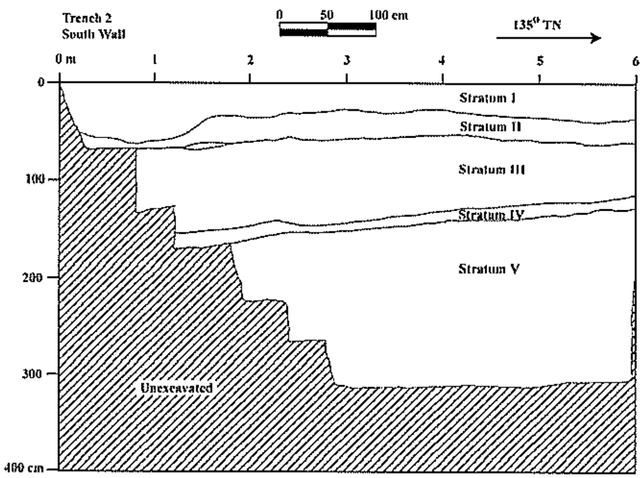

Figure 47. Backhoe Trench 2, south wall profile

Backhoe Trench 2
Stratum-Depth

I	0-25 cmbs	Very dark grayish brown (10YR3/2) silty clay loam; moderate, medium, subangular blocky structure; very firm when moist, very sticky and moderately plastic consistence; terrestrial origin; extensive charcoal flecking; abrupt, wavy boundary;
II	25-53 cmbs	Dark brown (7.5YR3/2) clay loam; moderate, medium subangular blocky structure; friable when moist, sticky and moderately plastic consistence; terrestrial origin; clear, smooth boundary;
III	53-140 cmbs	Very dark gray (10YR3/1) clay loam; strong, coarse, angular blocky structure; extremely hard when moist, sticky and slightly plastic consistence; terrestrial origin; very abrupt, wavy boundary;
IV	140-147 cmbs	Gray (10YR6/1) ashy silt; structureless; slightly hard when moist; very sticky and slightly plastic consistence; terrestrial origin; abrupt, wavy boundary;
V	147-310+ cmbs	Dark yellowish brown (10YR3/4) silty loam; structureless; loose when moist; slightly sticky and moderately plastic; terrestrial origin; excavation arbitrarily terminated at 310 cmbs.

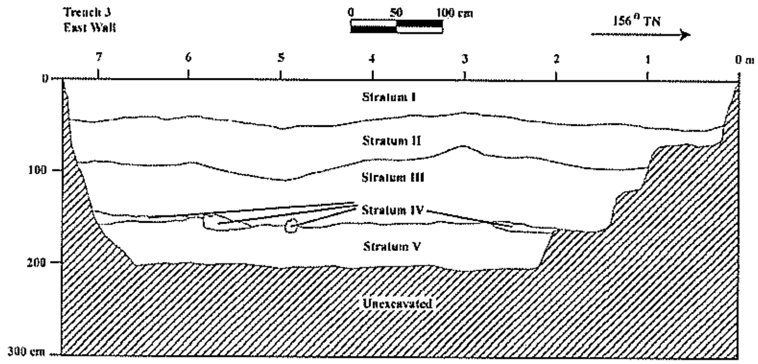

Figure 48. Backhoe Trench 3, north wall profile

Backhoe Trench 3
Stratum-Depth

I	0-41 cmbs	Very dark grayish brown (10YR3/2) silty clay loam with 90% gravel (old road bed); moderate, medium subangular blocky structure; very firm when moist, sticky and moderately plastic consistence; terrestrial origin; abrupt, smooth boundary;
II	40-85 cmbs	Dark brown (7.5YR3/2) clay loam; moderate, medium subangular blocky structure; friable when moist, sticky and moderately plastic consistence; terrestrial origin; abrupt, wavy boundary;
III	85-155 cmbs	Dark yellowish brown (10YR4/4) silty clay loam; moderate, medium structure; friable when moist, sticky and plastic; very abrupt, irregular boundary;
IV	145-162 cmbs	Gray (10YR6/1) ashy silt; structureless; slightly hard when moist; very sticky and slightly plastic consistence; terrestrial origin; abrupt, wavy boundary, several large coral borders at boundary;
V	155-200+ cmbs	Dark yellowish brown (10YR3/4) silty loam with 25% coral cobbles; structureless; loose when moist; slightly sticky and moderately plastic; terrestrial origin; excavation arbitrarily terminated at 200 cmbs.

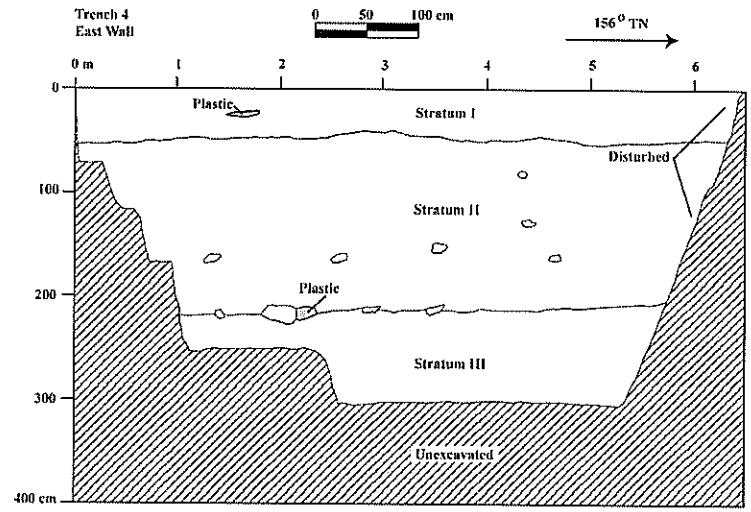

Figure 49. Backhoe Trench 4, north wall profile

Backhoe Trench 4
Stratum--Depth

I	0-48 cmbs	Very dark grayish brown (10YR3/2) silty clay loam with 25% gravel (old road bed); moderate, medium subangular blocky structure; very firm when moist, sticky and moderately plastic consistence; terrestrial origin; abrupt, smooth boundary;
II	40-210 cmbs	Dark brown (7.5YR3/2) clay loam; moderate, medium subangular blocky structure; friable when moist, sticky and moderately plastic consistence; terrestrial origin; scattered coral cobbles; abrupt, wavy boundary, modern plastic found at II/III interface at 210 cmbs;
III	210-300+ cmbs	Dark yellowish brown (10YR3/4) silty loam with 25% coral cobbles; structureless; loose when moist; slightly sticky and moderately plastic; terrestrial origin; excavation arbitrarily terminated at 300 cmbs.

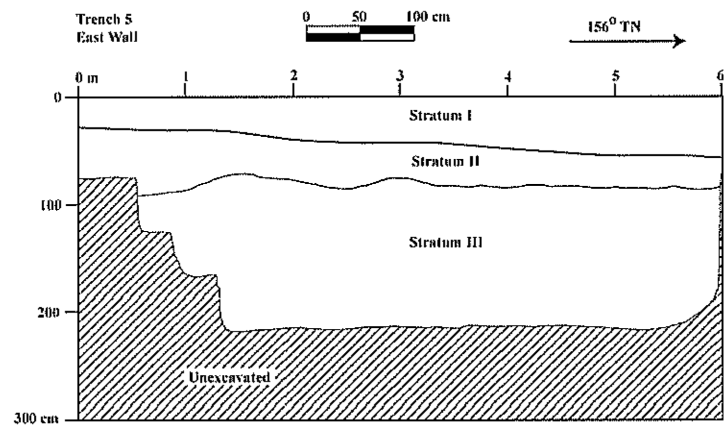

Figure 50. Backhoe Trench 5, east wall profile

Backhoe Trench 5
Stratum--Depth

I	0-50 cmbs	Old asphalt fragments;
II	50-82 cmbs	Very dark grayish brown (10YR3/2) clay loam with 1% basalt cobbles; moderate, medium angular blocky structure; extremely hard when dry, sticky and plastic consistence; terrestrial origin; diffuse, wavy boundary;
III	82-213+ cmbs	Dark brown (10YR3/3) silty clay loam; weak, fine subangular blocky structure; hard when dry, sticky and moderately plastic consistence; terrestrial origin; excavation arbitrarily terminated at 213 cmbs.

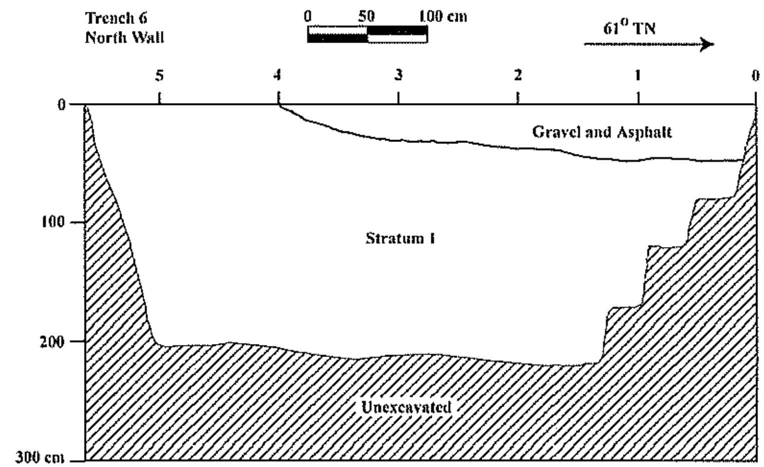

Figure 51. Backhoe Trench 6, north wall profile

Backhoe Trench 6
Stratum-Depth

I	0-48 cmbs	Old asphalt fragments;
II	48-119+ cmbs	Brown (10YR4/3) clay loam; medium moderate subangular blocky structure; moderately firm when moist, sticky and very plastic consistence; terrestrial origin; excavation arbitrarily terminated at 119 cmbs.

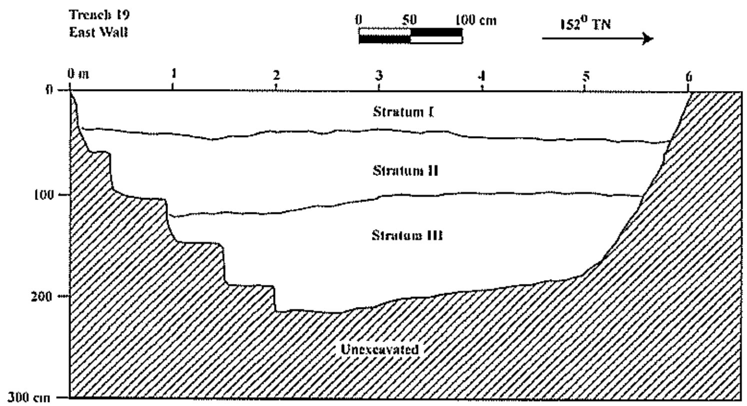

Figure 52. Backhoe Trench 19, east wall profile

Backhoe Trench 19
Stratum--Depth

I	0-48 cmbs	Old asphalt fragments;
II	48-102 cmbs	Very dark grayish brown (10YR3/2) clay loam with 1% basalt cobbles; moderate, medium angular blocky structure; extremely hard when dry, sticky and plastic consistence; terrestrial origin; diffuse, wavy boundary;
III	102-210+ cmbs	Dark brown (10YR3/3) silty clay loam; weak, fine subangular blocky structure; hard when dry, sticky and moderately plastic consistence; terrestrial origin; excavation arbitrarily terminated at 210 cmbs.

5.3.2 Honouliuli Taro Land Trenches

Five trenches (BHT 7-11) were excavated in the Honouliuli Taro Lands area. This portion of the project area was thickly vegetated with low (ca. 1 m tall) *koa haole* trees and larger *'opiuma* (*Pithecellobium dulce*) trees. The area available for backhoe testing was circumscribed by the presence of these larger trees; trenches could only be placed in areas where the smaller *koa haole* trees could be knocked down with the backhoe. There was also a large pit in the southwestern section of this area used for flood control. This area is adjacent and east of the Ewa Plantation Railroad berm (Site 50-80-12-4345).

No shaped stones, cultural layers, *'auwai* (irrigation ditches used in wetland cultivation) organic soils (soils once used for wetland agriculture), walls, habitation platforms, boundary walls or alignments, or artifacts were found in any of the five trenches; however, many of the trenches did contain fragments of limestone mortar, asphalt, and slag to a depth of 1.7 m below surface. One *Tellina* sp. bivalve shell was found at a depth of 150 cmbs, but it was adjacent to a fragment of slag at 170 cmbs, and thus was deposited in modern times (or is in a disturbed stratum). Only one stratum of soil was found in each of the five trenches; some trenches had trash deposits. The disturbed nature of the top stratum may be related to the nearby railroad berm. Stones and even soil may have been moved and excavated from this area to build the earth and rock berm for the railway bed. The presence of limestone mortar, slag, asphalt, and charcoal lenses found in several trenches may also be associated with this berm construction and use.

The stratigraphic profiles (Figure 53 to Figure 57) and soil descriptions for the five trenches follows.

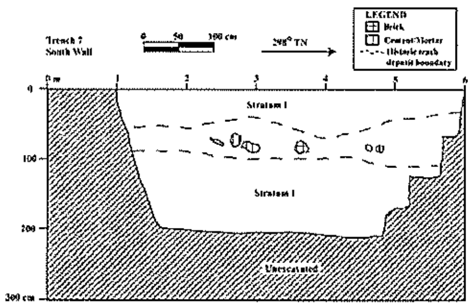

Figure 53. Backhoe Trench 7, south wall profile

Backhoe Trench 7
Stratum-Depth

I	0-210+ cmbs	Very dark brown (7.5YR5/3) silt loam; moderate, medium, subangular blocky structure; slightly hard when moist, non-sticky and non-plastic consistence; terrestrial origin; layer containing brick, cement, and mortar extending within Stratum I from 40-100 cmbs; excavation arbitrarily terminated at 210 cmbs.

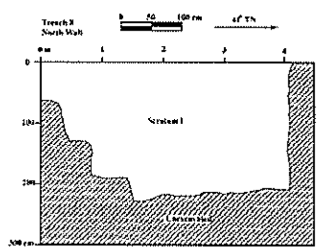

Figure 54. Backhoe Trench 8, north wall profile

Backhoe Trench 8
Stratum-Depth

I	0-230+ cmbs	Very dark brown (7.5YR5/3) silt loam; moderate, medium, subangular blocky structure; slightly hard when moist, non-sticky and non-plastic consistence; terrestrial origin; cement fragments only on surface and top; has slag and decomposing limestone fragments throughout; excavation arbitrarily terminated at 230 cmbs.

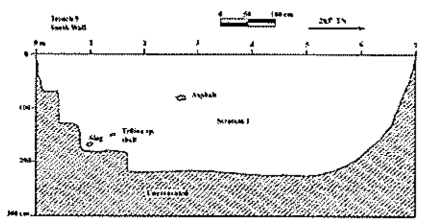

Figure 55. Backhoe Trench 9, south wall profile

Backhoe Trench 9
Stratum- Depth

I	0-227+ cmbs	Very dark brown (7.5YR5/3) silt loam; moderate, medium, subangular blocky structure; slightly hard when moist, non-sticky and non-plastic consistence; terrestrial origin; decomposing limestone fragments throughout; *Tellina* sp. marine bivalve shell found at 150 cmbs; slag found at 170 cmbs; excavation arbitrarily terminated at 227 cmbs.

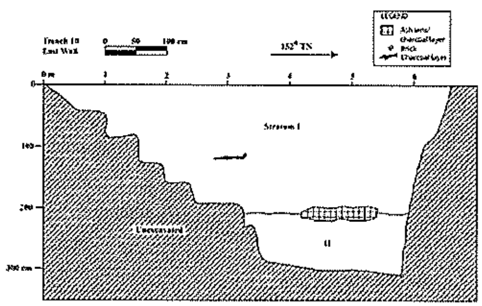

Figure 56. Backhoe Trench 10, east wall profile

Backhoe Trench 10
Stratum-Depth

I	0-305+ cmbs	Very dark brown (7.5YR5/3) silt loam; moderate, medium, subangular blocky structure; slightly hard when moist, non-sticky and non-plastic consistence; terrestrial origin; slag, brick fragments, charcoal flecks, and decomposing limestone fragments throughout; charcoal lens at 120 cmbs and ash/charcoal lens at 200-220 cmbs; excavation arbitrarily terminated at 305 cmbs.

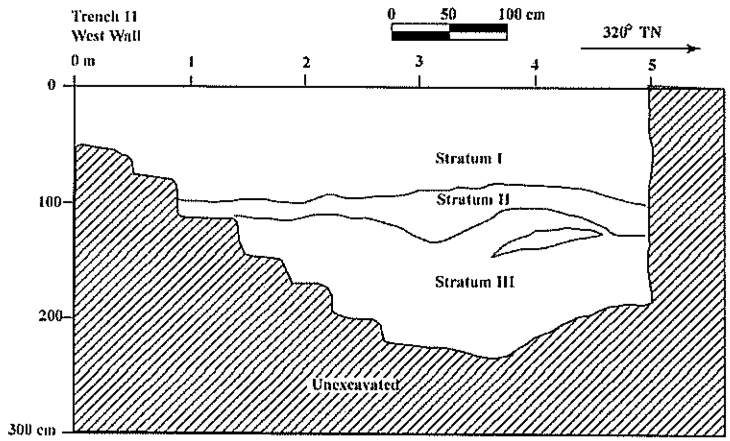

Figure 57. Backhoe Trench 11, west wall profile

Backhoe Trench 11
Stratum-Depth

I	0-88 cmbs	Very dark brown (7.5YR5/3) silt loam; moderate, medium, subangular blocky structure; slightly hard when moist, non-sticky and non-plastic consistence; terrestrial origin; slag, brick fragments, charcoal flecks, and decomposing limestone fragments throughout; clear, wavy boundary;
II	88-110 cmbs	Brown (10YR4/3) silty clay loam; moderate, medium subangular blocky structure; very hard when dry, slightly sticky and slightly plastic consistence; terrestrial origin; abrupt, smooth boundary;
III	110-240+ cmbs	Very dark gray (10YR3/1) clay loam; strong, coarse, angular blocky structure; extremely hard when moist, slightly sticky and slightly plastic consistence; terrestrial origin; excavation arbitrarily terminated at 240 cmbs.

5.3.3 Drivers and Stable Villages

One trench (BHT-12) was excavated in the Drivers/Stable Villages area. In the last ten years, this area has been very susceptible to floods, so much so that when water would come into this area it would wash soil onto Old Fort Weaver Road. To control these floods, the majority of this area had been bulldozed, excavated, and filled with gravel. Only a small portion of this area near the extreme southeastern corner of the project area still had some vegetation and was thought to have been undisturbed by this excavation and filling. The one trench (BHT-12) excavated in this area had two strata, separated by an asphalt layer, possibly an old roadbed. It is unlikely that this road was built for the Drivers/Stable Village, since the name "Stable" suggests that horses and mules were still the predominant method of hauling and travel in this period, not car or tractors. There were no other artifacts or material from the villages indicated by this trench excavation. The stratigraphic profile (Figure 58) and soil descriptions for Trench 12 are presented below:

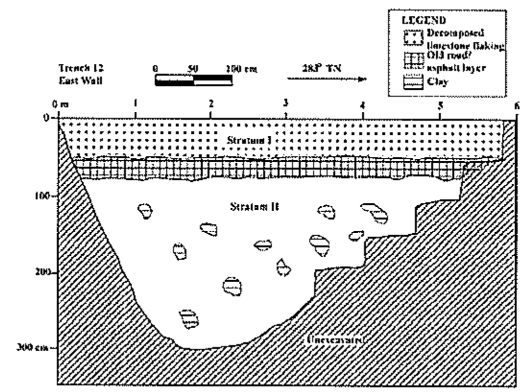

Figure 58. Backhoe Trench 12, east wall profile

Backhoe Trench 12
Stratum-Depth

I	0-50 cmbs	Very dark brown (7.5YR5/3) silt loam; moderate, medium, subangular blocky structure; slightly hard when moist, non-sticky and non-plastic consistence; terrestrial origin; with many small fragments of decomposed limestone; abrupt, smooth, boundary; old road/asphalt bed at 50-70 cmbs;
II	70-300+ cmbs	Dark brown (7.5YR3/4) silty clay loam; strong, medium blocky structure; friable when moist, slightly sticky and plastic consistence; strong cementation; terrestrial origin; soil intermixed with 50% pockets of clay; excavation arbitrarily terminated at 300 cmbs.

5.3.4 PipeLine Village

Six trenches (BHT-13-18) were excavated in the former location of PipeLine Village. The first trench was placed in the area thought to be the former location of the church shown on the 1927 USGS map (see Figure 19). This section of the project area is flat, open, plowed fields planted in pumpkins and squash. Trenches were placed on roads along the sides and between the plowed fields. The surface and the plow zone had a dense concentration of concrete fragments (less than 20 cm in diameter), especially near the southern section of the project area (near where the church may have been). Two to three strata were found in the six trenches. The concrete fragments were only found on the ground surface or within the loose soil, the top 20 cm of the plow zone. None were found any deeper. No privy pits were found, no food remains, no historic artifacts, and no firepits or other habitation features were found. In conclusion, it seems that when the houses of PipeLine Village were moved in 1931, little remained behind. The concrete fragments are probably fragments of the blocks on which the wooden houses rested, or are part of some of the coral/gravel roads between the house roads. The stratigraphic profiles for these six trenches (Figure 59 to Figure 64) are presented below, with the soil descriptions following.

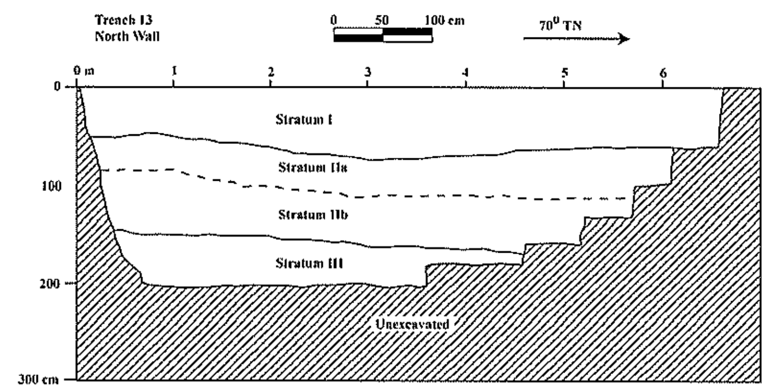

Figure 59. Backhoe Trench 13, north wall profile

Backhoe Trench 13
Stratum-Depth

I	0-60 cmbs	Dark yellowish brown (10YR3/4) silty clay loam; moderate, medium, subangular blocky structure; friable when moist, sticky and moderately non-plastic consistence; terrestrial origin; cobble-size concrete fragments found only on the surface and the upper 20 cm of loose soil; abrupt, smooth, boundary;
IIA	60-100 cmbs	Strong brown (7.5YR4/6) sandy loam; moderate, fine, subangular blocky structure; firm when moist, slightly sticky and slightly plastic consistence; terrestrial origin, diffuse, irregular boundary;
IIB	100-150 cmbs	Brown (7.5YR4/3) sandy loam; strong, medium blocky structure; friable when moist, non-sticky and non-plastic consistence; 60% gravel; terrestrial origin; clear, wavy boundary;
III	150-200+cmbs	Brown (7.5YR4/2) clay; weak, very fine prismatic structure; friable when moist, sticky and very plastic consistence; terrestrial origin; excavation arbitrarily terminated at 200 cmbs.

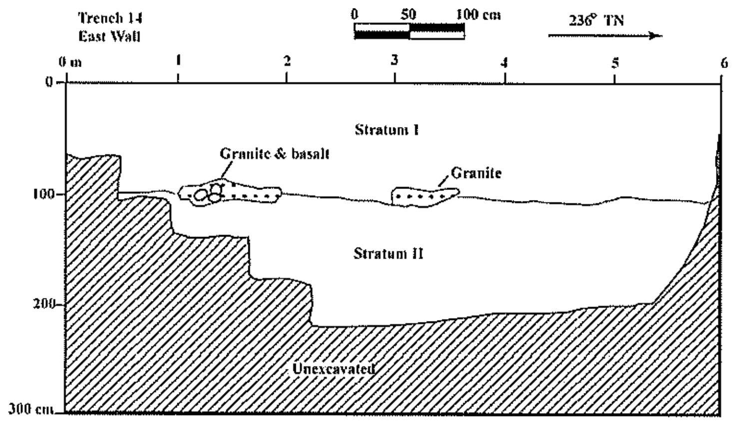

Figure 60. Backhoe Trench 14, east wall profile

Backhoe Trench 14
Stratum-Depth

I	0-110 cmbs	Dark yellowish brown (10YR3/4) silty clay loam; moderate, medium, subangular blocky structure; friable when moist, sticky and moderately non-plastic consistence; terrestrial origin; cobble-size concrete fragments found on the surface and the upper 20 cm of loose soil; basalt cobbles and boulders at I/II interface; abrupt, smooth, boundary;
II	110-220+cmbs	Brown (7.5YR4/2) clay; weak, very fine prismatic structure; friable when moist, sticky and very plastic consistence; terrestrial origin; excavation arbitrarily terminated at 220 cmbs.

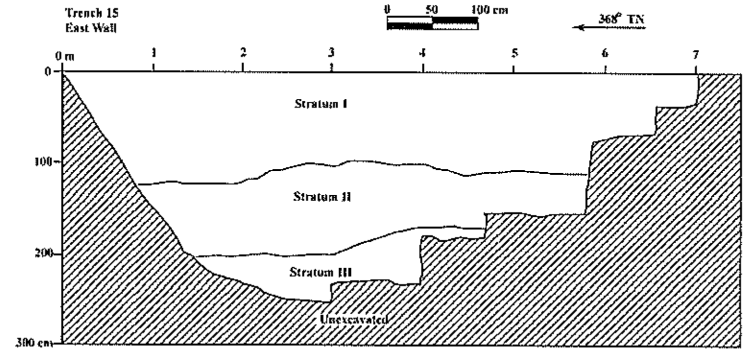

Figure 61. Backhoe Trench 15, east wall profile

Backhoe Trench 15
Stratum-Depth

I	0-98 cmbs	Dark yellowish brown (10YR3/4) silty clay loam; moderate, medium, subangular blocky structure; friable when moist, sticky and moderately non-plastic consistence; terrestrial origin; cobble-size concrete fragments found on the surface and the upper 20 cm of loose soil; abrupt, smooth, boundary;
II	90-200 cmbs	Yellowish red (5YR4/6) clay loam (50% clay); moderate, medium, blocky structure; firm when moist; sticky and plastic; strong cementation; terrestrial origin; abrupt, wavy boundary;
III	200-255+ cmbs	Brown (7.5YR4/2) clay; weak, very fine prismatic structure; friable when moist, sticky and very plastic consistence; terrestrial origin; excavation arbitrarily terminated at 255 cmbs.

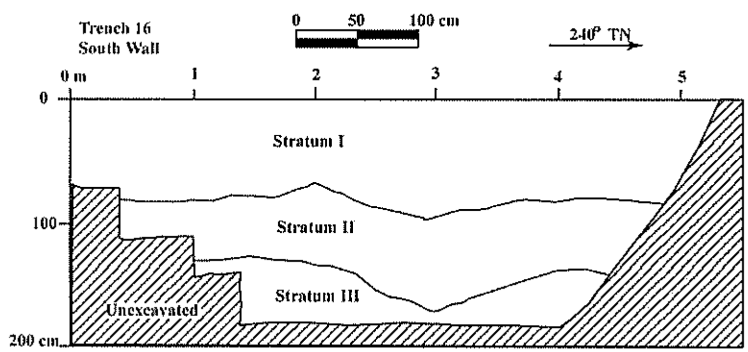

Figure 62. Backhoe Trench 16, south wall profile

Backhoe Trench 16
Stratum-Depth

I	0-100 cmbs	Dark Yellowish Brown (10YR3/4) silty clay loam; moderate, medium, subangular blocky structure; friable when moist, sticky, moderately plastic consistence; terrestrial origin; cobble-size concrete fragments found on the surface and the upper 20 cm of loose soil; abrupt, smooth boundary;
II	100-200 cmbs	Yellowish red (5YR4/6) clay loam; moderate, medium, subangular blocky structure; firm when moist, sticky and plastic consistence; terrestrial origin; abrupt, wavy boundary;
III	200-255+ cmbs	Brown (7.5YR4/2) clay; weak, very fine, platy structure; friable when moist; sticky and very plastic consistence; terrestrial origin; excavation arbitrarily terminated at 255 cmbs.

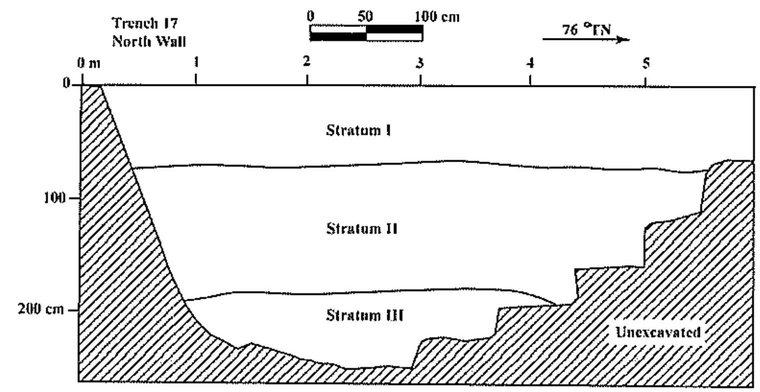

Figure 63. Backhoe Trench 17, north wall profile

Backhoe Trench 17
Stratum-Depth

I	0-41 cmbs	Dark yellowish brown (10YR3/4) silty clay loam; moderate, medium, subangular blocky structure; friable when moist, sticky and moderately non-plastic consistence; terrestrial origin; cobble-size concrete fragments found on the surface and the upper 20 cm of loose soil; abrupt, smooth, boundary;
II	41-132 cmbs	Yellowish red (5YR4/6) clay loam (50% clay); moderate, medium, blocky structure; firm when moist; sticky and plastic; strong cementation; terrestrial origin; abrupt, wavy boundary;
III	132-200+ cmbs	Brown (7.5YR3/2) clay loam; weak, medium subangular blocky structure; friable when moist; sticky and slightly plastic consistence; weak cementation; terrestrial origin; excavation arbitrarily terminated at 200 cmbs.

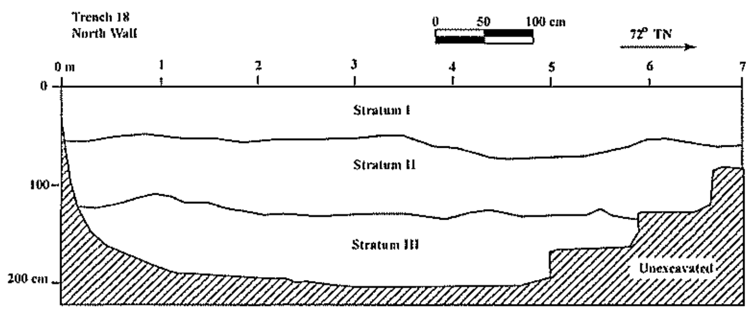

Figure 64. Backhoe Trench 18, north wall profile

Backhoe Trench 18
Stratum-Depth

I	0-70 cmbs	Dark yellowish brown (10YR3/4) silty clay loam; moderate, medium, subangular blocky structure; friable when moist, sticky and moderately non-plastic consistence; terrestrial origin; cobble-size concrete fragments found only on the surface and the upper 20 cm of loose soil; abrupt, smooth, boundary;
IIA	70-183 cmbs	Strong brown (7.5YR4/6) sandy loam; moderate, fine, subangular blocky structure; firm when moist, slightly sticky and slightly plastic consistence; terrestrial origin, diffuse, irregular boundary;
III	183-250+cmbs	Brown (7.5YR4/2) clay; weak, very fine prismatic structure; friable when moist, sticky and very plastic consistence; terrestrial origin; excavation arbitrarily terminated at 250 cmbs.

Section 6 Project Summary and Mitigation Recommendations

During a 1990 inventory survey of the southeastern portion of the current project area (West Loch Bluffs area), five sites, a railroad berm (Site 50-80-12-4345), three pumping station (Sites 50-80-12-4346, -4347, and -4348), and three features related to plantation infrastructure (Site 50-80-12-4344) were recorded and assigned SIHP permanent site numbers. During this survey, four historic documented areas of Hawaiian and later immigrant residence were also identified: the former sites of Honouliuli Taro Lands, Kapalani Church, PipeLine Village, and Drivers/Stable Village. Further work, especially subsurface testing, was recommended for these four areas.

During the recent 2005 surface survey of non-plowed areas of the 1594-acre East Kapolei project area, four new features related to sugar cane cultivation or irrigation were recorded. These four features (Features D-G) were subsumed under the previous site number, Site 50-80-12-4344, used for scattered plantation infrastructure features.

A total of 19 trenches were excavated in the four areas of historic habitation and/or agriculture identified in the 1990 CSH survey to determine if there were any subsurface remains of: (1) nineteenth century (or earlier) habitation and agricultural lots in the Honouliuli Taro Lands; (2) structures or burials associated with the nineteenth century Kapalani Catholic Church; (3) structures or historic domestic artifacts associated with the early twentieth century Drivers and Stable Village; and, (4) structures or historic domestic artifacts or pit/privy features associated with the early twentieth century PipeLine Village. No cultural deposits, no privy pits, no burials, and no artifacts or any type were found or recovered from the 19 trenches. It seems that sugarcane cultivation, irrigation, flood control, railroad construction, later road construction, the demolition and movement of workers camps, and other factors have obliterated all, or almost all, traces of these former traditional Hawaiian habitation and agricultural lands and the later sugar cane plantation workers camps, churches, and schools.

6.1 Significance Assessments

Sites are evaluated for significance according to the broad criteria established for the National and State Registers. The five criteria are:

A	Site reflects major trends or events in the history of the state or nation.
B	Site is associated with the lives of persons significant in our past.
C	Site is an excellent example of a site type.
D	Site may be likely to yield information important in prehistory or history.
E	Site has cultural significance; probable religious structures and/or burials present.

During the 1990 survey of the West Loch Bluffs project area (southeastern section of the current project area) five sites were identified and given SIHP site designations. All five sites were determined as significant under criteria C and D. The three features (Features A-C) of Site

50-80-12-4344 (plantation infrastructure) were not recommended for any further work or for preservation. Sites 50-80-12-4345 (railroad berm), and Sites 70-12-4346, -4347, and -4348 (three pumping stations) were all recommended for preservation.

During the recent 2005 survey of the East Kapolei project area, four additional plantation infrastructure features adjacent to Honouliuli Gulch were identified. These features (Features D-G) were added to the Site -4344 description. The significance and recommendation for this site remains the same (no further work and no preservation); they have all had adequate documentation and do not need to be preserved.

The four areas of historic interest identified in the 1990 West Loch Bluffs survey (Honouliuli Taro lands, Kapalani Catholic Church, PipeLine Village, and Drivers/Stable Village) were not given site designations in the 1990 report since there were no surface remains. In the recent 2005 subsurface inventory of these four areas, no trace of any remains (charcoal, food remains, structural remains, cultural layers, firepits, artifacts, burials, etc.) associated with these four former habitation areas could be found. Therefore, again, these four areas are not assigned permanent state site numbers.

6.2 Mitigation Recommendations

Five sites have been previously identified in the project area during a 1990 CSH survey. Four new features were found for one of these sites during the current 2005 survey. No subsurface remains were found within 19 trenches during the recent backhoe testing of four habitation loci (Honouliuli Taro Lands, Kapalani Catholic Church, PipeLine Village, Drivers/Stable Village) (see Figure 44 for location of four habitation loci). However, it is possible that some traces of these habitation areas remain in subsurface deposits in areas not covered by the test trenches. Thus, an on-call/on-site monitoring program is recommended for these four specific areas during any future development. A summary of findings and recommendations for the project area is presented in Table 5; areas of concern for mitigation recommendations are shown on Figure 65.

Table 5. Significance and Mitigation Recommendations

Site (50-80-12)	Description	Significance	Further Work	Mitigation Recommendation
-4344 Fea. A-C	3 pipe features	C, D	None. Features were destroyed sometime between the 1990 and 2005 survey	None
-4344 Fea. D-G	Sugar cane cultivation/ irrigation features	C, D	None. The features were adequately recorded during the 2005 survey.	No preservation
-4345	Ewa Plantation Railroad Berm	C, D	Architectural Evaluation	Preservation
-4346	Northern Pumping Station	C, D	Architectural Evaluation	Preservation
-4347	Central Pumping Station	C, D	Architectural Evaluation	Preservation
-4348	Southern Pumping Station	C, D	Architectural Evaluation	Preservation
Honouliuli Taro Lands	Nineteenth century (and earlier) Hawaiian Habitation/Agricultural Area	None	No surface or subsurface remains were found during a recent 2005 inventory survey. No additional testing is necessary.	On-call/on-site archaeological monitoring during future development of the area
Kapalani Church	Nineteenth century Hawaiian Catholic Church, schoolhouse, and possible cemetery area	None	No surface or subsurface remains were found. No additional inventory survey is necessary.	On-call/on-site archaeological monitoring during future development of the area
PipeLine Village	Early twentieth century immigrant plantation habitation camp	None	No surface or subsurface remains were found. No additional inventory survey is necessary.	On-call/on-site archaeological monitoring during future development of the area
Drivers/Stable Villages	Early twentieth century immigrant plantation habitation camps	None	No surface or subsurface remains were found. No additional inventory survey is necessary.	On-call/on-site archaeological monitoring during future development of the area

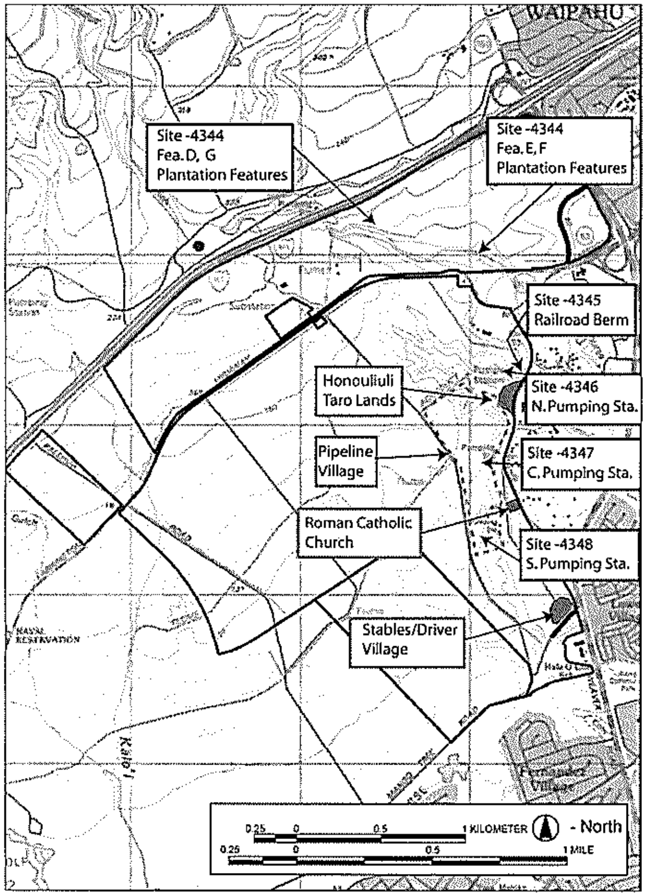

Figure 65. Areas of concern for significance and mitigation recommendations

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An Archaeological Assessment for the Ho‘opili Project 440-Foot Elevation Reservoir and Waterline Project,

Honouliuli Ahupua‘a, ‘Ewa District, Island of O‘ahu

TMK (1) 9-2-001:001 (por.), 004, 005, 006, 007 (por.); 9-2-002:002

Prepared for

PBR Hawai‘i, Inc.

Prepared by

Randy Groza, M.A.,

Constance O'Hare, B.A.,

and

Hallett H. Hammatt, Ph.D.

Cultural Surveys Hawai‘i, Inc.

Kailua, Hawai‘i

(Job Code: HONOU 14)

December 2006

O‘ahu Office
P.O. Box 1114
Kailua, Hawai‘i 96734
Ph.: (808) 262-9972
Fax: (808) 262-4950

www.culturalsurveys.com

Maui Office
16 S. Market Street, Suite 2N
Wailuku, Hawai‘i 96793
Ph: (808) 242-9882
Fax: (808) 244-1994

Management Summary

Reference	An Archaeological Assessment for the Ho‘opili Project 440-Foot Elevation Reservoir and Waterline Project, Honouliuli Ahupua‘a, ‘Ewa District, Island of O‘ahu TMK (1) 9-2-001:001 (por.), 004, 005, 006, 007 (por.); 9-2-002:002, by Randy Groza, Constance R. O'Hare, and Dr. Hallett H. Hammatt
Date	November 2006
Project Number (s)	CSH Job Code: HONOU 14
Investigation Permit Number	CSH completed the inventory survey fieldwork under state archaeological permit No. 0605 issued by the State Historic Preservation Division, per Hawai‘i Administrative Rules (HAR) Chapter 13-13-282.
Project Location	The project area consists of several parcels which are identified by the following tax map key numbers: TMK (1) 9-2-001:001 (por.), 004, 005, 006, 007 (por.); 9-2-002:002. The project area is located within agricultural lands that are generally bound on the south by the H-1 Interstate (I H-1), on the east by Kunia Road, on the north by Kupehau Road, and the Honouliuli Gulch to the west. There are two non-contiguous sections linked by a waterline. The area of development immediately north of H-1 contains an existing reservoir, and the proposed waterline will run parallel to an existing waterline in the middle of an existing dirt road. The mauka area of development contains a pump house and is within a former pineapple field north of an existing dirt road.
Land Owner	TMK (1) 9-2-001:001 (por.), Monsanto Company TMK (1) 9-2-001: 004, HECO TMK (1) 9-2-001: 005, Monsanto Company TMK (1) 9-2-001:006, City & County of Honolulu TMK (1) 9-2-001:007 (por.) City & County of Honolulu TMK (1) 9-2-002:002 City & County of Honolulu
Reviewing Agencies	State Historic Preservation Division / Department of Land and Natural Resources (SHPD/DLNR)
Project Description	The client, PBR Hawai‘i, Inc. plans to develop the project area with a 440-foot elevation reservoir and waterline in support of a new mixed residential, commercial, and recreational property (the Ho‘opili project).
Project Acreage	Approximately 6 acres
Area of Potential Effect (APE)	For the purposes of this study the area of potential effect (APE) and the project area are considered one and the same.
Historic Preservation Regulatory Context	The client, PBR Hawai‘i, Inc. proposed development of the Ho‘opili Reservoir and Waterline Project constitutes a project requiring compliance with and review under State of Hawai‘i historic preservation review legislation (Hawai‘i Revised Statutes (HRS) Chapter 6E-42 and Hawai‘i Administrative Rules (HAR) 13-284). At the request of PBR Hawai‘i, CSH completed an archaeological assessment, per the requirements of HAR Chapter 13-13-276, of the subject 6-acre parcel. This archaeological assessment report was prepared to support the proposed property's historic preservation review and any other project-related historic preservation consultation.
Fieldwork Effort	Constance R. O'Hare, B.A., and Randy Groza, M.A. under the general direction of Hallett H. Hammatt, Ph.D. conducted surface survey in the project area. Fieldwork was conducted on November 7, 2006.
Number of Historic Properties Identified	No sites had been previously identified in the project area. During the recent 2006 surface survey, no sites were identified. No historic properties are believed to be present.
Mitigation Recommendation	No further work is recommended for the project area.

Table of Contents

List of Figures

Section 1 Introduction

1.1 Project Background

At the request of PBR Hawai'i, Inc. (1001 Bishop Street, Suite 650, Honolulu, Hawai'i 96813), Cultural Surveys Hawai'i, Inc. (CSH) has completed this archaeological assessment for the Ho'opili 440-Foot Elevation Reservoir and Waterline Project, Honouliuli Ahupua'a, 'Ewa District, O'ahu Island (TMK:(1) 9-2-001:001, 004, 005, 006, 007 (por.); 9-2-002:002) (Figures 1 through 3). The project area is located within agricultural lands that are generally bound on the south by the H-1 Interstate (I H-1), on the east by Kunia Road, on the north by Kupehau Road, and the Honouliuli Gulch to the west. There are two non-contiguous areas linked by a waterline. The area of development immediately north of H-1 contains an existing reservoir, and the proposed waterline will run parallel to an existing waterline in the middle of an existing dirt road extending approximately 4,000 ft (1200 m) to the northeast. The *mauka* area of development contains two substations and is within a former pineapple field north of an existing dirt road. In all, the project area is approximately 6 acres. Plans are to develop these areas with two new reservoirs and a waterline for a mixed residential, commercial, and recreational property located south of H-1.

There seems to be little likelihood that this undertaking will impact any ongoing cultural practices. No traditional Hawaiian sites have been previously reported in the project area, and no new traditional Hawaiian or post-contact sites were found during the recent fieldsurvey; thus, this report is considered an archaeological assessment, not an inventory survey in the parlance of the State Historic Preservation Division. This archaeological assessment details the research and field inspection methods, presents a summary of all field inspection findings, and assesses the potential for significant historic properties (archeological/ historical potential) and potential impacts to cultural practices.

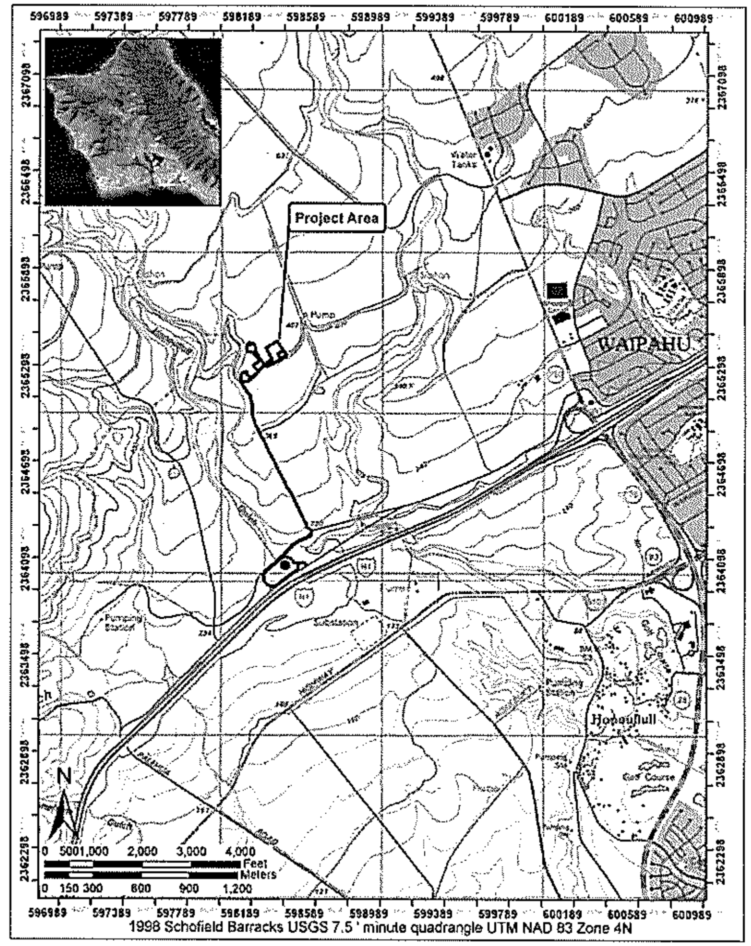

Figure 1. US Geological Survey map (1998), Schofield Barracks quadrangle, showing project area

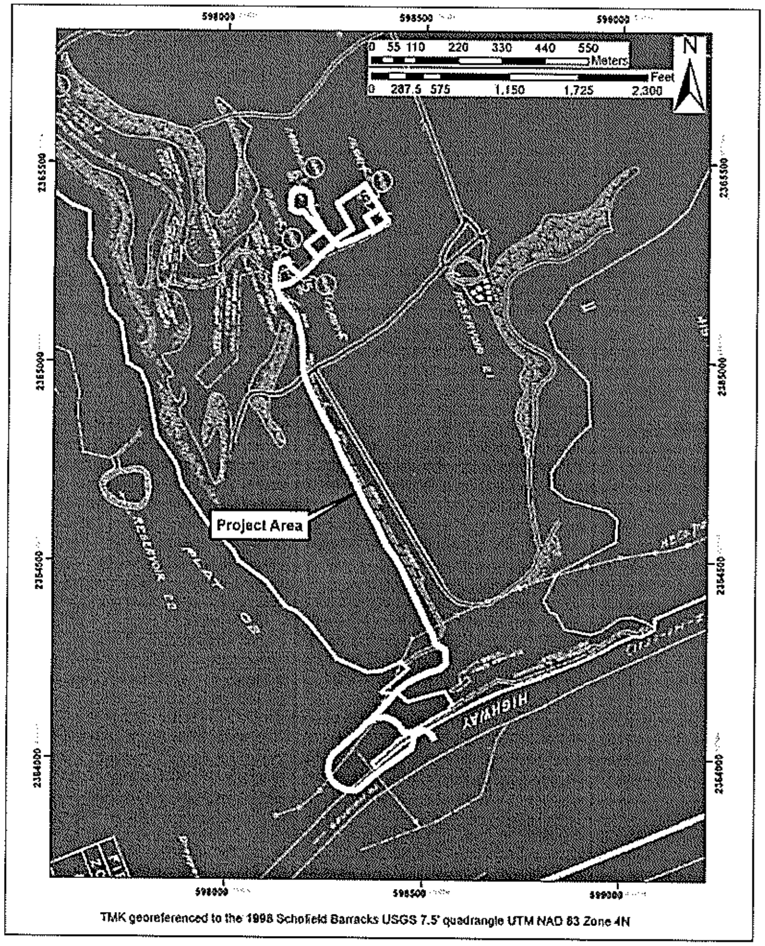

Figure 2. Portion of Tax Map Keys (TMK) Plats 9-2-001 and 9-2-002, showing project area

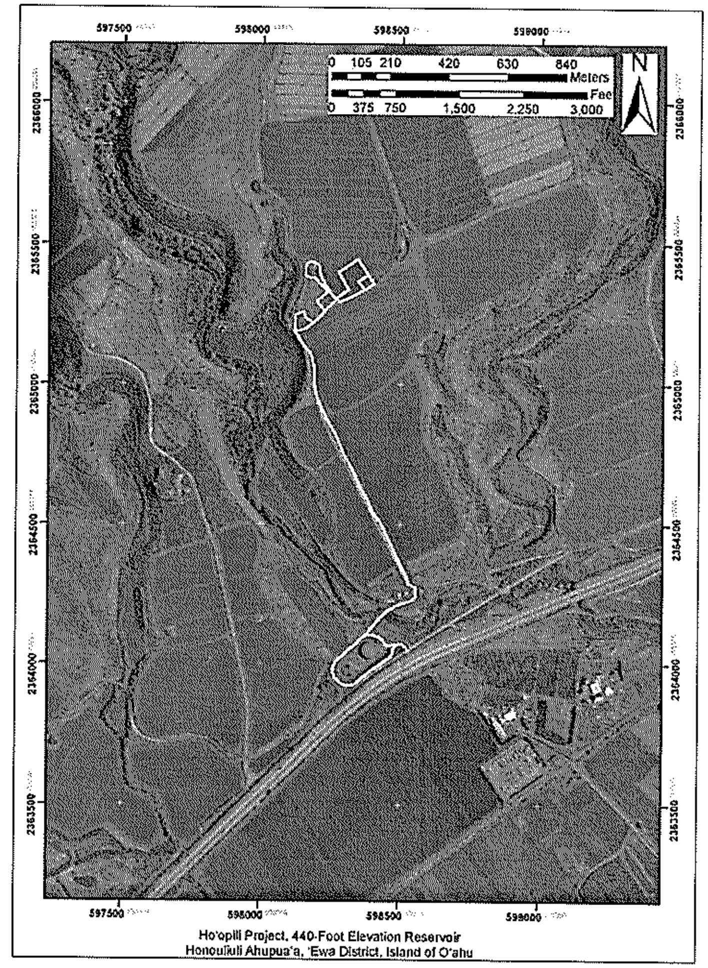

Figure 3. Aerial photograph showing the project area

1.2 Scope of Work

This archaeological assessment report details results of research and present conditions of the property. This report assesses both the potential for significant historic properties (archaeological/historical potential) and potential impacts to cultural practices.

The scope of work for this assessment includes:

a. Historical and previous archaeological background research to include study of archival sources, historic maps, Land Commission Awards, and previous archaeological reports to construct a history of land use and to determine if archaeological sites have been recorded on or near this property.

b. A complete ground survey of the entire project area for the purpose of site inventory was conducted to identify any surface archaeological features and to investigate and assess the potential for impact to such sites.

c. The report assesses the likelihood that the proposed project will not impact cultural practices. This assessment is based on the background research, and the review of land use within the vicinity of the project area.

d. Preparation of a report to include the results of the historical research and the fieldwork, with an assessment of archaeological potential based on that research, with recommendations for further archaeological work, if appropriate. This report was also to provide mitigation recommendations if there were any archaeologically sensitive areas that need to be taken into consideration.

1.3 Environmental Setting

1.3.1 Natural Environment

Honouliuli Ahupua'a is the largest traditional land unit on O'ahu, extending from the West Loch of Pearl Harbor in the east, to the border of Nānākuli Ahupua'a at Pili o Kahe in the west. Honouliuli Ahupua'a includes approximately 19 km (kilometers), or 12 mi (miles) of open coastline from One'ula westward to Pili o Kahe. The *ahupua'a* extends *mauka* (inland) from West Loch nearly to Schofield Barracks in Wahiawā. The western boundary is the Wai'anae Mountain crest running north as far as Pu'u Hāpapa (or to the top of Ka'ala Mountain, according to some).

Topographically, the southern portion of the project area, north of H-1, and the northern portion are generally flat. The approximately 4,000-ft (1300 m) of existing dirt road that connects the northern and southern portions of the project area climbs from 220 to 400 feet (ft) or 67-122 meters (m).

Lying in the lee of the Wai'anae mountain range, the project area is one of the driest areas of O'ahu with most of the area averaging about 18 inches of rainfall annually (Juvik and Juvik 1998:56). Temperatures range between 60° to 90°F through the year; the highest temperatures are in August and September (Armstrong 1973). Elevation in the project area ranges from 220 ft

AMSL (above mean sea level) to 400 ft (67-122 m). Intermittently running Honouliuli Stream is approximately 500 ft (150 m) north of the southern portion of the project area, 1000 ft (300 m) west of the waterline, and 1300 ft (400 m) west of the northern portion of the project area.

A total of five soil series are found in the project area (Figure 4). The Kawaihapai Series consists of well-drained soils in drainage ways and on alluvial fans on the coastal plains, which formed in alluvium derived from basic igneous rock in humid uplands. The annual rainfall amounts to 30 to 50 inches. The natural vegetation consists of *kiawe*, *koa haole*, lantana, and bermudagrass. Kawaihapai clay loam (KiB), 2 to 6 percent slope, is used for sugarcane, truck crops, and pasture. The Kunia Series consists of well-drained soils on upland terraces and fans; the soils developed in old alluvium. They are nearly level to moderately sloping. Kunia silty clay, 0 to 3 percent slopes (KyA) and 3 to 8 percent slopes (KyB), are used for sugarcane, pineapple, and homesites. The Lahaina Series consists of well-drained soils on uplands that developed in material weathered from basic igneous rock. They are nearly level to steep. Lahaina silty clay, 7 to 15 percent slopes, is used for sugarcane and pineapple. Small acreages are used for truck crops, pasture, and wildlife habitat. The Molokai Series consists of well-drained soils on uplands, formed in material weathered from basic igneous rock. They are nearly level to moderately steep. Molokai silty clay loam, 3 to 7 percent (MuA) and 7 to 15 percent slopes (MuB), are used for sugarcane, pineapple, pasture, wildlife habitat, and homesites. The natural vegetation consists of *kiawe*, *ilima*, *uhaloa*, feather fingergrass, and buffelgrass (Foote et al. 1972).

1.3.2 Built Environment

During the post-contact period, the project area was used for cattle grazing. In 1890, the land was primarily used for sugar cane and pineapple cultivation by the Ewa Plantation Company. Currently, the mauka area of the project area is fallow and contains low grass (Figure 5). There are also two substations within that northernmost portion (Figures 6 and 7). The central portion, the location of the water line, is an existing dirt road (Figure 8), and the southernmost portion is fenced and contains a water retention tank (Figure 9).

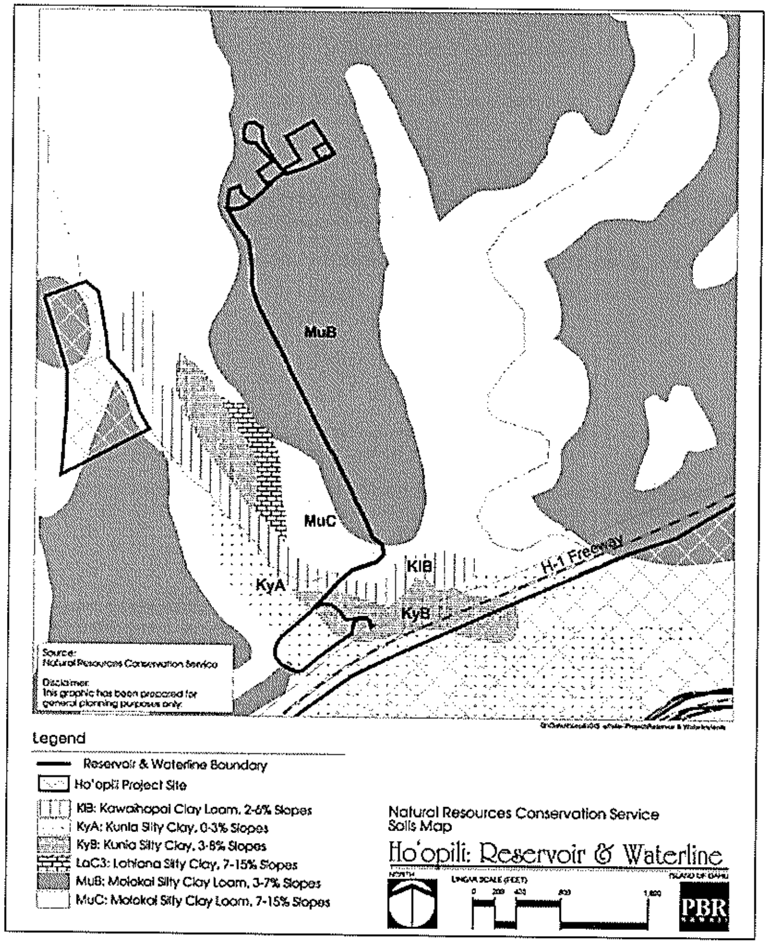

Figure 4. Soil Map of Ho'opili 440-Foot Elevation Reservoir and Waterline Project Area

Figure 5. Northern parcel, view to northeast

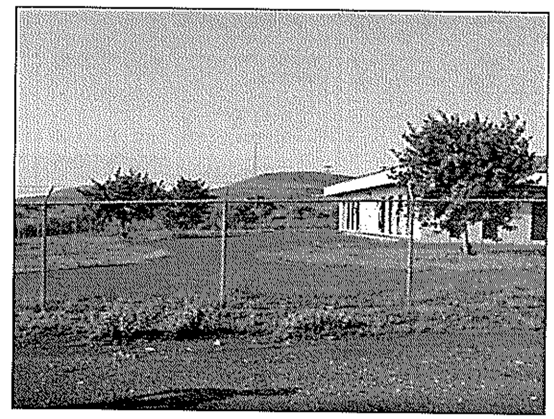

Figure 6. Substation within central portion of northern parcel, view to west

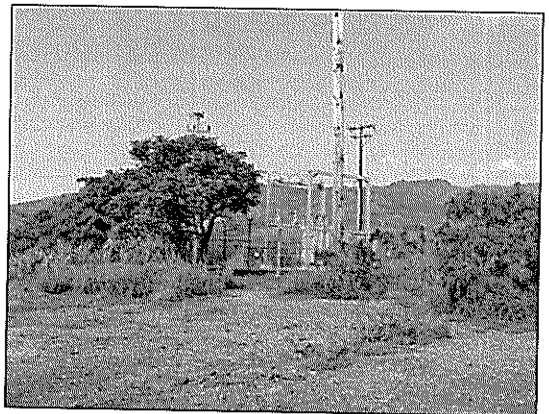

Figure 7. Substation within western portion of northern parcel, view to north

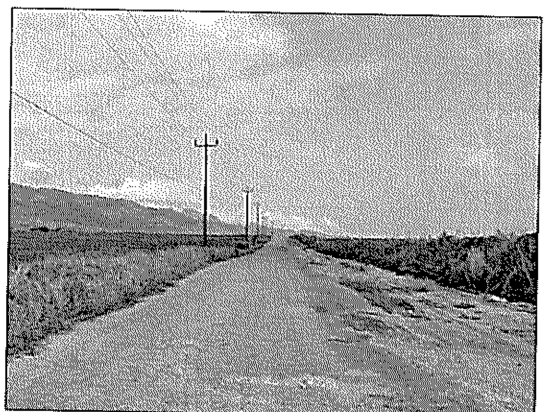

Figure 8. Dirt road connecting northern parcel and southern parcel, view to northwest

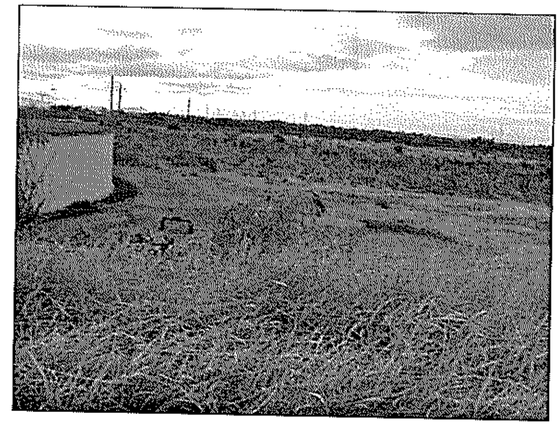

Figure 9. Southern parcel showing existing tank and location of planned tank, view to south/southeast

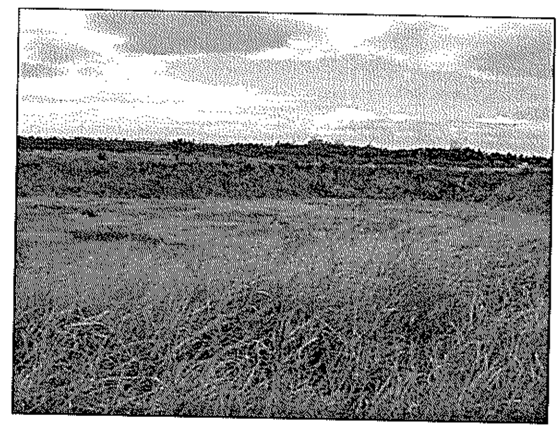

Figure 10. Southern parcel showing western portion and location of planned tank, view to southwest

Section 2 Methodology

For this report, CSH reviewed previous archaeological studies on file at the State Historic Preservation Division. CSH also reviewed geology and cultural history documents at Hamilton Library at the University of Hawai'i, the Hawai'i State Archives, the Hawai'i Public Library, and the Archives of the Bishop Museum. Additional research included a study of historic maps at the Survey Office of the Department of Accounting and General Services. Information regarding LCAs was obtained from the Waihona 'Āina Corporation's Māhele Data Base (www.waihona.āina.com).

2.1 Field Methods

The pedestrian inspection of the project area was conducted on November 7, 2006 with two Cultural Surveys Hawai'i staff archaeologists, Constance R. O'Hare, B.A., and Randy Groza, M.A., under the general direction of Hallett H. Hammatt, Ph.D. The entire northern portion of the project area was surveyed by pedestrian sweeps. CSH archaeologists conducted a windshield survey of the approximately 4,000 ft (1200 m) of existing road, where the new water line will run parallel to the existing water line in the center of the road and connect the northern portion of the project area with the southern portion. The southern section of the project area was reviewed through the chain link fence.

No historic properties were encountered and the pedestrian inspection was documented with field notes, maps, and photographs.

2.2 Laboratory Methods

Because no archaeological artifacts, midden, or soil samples were recovered, no laboratory work was undertaken.

2.3 Consultation

Pre-contact sites were not perceived to be present nor were any pre-contact sites found within the project area, and there appears to be little likelihood that the undertaking will impact any ongoing cultural practices. Pursuant to Chapter 13-276-5 (g), there was no need indicated for consultation, and a summary of findings has been sent to the Office of Hawaiian Affairs (see Appendix A).

Section 3 Documentary Research

3.1 Mythological and Traditional Accounts

The traditions of Honouliuli Ahupua'a have been compiled by several authors, in studies by Sterling and Summers (1978), Hammatt and Folk (1981), Kelly (1991), Charvet-Pond and Davis (1992), Maly (1992), and Tuggle and Tomonari-Tuggle (1997). Some of the traditional themes associated with this area include connections with Kahiki, the traditional homeland of Hawaiians in central Polynesia. There are several versions of the chief Kaha'i leaving from Kalaeloa for a trip to Kahiki; on his return to the Hawaiian Islands he brought back the first breadfruit (Kamakau 1991a:110) and planted it at Pu'uloa, near Pearl Harbor in 'Ewa (Beckwith 1940:97). Several stories associate places in Honouliuli to the gods Kāne and Kanaloa, with the Hawaiian pig god Kamapua'a and the Hina family, and with the sisters of Pele, the Hawaiian volcano goddess, all of who have strong connections with Kahiki (Kamakau 1991a:111; Pukui et al. 1974:200). The locations of traditional places names for Honouliuli are illustrated in Figure 11.

3.1.1 The Naming of 'Ewa and Honouliuli

Honouliuli is the largest *ahupua'a* in the *moku* (district) of 'Ewa. One translation of the name for this district is given as "unequal" (*Saturday Press* Aug. 11, 1883). Others translate the word as "strayed" and associate it with the legends of the gods, Kāne and Kanaloa.

> When Kane and Kanaloa were surveying the islands they came to Oahu and when they reached Red Hill saw below them the broad plains of what is now Ewa. To mark boundaries of the land they would throw a stone and where the stone fell would be the boundary line. When they saw the beautiful land lying below them, it was their thought to include as much of the flat level land as possible. They hurled the stone as far as the Wai'anae range and it landed somewhere, in the Waimānalo section. When they went to find it, they could not locate the spot where it fell. So Ewa (strayed) became known by the name. The stone that strayed [Told to E.S. by Simeon Nawaa, March 22, 1954; cited in Sterling and Summers 1978:1].

Honouliuli means "dark water," "dark bay," or "blue harbor" and was named for the waters of Pearl Harbor (Jarrett 1930:22), which marks the eastern boundary of the *ahupua'a*. The Hawaiians called Pearl Harbor, Pu'uloa (*lit.* long hill). Another explanation for the names comes from the "Legend of Lepeamoa", the chicken-girl of Pālama. In this legend, Honouliuli is the name of the husband of the chiefess Kapālama and grandfather of Lepeamoa (Thrum 1923:164-184). "Her grandfather gave his name, Honouliuli to a land district west of Honolulu . . ." (Thrum 1923:170). Westervelt (1963:209) gives an almost identical account.

It seems likely the boundaries of the western-most *ahupua'a* of 'Ewa were often contested with Wai'anae people. The 'Ewa people could cite divine sanction that the dividing point was between two hills at Pili o Kahe:

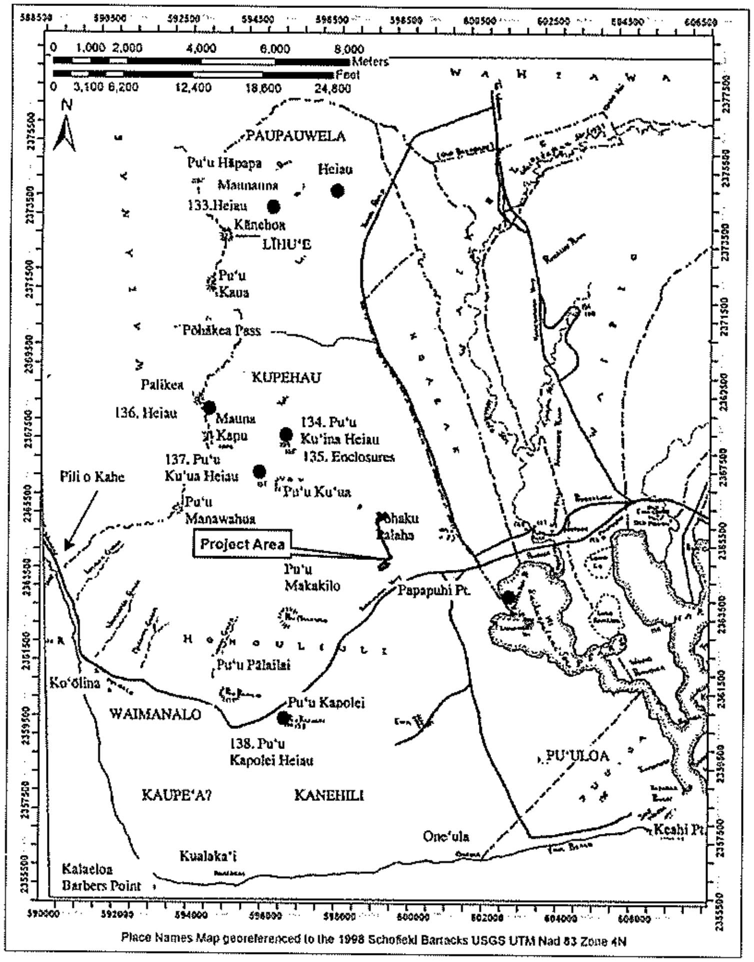

Figure 11. Place Names of Honouliuli (map adapted from Sterling and Summers 1978)

Eventually the stone was found at Pili o Kahe. This is a spot where two small hills of the Wai'anae Range come down parallel on the boundary between Honouliuli and Nānākuli ('Ewa and Wai'anae). The ancient Hawaiians said the hill on the 'Ewa side was the male and the hill on the Wai'anae side was female. The stone was found on the Wai'anae side hill and the place is known as Pili o Kahe.

> (Pili = cling to, Kahe = flow). The name refers, therefore, to the female or Wai'anae side hill. And that is where the boundary between the two districts runs [Told to E.S. by Simeon Nawaa, March 22, 1954; cited in Sterling and Summers 1978:1].

3.2 Historic Background

3.2.1 Pre-Contact and Early Post-Contact Periods

By ca. A.D. 1320, 'Ewa, along with Kona, and Ko'olaupoko were the dominant polities, ruled by the sons of a chief named Māweke (Cordy 2002:21). 'Ewa at this time included the traditional districts of 'Ewa, Wai'anae, and Waialua (Fornander 1880:48). Around A.D. 1400, the entire island was ruled by King La'akona; chiefs within his line, the Māweke-Kumuhonua line, reigned until about A.D. 1520-1540, with their major royal center in Līhu'e, in 'Ewa. (Cordy 2002:24). Haka was the last chief of the Māweke-Kumuhonua line; he was slain by his men at the fortress of Waewae near Līhu'e (Kamakau 1991b:54-54; Fornander 1880:88). Power shifted between the chiefs of different districts from the 1500s until the early 1700s, when Kūali'i achieved control of all of O'ahu by defeating the Kona chiefs, then the 'Ewa chiefs, and then expanding his control on windward Kaua'i. Peleiholani, the heir of Kūali'i, gained control of O'ahu ca. 1740, and later conquered parts of Moloka'i. He was ruler of O'ahu until his death in ca. 1778 when Kahahana, of the 'Ewa line of chiefs was selected as the ruler of O'ahu (Cordy 2002:24-41).

After Kamehameha's O'ahu victory, he gave the *ahupua'a* of Honouliuli to Kalanimōkū as part of the *panalā'au*, or conquered lands, with the right to pass the land on to his heirs rather than having it revert to Kamehameha (Kame'eleihiwa 1992:58, 112). Kalanimōkū subsequently gave the *ahupua'a* to his sister, Wahinepi'o.

Various Hawaiian legends and early historical accounts indicate that the *ahupua'a* (land division) of Honouliuli was once widely inhabited by pre-Contact populations, including the Hawaiian *ali'i* (chiefly class). This would be attributable for the most part to the plentiful marine and estuarine resources available at the coast, along which several sites interpreted as permanent habitations and fishing shrines have been located. Other attractive subsistence-related features of the *ahupua'a* include irrigated lowlands suitable for wetland taro cultivation, as well as the lower forest area of the mountain slopes for the procurement of forest resources. Handy and Handy (1972:429) report:

> The lowlands, bisected by ample streams, were ideal terrain for the cultivation of irrigated taro. The hinterland consisted of deep valleys running far back into the Ko'olau range. Between the valleys were ridges, with steep sides, but a very

gradual increase of altitude. The lower part of the valley sides were excellent for the cultivation of yams and bananas. Farther inland grew the 'awa for which the area was famous.

In addition, breadfruit, coconuts, *wauke* (paper mulberry; *Broussonetia papyrifera*), bananas, and *olona* (*Touchardia latifolia*) and other plants were grown in the interior. 'Ewa was known as one of the best areas to grow gourds and was famous for its *mamaki*. It was also famous for a rare taro called the *kai o 'Ewa*, which was grown in mounds in marshy locations (Handy and Handy 1972:471). The cultivation of this prized and delicious taro led to the saying:

He has eaten the Kāī-koi taro of 'Ewa. *Ua 'ai i ke kāī-koi o 'Ewa.*
Kāī is O'ahu's best eating taro; one who has eaten it will always like it. Said of a youth of a maiden of 'Ewa, who, like the Kāī taro, is not easily forgotten [Pukui 1983:#2770].

The lochs of Pearl Harbor were ideal for the construction of fishponds and fish traps. Forest resources along the slopes of the Wai'anae Range probably acted as a viable subsistence alternative during times of famine and/or low rainfall (Handy 1940:211; Handy and Handy 1972:469-470). The upper valley slopes may have also been a resource for sporadic quarrying of basalt used in the manufacturing of stone tools. At least one probable quarrying site (SIHP site 50-80-12-4322) is present in Maka'īwa Gulch at 152 m (500 ft) above mean sea level (Hammatt, et al. 1990).

John Papa 'Ī'ī described a network of Leeward O'ahu trails, which in historic times encircled and crossed the Wai'anae Range, allowing passage from Honouliuli to Wai'anae by three different trails. "As mentioned before, there were three trails to Wai'anae, one by way of Pu'u o Kapolei, another by way of Pohakea, and the third by way of Kolekole" ('Ī'ī 1959:97). Following 'Ī'īs description, a portion of the coastal trail would have passed close to the existing Farrington Highway, approximately 1 km (.6 mi) south of the southern portion of the project area, as seen in an 1825 map (Figure 12) map of the south coast of O'ahu by Charles Malden of the British ship the *Blonde*.

Early historical accounts of the general region typically refer to the more populated areas of the 'Ewa district, where missions and schools were established and subsistence resources were perceived to be greater. However, the presence of archaeological sites along the barren coral plains and coast of southwest Honouliuli Ahupua'a, indicate that prehistoric and early historic populations also adapted to less inviting areas, despite the environmental hardships.

3.2.2 Observations of Early Explorers and Foreign Residents

Captain Vancouver sailed by Kalaeloa (Barbers Point) in 1792, and recorded his impression of the small coastal village of Kualaka'i and the arid Honouliuli coast.

> The point is low flat land, with a reef round it . . . Not far from the S.W. point is a small grove of shabby cocoa-nut trees, and along these shores are a few struggling fishermen's huts [Vancouver 1798, Vol. I:167].
>
> . . . from the commencement of the high land to the westward of Opooroah [Pu'uloa], was composed of one very barren rocky waste, nearly destitute of

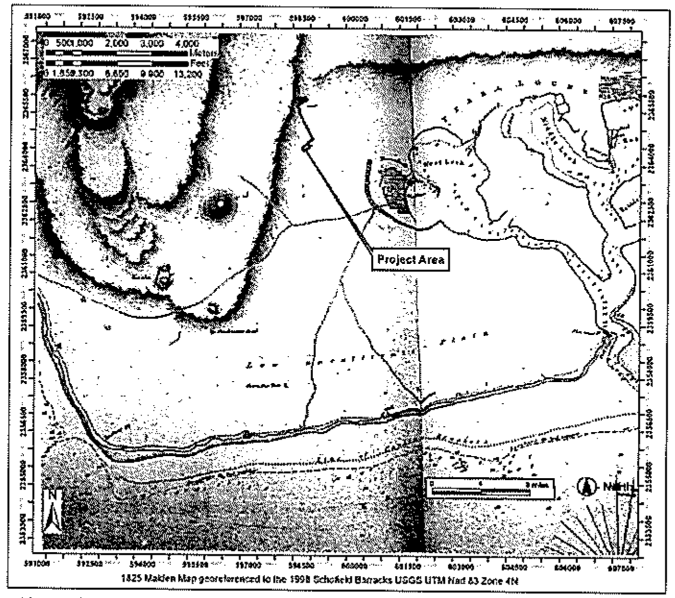

Figure 12. Portion of 1825 Map of the South Coast of Woahoo (O'ahu) and Honolulu by Lieut. C.R. Malden from the British ship the *Blonde*

> verdure, cultivation or inhabitants, with little variation all the way to the west point of the island . . . [Vancouver 1798, Vol. II:217]. . . This tract of land was of some extent but did not seem to be populous, nor to possess any great degree of fertility; although we were told that at a little distance from the sea, the soil is rich, and all necessaries of life are abundantly produced . . . [Vancouver 1798, Vol. III:361-363].

Archibald Campbell, an English seamen who was given some land in Waimano Ahupua'a by King Kamehameha in 1809, described his land around Pearl Harbor:

> In the month of November the king was pleased to grant me about sixty acres of land, situated upon the Wymummee [traditional Hawaiian name for Pearl River], or Pearl-water, an inlet of the sea about twelve miles to the west of Hanaroora [Honolulu]. . . . We passed by footpaths, winding through an extensive and fertile

> plain, the whole of which is in the highest state of cultivation. Every stream was carefully embanked, to supply water for the taro beds. Where there was not water, the land was under crops of yams and sweet potatoes [Campbell 1967:103-104].

Pearl and mother-of-pearl shells are found here in considerable quantity. Since the king has learned of their value, he has kept the fishing to himself, and employs divers for the purpose [Campbell 1967:114-115].

Subsequent to western contact in the area, the landscape of the 'Ewa plains and Wai'anae slopes was adversely affected by the removal of the sandalwood forest, and the introduction of domesticated animals and new vegetation species. Domesticated animals, including goats, sheep and cattle, were brought to the Hawaiian Islands by Vancouver in the early 1790s, and allowed to graze freely about the land for some time after. It is unclear when the domesticated animals were brought to O'ahu, however, L.A. Henke reports the existence of a longhorn cattle ranch in Wai'anae by at least 1840 (Frierson 1972:10). During this same time, perhaps as early as 1790, exotic vegetation species were introduced to the area. These typically included vegetation best suited to a terrain disturbed by the logging of sandalwood forest and eroded by animal grazing. Within the current project area, the majority of the (non-cultivated) vegetation is comprised of introduced species, mainly grasses.

At contact, the most populous *ahupua'a* on the island was Honouliuli, with the majority of the population centered on Pearl Harbor. In 1832, a missionary census of Honouliuli recorded the population as 1,026. Within four years the population was down to 870 (Schmitt 1973:19, 22). In 1835, there were eight to ten deaths for every birth (Kelly 1991:157-158). Between 1848 and 1853, there was a series of epidemics of measles, influenza, and whooping cough that often wiped out whole villages. In 1853, the population of 'Ewa and Wai'anae combined was 2,451 people. In 1872, it was 1,671 (Schmitt 1968:71). The inland area of 'Ewa was probably abandoned by the mid-nineteenth century, due to population decline and consolidation of the remaining people in the town of Honouliuli (at Kapapapuhi Point, southeast of the project area). A detailed discussion of the historic population counts in the 'Ewa District has been presented by Charvet-Pond and Davis (1992).

The first mission station in 'Ewa was established in 1834 at Kalua'aha near Pearl Harbor. Charles Wilkes, of the U.S. Exploring Expedition visited the missionary enclave at Honouliuli town in 1840.

> At Ewa, Mr. Bishop has a large congregation. The village comprises about fifty houses, and the country around is dotted with them. . . . The natives have made some advance in the arts of civilized life; there is a sugar-mill which, in the season, makes two hundred pounds of sugar a day. . . . In 1840, the church contained nine hundred members, seven hundred and sixty of whom belonged to Ewa, the remainder to Wai'anae; but the Catholics have now established themselves at both these places, and it is understood are drawing off many from their attendance on Mr. Bishop's church [Wilkes 1970:80-81].

A portion of the 1825 map of the South Coast of Woahoo (O'ahu) and Honolulu by Lieut. C.R. Malden from the British ship the *Blonde* (see Figure 12) depicts substantial settlement at the "Honouliuli Taro Land" in the Kapapapuhi Point area, and it seems clear that in early historic

times, this was the focus of the population of Honouliuli. The amenities of the area - including fishponds, taro *lo'i*, abundant shellfish, and salt pans - would have focused population there in pre-Contact times as well.

3.2.3 Mid-Nineteenth Century and the Māhele

The Organic Acts of 1845 and 1846 initiated the process of the *māhele* - the division of Hawaiian lands, which introduced private property into Hawaiian society. In 1848, the crown and the *ali'i* (chiefly class) received their land titles. The common people received their *kuleana* (individual parcels) in 1850.

During the *Māhele* of 1848, 72 individual land claims in the *ahupua'a* of Honouliuli were registered and awarded by King Kamehameha III (Tuggle and Tomonari-Tuggle 1997:34). The 72 *kuleana* awards, awards given to commoners, were almost all made adjacent to Honouliuli Gulch, which contained fishponds and irrigated taro fields. Kepā Maly (1997, Table 3: 38-42) provides a table recording information on each award, including awardee, '*ili*, and land use of the '*āpana* (lot). Project area lands were unclaimed and subsequently were granted to Miriam Ke'ahi-Kuni Kekau'ōnohi.

3.2.4 Honouliuli Māhele Awards to *Ali'i*

In 1855, the Land Commission awarded all of the unclaimed lands in Honouliuli, 43,250 acres, to Miriam Ke'ahikuni Kekau'ōnohi (Royal Patent #6971 in 1877; Parcel #1069 in the Land Court office), a granddaughter of Kamehameha I, and the heir of Kalanimōkū, who had been given the land by Kamehameha after the conquest of O'ahu (Indices of Awards 1929; Kame'eleihiwa 1992). Kekau'ōnohi was also awarded the *ahupua'a* of Pu'uloa, but she sold this land in 1849 to Isaac Montgomery, a British lawyer.

Kekau'ōnohi was one of Liholiho's (Kamehameha II's) wives, and after his death, she lived with her half-brother, Luanu'u Kahalai'a, who was governor of Kaua'i (Hammatt and Shideler 1990:19-20:20). Subsequently, Kekau'ōnohi ran away with Queen Ka'ahumanu's stepson, Keli'iahonui, and then became the wife of Chief Levi Ha'alelea. Upon her death on June 2, 1851, all her property was passed on to her husband and his heirs. A lawsuit (Civil Court Case No. 348) was brought by Ha'alelea in 1858, to reclaim the fishing rights of the Pu'uloa fisheries from Isaac Montgomery, and the court ruled in Ha'alaea's favor. In 1863, the owners of the *kuleana* lands deeded their lands back to Ha'alelea to pay off debts owed to him (Frierson 1972:12). In 1864, Ha'alelea died, and his second wife, Anadelia Amoe, transferred ownership of the land to her sister's husband John Coney (Yoklavich et al 1995:16).

3.2.5 Early Ranching on the 'Ewa Plain

John Coney rented the land to James Dowsett and John Meek in 1871, who used the land for cattle grazing. In 1877, the land, except for the '*ili* of Pu'uloa, was sold to James Campbell. He drove off 32,237 head of stock belonging to Dowsett and Meek and to James Robinson and constructed a fence around the outer boundary of his property (Bordner and Silva 1983:C-12). He let the land rest for one year and then began to restock the ranch, so that he had a head of 5,500 head after a few years (Dillingham 1885, cited in Frierson 1972:14)

In 1880-81, the Honouliuli ranch was described as:

> . . . Acreage, 43,250, all in pasture, but possessing fertile soils suitable for agriculture; affords grazing for such valuable stock. The length of this estate is no less than 18 miles. It extends to within less than a mile of the sea coast, to the westward of the Pearl River inlet. . . . There are valuable fisheries attached to this estate . . . . [Bowser 1880:489].
>
> From Mr. Campbell's veranda, looking eastward, you have one of the most splendid sights imaginable. Below the house there are two lochs, or lagoons, covered with water fowl, and celebrated for their plentiful supply of fish, chiefly mullet. . . . Besides Mr. Campbell's residence, which is pleasantly situated and surrounded with ornamental and shade trees, there are at Honouliuli two churches and a school house, with a little village of native huts [Bowser 1880:495].

Most of Campbell's lands in Honouliuli were used exclusively for cattle ranching. At that time, one planter remarked "the country was so dry and full of bottomless cracks and fissures that water would all be lost and irrigation impracticable" (Ewa Plantation Co. 1923:6-7). In 1879, Campbell brought in a well-driller from California to search the 'Ewa plains for water, and the well, drilled to a depth of 240 feet near Campbell's home in 'Ewa, resulted in ". . . a sheet of pure water flowing like a dome of glass from all sides of the well casing" (The Legacy of James Campbell n.d., cited in Pagliaro 1987:3). Following this discovery, plantation developers and ranchers drilled numerous wells in search of the valuable resource.

3.2.6 History of Oahu Sugar Company

3.2.6.1 General History of the Company

In 1897, B. F. Dillingham established the Oahu Sugar Company on 12,000 acres leased from the John Papa 'Ī'ī, Bishop, and Robinson estates. Prior to commercial sugar cultivation, these lands were described as being "of near desert proportion until water was supplied from drilled artesian wells and the Waiahole Water project" (Condé and Best 1973:313). Dillingham had successfully promoted the Ewa Plantation Company in 1890; the sprawling sugar company was just south of and adjacent to the Oahu Sugar Company. Artesian wells had converted those arid Eva lands into a thriving plantation and Dillingham recognized the same potential in the northern area.

The project area is located in the western portion of the Oahu Sugar Company, which was also known as the Oahu Plantation (Figure 13and Figure 14). The northern portion of the project area is within Field 37; the central portion of the project area extends from Field 27 to Field 37, and the southern portion of the project area is within Field 28. Water to irrigate the upper cane fields was initially pumped to levels of 500 ft (150 m) by some of the "largest steam pumps ever manufactured" (Dorrance and Morgan 2000:49). Oahu Sugar Company's innovations to utilize the arid Ewa Plains and increase production within the plantation were so successful that the improvements were incorporate throughout the sugar cane industry. The Oahu Sugar Company constructed Hawai'i's first 12-roller mill in 1907, and P.A. Messchaert, the plantation's chemist,

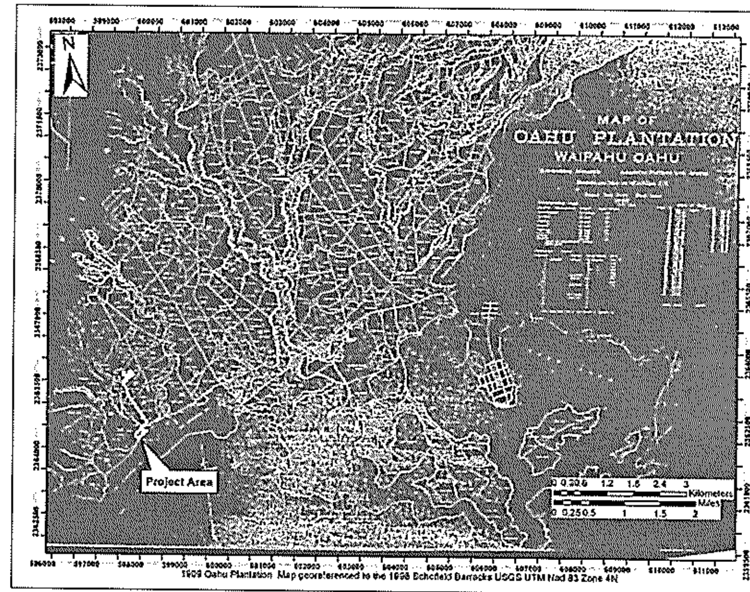

Figure 13. Oahu Plantation, 1909

invented a mechanized grooving method in 1913 that maintained pressure on the processing cane while allowing the cane juice to flow (Dorrance and Morgan 2000:49).

The expense of pumping water to the high elevations of the plantation led to the proposal to transport water from the windward side of the Koolaus. The Waiahole Water Company was formally incorporated in 1913 and was originally a subsidiary of the Oahu Sugar Company. The Waiahole Ditch was designed by engineer Jorgen Jorgensen, with recommendations by engineer J.B. Lippencott and assisted by W.A. Wall. The ditch began in Kahana Valley at an elevation of 790 ft (240 m), and ran almost entirely through tunnels through the Waikane and Waiahole valleys, the Koolaus, and was finally captured in a reservoir at 600-foot (180 m) elevation in the Wai'anae Range. Upon its completion in 1916, the Waiahole Ditch was 21.9 miles long (35 kilometers) and cost $2.3 million. The 32 million gallons of daily water enabled the O'ahu Sugar Company to grow to "some 20 square miles . . . ranging in elevation from 10 feet at the Waipio Peninsula . . . to 700 feet at the Waiahole Ditch" (Condé and Best 1973:313).

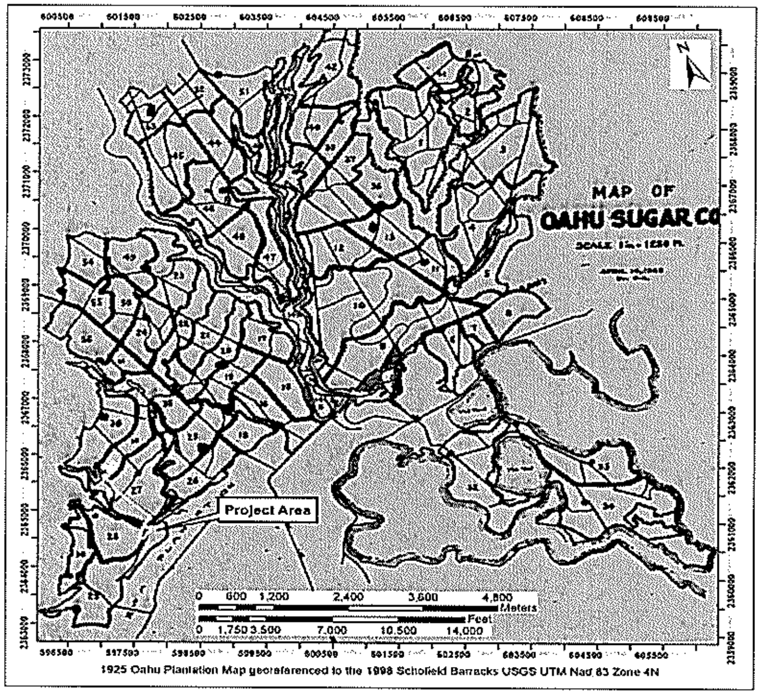

Figure 14. Oahu Sugar Company 1925, project area depicted in white

Annual sugar production increased to over 50,000 tons in 1918 and exceeded 40,000 tons annually for decades. In 1928, the Oahu Sugar Company broke a world's record by averaging more than 12 tons of sugar per acre. Mechanical harvesting innovations within the industry continued to develop and further increased production. They included mechanically loading cane in 1924, the removal of impurities during processing with an Oliver filer in 1926, and, during World War II, all cane was mechanically harvested. In 1950, sugar railroads were replaced with trucks.

By 1960, the Oahu Sugar Company was the largest producer on Oahu, with 75,000 tons annually. The company took control of the Ewa Plantation lands (Figure 15) in 1970 and continued operations until 1995, when sugar cane production in the combined plantation area ended (Dorrance and Morgan 2000:45, 50).

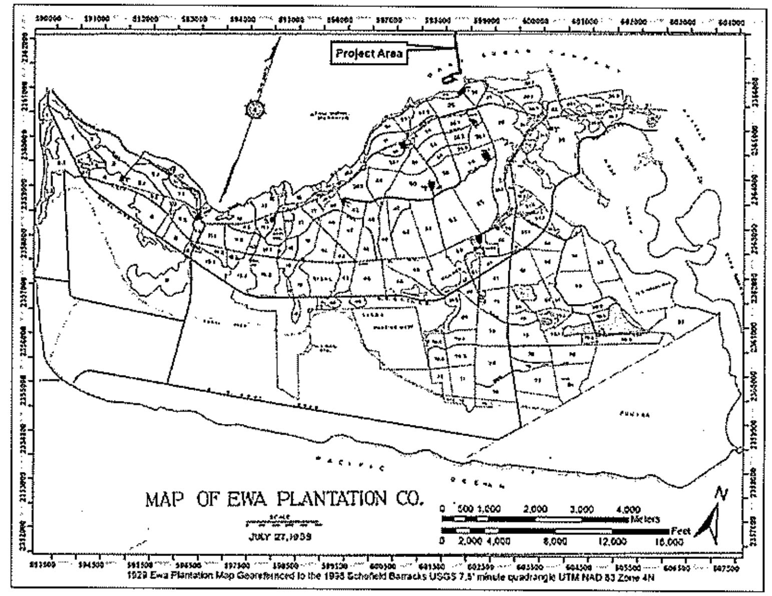

Figure 15. 1939 map of the Ewa Plantation Co. lands, showing project area

3.2.7 History of the Ewa Sugar Plantation

In 1886, James Campbell and B. F. Dillingham put together the "Great Land Colonization Scheme," which was an attempt to sell Honouliuli land to homesteaders (Thrum 1886:74). This homestead idea failed, but with the water problem solved by the drilling of artesian wells, Dillingham decided that the area could be used instead for large-scale cultivation (Pagliaro 1987:4). During the last decade of the nineteenth century, the railroad would reach from Honolulu to Pearl City in 1890, to Wai'anae in 1895, to Waialua Plantation in 1898, and to Kahuku in 1899 (Kuykendall 1967:III, 100). This railroad line eventually ran across the center of the 'Ewa Plain at the lower boundary of the sugar fields.

To attract business to his new railroad system, Dillingham subleased all land below 200 ft to William Castle, who in turn sublet the area to the newly-formed Ewa Plantation Company (Frierson 1972:15). Dillingham's Honouliuli lands above 200 ft that were suitable for sugar cane cultivation were sublet to the Oahu Sugar Company. Throughout this time, and continuing into modern times, cattle ranching continued in the area, and Honouliuli Ranch - established by Dillingham - was the "fattening" area for the other ranches (Frierson 1972:15).

Ewa Plantation Company was incorporated in 1890 for sugar cane cultivation. As a means to generate soil deposition on the coral plain and increase arable land in the lowlands, the Ewa Plantation Company installed ditches running from the lower slopes of the mountain range to the lowlands. When the rainy season began, they plowed ground perpendicular to the slope so that soil would be carried down the drainage ditches into the lower coral plain. After a few years, about 373 acres of coral wasteland were reclaimed in this manner (Immisch 1964). By the 1920s, Ewa Plantation was generating large profits and was the "richest sugar plantation in the world" (*Paradise of the Pacific*, Dec. 1902:19-22, cited in Kelly 1985:171).

3.2.8 Pineapple Production

Although the northern portion of the project area was within the Oahu Sugar Company on the 1925 map (see Figure 14), these lands have been under pineapple cultivation for decades. Libby, McNeill and Libby began leasing the lands in 1921 (Smith 1924:133).

The first pineapples to arrive in Hawai'i may have been transported as early as 1527 by the Spanish. In 1794, a Spanish horticulturalist, Francisco de Paula Marin, immigrated to Hawai'i; he began experimentally raising pineapples in the early 1800s. Captain John Kidwell began pineapple crop development trials in 1885. Kidwell is considered to by the founder of Hawai'i's pineapple industry although James Drummond Dole is credited with advancing the industry. Dole became Hawai'i's "Pineapple King" after incorporating the Hawaiian Pineapple Company and commercially growing pineapples in 1901. Pineapple production grew to be Hawai'i's second largest industry (Fisher 2006).

Recently, the northern portion of the project area has been within pineapple fields cultivated by Del Monte. Del Monte had planned on harvesting their last crop of pineapple within the vicinity of the project area in 2008. However, the current crop has just been abandoned and future plans for the vicinity are unknown.

Section 4 Previous Archaeological Research

4.1 Overview of Archaeological Studies in Honouliuli

Two archaeological features, a boundary *pōhaku* or rock and a *hōlua*, or sledding site, are recorded only in the Boundary Commission Reports establishing the division lines between the *ahupua'a* of Honouliuli and Hō'ae'ae (to the east). The surveyor wrote of the southern point of this boundary:

> In regard to Hoaeae . . . the point of commencement is Pōhaku Palahalaha, a well known rock, now marked by an arrow and the name "Honouliuli" on one side and "Hoaeae" on the other, which I have made the initial point of the survey . . . [Commission on Boundaries, Vol. 1:243].

This rock is shown on the Sterling and Summer map (see Figure 11) as Pōhaku Palaha, east of the project area. In another boundary survey, the *pōhaku* is called a "large, flat rock" (Boundary Commission Vol. 1:249), which may indicate the origin of the name from the Hawaiian word *pālaha*, which means "flattened, wide" (Pukui and Elbert 1986:307). As the surveyor continued to walk the Honouliuli/Hō'ae'ae boundary, he marked the northern point of the division as:

> The Kamaaaina took me to the corner of Pauhala (?)-Hoaeae and Honouliuli – there is an ancient holua or sleding [*sic*] place near this – which is agreed for the ancient corner. . . [Commission on Boundaries Vol. 1:243].

The earliest attempt to record archaeological remains in Honouliuli Ahupua'a was made by Thrum (1906:46). He reported the existence of a *heiau* located on Pu'u Kapolei, southwest of the present study area. In a second monograph on *heiau*, Thrum (1917) called this *heiau* Palole'i [Kapolei]. Emory mapped and photographed these structures in 1933 (field notes), but they were dismantled and destroyed sometime before McAllister's survey of the islands in the 1930s. According to legend, Pu'u Kapolei was the location on which Kamapua'a, the pig-god, resided with his grandmother, Kamaunuahihio (McAllister 1933:108).

In his surface survey of the 1930s, archaeologist J. Gilbert McAllister recorded the specific locations of important sites, and the general locations of less important sites (at least at Honouliuli). McAllister recorded six sites (see Figure 11 for site locations) in the upland section of Honouliuli, *mauka* of the 'Ewa coral plain and Pu'u o Kapolei. Site 133 is a possible *heiau*, a small enclosure at the foot of Pu'u Kānehoa. It was still standing during McAllister's day, and local residents informed him of its sacred nature. Site 134 is Pu'u Kuina Heiau, located in a gulch at the foot of Mauna Kapu. Only traces of a large terrace remained. Site 135 is a series of enclosures *makai* of Pu'u Kuina Heiau. McAllister believed that the walls marked *kuleana* (commoner) lots. Site 136 is a small platform near Mauna Kapu, a sacred site, possibly an altar. Site 137 is Pu'u Ku'ua Heiau, plotted on a ridge near Pu'u Ku'ua. This *heiau* had been modified for use as a cattle pen; some areas had been cleared for pineapple cultivation or planted with ironwoods (McAllister 1933:107-108).

Between McAllister's 1930s study and the flurry of work that began in 1969, there are only a few sporadic pieces of research, which are not well documented. In 1933, Dr. Kenneth P. Emory recorded a well-preserved house site and a possible *heiau* (later destroyed by sugar cane cultivation) in the western part of the coral plains (Sinoto 1976:1). In 1959, William Kikuchi removed a number of burials from a burial cave site (Bishop Museum Site OA-B6-10) at the Standard Oil Refinery, which was subsequently destroyed (Barrera 1975:1). Kikuchi recovered 12-16 incomplete primary and/or secondary burials cached in a sinkhole or crevice exposed during construction activities near the big bend in Malakole Road (Kikuchi 1959; Davis 1990b: 146, 147): In 1960, Yoshi Sinoto and Elspeth Sterling visited a house site (BPBM. Site OA-B6-8) within 'Ēkaha Nui Gulch. "Around this elevation (1200 feet), along the sides of the stream, were seen remains of many terraces and some house sites" (Sterling and Summers 1978:37). In 1962, Lloyd Soehren recorded another secondary human burial in a sinkhole at the Barber's Point Naval Air Station (Davis 1990a:147). In 1966, Lloyd Soehren carried out salvage excavations at a possible fishing shrine (BPBM. Site # 50-OA-B6-13). The site was reported as destroyed by construction (Barrera 1975:1), but Davis relocated the shrine and performed additional excavations in 1982 (Davis 1990a:148). In 1969, artifacts were recovered by Roger Green from a beach midden site (B6-14), south of the barge harbor.

4.2 Previous Archaeological Work in the Vicinity of the Project Area

Beginning in the late 1970s, archaeological research has been conducted in Honouliuli south and east of the general vicinity of the project area (Figure 16).

CHS has recently completed an archaeological inventory survey just south of H-1 and the current project area (O'Hare, et al 2006). The reported findings are based on a 1990 CSH inventory survey and a 2005 CSH surface survey. A total of five sites, a railroad berm (Site 50-80-12-4345), three pumping stations (Sites 50-80-12-4346, -4347, and -4348), and three features related to plantation infrastructure (Site 50-80-12-4344) were recorded and assigned SIHP permanent site numbers. During the 1990 survey, four historic documented areas of Hawaiian and later immigrant residence were also identified: the former sites of Honouliuli Taro Lands, Kapalani Church, PipeLine Village, and Drivers/Stable Village. Further work, especially subsurface testing, was recommended for these four areas. During the recent 2005 surface survey of 1,630-acres, four new features related to sugar cane cultivation or irrigation were recorded. These four features (Features D-G) were subsumed under the previous site number, Site 50-80-12-4344, used for scattered plantation infrastructure features. A total of 19 trenches were excavated in the four areas of historic habitation and/or agriculture identified in the 1990 CSH survey to determine if there were any subsurface remains of: (1) nineteenth century (or earlier) habitation and agricultural lots in the Honouliuli Taro Lands; (2) structures or burials associated with the nineteenth century Kapalani Catholic Church; (3) structures or historic domestic artifacts associated with the early twentieth century Drivers and Stable Village; and, (4) structures or historic domestic artifacts or pit/privy features associated with the early twentieth century PipeLine Village. No cultural deposits, no privy pits, no burials, and no artifacts of any type were found or recovered from the 19 trenches.

The recent CHS survey included a non-contiguous northern parcel that is approximately 1640 feet (500 meters) west of the current project area (O'Hare, et al. 2006). No evidence of historic or prehistoric activity was identified within that portion of the project area.

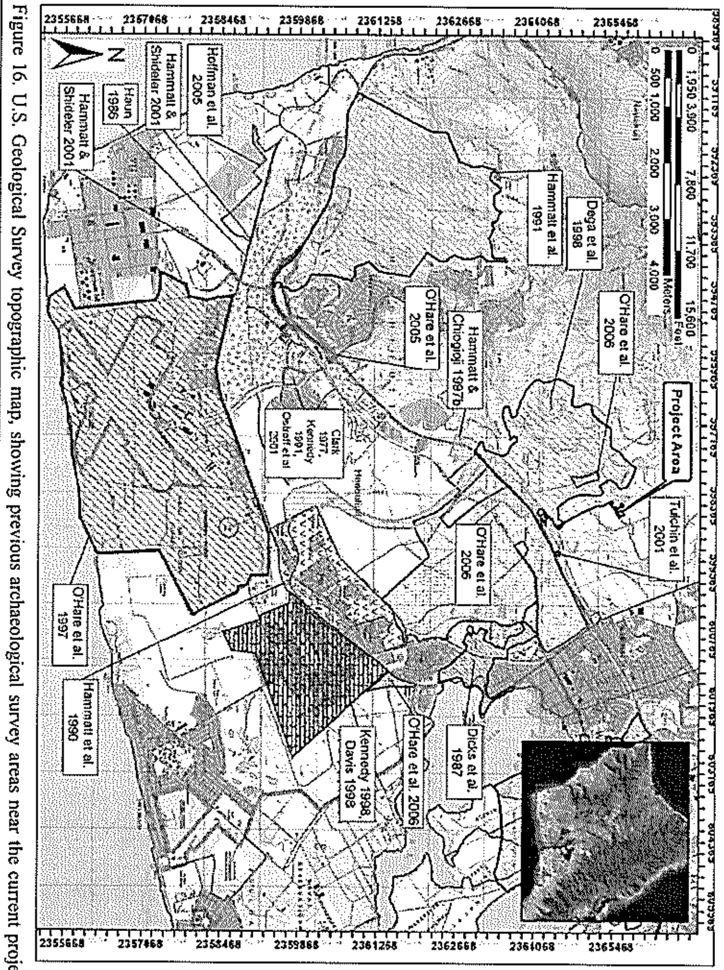

Figure 16. U.S. Geological Survey topographic map, showing previous archaeological survey areas near the current project area

In 1987, a reconnaissance survey was conducted on an approximately 200-acre property in 'Ewa (Kennedy 1987). The land is east of the current project area and within the *ahupua'a* of Hō'ae'ae, adjacent to the boundary of Honouliuli Ahupua'a. No prehistoric properties were found during the survey. The Waiahole ditch runs through the project area and two recently constructed reservoirs are within the project area. No further work was recommended since ground visibility was 100% and there was no indication the property contained subsurface deposits.

In 1991, Cultural Surveys Hawai'i conducted an archaeological inventory survey of the "Makaīwa Hills" development project (Hammatt, et al. 1991). The project area included a 1,915 acre parcel in Honouliuli *Ahupua'a*, between the town of Makakilo and Waimānalo Gulch (to the west of the current project area). 34 sites were located, including habitation structures (temporary and permanent), agricultural features (terrace and mounds), rock shelters, petroglyphs, and various other structures associated with sugar cane cultivation attributable to the Ewa Plantation Company. Eighteen of the recorded sites were considered significant and preservation was recommended. Sixteen of the sites, including cattle walls and other structures associated with the 'Ewa Plantation Co., were considered to be no longer significant and no further work was recommended.

An archaeological inventory survey of the University of Hawai'i, West O'ahu Campus, was conducted adjacent to and west of the southern portion of the current project area in 1998 (Dega, et al. 1998). Many historical features associated with sugarcane production and irrigation were identified and recorded as State Site Number 50-80-08-5593. Since sufficient data was collected, the site was considered no longer significant and no further work was required

In 2001, Cultural Surveys Hawai'i conducted an archaeological inventory survey of the proposed 'Ewa Shaft Renovation Project (Tulchin, et al. 2001). The approximately 1-acre project area is approximately 2,500 ft (750 m) east of the southern portion of the current project area. No prehistoric or historic properties were observed during the surface survey or subsequent subsurface testing.

4.3 Background Summary and Predictive Model

4.3.1 Honouliuli Settlement Patterns

The *ahupua'a* of Honouliuli is the largest traditional land unit on the island of O'ahu. Honouliuli includes all the land from the western boundary of Pearl Harbor (West Loch) westward to the 'Ewa/Wai'anae District Boundary with the exception of the west side of the harbor entrance, which is in the *ahupua'a* of Pu'uloa (the 'Ewa Beach/Iroquois Point area). This comprises approximately 12 miles of open coastline from One'ula westward to Pili O Kahe. The *ahupua'a* extends *mauka* (almost pie-shaped) from West Loch nearly to Schofield Barracks, and the western boundary is the Wai'anae Mountain crest running *makai* to the east ridge of Nānākuli Valley.

Not only is there a long coastline fronting the normally calm waters of leeward O'ahu, but there are also four miles of waterfront along West Loch. The land immediately *mauka* of the Pacific coast consists of a flat karstic raised limestone reef forming a level nearly featureless "desert" plain marked in pre-Contact times (previous to alluviation caused by sugar cultivation)

by a thin or non-existent soil mantle. The microtopography is notable in containing countless sinkholes in some areas caused by chemical weathering (dissolution) of the limestone shelf.

Along the eastern flank of the Wai'anae Mountains, numerous gulches have contributed to the alluvial deposits over the coastal limestone shelf. The largest of the gulches is Honouliuli Gulch, which drains into West Loch. The gulches are generally steep-sided in the uplands and generally of a high gradient until they emerge onto the flat 'Ewa plain. The alluvium they have carried has spread out in delta fashion over the *mauka* portions of the plain, which comprises a dramatic depositional environment at the stream gradient change. These gulches are generally dry, but during seasonal Kona storms carry immense quantities of runoff onto the plain and into the ocean. As typical drainages in arid slopes, they are either raging uncontrollably, or are dry and, as such, do not form stable water sources for traditional agriculture in their upper reaches. The Honouliuli gulches generally do not have valleys suitable for extensive irrigated agriculture; however, this lack is more than compensated for by the rich watered lowlands near West Loch.

Honouliuli Ahupua'a, as a traditional land unit, had abundant and varied resources available for exploitation by early Hawaiians. The "karstic desert" and marginal characterization of the limestone plain, which is the most readily visible terrain, does not do justice to the *ahupua'a* as a whole. The richness of this land unit is marked by the following available resources:

1) 12 miles of coastline with continuous shallow fringing reef, which offered rich marine resources.
2) Four miles of frontage on the waters of West Loch, which offered extensive fisheries (mullet, *awa*, shellfish), as well as frontage suitable for development of fishponds.
3) The lower portion of Honouliuli Valley in the 'Ewa plain offered rich level alluvial soils with plentiful water for irrigation from the stream as well as abundant springs. This land would have stretched well up the valley.
4) A broad limestone plain, which because of innumerable limestone sinkholes, offered a nesting home for a large population of avifauna. This resource may have been one of the early attractions to human settlement.
5) An extensive upland forest zone extending as much as 12 miles inland from the edge to the coastal plain. As Handy and Handy (1972:469) have pointed out, the forest was much more distant from the lowlands here than it was on the windward side, but on the leeward side was more extensive. Much of the upper reaches of the *ahupua'a* would have had species-diverse forest with *kukui*, *'ōhia*, sandalwood, *hau*, *ti*, banana, etc.

Within this natural setting, archaeological and traditional sources show a general pattern of settlement within the *ahupua'a* that includes the inland settlement at Pu'u Ku'ua.

4.3.2 Pu'u Ku'ua: Inland Settlement

Documentation of inland settlement in Honouliuli Ahupua'a is problematic in that there are relatively few documented archaeological sources. However, it is probable that the area around Pu'u Ku'ua, on the east side of the Wai'anae Ridge, was a Hawaiian place of some importance.

Pu'u Ku'ua is approximately 8,000 ft (2.5 km) west-south-west of the project area and is separated from the project area by Honouliuli Gulch.

There are two aspects of the stories related to Pu'u Ku'ua. One story relates that Pu'u Ku'ua was formerly a place of chiefs that was named for a chiefess. The other story relates that Pu'u Ku'ua was populated by the kauwa, or slaves.

In 1899, Hawaiian Newspaper *Ka Loea Kālai'āina* relates a story of Pu'uku'ua as "a place where chiefs lived in ancient times" and a "battle field," "thickly populated." The article summarizes:

There were two important things concerning this place. (1) This place was entirely deserted and left uninhabited and it seems that this happened before the coming of righteousness to Hawai'i Nei. Not an inhabitant is left. (2) The descendants of the people of this place were so mixed that they were all of one class. Here the gods became tired and returned to Kahiki [*Ka Loea Kālai'āina*, July 8, 1899, translated in Sterling and Summers 1978:32-33].

Thrum (1998:93) also mentions the hill Pu'uku'ua in the legend of the hero Kalelealuaka. In this legend, Kalelealuaka, who resides in Keahumoe in Waipi'o, 'Ewa, can transport himself long distances across the island of O'ahu. On a day before he is to meet the local chief, he transports to Helemano (near Wahiawa town) for a purifying bath, next transports himself to a place behind the visiting chief's retinue, and then flies with them to Pu'uloa (the east coastal area of Honouliuli).

> Returning from his purification, Kalelealuaka alighted just to the rear of the party, who had not noticed his absence, and becoming impatient at the tedious slowness of the journey, --for the day was waning, and the declining sun was already standing over a peak of the Wai'anae Mountains called Puukuua,--this marvelous fellow caught up the lame marshal [of the chief] in one hand and his two comrades in the other, and, flying with them, set them down at Puuloa. But the great marvel was, that they knew nothing about being transported, yet they had been carried and set down as from a sheet [Thrum 1998:93].

The same Hawaiian Newspaper *Ka Loea Kālai'āina* article cited above also states that the term *kauwā* (meaning slave or outcast) was first used to identify Pu'u Ku'ua because of a one armed chiefess who was ashamed and ran when other chiefs would visit. She was not a *kauwā* she only behaved as one [*Ka Loea Kālai'āina*, July 8, 1899, translated in Sterling and Summers 1978:33].

Another description of the *kauwā* residing in the vicinity of Pu'u Ku'ua follows:

> . . If you are above Puuloa, you will see Pu'u-o-Kapolei, a small hill. Lying below and back of that hill is the government road going to Wai'anae. Above that is also a small hill and back of that, is a big hill and above it is a large hollow. That is Pu'u-Kuua where the very dirty ones lived [*Ka Loea Kālai'āina* July 15, 1899, translation in Sterling and Summers 1978:32].

Kamakau says that the *kauwā* of O'ahu used the disruptions caused by the inter-island wars against several chiefs to assimilate into the general Hawaiian society.

The *kauwa* of Oah'u became "lost in the shuffle" (*huikau*) when Kahahana and the Oah'u chiefs died and Kahekili and his Maui chiefs took over the kingdom in 1783, and again when Kamehameha and his Hawai'i chiefs took the kingdom in 1795. The *kauwa* hid themselves until the time when the *kapu akua*, the god's kapus, were overthrown, and the kingdom became a "free-eating' one, *ke aupuni 'ainoa* [one without gods]. That released the *kauwa*. . . . By mixing here, mixing there, the blood of lords has become mixed with the blood of *kauwa*, and there is nothing that can cleanse it (*'a'ole mea nana i hiukala*) [Kamakau1991a:9].

Additionally, Kapo, Pele's sister, is believed to have left her flying vagina (*kohe lele*) at Pu'uku'ua.

McAllister recorded three sites in the vicinity of the project area and Pu'uku'ua, two *'heiau* (134, 137) (Pu'u Kuina and Pu'uku'ua, both destroyed) and a series of enclosures in Kukuilua which he called "kuleana sites" (McAllister 1933). McAllister (1933) noted that most of the stones of heiau 137 were used for a cattle pen located on the sea-side of the site; the portion of *heiau* that was cleared for pineapples has been planted in ironwood. On the opposite side of the Wai'anae range, along the trail to Pōhākea Pass, Cordy (2002:36) states "Kākuihihewa was said to have built (or rebuilt) Nōi'ula, a *pō'okanaka heiau* (1,300 sq. m.) in Hālona in upper Lualualei, along the trail to Pōhākea Pass leading into 'Ewa, ca. A.D. 1640-1660" (Cordy 2002:36). There is no direct archaeological evidence available to the authors' knowledge that intensive Hawaiian settlement occurred here, but it is considered as a place of high probability, based on the above indications. John Papa 'Ī'ī (1959) described a journey that Liholiho took which led him and an entourage through inland Honouliuli and over Pōhākea Pass. Geographically, the area receives sufficient quantities of water and would have had abundant locally available forest resources.

4.3.3 Project Area Predictive Model

Although the project area is near the Pu'uku'ua settlement area, approximately 8,000 ft (2.5 kilometers) west-south-west of the project area, it is separated from the project area by Honouliuli Gulch. The project area is not located near a source of water and was probably outside the boundary of the Pu'uku'ua population center. The project area was therefore not likely a focus for permanent habitation or agriculture.

Previous archaeological work conducted within the vicinity of the current project area also indicates that the project area is unlikely to contain subsurface prehistoric deposits.

4.3.4 Summary

On the basis of archaeological studies, informed by historic records, the following may be concluded:

1) There are three areas of Hawaiian settlement in the *ahupua'a* indicated in the historic record:

    a. the extensive limestone plain with recurrent use habitations for fishermen and gatherers and sometime gardeners;

b. the rich cultivated lands of Honouliuli 'ili for extensive wetland taro and clearly the *ahupua'a* population center; and,

c. the uplands around Pu'uku'ua associated with *kauwā* residence but probably used for agriculture and forest resources.

2) Honouliuli is designed as a unit to contain all the geographic elements of a typical Hawaiian valley *ahupua'a*, except they are arranged geomorphically in an atypical relationship. The *ahupua'a* is not organized around a single drainage network but shares the west portions of Waikele drainage in its upper reaches. A typical and highly advantageous characteristic for human subsistence is included in a vast coastline and fringing reef, an extensive limestone plain which would support only limited agriculture but would be excellent for bird catching in early times, and a huge expanse of sloping forest land. The richest forest land for foraging for wood, birds, feathers, etc. would have been the east slope of the Wai'anae Range. The surveys by Bordner and Silva (1983) and Hammatt and Shideler (1999) at Waimānalo Gulch indicated no evidence of Hawaiian occupation, but the gulch has been impacted in modern times.

3) The *makai* slope was not a major thoroughfare. We can see some very limited evidence of part-time agriculture in and around gulches and two foci of sparse habitation. The first is limited to *makai* portions of gulches and lava flats. This habitation is considered a *mauka* component or continuing of the Ko'ōlina coastal settlement rather than an independent focus. The second focus, separated from the first by a barren zone, is generally above the 800-foot elevation. This *mauka* habitation which could have been supported by seasonal dry land planting and forest foraging may be the lower portion of a thinly scattered, but widespread zone of settlement which stretches eastward and northeast along the east Wai'anae Range slopes and may increase in intensity along the more watered lands forming the *mauka* western boundary of Honouliuli.

4) There is to date no archaeological evidence of high status residence in Honouliuli. Large residential structures are not present along the Pacific shoreline where they would be expected. The late prehistoric occurrence of chiefs' houses is not apparent, perhaps because the ocean shoreline, although rich in marine resources, is uninviting for sport and unsuitable for fishponds. The chiefly focus of 'Ewa District was Waipi'o. Whatever activities of this class occurred in Honouliuli would have been in or near the rich lands fronting West Loch (the *'ili* of Honouliuli). Concerning status associations with Honouliuli, it is interesting to note the connection of the Pu'uku'ua settlement with slaves (*kauwā*), the lowest class of Hawaiians (Sterling and Summers 1978:33).

5) The focus of population and agriculture within the *ahupua'a* of Honouliuli was the *'ili* of Honouliuli. There is good reason to assume, given the lack of intensive agricultural resources in other prehistoric times, all other habitation zones were economically and socially co-dependent.

Section 5 Results of Fieldwork

The pedestrian inspection of the project area was conducted on November 7, 2006 with two Cultural Surveys Hawai'i staff archaeologists, Constance R. O'Hare, B.A., and Randy Groza, M.A., under the general direction of Hallett H. Hammatt, Ph.D. At least 90% of the project area has been denuded of all natural vegetation and had been previously planted with pineapple. The entire northern portion of the project area, which appeared to have been bulldozed and contained remnants of black plastic for weed control, was surveyed by pedestrian sweeps. CSH archaeologists conducted a windshield survey of the approximately 4,000 ft (1200 m) of existing road, where the new water line will run parallel to the existing water line in the center of the road and connect the northern portion of the project area with the southern portion. The southern section of the project area was fenced; it contains an existing water tank and is the proposed location of the new water tank. This southern portion was reviewed through the chain link fence.

No historic properties were encountered and the pedestrian inspection was documented with field notes, maps, and photographs.

Section 6 Summary and Mitigation Recommendations

Background historical research for this project indicates that this area of the 'Ewa Plain was not a locus for traditional Hawaiian habitation, agriculture, or ceremonial activities. No historic properties were found in the project area during the recent field survey. Based on the results of the background research, previous work conducted by CSH within the vicinity of the project area, and the field assessment of the project area, it appears that no further archaeological or cultural work is appropriate for this project. The proposed construction of the new reservoirs and waterline to support a mixed residential, commercial, and recreational property that is located south of the H-1 will have no effect on any historic properties or on any on-going cultural practices in the project area.

As always, if in the unlikely event that development activities uncover significant subsurface finds, all work in the immediate vicinity should stop and the State Historic Preservation Division should be promptly notified.

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Appendix A

Letter to OHA

Cultural Surveys Hawai'i, Inc.
Archaeological and Cultural Impact Studies
Hallett H. Hammatt, Ph.D., President

P.O. Box 1114 • Kailua, Hawai'i 96734 • Ph.: (808) 262-9972 • Fax: (808) 262-4950
dshideler@culturalsurveys.com • www.culturalsurveys.com

December 15, 2006

Clyde Nāmu'o, Administrator
Office of Hawaiian Affairs
711 Kapi'olani Boulevard
Honolulu, HI 96813

Dear Mr. Nāmu'o:

A complementary copy of our archaeological assessment, *An Archaeological Assessment for the Ho'opili Project 440-Foot Elevation Reservoir and Waterline Project,Honouliuli Ahupua'a, 'Ewa District, Island of O'ahu, TMK:(1) 9-2-001:001, 004, 005, 006, 007 (por.); 9-2-002:002*, is enclosed.

No sites or cultural materials were found during the survey and background information also indicated that no sites were present.

If you have any questions or concerns about the location of the proposed project, please call me.

Sincerely,

David Shideler

APPENDIX E

SHPD Archaeological Inventory Acceptance Letter

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR - LAND

DEAN NAKANO
ACTING DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
601 KAMOKILA BOULEVARD, ROOM 555
KAPOLEI, HAWAII 96707

November 3, 2006

LOG NO: 2006.3670
DOC NO: 0611amj01
Archaeology

Dr. Hallett H. Hammatt
Cultural Surveys of Hawai'i, Inc.
P.O. Box 1114
Kailua, Hawai'i 96734

Dear Dr. Hammatt:

SUBJECT: Chapter 6E-42 Historic Preservation Review –
Revised Archaeological Inventory Survey for the Ho'opili Project
Hono'uli'uli Ahupua'a, 'Ewa District, Island of O'ahu
TMK: (1) 9-1-010:002, 9-1-017:004, 059, 072, 9-1-018:001, 004, 9-2-002:004, 005

Thank you for submitting the revised report by O'Hare *et al.* (2006), which we received on September 6, 2006. We apologize for the delay in responding. Five historic properties (SIHP Nos. 50-80-12-4344, 4345, 4346, 4347, and 4348) were documented during inventory survey of a 2625-acre project area. In a letter (LOG NO. 2006.1523, DOC NO: 0605CM22) dated June 6, 2006, we reviewed a previous version of this report, and requested a number of revisions, which you have now made to our satisfaction.

All five historic properties have been assessed as eligible for the State Register of Historic Places under criteria C and D, except for Site 4344, which is only eligible under criterion D. We concur with these significance assessments.

We also concur with your mitigation recommendations, which include: (1) no further archaeological work at Site 4344, (2) preservation of Sites 4345, 4346, 4347, and 4348, and (3) archaeological monitoring in the vicinity of the four areas of historic habitation (Hono'uli'uli taro lands, Kapalani Catholic Church, Pipeline Village, and Drivers/Stable Village).

The report is now accepted in fulfillment of HAR 13-284 and 13-276. We look forward to receipt of a preservation plan and an archaeological monitoring plan.

Please contact Mr. Adam Johnson (O'ahu Assistant Archaeologist) at (808) 692-8015 if you have any questions or concerns regarding this letter.

Aloha,

Melanie Chinen, Administrator
State Historic Preservation Division

amj:

APPENDIX F
Cultural Impact Assessment

Cultural Impact Assessment

for the Ho'opili Project,

Honouliuli Ahupua'a, 'Ewa District, Island of O'ahu

TMK: [1] 9-1-010:002; 9-1-017:004 & 059; 9-1-018:001, 004 & 072; and 9-2-001:001 (por)

Prepared for

D. R. Horton – Schuler Division

Prepared by

Hallett H. Hammatt, Ph.D.

Cultural Surveys Hawai'i, Inc.

Kailua, Hawai'i

(Job Code: HONO 76)

December 2006

www.culturalsurveys.com

Maui Office
16 S. Market Street, Suite 2N
Wailuku, Hawai'i 96793
Ph: (808) 242-9882
Fax: (808) 244-1994

Section 1 Management Summary

Reference	A Cultural Impact Assessment Report for the Ho'opili Project, Honouliuli Ahupua'a, 'Ewa District, O'ahu Island TMK: TMK: [1] 9-1-010:002; 9-1-017:004 & 059; 9-1-018:001, 004 & 072; and 9-2-001:001 (por)
Date	December 2006
Project Number (s)	CSH Job Code: HONO 76
Project Area	The Project Areaproposed Project Area consists of several parcels which are identified by the following Tax Map Key numbers TMK: [1] 9-1-010:002; 9-1-017:004, 059; 9-1-018:001, 004 & 072.
Project Location	East Kapolei, 'Ewa District, O'ahu. The Project Area is generally bound on the north by the H-1 Interstate (I H-1), on the south by Mango Tree Road (a dirt road along the 'Ewa Villages Golf Course), Palehua Drive on the west, and Old Fort Weaver Road on the east There are two non-contiguous parcels,the first is located on the east side of new Fort Weaver Road (TMK 9-1-010:002), and the second is north of the H-1 Interstate in proximity to a reservoir (TMK 9-2-001:001).
Land Owner	TMK: [1] 9-1-010:002 D.R. Horton-Schuler Homes LLC 9-1-017:004 & 059; D.R. Horton-Schuler Homes LLC 9-1-018:001, 004 & 072; D.R. Horton-Schuler Homes LLC 9-2-001:001 (por) Monsanto Company
Reviewing Agencies	State of Hawai'i Department of Health (DOH)/ Office of Environmental Quality Control (OEQC)
Project Description	The landowner plans to develop the project area into a mixed residential, commercial, and recreational property.
Project Acreage	1,630 acres
Document Purpose	Article IX and XII of the state constitution, other state laws, and the courts of the state require government agencies to promote and preserve cultural beliefs, practices and resources of native Hawaiians and other ethnic groups pursuant to this legal mandate, cultural Surveys Hawai'i Inc. (CSH) conducted an analysis of the proposed projects impacts on cultural practices and features identified within the Project Area. CSH prepared this report in accordance with the requirement set forth under Hawaii revised status as amended (HRS), Chapter 343 and the OEQC's guidelines for assessing cultural impacts.

Consultation Effort	CSH consulted with various Hawaiian organizations, agencies and community members were contacted in order to identify potentially knowledgeable individuals with cultural expertise and/or knowledge of the Project Area and the surrounding area. CSH consulted with the State Historic Preservation Division, the Office of Hawaiian Affairs, the O'ahu Island Burial Council, and the 'Ewa Neighborhood Board. Information gathering sessions with the following community members: Arline Eaton, Richard Hirata, Richard Oshiro, Kenneth Soma, and Charles Nakamatsu along with many others in the community.
Summary and Recommendation	No contemporary or continuing cultural practices currently occur within the Project Area. It should be noted that subsurface historic properties associated with former traditional Hawaiian activities in the Project Area, such as artifacts and cultural layers, may be present despite the decades of modern activities such as ranching and sugar cane. As a precautionary measure, personnel involved in future development should be informed of the possibility of inadvertent cultural finds, and should be made aware of the appropriate notification measures to follow.

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Section 2 Introduction

2.1 Project Background

At the request of D.R. Horton-Schuler Division (828 Fort Street Mall, 4th Floor, Honolulu, HI 96813), Cultural Surveys Hawai'i, Inc. (CSH) has completed this Cultural Impact Assessment Report for the East Kapolei Project, Honouliuli Ahupua'a, 'Ewa District, O'ahu Island TMK: TMK: [1] 9-1-010:002; 9-1-017:004 & 059; 9-1-018:001, 004 & 072; and 9-2-001:001 (por) (Figure 1 and Figure 2).

The H-1 Interstate (I H-1) runs along the northern boundry of the project area. Mango Tree Road (i.e. a dirt road along the 'Ewa Villages Golf Course) is on the south. Pelehua Drive on the west, and Old Fort Weaver Road on the east.

Article IX and XII of the state constitution, other state laws, and the courts of the state require government agencies to promote and preserve cultural beliefs, practices and resources of native Hawaiians and other ethnic groups pursuant to this legal mandate, cultural Surveys Hawaii Inc. (CSH) conducted an analysis of the proposed projects impacts on cultural practices and features identified within the Project Area. CSH prepared this report in accordance with the requirement set forth under Hawaii revised status as amended (HRS), Chapter 343 and the OEQC's guidelines for assessing cultural impacts

2.2 Scope of Work

The scope for the Cultural Impact Assessment is summarized as follows:

1) Examined historical documents, Land Commission Awards, historic maps, with the specific purpose of identifying traditional Hawaiian activities including gathering of plant, animal and other resources or agricultural pursuits, as may be indicated in the historic record.
2) Reviewed the existing archaeological information pertaining to the sites within the profect area as they allowed us to reconstruct traditional land use activities and identify and describe the cultural resources, practices, and beliefs associated with the parcel and identify present uses, if appropriate.
3) Conducted oral interviews with persons knowledgeable about the historic and traditional practices in the Project Area and the surrounding region. We experienced both formal and informal interviews.
4) Preparaed a report on items 1-3 summarizing the information gathered related to traditional practices and land use. The report assessed the impact of the proposed action on the cultural practices and any features identified.

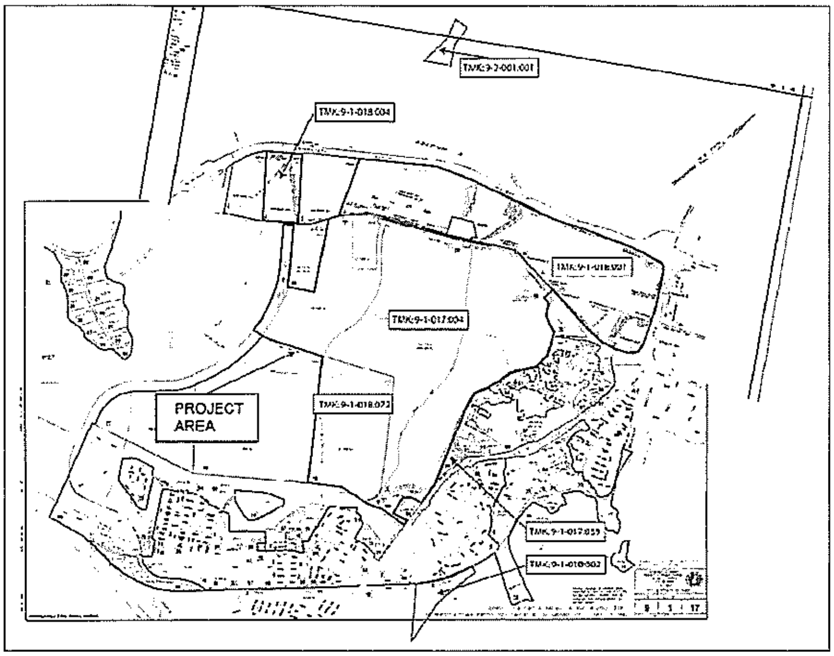

Figure 2. Tax Map Key (1) 9-1-010, 9-1-17, 9-1-018 and 9-2-002, showing Project Area

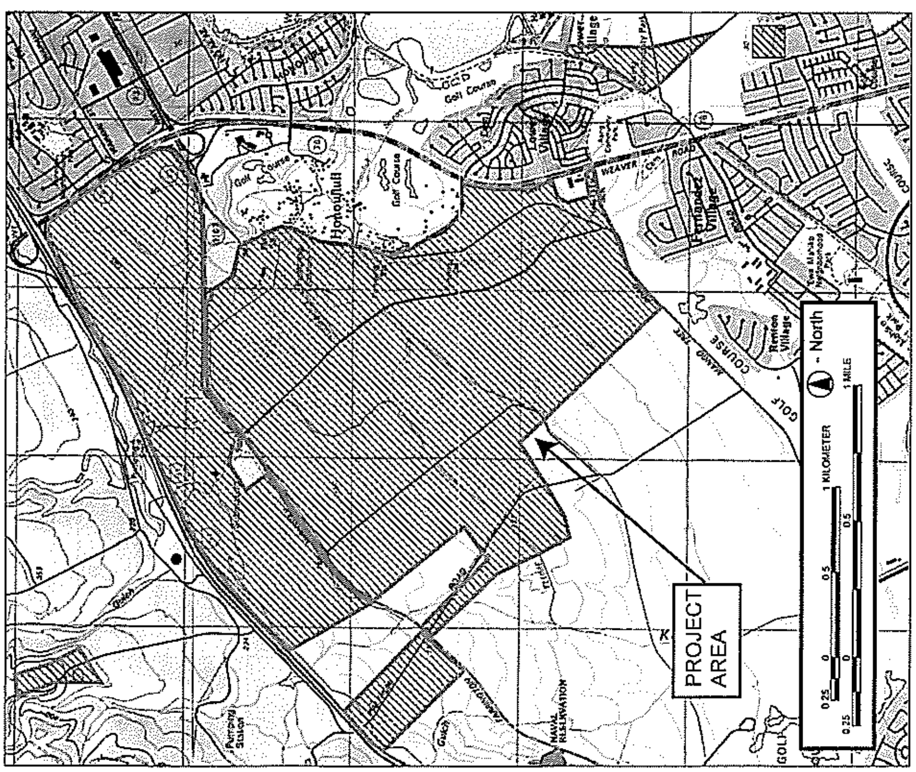

Figure 1. US Geological Survey map (2002), Waipahu quadrangle, showing Project Area (hatched area)

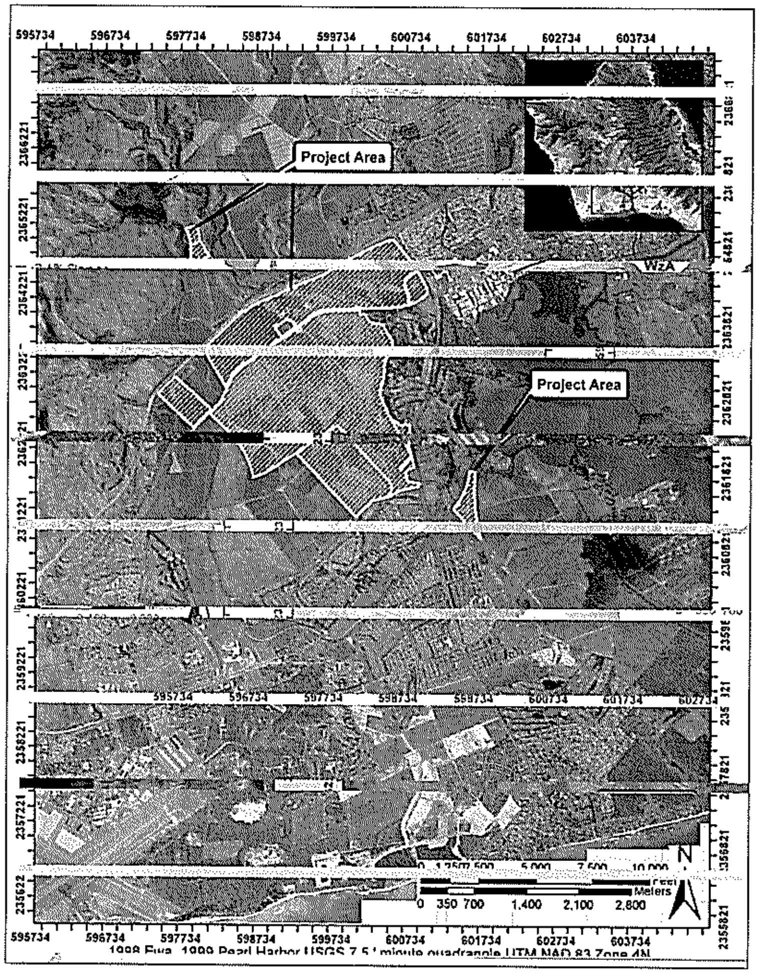

Figure 3. 2000 Aerial photograph of the Project Area, showing plowed fields

2.3 Environmental Setting

2.3.1 Natural Environment

Honouliuli Ahupua'a is the largest traditional land unit on O'ahu, extending from the West Loch of Pearl Harbor in the east, to the border of Nānākuli Ahupua'a at Pili o Kahe in the west. Honouliuli Ahupua'a includes approximately 19 km (kilometers), or 12 mi (miles) of open coastline from One'ula westward to Pili o Kahe. The *ahupua'a* extends *mauka* (inland) from West Loch nearly to Schofield Barracks in Wahiawā; the western boundary is the Wai'anae Mountain crest running north as far as Pu'u Hāpapa (or to the top of Ka'ala Mountain, according to some).

Topographically, the portion of the Project Area to the south of Farrington Highway is most notable for a scarp feature, typically 50 ft (15 m) high, the feature runs roughly north/south through the southeastern portion of the Project Area. This scarp is a Pleistocene fossil sea bluff. The northern portion of the Project Area is generally flat, except along Honouliuli Gulch, which runs through the center of this western portion.

Lying in the lee of the Wai'anae mountain range, the Project Area is one of the driest areas of O'ahu with most of the area averaging about 18 inches of rainfall annually (Juvik and Juvik 1998:56). Temperatures range between 60° to 90° Fahrenheit through the year; the highest temperatures are in August and September (Armstrong 1973). Elevation in the Project Area ranges from 40 ft (feet) AMSL (above mean sea level) to 240 feet, or 12 to 73 meters. The Project Area is located within the 'Ewa Plain, which is a Pleistocene (>38,000 years old) reef platform overlain by alluvium from the southern end of the Wai'anae Mountain Range. This alluvium supported commercial sugar cane cultivation for over a century.

In pre-contact Hawai'i the Project Area would have been mostly lowland dry shrub and grassland, dominated by species such as *wiliwili* (*Erythrina sandwicensis*), *lama* (*Diospyros ferrea*), sandalwood (*Santalum* sp.), *'a'ali'i* (*Dodonea eriocarpa*), scrub *'ōhi'a* (*Metrosideros collina*) and *pili* grass (*Heteropogon contortus*). Today in contrast, the non-cultivated portions of the Project Area are dominated by introduced species such as *kiawe* and *koa haole*. Understory plants include *'ilima ku kula* (*Sida cordifola*), cayenne vervain (*Stachytarpheta urticaefolia*), *ko'oko'olau* (*Bidens pilosa*), and morning glory (*Ipomoea indica*) (Moore and Kennedy 2002:3). The vast majority of the Project Area consists of plowed fields, with crops of pumpkins, squash, cucumbers, bananas, beans, and other vegetable products.

A total of ten soil series are found in the Project Area (Figure 4). The Ewa Series consists of well-drained soils in basins and on alluvial fans, developed in alluvium derived from basic igneous rock. They are nearly level to moderately sloping. These soils are used for sugarcane, truck crops, and pasture. The Helemano Series consists of well-drained soils on alluvial fans and colluvial slopes on the sides of gulches, which developed in alluvium and colluvium derived from basic igneous rock. They are steep to extremely steep. These soils are used for pasture, woodland, and wildlife habitat. The Honouliuli Series consists of well-drained soils on coastal plains; which developed in alluvium derived from basic igneous material. They are nearly level and gently sloping. These soils are used for sugarcane, truck crops, orchards, and pasture. The Kaloko Series consists of poorly drained soils on coastal plains which developed in alluvium derived from basic igneous rock; the alluvium has been deposited over marly lagoon deposits. The soils are nearly level. These soils are used for irrigated sugarcane and pasture. The Kawaihapai Series consists of well-drained soils in drainageways and on alluvial fans on the coastal plains. The soils formed in alluvium derived from basic igneous rock in humid uplands. These soils are used for sugarcane, truck crops, and pasture. The Keaau Series consists of poorly drained soils on coastal plains, which developed in alluvium deposited over reef limestone or consolidated coral sand. They are nearly level and gently sloping. These soils are used for sugarcane and pasture. The Kunia Series consists of well-drained soils on upland terraces and fans; the soils developed in old alluvium. They are nearly level to moderately sloping. These soils are used for sugarcane, pineapple, homesites, and military reservations. The Molokai Series consists of well-drained soils on uplands, formed in material weathered from basic igneous rock. They are nearly level to moderately steep. These soils are used for sugarcane, truck crops, orchards, and pasture. The Waipahū Series consists of well-drained soils on marine terraces, which developed in old alluvium derived from basic igneous rock. They are nearly level to moderately sloping. These soils are used for sugarcane and homesites (Foote et al. 1972).

2.3.2 Built Environment

During the post-contact period the Project Area was primarily used for pastureland and for sugar cane irrigation and cultivation. At present, the Project Area is currently used for diversified agricultural activities, pastureland, seed cultivation, etc.

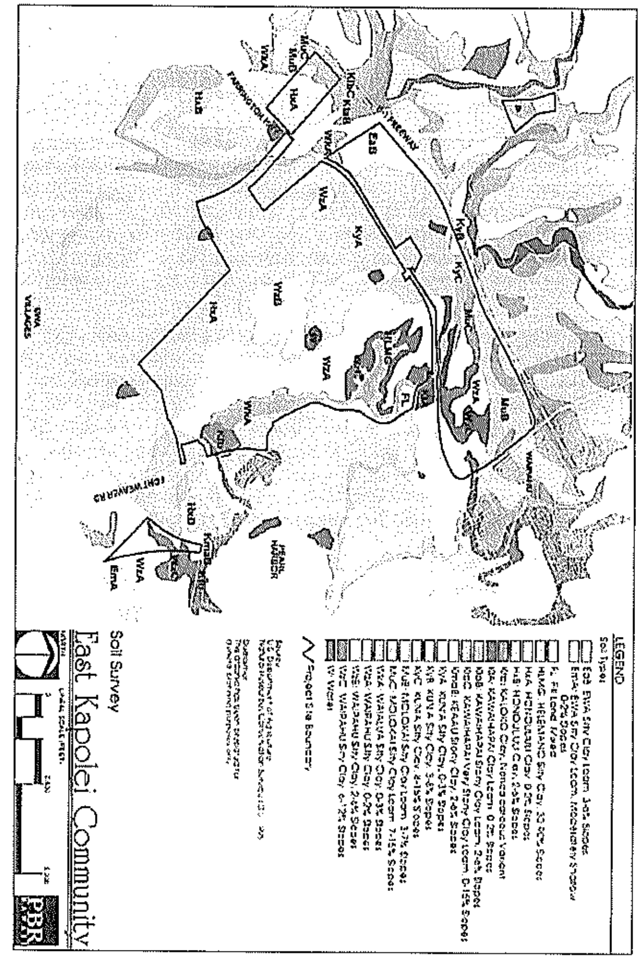

Figure 4. Soil Map of the Ho'opili Community Project Area

2.4 Methods

2.4.1 Documentary Research

CSH reviewed previous archaeological studies on file at the State Historic Preservation Division, CSH also reviewed geology and cultural history documents at Hamilton Library at the University of Hawai'i, the Hawai'i State Archives, the Mission House Museum Library, the Hawai'i Public Library, and the Archives of the Bishop Museum. Further research included a study of historic photographs at the Hawai'i State Archives and the Archives of the Bishop Museum, a study of historic maps at the Hawai'i State Archives and the Archives of the Bishop Museum, and a study of historic maps at the Survey Office of the Department of Accounting and General Services. Information regarding LCAs was obtained from Waihona 'Āina Corporation's Māhele Data Base (www.waihona.com).

2.4.2 Identification of Knowledgeable Informants

CSH consulted with various organizations and member of the community in order to identify *kūpuna* and other individuals with historic knowledge with respect to the Project Area and the surroundings. CSH consulted the Office of Hawaiian Affairs, the O'ahu Island Burial Council, 'Ahahui Siwila Hawai'i O Kapolei Hawaiian Civic Club, and the 'Ewa Neighborhood Board.

Based on recommendations from organizations and the community, the following individuals were contacted for information gathering sessions Arline Eaton, Richard Hirata, Richard Oshiro, Kenneth Soma, Charles Nakamatsu and many other talk story sessions (see Section 7 Community Consultation). These sessions were conducted in-person or by telephone.

Cultural anthropologist Kēhaulani Souza, B.A. conducted information gathering sessions under the general supervision of Hallett H. Hammatt, Ph.D. (Principal Investigator).

Section 3 Mythological and Traditional Accounts

The traditions of Honouliuli Ahupua'a have been compiled by several authors, in studies by Sterling and Summers (1978), Hammatt and Folk (1981), Kelly (1991), Charvet-Pond and Davis (1992), Maly (1992), and Tuggle and Tomonari-Tuggle (1997). Some of the traditional themes associated with this area include connections with Kahiki, the traditional homeland of Hawaiians in central Polynesia. There are several versions of the chief Kaha'i leaving from Kalaeloa for a trip to Kahiki; on his return to the Hawaiian Islands he brought back the first breadfruit (Kamakau 1991a:110) and planted it at Pu'uloa, near Pearl Harbor in 'Ewa (Beckwith 1940:97). Several stories associate places in Honouliuli to the gods Kāne and Kanaloa, with the Hawaiian pig god Kamapua'a and the Hina family, and with the sisters of Pele, the Hawaiian volcano goddess, all of who have strong connections with Kahiki (Kamakau 1991a:111; Pukui et al. 1974:200). The locations of traditional places names for Honouliuli are illustrated in Figure5.

3.1 The Naming of 'Ewa and Honouliuli

Honouliuli is the largest *ahupua'a* in the *moku* (district) of 'Ewa. One translation of the name for this district is given as "unequal" (*Saturday Press* Aug. 11, 1883). Others translate the word as "strayed" and associate it with the legends of the gods, Kāne and Kanaloa.

> When Kane and Kanaloa were surveying the islands they came to Oahu and when they reached Red Hill saw below them the broad plains of what is now Ewa. To mark boundaries of the land they would throw a stone and where the stone fell would be the boundary line. When they saw the beautiful land lying below them, it was their thought to include as much of the flat level land as possible. They hurled the stone as far as the Waianae range and it landed somewhere, in the Waimanalo section. When they went to find it, they could not locate the spot where it fell. So Ewa (strayed) became known by the name. The stone that strayed [Told to E.S. by Simeon Nawaa, March 22, 1954; cited in Sterling and Summers 1978:1].

Honouliuli means "dark water," "dark bay," or "blue harbor" and was named for the waters of Pearl Harbor (Jarrett 1930:22), which marks the eastern boundary of the *ahupua'a*. The Hawaiians called Pearl Harbor, Pu'uloa (*lit.* long hill). Another explanation for the names comes from the "Legend of Lepeamoa", the chicken-girl of Pālama. In this legend, Honouliuli is the name of the husband of the chiefess Kapālama and grandfather of Lepeamoa (Thrum 1923:164-184). "Her grandfather gave his name, Honouliuli to a land district west of Honolulu . . ." (Thrum 1923:170). Westervelt (1963:209) gives an almost identical account.

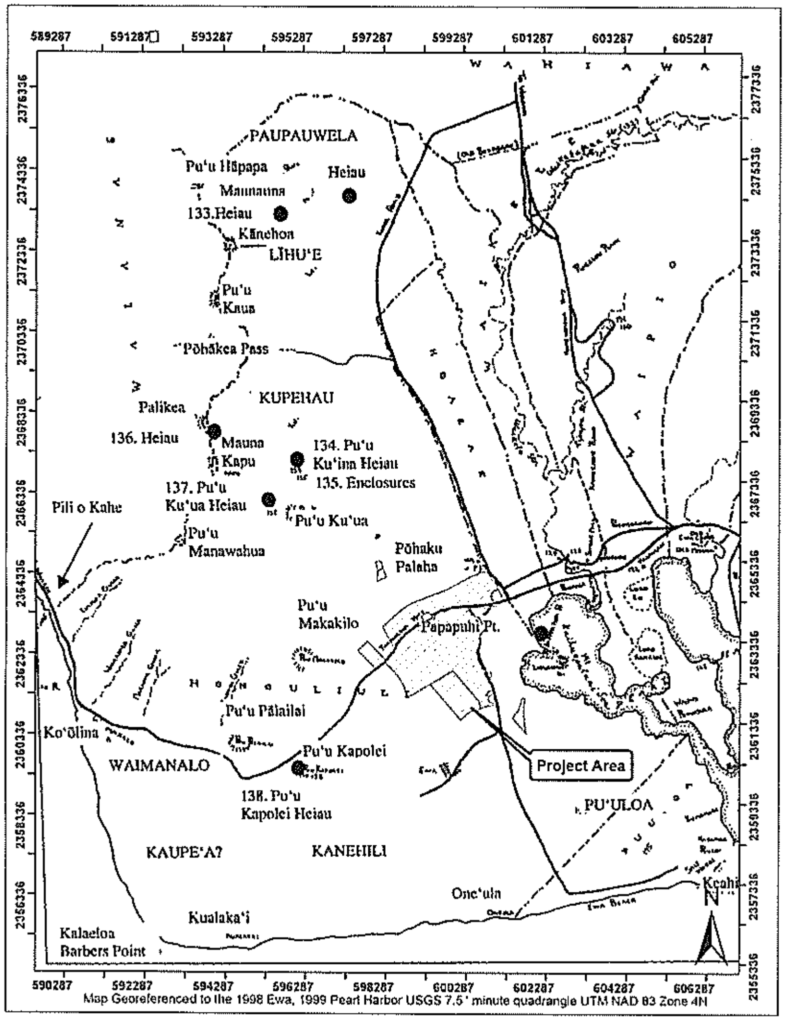

Figure 5. Place Names of Honouliuli (map adapted from Sterling and Summers 1978

It seems likely the boundaries of the western-most *ahupua'a* of 'Ewa were often contested with Wai'anae people. The 'Ewa people could cite divine sanction that the dividing point was between two hills at Pili o Kahe:

Eventually the stone was found at Pili o Kahe. This is a spot where two small hills of the Wai'anae Range come down parallel on the boundary between Honouliuli and Nānākuli ('Ewa and Wai'anae). The ancient Hawaiians said the hill on the 'Ewa side was the male and the hill on the Wai'anae side was female. The stone was found on the Waianae side hill and the place is known as Pili o Kahe.

> (Pili=cling to, Kahe=flow). The name refers, therefore, to the female or Waianae side hill. And that is where the boundary between the two districts runs [Told to E.S. by Simeon Nawaa, March 22, 1954; cited in Sterling and Summers 1978:1].

3.2 Legends and Place Name Meanings of the Upland Hills of Honouliuli

Honouliuli is divided from Wai'anae Ahupua'a on the west by a ridge with several prominent hills. From north (*mauka*) to south (*makai*) these peaks are: Hāpapa, which means "rock stratum (Pukui et al. 1974:42) or "shallow soil (Sterling and Summers 1978:1); Kānehoa (which will be discussed in more detail below); Pu'u Kaua, which means "war hill or fort hill" (Pukui et al. 1974:199); Palikea, which means "white cliff" (Pukui et al. 1974:177); Mount Kapu (meaning "tabu mountain"); and, Pu'u Manawahua, which means "great grief hill or nausea hill" (Pukui et al. 1974:203).

The central section of 'Ewa is divided by a series of northeast-southwest trending gulches that intermittently carry rainwater towards the coast. In this area there are several other notable hills; Pu'u Makakilo, which translates as "observing eyes hill" (Pukui et al. 1974:201); Pu'u Kapua'i, or "footprint hill" (Pukui et al. 1974:199); and, Pu'u Pālailai, probably meaning the young *lai* (*Scomberoides* sp.) fish (Pukui et al. 1974:205).

To the north (*mauka*) is Kānehoa, which can be translated as "companion of Kāne" (Pukui et al. 1974:84), "Kāne, the divine companion or friend," or Kāne, the divine fire-maker" (Westervelt 1999:64). This peak was named for a god (Kāne-hoa-lani), who was said to be the father of Pele (Emerson 1915:ix) in some versions, and the brother of Pele in others (Westervelt 1999:64). The hill Kānehoa is mentioned in the following hula chant.

Anklet Song	*Mele Ku-pe'e*
Fragrant the grasses of high Kanehoa.	*Aala kupukupu ka uka o Kane-hoa*
Bind on the anklets, bind!	*E ho-a!*
Bind with finger deft as the wind	*Hoa na lima o ka makani, he Wai- kaloa.*
That cools the air of this bower.	*He Wai-kaloa ka makani anu Lihue.*
Lehua blooms pale at my flower,	*Alina lehua i kau ka opua-*
O sweet heart of mine,	*Ku'u pua,*
Bud that I'd pluck and wear in my wreath.	*Ku'u puai'ini e ku-i a lei.*

If thou wert but a flower!	*Ina ia oe ke lei 'a mai la.*

[Emerson 1998:49]

A similar chant is found in the Legend of Pamano, which mentions the *kupukupu* (fern), a fragrant flowering shrub.

The uplands of Kanehoa are scented with kupukupu.
Bind on, the hands of the Waikoloa wind are binding,
The Waikoloa wind is the cold wind of Lihue,
Withering the branches in the uplands of Waiopua,
My flower I said I would string into garlands. If you have it,
You would have worn it.

Aala kupukupu ka uka o Kanehoa la!
Hoa! Hoa na lima o ka makani Waikoloa,
He Waikoloa ka makani anu, o Lihue,
Weli no loha ka uka o Waiopua la,
Kuu pua i i ai e kui e lei, I na ia oe ke lei ia ala

[Fornander 1919, Vol. V, Part 2:310-311].

3.2.1 Pōhākea Pass

Pōhākea Pass lies between the peaks of Pu'u Kaua and Palikea along the Wai'anae Mountain range. Pōhākea means "white stone" (Pukui et al. 1974:185).

3.2.1.1 Hi'iaka at the summit of Pōhākea Pass (Pele and Hi'iaka)

Pōhākea Pass was one of the resting places of Pele's sister, Hi'iaka, as she was returning from Kaua'i with Pele's lover Lohiau (Fornander 1918 Vol. V, Part 1:188 note 6). Hi'iaka elected to travel overland, while her companions traveled by canoe. A considerable number of *mele* (songs) and *pule* (prayers) are ascribed to Hi'iaka as she stood at the summit of Pōhākea (*Aluna au a Pōhākea, Kū au, nānā ia Puna . . .*) (Emerson 1915:162-168). From this vantage point Hi'iaka could see through her powers of vision that her beloved *lehua* groves and friend Hōpoe at Puna, Hawai'i Island had been blasted by Pele. She could also see that in her canoe, off the coast of Wai'anae, Lohiau was seducing her traveling companion Wahine'ōma'o.

3.2.1.2 Keahumoa, Residence of Māui's Grandfather

In the Legend of Māui's Flying Expedition (Thrum 1923:252-259) Māui-kupua looked toward Pōhākea Pass and saw his wife, Kumulama, being carried away by chief Peapeamakawalu. After failing to recover her, Māui returned and told his problems to his mother, Hina. Hina instructed her son to go to Keahumoa and visit his grandfather, Kuolokele, who lived there in a large hut. The hump-backed Kuolokele returned home with a load of potato leaves, and Māui cured him by striking him in the back with a stone (which Kuolokele threw to Waipahu, where it remains). Kuolokele had Māui gather *kī* leaves, *'ie'ie* vines and bird feathers, from which the old man fabricated a "bird-ship" (*moku-manu*), which Māui used to defeat Peapeamakawalu and recover his wife. They returned to Kuolokele's house, where they feasted, and Māui ate Peapeamakawalu's eyeballs.

3.2.1.3 The Frightened Populace of Honouliuli

In the Legend of Palila (Fornander 1918, Vol. V, Part 1:136-153), the *kupua*, or demigod hero, of Kaua'i landed at Ka'ena Point with his fabulous war club (*lā'au pālau*), which required eighty men to carry, and crossed into Honouliuli through Pōhākea Pass. He traveled by throwing his supernatural war club and hanging on to one end. The first throw was to Ka'ena Point, Oahu.

> After leaving Kaena he came to Kalena, then on to Pohakea, then to Maunauna, then to Kanehoa, then to the plain of Keahumoa and looking toward Ewa. At this place he stood and looked at the dust as it ascended into the sky caused by the people who had gathered there; he then pushed his war club toward Honouliuli.
>
> *Haalele keia ia Kaena, hele mai la a Kalena, a Pohakea, maunauna, kanehoa, a ke kula o Keahumoa, nana ia Ewa. Ku keia I laila nana I ke ku a ka ea o ka lepo I na kanaka, e pahu aku ana keia I ka laau palau aia nei I kai o Honouliuli. . . .*
> [Fornander 1918, Vol. V, Part I:142-143]

He descended to the plain of Keahumoa:

> At this place he stood and looked at the dust as it ascended to the sky caused by the people who had gathered there; he then pushed his war club toward Honouliuli. When the people heard something roar like an earthquake they were afraid and they all ran to Waikele . . .
>
> *Kū kēia i laila nānā i ke kū ka ea o ka lepo i nā kānaka, e pahu aku ana kēia i ka lā'au pālau aia nei i kai o Honouliuli, kū ka ea o ka lepo o ka honua, me he ōla'i la, maka'u nā kānaka holo a hiki i Waikele.*
> [Fornander 1918, Vol. V, Part I:142-143]

3.2.1.4 Kahalaopuna at Pōhākea Pass

One of the most popular legends of O'ahu is that of Kahalaopuna (or Kaha), a young woman of Mānoa who was slandered by others and then killed by her betrothed, Kauhi, a chief from Ko'olau. While the numerous accounts (Day 1906:1-11, Fornander 1918 Vol. V, Part 1:188-193, Kalākaua 1888:511-522, Nakuina 1904:41-45, Patton 1932:41-49, Skinner 1971:220-223, Thrum 1907:118-132, Westervelt 1987 127-137, Westervelt 1998:84-93) vary in details, they typically have Kahalaopuna slain and then revived repeatedly with the aid of a protective owl. Kauhi forced her to hike west from Mānoa through the uplands until they got to Pōhākea Pass through the southern Wai'anae Range in north Honouliuli. At Pōhākea Pass, Kauhi beat her with a stick until she was dead (*Ia hahau ana a Kauhi i ka lā'au, make loa o Kahalaopuna*). Her spirit (*'uhane*) flew up into a *lehua* tree and chanted for someone to go notify her parents:

E hai aku oukou ua make o Kahalaopuna;	And tell them that Kahalaopuna is dead
Aia la i ka uka o Pohakea,	For she lies in the uplands of Pohakea
I ke kumu lehua la o lalo iho.	Beneath the lehua tree.

[Fornander 1918, Vol. V, part 1:192

Upon hearing the news, her parents fetched Kahalaopuna back to Mānoa, and she was restored.

3.2.2 Paupauwela and Līhu'e

Paupauwela, also spelled Popouwela (derivation unknown), is the name of the land area in the extreme *mauka* section of Honouliuli *Ahupua'a*. The land area of Līhu'e is just *makai* of this land, and extends into the *ahupua'a* of Waipi'o (adjacent to the eastern border of Honouliuli). Both place names are mentioned in a chant recorded by Abraham Fornander, which was composed as a *mele* for the O'ahu king, Kūali'i, as he was preparing to battle Kuiaia, the chief of Wai'anae:

Where? Where is the battle field	*Ihea, ihea la ke kahua,*
Where the warrior is to fight?	*Paio ai o ke koa-a?*
On the field of Kalena, I	*kai i kahua i Kalena,*
At Manini, at Hanini,	*I Manini, i Hanini*
Where was poured the water of the god	*I ninia i ka wai akua,*
By your work at Malamanui;	*I ko hana i Malamanui*
On the heights of Kapapa, at Paupauwela,	*Ka luna o Kapapa, i Paupauwela,*
Where they lean and rest;	*I ka hilinai i ke kalele,*
At the hala trees of indolent Halahalanui,	*Ka hala o Halahalanui maauea,*
At the ohia grove of Pule-e	*E kula ohia ke Pule-e,*
The god of Lono, of Makalii	*Ke 'kua o Lono o Makalii*
Thr fragrant branch of the Ukulonoku,	*Ka lala aalao Ukulonoku,*
Mayhap from Kona, from Lihue,	*No Kona paha, no Lihue.*
For the day at Maunauna	*No ka la i Maunauna,*
For the water at Paupauwela.	*No ka wai i Paupauwela.*

[Fornander 1917, Vol. IV, Part 2:384-386].

Red is the water of Paupauwela,	*Ula ka wai i Paupauwela,*
From the slain at Malamani,	*Ke kilau o Malamani,*
The slain on the ridge at Kapapa.	*Ka moo kilau I Kapapa.*

The derivation of the place name Līhu'e (meaning "cold chill") is illustrated in the following poem; all other places names mentioned in this poem are in Waipio:

The icy wind of Lihue plied its spurs,
Pulling up the bridle of Haleauau,
Speeding headlong over Kalena
And running over the plain of Kanoenoe

[*Ka Loea Kālai'āina*, July 22, 1899, translated in Sterling and Summers 1978:21].

This explains the meaning of a Hawaiian saying "*Hao na kēpā o Līhu'e i ke anu.* The spurs of Līhu'e dig in with cold" [Pukui 1983:#479].

The icy winds of Honouliuli are also noted in a *mele* for the high king Kūali'i. In this *mele*, the cold winds of Kumomoku and Leleiwe, near Pu'uloa in Honouliuli are compared unfavorably to the god Kū.

Not like these are thou,	*Ku Aole i like Ku.*
[Nor] the rain that brings the land breeze,	*Ia ua hoohali kehau,*
Like a vessel of water poured out.	*Mehe ipu wai ninia la,*
Nor to the mountain breeze of Kumomoku,	*Na hau o Kumomoku;*
[The] land breeze coming round to Leleiwi.	*Kekee na hau o Leleiwi,*
Truly, have you not known?	*Oi ole ka oe i ike*
The mountain breezes, that double up your back,	*I ka hau kuapuu.*
[That make you] sit crooked and cramped at Kaimohala,	*Kekee noho kee, o Kaimohala,*
The Kanehili at Kaupea?	*O Kanehili i Kaupea-la*
Not like these are thou, Ku.	*Aole i like Ku.*

[Fornander 1917, Vol. IV, Part II:390-391]

In the Legend of Halemano (Fornander 1919, Vol. V, Part II:252), the romantic O'ahu anti-hero chanted a love song with a reference to the winds of Līhu'e:

Search is made to the top of Ka'ala,	*Huli a'e la Ka'ala kau i luna,*
The lower end of Pōka'ī is plainly seen.	*Waiho wale kai o Pōka'ī,*
Love looks in from Honouliuli,	*Nānā wale ke aloha i Honouliuli,*
The dew comes creeping, it is like the wind of Līhu'e...	*Kokolo kēhau he makani no Līhu'e.*

The wind of Lihu'e and others in the region are also named by Moses K. Nakuina, as follows:

Moa'e-kū is of 'Ewaloa
Kēhau is of Waiopua
Waikōloa is of Līhu'e
Kona is of Pu'uokapolei
Maunuunu is of Pu'uloa

[Nakuina 1992:43]

The *ali'i* (chiefly class) were closely associated with Līhu'e, which had habitation areas and playing grounds set aside for their sports.

> Lolale was the father and Keleanohoapiapi the mother of Ka-lo-kaholi-a-Lale. He was born in the land of Lihue and there he was reared into manhood. He excelled in good looks and greatly resembled his mother.
>
> In the olden days the favorite occupation of Lihue chiefs was spear throwing and the best instructors hailed from this locality [*Ka Nūpepa Kū'oko'a*, Aug. 26, 1865, translation in Sterling and Summers 1978:23].

Līhu'e was also the home of a famous cannibal king-man, Kaupe, who overthrew the ruling chiefs to become the paramount power between Nu'uanu and the sea. He had a home and a *heiau* in Līhu'e. Kaupe was a *kapua*, a supernatural being who could take the form of a man or a dog; this type of dog man was known as an *'ōlohe*. Although he left the O'ahu *ali'i* alone, he killed many commoners in the area, and eventually sailed to the island of Hawai'i on a raid, where he captured a chief's son; he planned to sacrifice this boy at his *heiau* in Līhu'e. The father came to O'ahu, and with the help of the priests of the Hawaiian hero, Kahanaiakeakua, was able to free his son, escape back to Hawai'i, and eventually kill the dog-man, Kaupe (Westervelt 1963:90-96).

3.2.3 Hill of Maunauna

The hill Maunauna lies between the lands Paupauwela and Līhu'e. It was at Maunauna, according to one tradition, that the forces of the chiefs of Kūali'i and Kuiaia of Waianae met to do battle, but was averted when a *mele* honoring the god Kū was chanted (see previous section). (Fornander 1917, Vol IV, Part 2:348). In the Legend of Ke-ao-melemele, a woman named Paliuli traveled in this area.

> In a very short time she [Paliuli] walked over the plain of Ewa; Ewa that is known as the land of the silent fish [pearl oysters] . . . She went on to the plain of Punalu'u and turned to gaze at Maunauna point and the plain of Lihue [Manu 1885, translation in Sterling and Summers 1978:21].

According to the surveyor W. D. Alexander (1903:367-425), Maunauna means "waste."

Certain place names in the uplands, including Maunauna, are also mentioned in the story of Lo-lae's Lament. The place of Lolale's residence is given in King Kalākaua's version of this story. According to him (Kalākaua 1990:232): "There lived there at that time in Lihue, in the district of Ewa, on the island of Oahu, a chief named Lo-lale, son of Kalona-iki, and brother of Piliwale, the *alii-nui*, or nominal sovereign, of the island, whose court was established at Waialua."

In this story, Lolale was a chief of O'ahu who asked his friend Kalamakua to find him a bride (Kalākaua 1990:228-246; Skinner 1971:217-219). Kalamakua traveled to Maui and chose Kelea, the chief's sister, and returned with her to O'ahu; during this time the two grew close. Kelea lived with Lolale for a while, but he was a silent type that was often away from home playing sports and walking in the woodlands. Longing for Kalamakua, Kelea decided to leave her husband, Lolale voiced no "spoken bitterness;" however, after she left, he sang this lament:

Farewell, my partner of the lowland plains,
On the waters of Pohakeo, above Kanehoa,
On the dark mountain spur of Mauna-una!
O, Lihue, she is gone!
Sniff the sweet scent of the grass,
The sweet scent of the wild vines
That are twisted by Waikoloa,
By the winds of Waiopua,
My flower!

As if a mote were in my eye.
The pupil of my eye is troubled.
Dimness covers my eyes. Woe is me!

[Kalākaua 1990:244-245].

3.2.4 Pu'u Ku'ua

Makai of the land of Lihu'e was the land of Kupehau, which was itself *mauka* of Pu'u Ku'ua. Divine sanction was also given to social stratification and the designation of a land for *kauwā* (outcastes, pariahs), a low, slave caste of Hawai'i, in the vicinity of Pu'u Ku'ua:

> . . . If you are above Puuloa, you wil see Pu'u-o-Kapolei, a small hill. Lying below and back of that hill is the government road going to Waianae. Above that is also a small hill and back of that, is a big hill and above it is a large hollow. That is Pu'u-Kuua where the very dirty ones lived [*Ka Loea Kālai'āina* July 15, 1899, translation in Sterling and Summers 1978:32].

The creation of the *kauwā* class is told in a tradition of the gods Kāne and Kanaloa:

> *A penei na'e i kauwā loa [sic. "loa'a"] ai. Aia a mana'o ke Ali'i Nui (Mō'ī) e 'au'au kai i Waikīkī. Eia ka nīnau a ke Ali'i Nui i ke ali'i ma lalo iho ona, "Pehea āu mau wahi lepo kanu o Pu'u Ku'ua? 'A'ole paha he mau wahi pōhuli?" Eia ka pane a ke ali'i ma lalo iho ona, "He Pōhuli nō. 'O ke kauoha ia akula nō ia e ki'i. 'Oiai ko kāne me ka wahine e nanea ana me nā keiki, a hiki 'ana ke ki'i i mau keiki. 'O ke kū a'ela nō ia o ka makuakāne a lawe 'ana i kāna mau keiki a hiki i Waikīkī. Aia ho'i a hiki i ka wā a ke Ali'i e hele ai i ka 'au'au kai, a laila, hoouna 'ia mai ke kahu e ki'i mai i ua keiki a lawe aku ia ma kahi pāpa'u o ke kai, ma kahi a ke Ali'i nui e hele kū 'ana, a laila kau nā lima o ka Mō'ī i luna o kahi keiki a me kahi keiki, ma nā 'ā'ī o nā keiki a pa'a ai. 'O ka hua 'ōlelo ma ka waha o ke Ali'i nui e 'ōlelo ai, "'A'ole pau ku'u loa! 'A'ole pau ku'u loa!" 'Oiai 'o ia e 'au ana me ka pa'a nō o nā lima i nā keiki a hiki i ka umauma ke kai o ke ali'i. Ua lana a'ela nā keiki i luna o ka 'ilikai, aia ke alo i lalo. Eia ho'i ka 'ōlelo a ka makuakāne ma kula aku nei, "Moe mālie i ke kai o ko Haku," a pēlā aku.*
>
> *'O ke kai o Waikīkī ke kai i 'ōlelo 'ia he kai lumaluma'i kanaka o ka lua, aia i Kualoa* [*Ka Loea Kālai'āina*, July 8, 1899].
>
> Translation:
>
> The chiefs of old, who lived at that time, were of divine descent. The two gods [Kāne and Kanaloa] looked down on the hollow [vicinity of Pu'u Ku'ua] and saw how thickly populated it was. The mode of living here was so that chiefs and commoners mixed freely and they were so like the lowest of people (*kauwā*). That is what these gods said and that was the time when the term *kauwā* was first used, and was used for many years afterwards. . . . This was how they were made to be *kauwā*. When the ruling chief wished to go to Waikīkī for sea bathing he asked the chief just below him in rank, "How are my planting places at Pu'u Ku'ua,

have they not produced young suckers?" The chief next to him answered, "There are some suckers," and sent someone for them. When the men, women and children least expected it, the messenger came to get some of the children. The father stood up and took his sons to Waikīkī. Then, when the ruling chief went sea bathing, he sent an attendant to get the boys and take them to a shallow place where the ruling chief would come. Then the ruler placed a hand on each of the boys, holding them by the necks. The words he uttered were, "My height has not been reached! My height has not been reached!" He advanced and held onto the boys until the sea was up to his chest. The boys floated on the water face down. The father on shore called out, "Lie still in the sea of your Lord," and so on.

The Sea of Waikīkī is said to have been used to kill men in and the other place is Kualoa. The inhabitants of Pu'u-Kuua were so mixed, like taro beside an imu [translation in Sterling and Summers 1978:32-33].

A Hawaiian saying concerning 'Ewa suggests that this drowning also took place in this *ahupua'a*.

'Ewa of the drowning sea *'Ewa kai lumaluma'i*

An epithet applied to 'Ewa, where *kauwā* were drowned prior to offering their bodies in sacrifice [Pukui 1983:#385].

On Hi'iaka's journey as she leaves 'Ewa and descends to the coast, she sees some women stringing *lei* and offered a chant, naming several place names in the area:

Rising in the presence of the cliff of Pu'uku'ua	*Ke ku no i ke alo o pali o Pu'uku'ua*
The land is indeed a chief	*He ali'i nona'e ka 'āina*
Man is indeed a slave	*He kauwā no na'e kanaka*
I am indeed a slave to aloha – love	*I kauwā no na'e wau i ke aloha*

[*Ka hōkū o Hawai'i* February 22, 1927, translation in Maly 1997:17]

The great fisherman, Nihookeki, was born in Keauhou, Kona, but traveled to O'ahu and lived in Wai'anae and became a great chief. Fornander (1917, Vol. IV, Part 3:488) places his home at Pu'u ku'ua, in Pu'u o Kapolei in Wai'anae, possibly during one of the times that both Wai'anae and 'Ewa were ruled by one chief.

O Keauhou, i Kona, Hawaii, ka aina hanau o Nihooleki, a malaila mai ka hele ana a noho i Kuukuua, i Puuokapolei ma Waianae, no laila ka wahine.

Keauhou in Kona, Hawaii, was the birthplace of Nihooleki and it was from this place that he moved to Kuukuua, in Puuokapolei at Waianae, where he took unto himself a wife [Fornander 1917, Vol. IV, Part 3:488-489].

Keahaikiaholeha, the paramount chief of Wai'anae, owned a famous mother-of-pearl fishhook, called Pahuhu, which he used to catch many *aku* (bonito, *Katsuwonus pelamis*). He later sailed to Waimea, Kaua'i, where his wife had been born, and there also became the ruling

chief of Kaua'i. When Keahaikiaholeha died, his body was brought back to Kuukuua and placed in a *pu'āo* (*A make o Kaehaikiaholeha, hoihoi ia mai a Kuukuua, i Waianae, waiho ia kona kino kupapau; i loko o ka hale, puoa . . .*). A *pu'āo* is an open, small, temporary cone-shaped structure, of poles; in this case, this *pu'āo* was used as his tomb. The parents of the chief worshiped the spirit ('*uhane*) of their son, until it became strong enough to go about in the form of a live person. The spirit took the name of Nihooleki, traveled to Kaua'i, and married his wife, although she was unaware that this was the spirit of her dead husband. Nihooleki used his magic fishhook to catch canoes full of *aku* until it became the wonder of the islands. The piles of fish that he caught and gave away came to the ears of Kamapua'a, who was then living at Waiohuli, sick with dropsy.

Nihooleki told his wife that if a man with dropsy came to the door, to ask him in because he was a friend. But when Kamapua'a arrived, the wife would not let him in since he was so dirty. Kamapua'a had to wait in the pig pen for the return of his friend. Nihooleki was angry about the treatment of his friend when he returned and left the island with Kamapua'a.

Lohe aku la na 'lii, a me na kaikoeke, o ke 'lii no keia, alualu mai la lakou, luu laua nei i ke kai, a ea ana i Kuukuua, ma Waianae. . . .

A kokoke laua i ka hale o na mauka a me ke kaikuahine, a e ku ana hoi ka puoa hale o ke kino kupapau ona. ". . . A o ke kaikuahine o kaua, o kau wahine no ia, no ka mea, he wahine maikai, ua nui no ke kino."

O Kaehaikiaholeha, oia o Nihooleki, komo aku la ia i kona puoa kupapau a nalo iho la, oia ka pau o kona kaao ana.

He [Nihooleki] and his friend [Kamapua'a] then dove into the sea and swam under water until they came up at Kuukuua, at Waianae. . .. As they drew near to the house where the parents and sister of Nihooleki were living and near to the tomb where his dead body was laid, Nihooleki then turned to his friend. " . . . Take our sister and make her your wife as she is fair to look upon and is also of proper age." . . . Keahaikiaholeha, who was Nihooleki, entered the tomb and disappeared. Thus ends the story [Fornander 1917, Vol. IV, Part 3:496].

This legend suggests associations with Pu'u ku'ua to Pu'uokapolei , worship of the dead, and wandering souls, all of which are prominent themes associated with Pu'u Kapolei, as seen in the next section. It also ties the pig god Kamapua'a to Pu'uokapolei in 'Ewa.

3.3 Pu'uokapolei and the Plains of Kaupe'a

Pu'uokapolei is a prominent hill at the *mauka* edge of the coastal 'Ewa Plains and was the primary landmark for travelers on the trail that ran from Pearl Harbor west to Wai'anae ('Ī'ī 1959:27, 29; Nakuina 1992:54; E.M. Nakuina 1904, in Sterling and Summers 1978:34).

3.3.1 Pu'uokapolei , Astronomical Marker and Heiau

Pu'u means hill and Kapolei means "beloved Kapo," a reference to the sister of the Hawaiian volcano goddess, Pele. Samuel Kamakau (1976:14) says that ancient Hawaiians used Pu'u o

Kapolei as an astronomical marker to designate the seasons. Samuel Kamakau (1870 *Mo'olelo Hawai'i* Vol. I, Chap. 2, p. 23) relates:

> . . . the people of O'ahu reckoned from the time when the sun set over Pu'uokapolei until it set in the hollow of Mahinaona and called this period Kau [summer], and when it moved south again from Pu'uokapolei and it grew cold and the time came when young sprouts started, the season was called from their germination (*'ōilo*) the season of Ho'oilo [winter, rainy, season].

A *heiau* was once on Pu'u o Kapolei, but had been destroyed by McAllister's (1933:108) survey of the island in the early 1930s. The hill was used as a point of solar reference or as an observation place for such observations (Fornander 1919, Vol. VI, Part 2:292). Pu'uokapolei may have been regarded as the gate of the setting sun, just as the eastern gate of Kumukahi in Puna is regarded as the rising sun; both places are associated with the Hawaiian goddess Kapo (Emerson 1915:41). This somewhat contradicts some Hawaiian cosmologies, in which Kū was the god of the rising sun, and Hina, the mother of Kamapua'a was associated with the setting sun. Fornander (Fornander 1919, Vol. VI, Part 2:292) states that Pu'uokapolei may have been a jumping off place (also connected with the setting sun) and associated with the wandering souls who roamed the plains of Kaupe'a and Kāne-hili, *makai* of the hill.

3.3.2 Pu'uokapolei and the Plains of Kaupe'a and Kāne-hili

Hi'iaka sang this bitter chant addressed to Lohiau and Wahine-oma'o, which uses the association of the Plains of Kaupe'a as a place for the wandering of lost souls:

Ku'u aikana i ke awa lau o Pu'uloa,
Mai ke kula o Pe'e-kaua, ke noho oe,
E noho kaua e kui, e lei i ka pua o ke kauno'a,
I ka pua o ke akuli-kuli, o ka wili-wili;
O ka iho'na o Kau-pe'e i Kane-hili,
Ua hili au; akahi no ka hili o ka la pomaika'i;
E Lohiau ipo, e Wahine-oma'o,
Hoe 'a mai ka wa'a i a'e aku au.

We meet at Ewa's leaf-shaped lagoon, friends;
Let us sit, if you will on this lea
And bedeck us with wreaths of Kauno'a,
Of akuli-kuli and wili-wili,
My soul went astray in this solitude;
It lost the track for once, in spite of luck,
As I came down the road to Kau-pe'a.
No nightmare dream was that which tricked my soul.
This way, dear friends; turn the canoe this way;
Paddle hither and let me embark

[Emerson 1915:162-163].

Several other Honouliuli places are mentioned in this chant, including Pe'e-kaua, which may be a variation of Kau-pe'e or Kaupe'a, and the plains of Kānehili, the last of which again refers to wandering, as the word *hili* means "to go astray" (Emerson 1915:162). In the chant, Hi'iaka is moving downhill from Kaupe'a, probably the plains adjacent to Pu'uokapolei , toward the coast, the plain of Kānehili.

3.3.3 The plains of Kaupe'a and Pu'uokapolei and the Realm of Homeless Souls

There are several places on the 'Ewa coastal plain that are associated with *ao kuewa*, the realm of the homeless souls. Samuel Kamakau (1991b:47-49) explains the Hawaiian beliefs in the afterlife:

> . . . There were three realms (*ao*) for the spirits of the dead. . . There were, first, the realm of the homeless souls, the *ao kuewa*; second, the realm of the ancestral spirits, the *ao 'aumakua*; and third, the ream of Milu, *ke ao o Milu* . . .
>
> The *ao kuewa*, the realm of homeless souls, was also called the *ao 'auwana*, the realm of wandering souls. When a man who had no rightful place in the *'aumakua* realm (*kanaka kuleana 'ole*) died, his soul would wander about and stray amongst the underbrush on the plain of Kama'oma'o on Maui, or in the *wiliwili* grove of Kaupe'a on Oahu. If his soul came to Leilono [in Halawa, 'Ewa near Red Hill], there he would find the breadfruit tree of Leiwalo, *ka'ulu o Leiwalo*. If it was not found by an *'aumakua* soul who knew it (*i ma'a mau iaia*), or one who would help it, the soul would leap upon the decayed branch of the breadfruit tree and fall down into endless night, *the pō pau 'olo o Milu*. Or, a soul that had no rightful place in the *'aumakua* realm, or who had no relative or friend (*makamaka*) there who would watch out for it and welcome it, would slip over the flat lands like a wind, until it came to a leaping place of souls, a *leina a ka 'uhane*. . . [Kamakau 1991b:47].
>
> On the plain of Kaupe'a beside Pu'uloa [Pearl Harbor], wandering souls could go to catch moths (*pulelehua*) and spiders (*nanana*). However, wandering souls could not go far in the places mentioned earlier before they would be found catching spiders by 'aumakua souls, and be helped to escape. . . . [Kamakau 1991b:49].

The breadfruit tree Leilono was said to have been located on the 'Ewa-Kona border, above Āliamanu. In another section of his account of the dead, Kamakau calls the plain of wandering souls the "plain at Pu'uokapolei."

> There are many who have died and have returned to say that they had no claim to an 'aumakua [realm] (*kuleana'ole*). These are the souls, it is said, who only wander upon the plain of Kama'oma'o on Maui or on the plain at Pu'uokapolei on Oahu. Spiders and moths are their food [Kamakau 1991b:29].

This association of Pu'uokapolei and Kanehili with wandering souls is also illustrated in a lament on the death of Kahahana, the paramount chief of O'ahu, who was killed by his father, Kahekili, after Kahahana became treacherous and killed the high priest Kaopulupulu.

Go carefully lest you fall dead in the sun,	*E newa ai o hea make i ka la,*
The god that dwells on Kapolei hill.	*Akua noho la i Puuokapolei.*
The sun is wailing on account of the women of Kamao,	*E hanehane mai ana ka la i na wahine o Kamao,*
A hiding god, blossoming ohai of the banks,	*Akua pee, pua ohai o ke kaha,*
Contented among the stones-	*I walea wale i ke a-*
Among the breadfruit planted by Kahai.	*I ka ulu kanu a Kahai.*
Thou wast spoken of by the oo-	*Haina oe e ka oo-*
By the bird of Kanehili.	*E ka manu o Kanehili.*

[Fornander 1919, Vol. VI, Part 2:297]

Fornander provides some notes on this lament. The god dwelling at Kapolei is the god Kahahana, stating that this is where his soul has gone. Kamao is one of the names of the door to the underworld. This lament draws an association with wandering souls and the place where the first breadfruit tree was planted by Kahai at Pu'uloa (Fornander 1919, Vol. VI, Part 2:304).

Pukui (1983:180) offers this Hawaiian saying, which places the wandering souls in a *wiliwili* grove at Kaupe'a.

The wiliwili grove of Kaupe'a   *Ka wiliwili of Kaupe'a.*
In 'Ewa, O'ahu. Said to be where homeless ghosts wander among the trees.

[Pukui 1983:#1666].

Beckwith (1940:154) has stressed that "the worst fate that could befall a soul was to be abandoned by its '*aumakua* and left to stray, a wandering spirit (*kuewa*) in some barren and desolate place." These wandering spirits were often malicious, so the places that they wandered were avoided.

3.3.4 The Plain of Pukaua

The Hawaiian language newspaper *Ka Loea Kālai'āina*, (January 13, 1900) relates that near Pu'uokapolei , on the plain of Pukaua, on the *mauka* side of the road, there was a large rock. This legend suggests that the plain around Pu'uokapolei was called Pukaua. The legend is as follows:

> If a traveler should go by the government road to Waianae, after leaving the village of gold, Honouliuli, he will first come to the plain of Puu-ainako and when that is passed, Ke-one-ae. Then there is a straight climb up to Puu-o-Kapolei and there look seaward from the government road to a small hill, That is Puu-o-Kapolei. . . . You go down some small inclines, then to a plain. This plain is Pukaua and on the mauka side of the road, you will see a large rock standing on the plain. . . . There were two supernatural old women or rather peculiar women with strange powers and Puukaua belonged to them. While they were down

> fishing at Kualaka'i [near BarbersPoint] in the evening, they caught these things, *'a'ama* crabs, *pipipi* shellfish, and whatever they could get with their hands. As they were returning to the plain from the shore and thinking of getting home while it was yet dark, they failed for they met a one-eyed person [bad omen]. It became light as they came near to the plain, so that passing people were distinguishable. They were still below the road and became frightened lest they be seen by men. They began to run - running, leaping, falling, sprawling, rising up and running on, without a thought of the *'a'ama* crabs and seaweeds that dropped on the way, so long as they would reach the upper side of the road. They did not go far for by then it was broad daylight. One woman said to the other, "Let us hide lest people see us," and so they hid. Their bodies turned into stone and that is one of the famous things on this plain to this day, the stone body. This is the end of these strange women. When one visits the plain, it will do no harm to glance on the upper side of the road and see them standing on the plain [*Ka Loea Kālai'āina*, January 13, 1900, translation in Sterling and Summers 1978:39].

In another version of this story, the two women met Hi'iaka as she journeyed toward the 'Ewa coast. The women were *mo'o* (supernatural beings) and were afraid that Hi'iaka would kill them, so they changed into their lizard form. One of the lizards hid in a little space on a stone beside the coastal trail, and the other hid nearby (*Ka Hōkū o Hawai'i*, February 15, 1927, translated in Maly 1997:19). From that time on the stone was known as *pe'e-kāua*, meaning "we two hidden." Hi'iaka greeted the two women but did not harm them, and passed on.

When she reached Pu'uokapolei , she also greeted two old women who lived at an '*ohai* grove on the hill. These women were named Pu'uokapolei and Nāwaineokama'oma'o (*Ka Hōkū o Hawai'i*, February 22, 1927, translated in Maly 1997:19). As she continued her travels, she looked to the ocean and saw the canoe carrying Lohi'au.

My man on the many harbored sea of Pu'uloa	*Ku'u kāne i ke awa lau o Pu'uloa*
As seen from the plain of Pe'ekāua	*Mai ke kula o Pe'ekāua ke noho*
Let us dwell upon the 'ōhai covered shore	*E noho kāua i ke kaha o ka 'ōhai*
Where the noni blossoms are twisted together	*I ka wiliwili i ka pua o ka lau noni*
Descending along Kānehili	*O ka ihona i Kānehili la*
I am winding along	*Ua hili ho'i au-e*

[*Ka Hōkū o Hawai'i*, February 22, 1927, translated in Maly 1997:20].

3.3.5 Pu'uokapolei and Kamapua'a

Pu'uokapolei was the home of Kamapua'a's grandmother, Kamaunuaniho, who was one of the three migrants from Kahiki that were ancestors to the people of O'ahu (Fornander 1919, Vol. V, Part 2:318; Kahiolo 1978:81, 107). Kamapua'a, the Hawaiian pig god once lived in Kaluanui on the windward side, but escaped to 'Ewa when he was pursued by the chief Olopana.

> Kamapua'a subsequently conquered most of the island of O'ahu, and, installing his grandmother [Kamaunuaniho] as queen, took her to Pu'uokapolei, the lesser of the two hillocks forming the southeastern spur of the Wai'anae Mountain Range, and made her establish her court there. This was to compel the people who were to pay tribute to bring all the necessities of life from a distance, to show his absolute power over all [Nakuina 1904:50-51].

Emma Nakuina goes on to note: "A very short time ago [prior to 1904] the foundations of Kamaunuaniho's house could still be seen at Pu'uokapolei." Another account (*Ka Loea Kālai'āina* January 13, 1900, from Sterling and Summers 1978:34) speaks of Kekeleaiku, the older brother of Kamapua'a, who also lived on Pu'uokapolei .

3.3.6 The Strife at Honouliuli; Kūali'i unites Hawai'i *nei* (*Mo'olelo o Kūali'i*)

The celebrated chief, Kūali'i, is said to have led an army of twelve thousand (*'ekolu mano*) against the chiefs of Ko'olauloa with an army of twelve hundred (*'ekolu lau*) upon the plains of Keahumoa (Fornander 1917 Vol. IV, Part 2:364-401). Perhaps because the odds were so skewed the battle was called off and the *ali'i* of Ko'olau ceded (*ha'awi a'e*) the districts of Ko'olauloa, Ko'olaupoko, Waialua and Wai'anae to Kūali'i. When the *ali'i* of Kaua'i heard of this victory at Honouliuli they gave Kaua'i to Kūali'i as well and thus he became possessed of all the islands (*a lilo a'e la nā moku a pau ia Kūali'i mai Hawai'i a Ni'ihau*). The strife at Honouliuli was the occasion of the recitation of a song for Kūali'i by a certain Kapa'ahulani (*Ka Pule Ana a Kapa'ahulani*). This *mele* compares the king to certain places and objects in the islands, in this instance to the first breadfruit planted by Kahai at Pu'uloa, and a pig and a woman on Pu'uokapolei, possibly a reference to Kamapua'a and his grandmother.

Not like these art thou, Ku.	*Aole I like Ku.*
Not like the pig	*Aole I like i ka puaa,*
Discerning the progeny of the god;	*I ka weke lao a ke akua,*
[Or] The breadfruit planted by Kahai.	*Ka ulu kanu a Kahai;*
Truly, have you not known	*Oi ole ka oe i ike,*
The woman with the dyed garment,	*Ka wahine pau mao*
On the top of Puuokapolei?	*I ka luna o Puuokapolei-la?*

[Fornander 1917, Vol. IV, Part 2:392-393].

A later section of this *mele* also refers to Pu'uokapolei and makes mention of the famous blue poi of Honouliuli.

O Kawelo! Say, Kawelo!	*O Kawelo-e, e Kawelo-e,*
Kawelokiki, the sharp-pointed hill,	*O Kaweloiki puu oioi,*
Hill of Kapolei.	*Puu of Kapolei-e-*
Blue is the poi which appeases [the hunger] of Honouliuli.	*Uliuli ka poi e piha nei-o Honouliuli;*

[Fornander 1917, Vol. IV, Part 2:400-401].

3.4 Pearl Harbor (Pu'uloa) and West Loch (Kaihu o pala'ai)

3.4.1 The "Silent Fish" of Pearl Harbor

Pearl Harbor was called Pu'uloa or *ke-awa-lau-o-Pu'uloa*, the many harbored-sea of Pu'uloa (Pukui 1983:#1686) by the Hawaiians. An alternate name was Awawa-lei, or "garland (*lei*) of harbors" (Handy and Handy 1972:469). Pukui (1983:#1126] also uses the name *Awalua* for Pearl Harbor, as in the saying "*Huhui na 'ōpua i Awalau*, The clouds met at Pearl Harbor. Said of the mating of two people." Emerson (1915:167) interprets Awalau as "leaf-shaped lagoon."

John Clark (1977:70) says that its English name came from the name Waimomi, or "water of the pearl," an alternate name for the Pearl River (Pearl Harbor). The harbor was named Pearl Harbor after the pearl oysters of the family Pteriidae (mainly *Pinctada radiata*), which were once abundant on the harbor reefs, but were later decimated by over-harvesting. This oyster was supposedly brought from Kahiki, the Hawaiian ancestral lands, by a *mo'o* (lizard or water spirit) named Kane-kua'ana (Handy and Handy 1972:470).

Kanekua'ana was the *kia'i* (food guardian) for 'Ewa. When food was scarce, the descendants of Kanekua'ana built *waihau heiau* (a *heiau* for *mo'o*) for her and lit fires to plead for her blessings. For 'Ewa the chief *i'a* (marine food) blessing was the famous *pipi*, or pearl oyster. Samuel Kamakau describes the *pipi* of Honouliuli.

> That was the oyster that came in from deep water to the mussel beds near shore, from the channel entrance of Pu'uloa to the rocks along the edges of the fishponds. They grew right on the *nahawele* mussels and thus was this *i'a* obtained. Not six months after the *hau* branches [that placed a *kapu* on these waters until the *pipi* should come up] were set up, the *pipi* were found in abundance-enough for all 'Ewa-and fat with flesh. Within the oyster was a jewel (*daimana*) called a pearl (*momi*), beautiful as the eyeball of a fish, white and shining; white as the cuttle fish, and shining with the colors of the rainbow-reds and yellow and blues, and some pinkish white, ranging in size from small to large. They were of great bargaining value (*he waiwai kumuku'ai nui*) in the ancient days, but were just "rubbish" (*'opala*) in 'Ewa [Kamakau 1991b:83].

This oyster, the *pipi*, was sometimes called "the silent fish," or *i'a hamau leo o 'Ewa*, 'Ewa's silent sea creature (Handy and Handy 1972:471), since the collectors were supposed to stay quiet while harvesting the shells, as in the sayings:

The fish of 'Ewa that silences the voice. *Ka ka'a hāmau leo o 'Ewa.*
The pearl oyster, which has to be gathered in silence [Pukui 1983:#1331].

'Ewa is disturbed by the Moa'e wind. *Haunāele 'Ewa i ka Moa'e.*

> Used about something disturbing, like a violet argument. When the people of 'Ewa went to gather the *pipi* (pearl oyster), they did so in silence, for if they spoke, a Moa'e breeze would suddenly blow across the water, rippling it, and the oysters would disappear [Pukui 1983:5#493].

Hush, lest the wind rise. *E hāmau o makani mai auane'i.*

> Hold your silence or trouble will come to us. When the people went to gather pearl oysters at Pu'uloa, they did so in silence, for they believed that if they spoke, a gust of wind would ripple the water and the oysters would vanish [Pukui 1983:#274].

The gesturing fish of 'Ewa. *Ka i'a kuhi lima o 'Ewa.*

> The *pipi*, or pearl oyster. Fishermen did not speak when fishing for them but gestured to each other like deaf-mutes [Pukui 1983:#1357].

Sereno Bishop, an early resident of O'ahu, wrote, of his time in the area around 1836, of the pearl oyster, the *pipi*, and another edible clam, identified by Margaret Titcomb (1979:351) as probably *Lioconcha heiroglyphica.*

> The lochs or lagoons of Pearl River were not then as shoal as now. The subsequent occupation of the uplands by cattle denuded the country of herbage, and caused vast quantities of earth to be washed down by storms into the lagoons, shoaling the water for a long distance seaward. No doubt the area of deepwater and anchorage has been greatly diminished. In the thirties, the small oyster was quite abundant, and common on our table. Small pearls were frequently found in them. No doubt the copious inflow of fresh water favored their presence. I think they have become almost entire extinct, drowned out by the mud. There was also at Pearl River a handsome speckled clam, of a delicate flavor which contained milk white pearls of exquisite luster and perfectly spherical. I think the clam is still found in the Ewa Lochs [Bishop 1901:87].

Older Hawaiians believed that the *pipi* disappeared around the time of the smallpox epidemic of 1850-1853, because Kanekua'ana became displeased at the greed of some *konohiki* (overseer).

> The people of the place believe that the lizard was angry because the konohikis imposed kapus [bans], were cross with the women and seized their catch of oysters. So this "fish" was removed to Tahiti and other lands. When it vanished a white, toothed thing grew everywhere in the sea, of Ewa, which the natives of Ewa had named the pahikaua (sword). It is sharp edged and had come from Kauai-helanai, according to this legend [Manu 1885:50].

Pahikaua is the Hawaiian name for the mussel, *Brachidontes crebristriatus* (Mytilidae), which was also a popular clam eaten by the residents of Pearl Harbor.

A clarification of the story of Kanekua'ana and the pearl oysters of Pearl Harbor is given, in which it seems an overseer had set a ban on the *pipi* for several months a year so that they could increase. A poor widow, a relation of the *mo'o*, took some of the *pipi* and hid them in a basket. The *konohiki* found the hidden shells, and took them from her, emptying them back into the sea, which was proper. However, after this he followed the woman home and also demanded that she pay a stiff fine in cash, which she did not have. The *mo'o* thought this was unjust and the next night she took possession of a neighbor who was a medium.

> . . . After the overseer had gone back to Palea the lizard goddess possessed her aged keeper [a woman of Ewa] and said to those in the house, "I am taking the

> pipi back to Kahiki and they will not return until all the descendants of this man are dead. I go to sleep. Do not awaken my medium until she wakes of her own accord." The command was obeyed and she slept four days and four nights before she awoke. During the time that she slept the pearl oysters vanished from the places where they were found in great numbers, as far as the shore . . . .The few found today are merely nothing . . .[*Ka Loea Kālai'āina*, June 3, 1899, translation in Sterling and Summers 1978:49-50].

3.4.2 Ka'ahupāhau, the Queen Shark of O'ahu

Pearl Harbor in legendary traditions is closely associated with shark '*aumakua*, guardian spirits for specific Hawaiian families or clans. Pukui (1943:56) and others (Sheldon 1883) claim that the sharks of Pearl Harbor were so tame that people used to ride on their backs, and that their human relatives would feed them with *awa*. The most famous guardian shark was Ka'ahupāhau, the queen shark of O'ahu, who lived in Pu'uloa, now called Pearl Harbor. Her name means "cloak well cared for" (Pukui 1943:56), or "well cared-for feather cloak;" the feather cloak was a symbol of royalty.

Ka'ahupāhau and her brother, Kahi'uka, had been born as humans and were turned into sharks (Mary Kawena Pukui, March 29, 1954, from Sterling and Summers 1978:56).

> The mother, who was a chiefess, of Ka'ahupahau was gathering limu [seaweed] in the waters of Pearl Harbor when she had a miscarriage. Thinking the baby dead she left it in the water to be washed away. Later she went again to gather limu and was bitten by a shark. She went to a kahuna [priest] who told her that the shark was Ka'ahupahau who was her own daughter, the baby she thought was dead. The kahuna advised her to go to the place and build and ahu (heap) of hau a sort of landing from which she could feed the shark and care for it. It was from that time by command of the mother that all people of Ewa were to be always be protected from sharks whether in Pearl Harbor or outside [E.S. as told by Simeon Nawaa, Mar. 22, 1954, from Sterling and Summers 1978:56].

This explains the meaning of the shark's name Ka'ahupāhau, "the mound (*ahu*) of *hau*" (*Hibiscus tiliaceus*). The grandmother of Ka'ahupāhau and her brother, Koihala, lived in Honouliuli and one day was making *lei* for her shark grandchildren. A young girl named Pāpio rudely begged for one of the *lei*, but Koihala refused. On her way to her favorite surfing spot at Keahi Point, Pāpio snatched up one of the *lei*, and laughingly went surfing. Koihala angrily told Ka'ahupāhua about the stolen *lei*, and the shark killed the girl, grabbing her from a rock in the sea where she was resting.

> Ka'ahupahau soon recovered from her anger and became very sorry. She declared that from hence forth all sharks in her domain should not destroy, but protect the people round about. As flowers were the cause of the trouble she forbade their being carried or worn on the water of Pu'uloa. From that time all the people of that locality and the sharks in the lochs were the best of friends . . . . [Pukui 1943:56].

In a second version of this story, the shark gods Kanehunamoku and Kamohoali'i were the ones that had placed a *kanawai* (decree) against the attack of men by all sharks around O'ahu. As the result of the attack of the chiefess Pāpio, Ka'ahupāhau was put on trial and tried at Uluka'a [the realm of the gods]. She escaped the punishment of death, but was placed in confinement. In his writing of 1870 (*Ke Au 'Oko'a* April 7, 1870), Samuel Kamakau asserted:

> After her confinement ended several years later Ka'ahupahau was very weak. She went on a sightseeing trip, got into trouble, and was almost killed. But she received great help from Kupiapia and Laukahi'u, sons of Kuhaimoana, when their enemies were all slain the *kanawai* was firmly established. This law-that no shark must bite or attempt to eat a person in Oahu waters-is well known from Pu'uloa to the Ewas. Anyone who doubts my work must be a *malihini* [recent resident] there. Only in recent times have sharks been known to bite people in Oahu waters or to have devoured them; it was not so in old times [Kamakau 1991b:73].

This information on the protective nature of Ka'ahupāhau is somewhat contradicted by the writings of the Russian explorer Otto Von Kotzebue, who walked to Pearl Harbor in 1821, but was unable to actually sail on the waters. He was told that people were thrown into the water as sacrifices to the sharks; however, it is uncertain if the person who told him this was an actual resident of 'Ewa, who would know the real truth. Kotzebue's account is:

> In the Pearl River there are sharks of remarkable size, and there have made on the banks an artificial pond of coral stones, in which a large shark is kept, to which, I was told, they often threw grown-up people, but more frequently children, as victims [Kotzebue 1821:338-348].

The protection of Ka'ahupāhau is emphasized in many other Hawaiian traditions. One time a man-eating shark called Mikololou from the Ka'ū district of the island of Hawai'i, came visiting at Pearl Harbor with other sharks, some man-eating, some not. Mikololou remarked "What fine, fat crabs you have here," from which Ka'ahupāhau knew that some of the sharks were man-eaters, since they referred to fishermen as "fat crabs." She directed the fishermen to place a barrier of nets across the entrance to the harbor, and when the sharks left her home, they could not get back out to the ocean.

> The sharks of the lochs attacked the man-eaters from outside and beat them unmercifully. A shark from Ka'u, Hawaii, who was not a man-eater, threw his weight over the nets and pressed them down. His sons changed themselves into pao'o [blennies] fishes and leaped where the net was forced down, thus escaping from the place where the battle of sharks was raging. Mikololou was caught fast in the nets and dragged ashore where his head was cut off and his body burned [Pukui 1943:56].

In another version of this story, Mikololou is accompanied to Pearl Harbor with his shark friends Kua, Keali'ikauaoka'ū, Pākaiea, and Kalani; Mikololou was the only man-eater. To escape the nets:

> Keali'ikauaoka'ū changed himself into a pao'o fish, which lives among the rocks, and leapt out of the net. Kua changed into a lupe, as the spotted stingray is called, and weighted down the net on one side, helping his son Kalani and nephew Pākaiea, who were half human, to escape [Pukui and Green 1995:40].

Only Mikololou was caught in the nets, and his body was tossed on shore to rot, until only the tongue was left. In some versions of this story, the tongue immediately jumps into the water and then becomes a shark again (Pukui and Green 1995:41); in other versions (Pukui 1943:56), the tongue is eaten by a dog, which then jumps into the water, turns into a shark, and escapes. In both versions, Mikololou returns to Ka'ū, never to bother Ka'ahupāhau again.

In Thrum's (1923:308) version, Mikololou went back to his home island of Hawai'i and organized an army of sharks to return to Pearl Harbor, but he was again defeated by the fishermen of 'Ewa under the command of Ka'ahupāhau, who slaughtered so many of the sharks that from then on "the sea of Pu'uloa is safe and peaceful through her law that sharks shall not attack man. That is why these waters are safe for people to swim from shore to shore without fear" (Thrum 1923:308). The watchful eye of Ka'ahupāhau led to these Hawaiian sayings:

Everywhere in Pu'uloa is the trail…of Ka'ahupāhau — *Alahula Pu'uloa, he alahelena Ka'ahupāhau*

Said of a person who goes everywhere, looking, peering, seeing all, or of a person familiar with every nook and corner of a place. Ka'ahupāhau is the shark goddess of Pu'uloa (Pearl Harbor) who guarded the people from being molested by sharks. She moved about, constantly watching [Pukui 1983:#105].

The man-eating sharks blamed Ka'ahupāhau. — *Ho'ahewa na niuhi ia Ka'ahupāhau.*

Evil-doers blame the person who safeguards the rights of others. Ka'ahupāhau was the guardian shark goddess of Pu'uloa (Pearl Harbor) who drove out or destroyed all the man-eating sharks [Pukui 1983:#1014].

Pu'uloa became lonely when Ka'ahupāhau went away. — *Mehameha wale no o Pu'uloa, i ka hele a Ka'ahupāhau.*

The home is lonely when a loved one has gone. Ka'ahupāhau, guardian shark of Pu'uloa (Pearl Harbor), was dearly loved by the people [Pukui 1983:#2152].

Mikololou died and came to life again… through his tongue. — *Make o Mikololou a ola i ke ale lo.*

Said of one who talks himself out of a predicament [Pukui 1983:#2111].

There were other guardian sharks in Pearl Harbor, including a brother of Ka'ahupāhau's named Kahi'ukā (the smiting tail), and a son name Kūpīpī (Pukui 1943:57), or, in some versions, twin sons, named Kūpīpī and Kūmaninini (Pukui and Green 1995:41). In one version of the

Story of Pāpio, recounted above, it is said the Ka'ahupāhau later turned into a stone, although the people of Pu'uloa continued to feed her (Martha Beckwith notes to Samuel Kamakau n.d., *Mo'olelo Hawaii*, vol. II:23, from Sterling and Summers 1978:56).

> Kahi'ukā was the brother of Ka'ahupahau. The name means "smiting tail." This shark was called by this name because it was his duty to warn the people of Ewa of the presence of strange and unfriendly sharks in these waters and he did so by nudging them or striking at them with his tail When ever anyone was fishing and felt a nudge they would know it was Kahi'uka, warning them and they would leave the water immediately [E.S. as told by Simeon Nawaa, Mar. 22, 1954, from Sterling and Summers 1978:56].

There are two different accounts of the home of this shark brother. The above reference says that Kahi'uka lived at the site of the old dry dock. Mary Pukui disagrees, and says the site of the old dry dock was the home of the son, not the brother of Ka'ahupāhau. Mary Pukui says Kahi'ukā lived in a cavern under water off Moku'ume'ume (Ford Island) near Keanapua'a Point; he had a stone form in deep water some distance from the cave that could be seen from the surface (Mary Kawena Pukui, Mar. 29, 1954, from Sterling and Summers 1978:56). J. S. Emerson (1892) wrote in the late nineteenth century that Kahi'uka's keeper, Kimona, would often find fish nets missing and knew that Kahi'ukā had carried them upshore to a place of safety. Pukui also relates that the shark was named "smiting tail" because one side was longer than the other, and the shark would use his tail to smite unfriendly sharks.

3.4.3 Story of Ka'ehu-iki-manō-o-Pu'uloa, the Little Yellow Shark

One of the shark *'aumakua* associated with Pearl Harbor, was the little yellow shark called Ka'ehu, who was born on the Big Island, but later traveled to O'ahu and settled at Pu'uloa. His ancestor was Kama'ili'ili, the Hawaiian shark god, brother of the Hawaiian volcano goddess, Pele. Ka'ehu was a guardian of the Hawaiian people and once saved several surf riders at Waikīkī from a man-eating shark called Pehu (Knudsen 1946:9-13; Westervelt 1963:55-58).

In Thrum's version of this legend, the shark's name is Ka-ehu-iki-mano-o-Puuloa, meaning "the small, blonde shark of Pu'uloa." He was born in Puna, Hawai'i, but soon left on a tour of all of the islands, so that he could call and pay respects to all of the king-sharks of Hawai'i.

> . . . Puuloa, Oahu, was the next objective. Reaching its entrance they visited the pit of Komoawa, where Kaahupahua's watcher lived. Here the young shark made himself known, as usual; the object of the journey, and the desire to meet the famous queen-shark protector of Oahu's waters. . . . Welcome greetings were sent by the messenger, who was bid entertain the visitors in the outer cave, and on the morrow the party could come up the lochs to meet the queen. . . .The company then repaired to the royal cave at Honouliuli, where the visitors were supplied with soft coconut and *awa*, their home food and beverage [Thrum 1923:301-302].

The cave of Komoawa may be the Hawaiian words for "channel" or harbor" entrance (Pukui and Elbert 1986). In another version of this story, the shark watcher himself is named Komoawa and the cave that he lives in is called Keaali'i. Keaali'i guards the entrance to Pearl Harbor,

while the home of Ka'ahupāhau is deeper into Honouliuli lagoon (*Saturday Press*, Dec. 29, 1883).

In 1823, the missionary Hiram Bingham accompanied Liholiho (King Kamehameha II) and his company to the royal compound at Pu'uloa, where he was shown a cave that was home to a shark god.

> I one day accompanied the king and others by boat to see the reputed habitation of an Hawaiian deity, on the bank of the lagoon of Ewa. It was a cavern or fissure in a rock, chiefly under water, where, as the traditions teach, and as some then affirmed, a god, once in human form, taking the form of a shark, had his subterraqueous abode. Sharks were regarded by the Hawaiians as gods capable of being influenced by prayers and sacrifices, either to kill those who hate and despise them, or to spare those who respect and worship them . . . [Bingham 1847:177].

Although Bingham stated in this year that no one any longer believed these stories, there were some who kept the beliefs of the guardian sharks alive. In 1912, dredging in Pearl Harbor was completed and a large drydock was completed, but collapsed the very next year. The native Hawaiians believed that the dock had collapsed because it had been built over the home of Kūpipi the shark son of Ka'ahupāhau's, who lived in a cavern near the harbor entrance at Pu'uloa. "Angered by the violation of his home, the shark prince destroyed the imposing structure" (Clark 1977:69-70). The dock was rebuilt in the same year, but this time only after a blessing on the construction was made by Hawaiian traditional practioners.

In other versions of this story, the name of the shark is interpreted as "the little ruddy shark" (Emerson n.d.), or the "little reddish-haired shark," named for the reddish (*'ehu*) hair of Ka'ahupāhau. In this version, the cave of Ka'ehu is called Pānau, and the human mother and father of the little shark are Kapukapu and Holei of Pānau, in Puna, Hawai'i (Emory et al. 1959:63).

3.4.4 Kāne and Kanalao and the Fish Ponds of West Loch

According to an account in the Hawaiian newspaper *Ka Loea Kālai'āina* (June 10, 1899), several of the fishponds in the Pu'uloa area were made by the brother gods, Kāne and Kanaloa. A fisherman living in Pu'uloa, named Hanakahi, prayed to unknown gods, until one day two men came to his house. They revealed to him that they were the gods to whom he should pray. Kāne and Kanaloa then built fishponds at Ke'ana-pua'a, but were not satisfied. Then they built the fishpond, Kepo'okala, but were still not satisfied. Finally they made the pond Kapākule, which they stocked with all manner of fish. They gifted all of these fishponds to Hanakahi and his descendants (Handy and Handy 1972:473; *Ka Loea Kālai'āina*, July 8, 1899).

According to Mary Pukui (1943:56-57), who visited Kapākule fishpond when she was young, the pond was built by the legendary little people of Hawai'i, the *menehune*, under the direction of the gods Kāne and Kanaloa. Pukui describes several unique aspects of this pond:

> On the left side of the pond stood the stone called Hina, which represented a goddess of the sea by that by that name. Each time the sea ebbed, the rock became

gradually visible, vanishing again under water at high tide. Ku, another stone on the right, was never seen above sea level. This stone represented Ku'ula, Red Ku, a god for fish and fishermen. From one side of the pond a long wall composed of driven stakes of hard wood, ran toward the island [Laulaunui] in the lochs. When the fish swam up the channel and then inside of this wall, they invariably found themselves in the pond. A short distance from the spot where the pond touched the shore was a small koa or altar composed of coral rock. It was here that the first fish caught in the pond was laid as an offering to the gods [Pukui 1943:56].

The fishpond contained many fish, especially the *akule* (scad fish, *Trachurops crumenophthalmus*), thus its name, "the enclosure for *akule* fish" (Pukui 1943:56-57). The pond was destroyed when the channel to Pearl Harbor was dredged in the early twentieth century. The caretaker of the pond took the stones Kū and Hina to a deep place in the ocean and sunk them so "none would harm or defile them." Cobb (1903:733) says it was used to catch the larger *akule (*goggler*)*, *opelu* (mackeral scad), *weke* (goat fish), *kawakawa* (bonito), and sharks; it was unusual for having walls made of coral. This contradicts much of the legendary material that says that sharks were not killed within Pearl Harbor; however, Kamakau does relate that Kekuamanoha and Kauhiwawaeono, two conspirators against Kamehameha I, lived at Pu'uloa. The chief Kauhiwawaeono was known to murder people and use their bodies as shark bait (Kamakau 1961:182, 232).

Samuel Kamakau adds more information on the pond Kapākule, and a second one called Kepo'okala.

> At Pu'uloa on Oahu were two unusual ponds [fish traps]—Kapakule and Kepoolala. Kapakule was the better one. The rocks of its walls, *kuapa*, could be seen protruding at high tide, but the interlocking stone walls (*pae niho pohaku*) of the other pond were still under water at high tide. . . . It [Kapakule] was said to have been built by the *'e'epa* people [mysterious people] at the command of Kane....This is how the fish entered the pond. At high tide many fish would go past the mauka side of the pond, and when they returned they would become frightened by the projecting shadows of the trunks, and would go into the opening. The fish that went along the edge of the sand reached the seaward wall, then turned back toward the middle and entered the *anapuna* (the arched portion of the trap) A man ran out and placed a "cut-off" seine net (*'omuku lau*) in the opening, and the fish shoved and crowded into it. The fish that were caught in the net were dumped out, and those not caught in the net were attacked with sharp sticks and tossed out, or were seized by those who were strong [Kamakau 1976:88].

3.4.5 The Story of Kaihuopala'ai Pond, Honouliuli (*Ka'ao no Maikohā*)

In the Legend of Maikohā (Fornander 1917, Vol. V, Part 2:270-271), a sister of Maikohā, a deified hairy man who became the god of *tapa* makers, named Kaihuopala'ai, journeys to O'ahu:

> Kaihuopala'ai saw a goodly man by the name of Kapapaapuhi who was living at Honouliuli, 'Ewa; she fell in love with him and they were united, so

> Kaihuopala'ai has remained in 'Ewa to this day. She was changed into that fishpond in which mullet are kept and fattened, and that fish pond is used for that purpose to this day,
>
> *'Ike aku la o Kaihuopala'ai i ka maikai o Kapapaapuhi, he kāne e noho ana ma Honouliuli ma 'Ewa. Moe iho la lāua, a noho iho la o Kaihuopala'ai i laila a hiki i kēia lā. 'Oia kēlā loko kai e ho'opuni ia nei i ka 'anae, nona nā i'a he nui loa, a hiki i kēia kākau ana* [Fornander 1919, Vol. V, Part 2:270].

The name of Maikohā's sister, Kaihuopala'ai, which means "the nose of Pala'ai" (Pukui et al. 1974:68) is also the name the Hawaiians used for the west loch of Pearl Harbor, adjacent to the Project Area. McAllister recorded that other Hawaiians say there never was a fishpond by that name Beckwith (1918) says that Kaihuopala'ai changed into the fishpond near Kapapapuhi, which means "the eel flats." This is identified on old maps as the point north of the Project Area (sometimes spelled Kapapa'apuhi) that juts into the loch; early Hawaiian settlement was focused on this area.

There is also a famous *pōhaku*, or rock, associated with the traveling mullet of Pearl Harbor.

> . . .I . . .asked the person sitting on my left, "What place is this?" Answer – "This is Pearl City." It was here that mullets were bred in the ancient times and that flat stone there was called Mullet Rock or Pōhaku Anae. It lies near the beach by Ewa mill [*Ka Nūpepa Kū'oko'a*, Oct. 2, 1908, from Sterling and Summers 1978:53].

3.4.6 The Traveling Mullet of Honouliuli (Fish Stories and Superstitions)

The story of Kaihuopala'ai, or Ihuopala'ai, is also associated with the tradition of the *anae-holo*, the traveling mullet of Pearl Harbor (Thrum 1998:270-272):

> The home of the *'anae-holo* is at Honouliuli, Pearl Harbor, at a place called Ihuopala'ai. They make periodical journeys around to the opposite side of the island, starting from Pu'uloa and going to windward, passing successively Kumumanu, Kalihi, Kou, Kālia, Waikīkī, Ka'alāwai, and so on, around to the Ko'olau side, ending at Lā'ie, and then returning by the same course to their starting point [Thrum 1998:271].

In Thrum's account, Ihuopala'ai is a male who possesses a Kū'ula or fish god that supplied the large mullet known as "*anae*." His sister lived in Lā'ie, and there came a time when there were no fish to be had. She sent her husband to visit Ihuopala'ai, who was kind enough to send the fish following his brother-in-law on his trip back to Lā'ie.

This story is associated with a proverb or poetical saying identified with Honouliuli:

The fish fetched by the wind. *Ka I'a hali a ka makani*

> The *'anaeholo*, a fish that travels from Honouliuli, where it breeds, to Kaipāpa'u, on the windward side of O'ahu. It then turns about and returns to its original home. It is driven closer to shore when the wind is strong [Pukui 1983:#1330].

Pukui et al. (1974:68) gives the name of the husband in this story as Lā'ie and the name of the wife as Pala'ai, which ties into the name of the west loch of Pearl Harbor, called Ka-ihu o Pala'ai, "the nose of Pala'ai." Another version has a woman named Awawalei (an alternate version for the name of Pearl Harbor), who had a brother named Laniloa (the point on Lā'ie at which the mullet stops its migration and makes its way back to Pearl Harbor), and another brother (a mullet) who lived with an eel named Papa-puhi, which relates to the name of the fishpond in the tale called Kapapapuhi (*Ka Loea Kālai'āina*, Oct. 21, 1899). On historic maps, Kapapapuhi is a point of land that juts into West Loch and was a focus for habitation, taro cultivation, and fishpond maintenance in the early post-Contact (and probably earlier) period.

3.4.7 The Caves of Pu'uloa

'Ewa was famous for the many limestone caves formed in the uplifted coral. Some of these caves, called *ka-lua-ōlohe* were inhabited by the *ōlohe*, a type of people that looked like other humans but had tails like dogs (Beckwith 1940:343). These people were skilled in wrestling and bone-breaking and often hid along narrow passes to rob travelers; they were also reputed to be cannibals. As mentioned in a previous section of this report, the famous cannibal king, Kaupe, who lived in Līhu'e in upland Honouliuli, was an *ōlohe*.

There was once a cave named Kapuna on Waipi'o peninsula that was associated with a famous riddle. *No Kapuna kane hale noho ia e ke kai*, or "To Kapuna belongs the house, the sea dwells in it."

> This cave is on the Waipio side and a sea passage separates Waipio and Waikele and Waikele and Honouliuli. The passage is obstructed by three small islands, a middle one and Manana and Laulaunui. These small islands in the middle of the passage to Honouliuli and inside and outside of these small islands is the sea of Kaihuopalaai [Hawaiian name for West Loch] where mullet lived till they whitened with age [*Ka Loea Kālai'āina*, Oct. 7, 1899, translation in Sterling and Summers 1978:24].

Another famous cave of the area was Keanapua'a [in Halawa opposite Waipi'o peninsula], which means "the pig's cave," so named because Kamapua'a once slept there (Pukui et al. 1974:103). This cave was one of the places that the high king of O'ahu, Kahahana, hid after he had killed the priest Kaopulupulu, thus angering the high chief of Maui, Kahekili (Kahahana's father).

> Upon the arrival here at Oahu of Kahekili, Kahahana fled, with his wife Kekuapoi, and friend Alapai, and hid in the shrubbery of the hills. They went to Aliomanu, Moanalua, to a place called Kinimakalehua; then moved along to Keanapuaa and Kepookala, at the lochs of Puuloa, and then from there to upper Waipio; thence to Wahiawa, Helemano, and on to Lihue; thence they came to Poohilo, at Honouliuli, where they first showed themselves to the people and submitted themselves to their care.
>
> Through treachery, Kahahana was induced to leave Po'ohilo, Honouliuli and was killed on the plains of Hō'ae'ae [Thrum 1906:213-214].

The place Pō'o Hilo was somewhere on the border between Honouliuli and Hō'ae'ae (north of the Project Area). In the "Legend of the Sacred Spear-point" (Kalākaua 1990:209-225) is a reference to the Hawai'i Island chief, Hilo-a-Lakapu. Following his unsuccessful raid against O'ahu "he was slain at Waimano, and his head was placed upon a pole near Honouliuli for the birds to feed upon"(Kalākaua 1990:224). This place was called Pō'o Hilo, which literally means "the head of Hilo."

The caves of Pu'uloa were sometimes used as burial caves. In 1849, Keali'iahonui, son of Kaua'i's last king, Kaumuali'i, died. He had once been married to the chiefess Kekau'ōnohi, who had stayed with him until 1849. She wanted to bury her ex-husband at sea.

> It seems that by Kekauonohi's orders, the coffin containing her late husband's remains was removed to Puuloa, Ewa, with the view of having it afterwards taken out to sea and there sunk. It was temporarily deposited in a cavern in the coral limestone back of Puuloa, which has long been used for a burial place, and has lately been closed up [Alexander 1907:27].

After some initial objections by the niece of Kealai'iahonui, the body was removed from the outer coffin, the rest was sunk, and the coffin was later buried somewhere in Pu'uloa.

3.4.8 Coastal Honouliuli

The coastal area of Honouliuli is a triangular area that stretches from Pili o Kahe on the northwestern corner that marks the boundary with the Wai'anae District to Kalaeloa (now Barbers Point) on the southwestern corner, to Keahi Point on the southeastern corner at the mouth of Pearl Harbor. There were likely Hawaiian settlements at Ko'ōlina on the west side, at Kualaka'i on the south, at the royal residence in Pu'uloa near the mouth of the harbor, and at Honouliuli town at the upper end of West Loch, surrounding Kapapapuhi Point, north of the Project Area.

Kalaeloa literally means "the long point" (Pukui et al. 1974:72), but Raphaelson (1925) has a different translation. He says the name of the point is Kalaiekao, meaning "sky rocket cape," because it was on this point that signal fires were set to signal canoes to go out to meet European boats during the early historic period. Kalaeloa Point was the home of Uhu makaikai, a *kupua* (supernatural being) who could take the form of a man or a giant parrotfish (*uhu*). He is mentioned in several legends concerning the hero Kawelo and his struggles with the ruling chief of Kaua'i, Aikanaka.

> This friend was Kauahoa also an alii of Wailua (Kauai). Their king, Aikanaka, in the time of Kākuhihewa of Oahu and Lonoikamakahiki of Hawaii. Aikanaka got offended with Kawelo and sent him to live at Waikiki. The king at a surf bathing told Kawelo to get a calabash of water for him to wash off with, but on Kawelo's failing to do it, he took a calabash of soft poi and threw it over Kawelo and sent him off as already stated. At Waikiki, Kawelo studied the art of fighting to be revenged on Aikanaka. A *kupua*, Uhu makaikai, a fish was his teacher. Makuakeke was his helper in the canoe. The fish lived at Pōhaku o Kawai near Kalailoa (Kalaeloa), Oahu (BarbersPoint) . . . . [Hawaiian Ethnological Notes, Bishop Museum Vol. II:114, translation in Sterling and Summers 1978:41].

One historical account of particular interest refers to an *ali'i* residing in Ko'ōlina, within Waimanalo (meaning "brackish water").

> Ko'ōlina is in Waimānalo near the boundary of 'Ewa and Wai'anae. This was a vacationing place for chief Kākuhihewa and the priest Napuaikamao was the caretaker of the place. Remember reader, this Ko'ōlina is not situated in the Waimānalo on the Ko'olau side of the island but the Waimānalo in 'Ewa. It is a lovely and delightful place and the chief, Kākuhihewa loved this home of his [*Ke Au Hou* July 13, 1910, from Sterling and Summers 1978:41].

Between Pili o Kahe and Kalaeloa there is Kahe Point, which was formerly marked by two drainage ditches called Keone'ō'io and Limaloa, which may explain the name Kahe, which means "flow" (Pukui et al. 1974:64). Keone'ō'io means "the *'ō'io* sand; this area once had large schools of *'ō'io* (bonefish; Albulidae), a fish usually found on sandy-bottom areas (Clark 1977:77). Kalaeloa, meaning "the long point", got its present name Barbers Point from Captain Henry Barber of the brig *Arthur*, who ran aground on October 31, 1796 on a shoal west of the entrance to Pearl Harbor. Hawaiians, under the command of Kamehameha I, salvaged the cannon from the ship and used them to man a new fort on Lahaina, Maui (Clark 1977:75-76).

Kualaka'i is the name of the beach area on the south ocean coast of Honouliuli. Clark (1977:74) says it is named for a type of sea cucumber that squirts a purple fluid when squeezed, but, the book *Hawaiian Place Names* (Pukui et al. 1974:119) identifies the sea creature as 'tethys," a member of the invertebrate family Aplysiidae, commonly called sea hares. In the legend of Hi'iaka, there was a spring located at Kualaka'i named Hoaka-lei (*lei* reflection) where Hi'iaka picked *lehua* flowers to make a *lei* and saw her reflection in the water (*Ka Hōkū o Hawai'i*, February 22, 1927, translated in Maly 1997:20).

Keahi Point, at the entrance to Pearl Harbor, has already been noted as the surf spot for the chiefess Pāpio who was killed by the queen shark of Pearl Harbor, Ka'ahupāhau. It was also known as a good fishing spot for the *'ō'io* (bonefish, *Albula vulpes*). The *'ō'io* from Keahi were famed for their fragrance, like that of the *līpoa* (*Dictyopteris* spp.) seaweed (Pukui 1943:56).

In pre-Contact times, Pu'uloa was an *'ili* of Honouliuli, but sometime after 1868, it was designated as a separate *ahupua'a* (Maly 1997:9). Pu'uloa was a royal habitation area, and according to one tradition, was the first place that "human beings" landed on O'ahu (Beckwith 1940:343). Within Pu'uloa (meaning "long hill') on the seashore side was a beach area called One'ula, which means "red sand," possibly named for a large drainage ditch which carried red dirt from the inlands to the seashore (Clark 1977:73).

3.4.8.1 The Strife of Nāmakaokapāo'o and Puali'i (*Ka'ao no Nāmakaokapāo'o*)

In the Legend of Nāmakaokapāo'o (Fornander 1919, Vol. V, Part 2:274-277), the brave boy, Nāmakaokapāo'o, and his mother, Pokai, appear to have been living near the coast but were quite destitute (*'ilihune loa*). His mother met Puali'i when he came from Līhu'e to fish at Honouliuli, the two married, and the new family went to live on the plains of Keahumoa (*ke kula o Keahumoa*). Puali'i kept sweet potato patches (*māla uala*) and fished for *ulua*. Following a dispute over sweet potatoes, Nāmakaokapāo'o defeated his step-father, Puali'i and:

> Nāmakaokapāo'o picked up Puali'i's head and threw it towards Waipouli, a cave situated on the beach at Honouliuli (a distance of about five miles).
>
> *Lālau aku la o Nāmakaokapāo'o i ke po'o o Puali'i a kiola aku la i kai o Waipouli, he ana ma kahakai o Honouliuli, o kona loa, 'elima mile ka loa* [Fornander 1919, Vol. V, Part 2:276-277].

3.4.8.2 Coastal Village of Kualaka'i

In the Legend of the Children, is a tale that foretold the later breaking of the eating *kapu* by the *ali'i*. A young brother and sister always fished at Kualaka'i, a beach area on the southern coast of Honouliuli. One day they laid out their nets, but all they caught was one *palani* (surgeonfish), a fish that was *kapu* (tabu) for men; only women could eat it.

> . . . They fished again and again until the afternoon and nothing was caught. The children were weary and went home without fish. When they came as far as Pu'u-o-Kapolei where the blossoms of the ma'o looked golden in the sunlight, the sister sat down to make ma'o leis for themselves. When the leis were made they went across the breadth of Kaupe'a to Waipio [*Ka Loea Kālai'āina*, July 22, 1899:15; translation in Sterling and Summers 1978:7].

They stopped at the stream of Ka'aimalu on the way to their home, and the sister convinced her brother to share the fish between the two, thus breaking the *kapu*. "Because these children ate fish secretly, the spot is called Ka'ai-malu (Secret eating) to this day" (Sterling and Summers 1978:7). This legend also shows the relation of several landmarks on the coastal plain, as the children travel from the coast at Kualaka'i, across the plain of Kaupe'a to Waipi'o, passing next to Pu'uokapolei .

3.4.8.3 Pu'uloa and the Breadfruit

Pu'uloa was noted as one of the first places to have breadfruit. It was brought to the islands by Kaha'i, son of Ho'okamali'i and grandson of Moikehā, who brought the plant from Upolu (central Polynesia) to Hawai'i and planted it at Pu'uloa (Beckwith 1940:97).

Two other versions can be found in Fornander. In the first, the location of the first planting is in Pu'uloa, but does not mention Kaha'i (Fornander 1919, Vol. V, Part 3:678):

> At Puuloa, Oahu. Its breadfruit plant came from Kanehunaamoku [a mythical land supposed to have been hidden by the god Kāne], brought by two men at Puuloa who were out fishing and were blown off by a heavy wind and rainstorm and landed at the uninhabited land, save gods only. Therefore by them it was introduced at Puuloa and planted in a large excavation where it grew and bore fruit, which they ate.
>
> *Ma Puuloa i Oahu. Ko laila ulu no Kanehunamoku mai, na kekahi mau kanaka o Puuloa i hele i ka lawaia a puhia e ka ino nui, makani a me ka ua, a pae i keia aina kanaka ole, he akua wale no; nolaila mai ka laua lawe ana mai i keia ulu a hiki i Puuloa, kanu a ulu i kekahi lua niu a hua, ai keia mau kanaka.*

[Fornander 1919, Vol. V, Part 3:678-679].

A second version associates the breadfruit tree in 'Ewa to the chief Namaka-o-ka-paoo, the Hawaiian born son of Ka-ulu-o-kaha'i, which means "Breadfruit of Kaha'i." Kauluokaha'i had left O'ahu to return to his ancestral lands of Kahiki (Hawaiian ancestral land). Once Namakaokapa'o had conquered the island of O'ahu, he wanted to travel to Hawai'i in secret to spy on the land.

> . . . He [Namakaokapaoo] then went and got a small gourd wherein to place his garments which his father had left him. This gourd was deposited at Kualakai, where a breadfruit tree is standing to this day. This is the breadfruit impersonation of his father, Kahaiulu. When the real person went home the breadfruit tree remained, being in the supernatural state.

> . . *Alaila, kii aku la ia he wahi hokeo waiho kapa nona, na kona makuakane i waiho nona. O kahi i waiho ai ua wahi hokeo la, makai o Kualakai, oia kela ulu e ku nei a hiki i keia la ma Kualakai. Oia ke kino ulu o kona makuakane o Kahaiulu. Hoi ke kino maoli, koe ke kino ulu, ma ke ano akua keia kino* [Fornander 1919, Vol. V, Part 2:279-280].

Section 4 Historic Background

4.1 Pre-Contact and Early Post-Contact Period

By ca. A.D. 1320, 'Ewa, along with Kona, and Ko'olaupoko were the dominant polities, ruled by the sons of a chief named Māweke (Cordy 2002:21). 'Ewa at this time included the traditional districts of 'Ewa, Wai'anae, and Waialua (Fornander 1880:48). Around A.D. 1400, the entire island was ruled by King La'akona; chiefs within his line, the Māweke-Kumuhonua line, reigned until about A.D. 1520-1540, with their major royal center in Līhu'e, in 'Ewa. (Cordy 2002:24). Haka was the last chief of the Māweke-Kumuhonua line; he was slain by his men at the fortress of Waewae near Līhu'e (Kamakau 1991a:54-54; Fornander 1880:88). Power shifted between the chiefs of different districts from the 1500s until the early 1700s, when Kūali'i achieved control of all of O'ahu by defeating the Kona chiefs, then the 'Ewa chiefs, and then expanding his control on windward Kaua'i. Peleiholani, the heir of Kūali'i, gained control of O'ahu ca. 1740, and later conquered parts of Moloka'i. He was ruler of O'ahu until his death in ca. 1778 when Kahahana, of the 'Ewa line of chiefs was selected as the ruler of O'ahu (Cordy 2002:24-41).

After Kamehameha's O'ahu victory, he gave the *ahupua'a* of Honouliuli to Kalanimōkū as part of the *panalā'au*, or conquered lands, with the right to pass the land on to his heirs rather than having it revert to Kamehameha (Kame'eleihiwa 1992:58, 112). Kalanimōkū subsequently gave the *ahupua'a* to his sister, Wahinepi'o.

Various Hawaiian legends and early historical accounts indicate that the *ahupua'a* (land division) of Honouliuli was once widely inhabited by pre-contact populations, including the Hawaiian *ali'i* (chiefly class). This would be attributable for the most part to the plentiful marine and estuarine resources available at the coast, along which several sites interpreted as permanent habitations and fishing shrines have been located. Other attractive subsistence-related features of the *ahupua'a* include irrigated lowlands suitable for wetland taro cultivation, as well as the lower forest area of the mountain slopes for the procurement of forest resources. Handy and Handy report:

> The lowlands, bisected by ample streams, were ideal terrain for the cultivation of irrigated taro. The hinterland consisted of deep valleys running far back into the Ko'olau range. Between the valleys were ridges, with steep sides, but a very gradual increase of altitude. The lower part of the valley sides were excellent for the cultivation of yams and bananas. Farther inland grew the 'awa for which the area was famous. [1972:429]

In addition, breadfruit, coconuts, *wauke*, bananas, and *olona* and other plants were grown in the interior. 'Ewa was known as one of the best areas to grow gourds and was famous for its *mamaki*. It was also famous for a rare taro called the *kai o 'Ewa*, which was grown in mounds in marshy locations (Handy and Handy 1972:471). The cultivation of this prized and delicious taro led to the saying:

He has eaten the Kāī-koi taro of 'Ewa. *Ua 'ai i ke kāī-koi o 'Ewa.*

> Kāī is O'ahu's best eating taro; one who has eaten it will always like it. Said of a youth of a maiden of 'Ewa, who, like the Kāī taro, is not easily forgotten [Pukui 1983:#2770].

The lochs of Pearl Harbor were ideal for the construction fishponds and fishtraps. Forest resources along the slopes of the Wai'anae Range probably acted as a viable subsistence alternative during times of famine and/or low rainfall (Handy 1940:211; Handy and Handy 1972:469-470). The upper valley slopes may have also been a resource for sporadic quarrying of basalt used in the manufacturing of stone tools. At least one probable quarrying site (SIHP site 50-80-12-4322) is present in Maka'īwa Gulch at 152 m (500 ft) above mean sea level (Hammatt, Robins, et al. 1990).

John Papa 'Ī'ī describes a network of Leeward O'ahu trails (Figure 6), which in historic times encircled and crossed the Wai'anae Range, allowing passage from Lualualei to Honouliuli by three different trails ('Ī'ī 1959:96-98). The coastal trail skirted Pearl Harbor, passing by Pu'uokapolei ; this would have been the nearest of three Honouliuli trails to the current Project Area. Following 'Ī'ī's description, a portion of this trail network, would have passed close to the existing Farrington Highway, near the northern border of the Project Area, as seen in an 1825 map

The trail is described by 'Ī'ī as:

> The trail went down to the stream and up again, then went above the taro patches of Waiau, up to a *makai* field, to Waimano, to Manana, and to Waiawa; then to the stream of Kukehi and up to two other *maika* fields, Pueohulunui and Haupuu. At Pueohulunui was the place where a trail branched off to go Waialua and down to Honouliuli and on to Waianae. As mentioned before, there were three trails to Waianae, one by way of Pu'u o Kapolei, another by way of Pohakea, and the third by way of Kolekole ['Ī'ī 1959:97].

Early historical accounts of the general region typically refer to the more populated areas of the 'Ewa district, where missions and schools were established and subsistence resources were perceived to be greater. However, the presence of archaeological sites along the barren coral plains and coast of southwest Honouliuli Ahupua'a, indicate that prehistoric and early historic populations also adapted to less inviting areas, despite the environmental hardships.

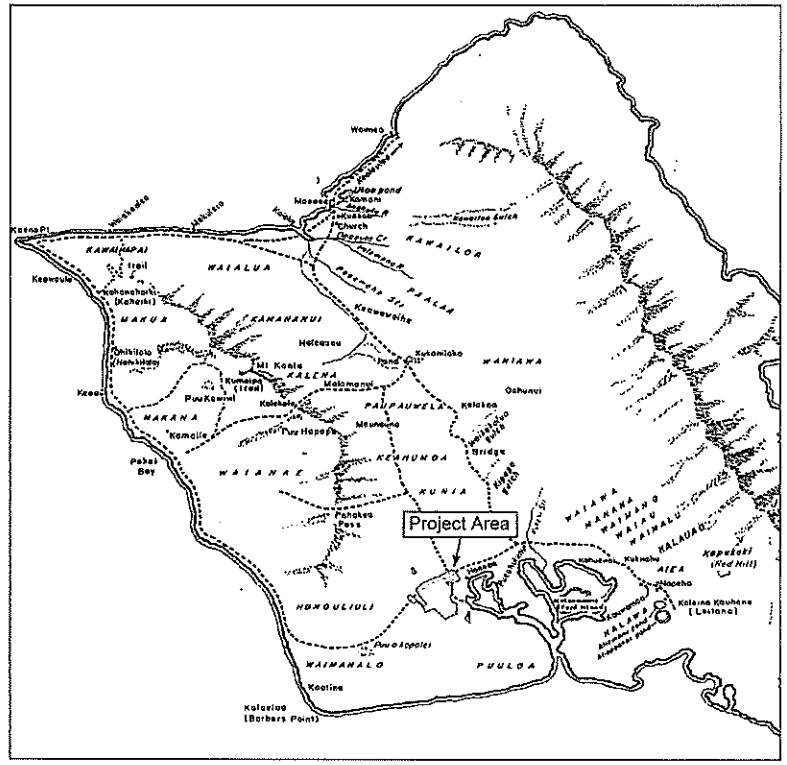

Figure 6. Trails of Leeward Oahu. Map by Paul Rockwood. ('Ī'ī 1959:96) Mid- to late-1800s

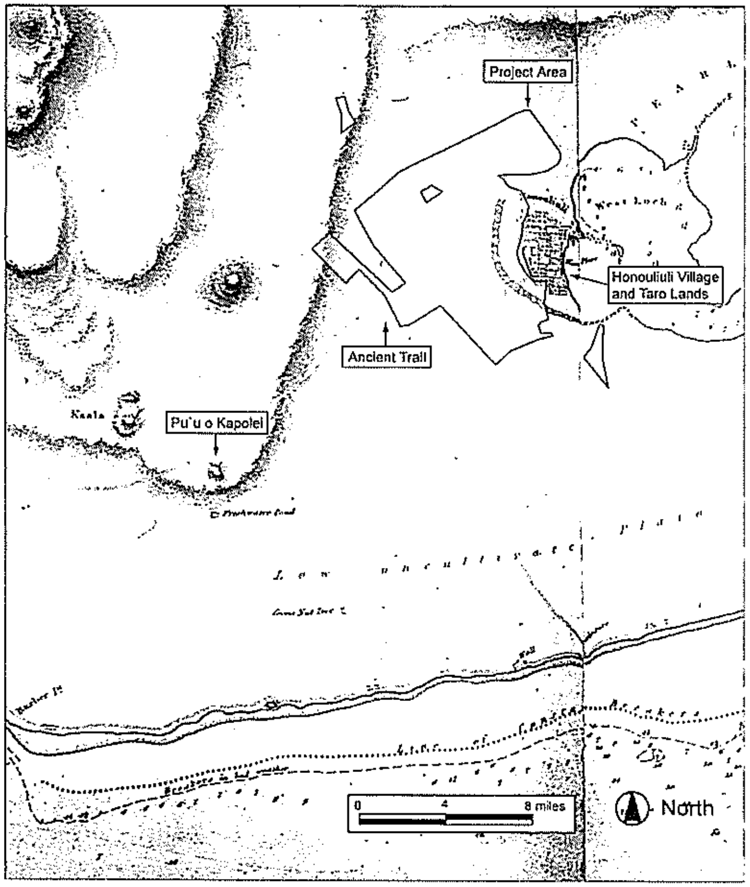

Figure 7. Portion of 1825 Map of the South Coast of Woahoo (O'ahu) and Honolulu by Lieut. C.R. Malden from the British ship the *Blonde* showing Honouliuli, the ancient trail, Pu'uokapolei, and the Project Area

4.1.1 Observations of Early Explorers and Foreign Residents

Captain Vancouver sailed by Kalaeloa (Barbers Point) in 1792, and recorded his impression of the small coastal village of Kualaka'i and the arid Honouliuli coast.

> The point is low flat land, with a reef round it. . . Not far from the S.W. point is a small grove of shabby cocoa-nut trees, and along these shores are a few struggling fishermen's huts [Vancouver 1798, Vol. I:167].

> . . .from the commencement of the high land to the westward of Opooroah [Pu'uloa], was composed of one very barren rocky waste, nearly destitute of verdure, cultivation or inhabitants, with little variation all the way to the west point of the island . . .[Vancouver 1798, Vol. II:217].

> . . .This tract of land was of some extent but did not seem to be populous, nor to possess any great degree of fertility; although we were told that at a little distance from the sea, the soil is rich, and all necessaries of life are abundantly produced . . . [Vancouver 1798, Vol. III:361-363].

Archibald Campbell, an English seamen who was given some land in Waimano Ahupua'a by King Kamehameha in 1809, described his land around Pearl Harbor:

> In the month of November the king was pleased to grant me about sixty acres of land, situated upon the Wymummee [traditional Hawaiian name for Pearl River], or Pearl-water, an inlet of the sea about twelve miles to the west of Hanaroora [Honolulu]. . . .We passed by footpaths, winding through an extensive and fertile plain, the whole of which is in the highest state of cultivation. Every stream was carefully embanked, to supply water for the taro beds. Where there was not water, the land was under crops of yams and sweet potatoes [Campbell 1967:103-104].

> Pearl and mother of-pearl shells are found here in considerable quantity. Since the king has learned of their value, he has kept the fishing to himself, and employs divers for the purpose [Campbell 1967:114-115].

Subsequent to western contact in the area, the landscape of the 'Ewa plains and Wai'anae slopes was adversely affected by the removal of the sandalwood forest, and the introduction of domesticated animals and new vegetation species. Domesticated animals, including goats, sheep and cattle, were brought to the Hawaiian Islands by Vancouver in the early 1790s, and allowed to graze freely about the land for some time after. It is unclear when the domesticated animals were brought to O'ahu; however, L.A. Henke reports the existence of a longhorn cattle ranch in Wai'anae by at least 1840 (Frierson 1972:10). During this same time, perhaps as early as 1790, exotic vegetation species were introduced to the area. These typically included vegetation best suited to a terrain disturbed by the logging of sandalwood forest and eroded by animal grazing. Within the current Project Area, the majority of the vegetation is comprised of introduced species, mainly grasses.

At contact, the most populous *ahupua'a* on the island was Honouliuli, with the majority of the population centered on Pearl Harbor. In 1832, a missionary census of Honouliuli recorded the population as 1,026. Within four years the population was down to 870 (Schmitt 1973:19, 22). In 1835, there were eight to ten deaths for every birth (Kelly 1991:157-158). Between 1848 and 1853, there was a series of epidemics of measles, influenza, and whooping cough that often wiped out whole villages. In 1853, the population of 'Ewa and Wai'anae combined was 2,451 people. In 1872, it was 1,671 (Schmitt 1968:71). The inland area of 'Ewa was probably abandoned by the mid-nineteenth, due to population decline and consolidation of the remaining people in the town of Honouliuli (at Papapuhi Point, east of the Project Area). A detailed discussion of the historic population counts in the 'Ewa District has been presented by Charvet-Pond and Davis (1992).

The first mission station in 'Ewa was established in 1834 at Kalua'aha near Pearl Harbor. Charles Wilkes, of the U.S. Exploring Expedition visited the missionary enclave at Honouliuli town in 1840.

> At Ewa, Mr Bishop has a large congregation. The village comprises about fifty houses, and the country around is dotted with them. . . . The natives have made some advance in the arts of civilized life; there is a sugar-mill which, in the season, makes two hundred pounds of sugar a day. . . . In 1840, the church contained nine hundred members, seven hundred and sixty of whom belonged to Ewa, the remainder to Waianae; but the Catholics have now established themselves at both these places, and it is understood are drawing off many from their attendance on Mr. Bishop's church [Wilkes 1970:80-81].

The earliest detailed map of the area (Alexander 1873 Figure 8) shows no habitation closer than the western edge of West Loch in the vicinity of Pāpapuhi Point. A Monsarrat survey map of 1878 documents substantial settlement at the "Honouliuli Taro Land" in the Pāpapuhi Point area, and it seems clear that in early historic times, this was the focus of the population of Honouliuli. The amenities of the area - including fishponds, taro *lo'i*, abundant shellfish, and salt pans - would have focused population there in pre-Contact times as well.

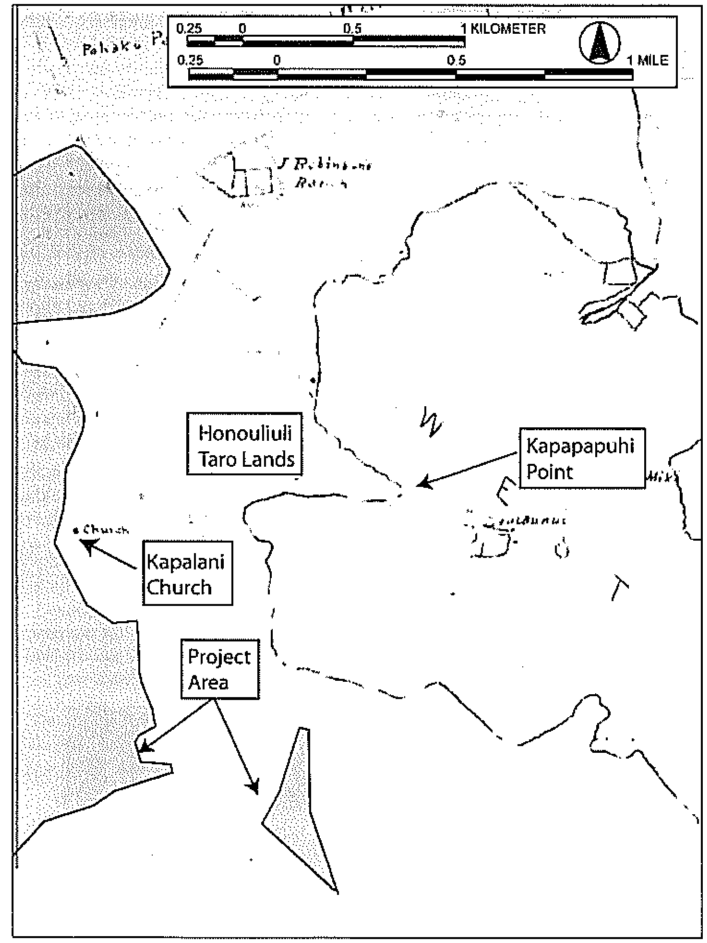

Figure 8. Portion of 1873 W.D. Alexander map of Honouliuli, showing location of Papapuhi Point (habitation symbols are illegible); also note location of Kapalani Catholic Church

4.2 Mid-Nineteenth Century and the Māhele

The Organic Acts of 1845 and 1846 initiated the process of the *māhele* - the division of Hawaiian lands, which introduced private property into Hawaiian society. In 1848 the crown and the *ali'i* (chiefly class) received their land titles. The common people received their *kuleana* (individual parcels) in 1850.

During the *Māhele* of 1848, 72 individual land claims in the *ahupua'a* of Honouliuli were registered and awarded by King Kamehameha III (Tuggle and Tomonari-Tuggle 1997:34). The 72 *kuleana* awards were almost all made adjacent to Honouliuli Gulch, which contained fishponds and irrigated taro fields. Kepa Maly (1997: 38-42) provides a table recording information on each award, including awardee, *'ili*, and land use of the *'āpana* (lot). A summary of the information on houses, fields, and boundary landmarks noted for each *'ili* is given below in Table 1 and *'ili* locations are shown on Figure 9.

4.2.1 Project Area Māhele Awards

A comparison of Project Area maps with an 1878 map surveyed by M.D. Monsarrat (Figure 10) clearly show that all or portions of certain land claims belonging to Kelia (LCA 763), Pue (LCA 869), Leleiupa (LCA 1699) and Kua (LCA 5653) lie within the Project Area. These LCAs were once located on the east side of the main road along Honouliuli town, but now portions lay west of the current alignment of Old Fort Weaver Road. A brief review of the four known LCAs within the Project Area follows (see Figure 10):

Kelia'a *'Āpana* (*'Āp.*) 1 (LCA 763)

Kelia's claimed this land situated in the *'ili* of Poohilo and Uani for his houses. His witnesses agreed with his claim, but there was a dispute over whether there were 3 or 4 houses within the parcel. All agreed Kelia has one house there and that his father, Pueeu had two. The west or Wai'anae boundary was described variously as the "*pali* of Makaaku," "a ravine" or "a cliff." The claimant received his house lot from his father Pueeu and "has accepted it ever since 1836."

Pue *'Āpana* 1 and *'Āpana* 2 (LCA 869)

Pue claimed four parcels in the *'ili* of Maui at Honouliuli, 'Ewa. One parcel was a houselot and had two houses on it, one for himself and one for Puali who was his father-in-law. The western side was bounded by the land of Koi, the *luna* (overseer), who gave Pue's family their land in 1842. The other parcel within the Project Area was *kula*, pasture land to the east of the houselot.

Leleiupa *'Āpana* 1 and *'Āpana* 2 (LCA 1699)

Leleiupa 'Āpana 1 and 2 were claims for two parcels situated in the *'ili* of Maui. 'Āpana 1 was bordered on the west by the land of Koi.

Kua (LCA 5623)

Kua claimed two taro patches and a *kula* land called Kahui in the *'ili* of Maui. Of note was the sworn testimony of Maakuia on the Land Court Application for Mahina (LCA 749), which stated that the western boundary of Mahina's land was [Kaulaula] Pali, which had a wall on its top.

Table 1. Summary of land use and boundary landmarks recorded in Honouliuli LCA awards

'Ili	Land Use and Boundary Landmarks
Hiwalalo	kou trees
Ka'aumakua	houselots, *kalo* (taro) patches; *kula* (pasture/dryland agriculture), two fishponds called Mokumeha; landmarks - *kula ālialia* (salt plains), land division wall, Pānāhāhā *loko* (fishpond), Kalahu fishpond, Naholowaa pond, Honouliuli Stream (called stream of Makai'i), or *'aka'akai* (bulrush growth) of Kamo'okahi
Kaihuopala'ai	*mo'i* (arable land in a long strip); on lot bounded by *'auwai* (irrigation ditch) called Panaenui
Ka'ilikahi	houselot and *kalo* patches; landmarks – highway, Kauhipuna cliff, *lapalapa* (*panax*) thickets,meeting house
Kamilomilo	houselot and *kalo* patches
Kamoku	fenced *mo'o kalo*, *lo'i* (irrigated fields) *kalo*, houselot; landmarks – Kauhipuna pali
Kamo'okahi	bulrushes
Kapāpahi	houselots, *kalo* patches; bounded by ponds of Healani
Kapapapūhi	houselots, vineyard, *kula*, pond, trails, hog pens, and salt beds; a church and cemetery are shown on Figure 10 but not mentioned in testimony; therefore it was probably built in the post-Māhele period
Ka'ula'ula	*mo'o* next to Kaulaula (cliff) with a houselot and a wall
Loloulu	*kalo* patches, 1/3 of a fishpond (in land of Kahakuli'ili'i), hala grove, pig pens, breadfruit, bulrushes
Maka'u	houselot and *kalo* patches
Maui	kalo patches, *kula*, houselots, bounded by *pā'āina a ke Aupini* (land division wall of the government)
Mokumeha	2 fishponds, salt beds (western one called Kohumakahou)
Niuke'e	*kalo* patches, *kula*, potato field, houselots; landmarks - *loko kalo* (taro/ fishpond) of Nihola, Loko'eli pond, Kehewanakawalu pond, Kalokoiki pond, *pali* of Kihewamakawela; Ka'akau pali; Ka'akau community, meeting house, prison plot, cattle fences
Polapola	*kalo* patches; houselots, school house, prison plot; some bounded by *pā'āina a ke Aupini*, or high road from the sea, or Catholic Chapel yard
Pō'ohilo	*kula*, *kalo* patches, *loko kalo*, houselots; landmarks - *pā'āina*, Ka'aimanō fishpond, *kula* of Kahakai, *loko kalo* of Kalokoloa, Aimea Pond, Waianu pond, Kahui pond, Ka'aimano fishpond, *pupulu* cave (wet cave?), prison plot, Makaakua pali, Puehuehu Stream, Puehuehu road
Pua'alu'u	*lo'i*, houselot
Pu'uloa	houselots; boundaries include the sea, a *kula* called Waioipu, and the plain of Kaluanohu

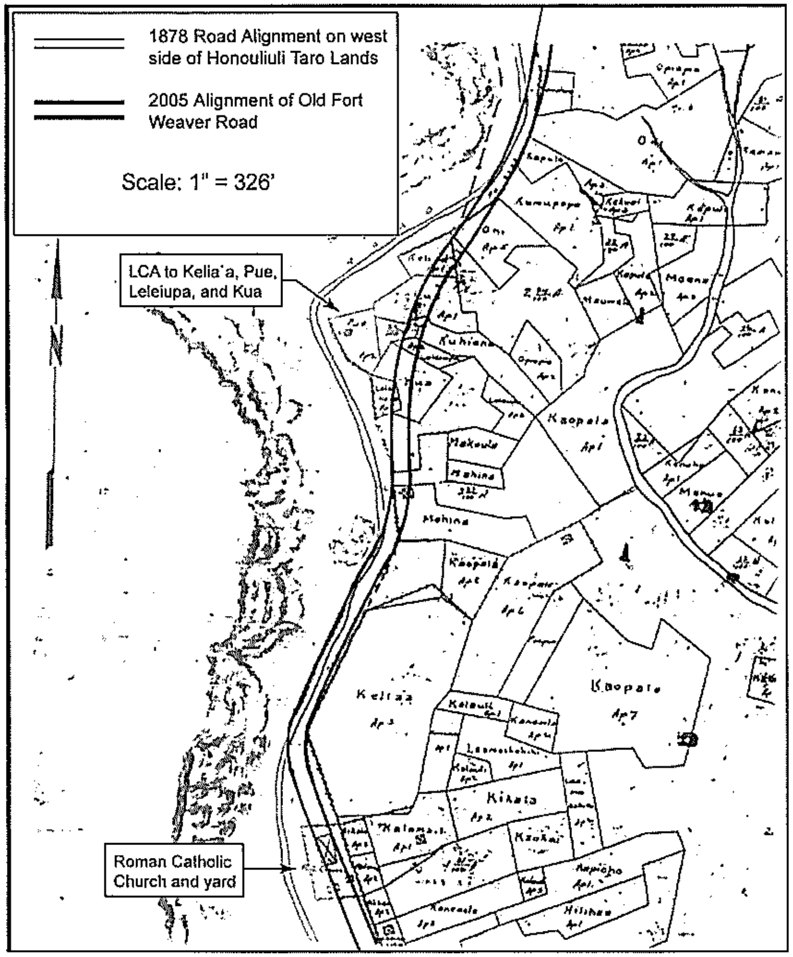

Figure 9. Portion of 1878 Monsarrat map, showing portion of Honouliuli Taro Lands in Relation to current alignment of Old Fort Weaver Road (eastern boundary of the Project Area)

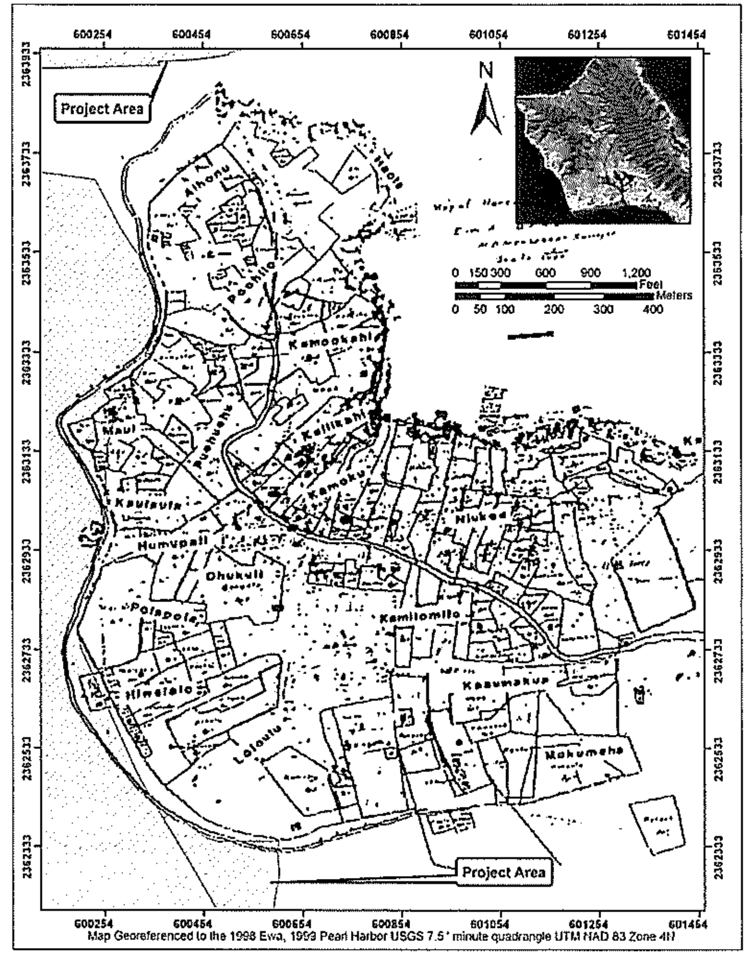

Figure 10. 1878 Map of Honouliuli Taro Lands (LCAs) by M.D. Monsarrat, with inserted *'ili* names

4.2.2 The Catholic Church

A portion of the former site of a Catholic church, called Kapalani Catholic Church, also now lies on the west side of the current road alignment, although the church itself was probably covered by the new road itself. This church and associated school house is believed to have been the site of the ministry of a particularly notable person, Kepelino Keauokalani.

There are two land applications that make reference to a Catholic Church near the town of Honouliuli. Kaohai in April of 1850 (LCA 5670B) claimed a house site in the *'ili* of Polapola "adjoining the Catholic Chapel yard." Hilinae (LCA 1720) in November of 1847 made a houselot claim in the *'ili* of Polapola bounded on the west by the Kapalani Church. Little is known about the Kapalani Roman Catholic Church. It is clearly annotated on Monsarrat's 1878 map (see) and is the lone "church" pictured on an 1873 and 1881 map of the Honouliuli district by Alexander (Figure 11). Even the name is uncertain, as Kapalani probably means "the Frenchmen's" church. Efforts to found a Catholic Mission in Hawai'i were initially met with hostility until the issuing of an edict of toleration in 1839. The establishment of the Catholic Mission in Hawai'i in May of 1849 initiated an active period of building churches and schools. The Kapalani church (and school house) cited in the Land Court Application of Hilinae in November of 1847 must have been constructed within the previous seven years. Father Raymond Delande was pastor of the Leeward District of the church from 1857-1885 and, operating out of Honouliuli, he covered an area extending as far as Makaha and Waialua. "Up to 1877, he had baptized 600 children and adults, all living along the SW coast of Oahu" (Schoofs 1978:110).

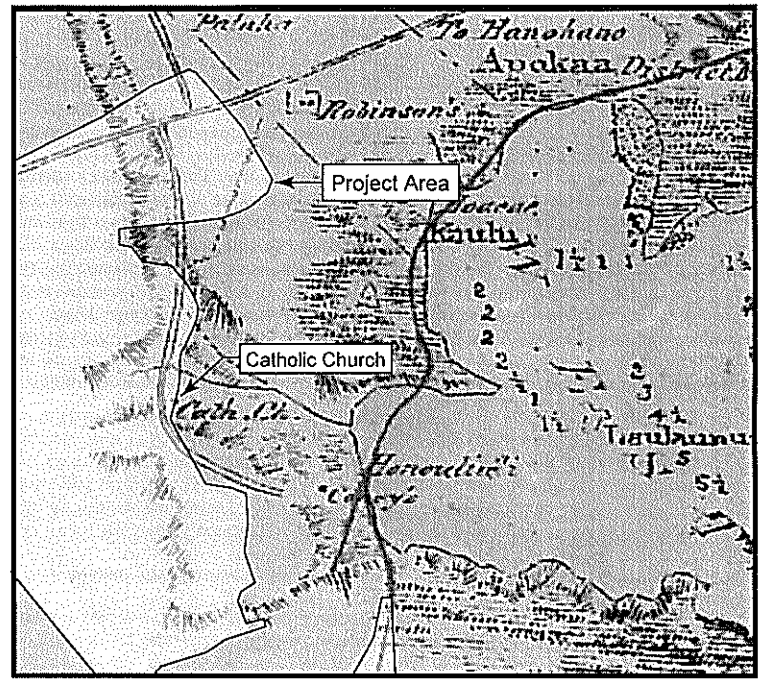

Figure 11. Portion of 1881 Hawai'i Government Survey Map (Alexander) showing location of the Catholic Church

Of particular interest is the association with this church of Kahoali'ikumaieiwakamoku Kepelino (Zepherino) Keauokalani, whose name means "to-be-the-chief-of-the-nine-districts" (Beckwith 1978:4). His father was Namiki, of the lineage of the high priest Pa'ao and his mother, Kahiwa Kaneikopulei, was a daughter of Kamehameha I. They had two children, the son Kepelino, and a daughter named Puahau. Namiki was the "old savage" whose narratives were collected by Jules Remy as "Contributions of a Venerable Savage to the Ancient History of the Hawaiian Islands" during his travels in the islands between 1851 and 1855. In a note on a section concerning the priest Pā'ao, the author talks about Namiki's son, who he met in 1853.

> The old historian Namiki, an intelligent man, and well versed in the secrets of Hawaiian antiquity, has left precious unedited documents, which have fallen into our hands. His son, Kuikauai, a school-master at Kailua, one of the true historico-sacerdotal race, has given us a genealogy of his ancestors which ascends without break to Paao [Remy 1857, in Nordhoff 1974:253].

The family was of Kailua, Kona, Hawai'i and converted to Catholicism very quickly after the arrival of Fathers Walsh and Ernest Herutel of the Catholic Mission to Kona in 1840. His parents sent him to Catholic school in Honolulu in 1845 to become a teacher. Father Ernest writes:

> Father Martial writes me about our little Zepherin, telling me that he has been received as teacher but that because they have no school to give him as yet, he has not received his diploma. Father Desire wants to keep him to send to the High School; but when will you have a High School? Perhaps not so soon. I think therefore that Zepherin would be more usful here as we lack teachers [cited in Beckwith 1978:4].

As noted above, Remy claims that at some point, Kepelino was a school teacher in Kailua; although Remy is believed to have met Kepelino in 1853, his teaching position at Kailua could have dated to an earlier period, possibly around 1845, when Father Ernst suggested that he return to the island of Hawai'i from Honolulu. At some point he attended the Catholic High School at Ahuimanu (established in 1846), where he is said "to have acquired English, French, Latin, and Greek" (Beckwith 1978:5). In 1847, at the age of 17, he was sent briefly with Father Ernest to Tahiti to help establish a Catholic mission. He developed a reputation for his pranks and was sent back to his partents (Beckwith 1978:5).

Controversial letters under the name of Z. Kahoali'i, addressed from the town of Honouliuli on O'ahu, were published in Catholic newspapers from 1860-1869. A letter in the Public Instruction Correspondence filed and dated 11/26/1851, written by a school teacher name Naheona to the Minister of Public Education, state his reasons for the rejection of a teacher "Kepilina" and accuses Kepilina of "dancing and thieving while employed as teacher of Honouliuli School and of general improper conduct." The letter also mentions "Catholic priests in the area who have been among the people for a while who do not recommend retaining Kepilina" (In Silva 1987:A8). It seems quite probable that Kepelino lived at Honouliuli from 1851 into the 1870s and that as a devout Catholic and teacher that he taught at the school house next to Kapalani Church.

Detailed biographic information on Kepelino is not readily available, which is probably due in part to the fact that he was "controversial" for the Catholics and for the government. He went on

to become Queen Emma's secretary (by at least 1874) and was one of the most important documenters about Hawaiian beliefs and traditions. He supported Queen Emma as the heir of King Lunalilo over David Kalākaua, and wrote letters to the king of Italy and the queen of England, asking for warships to support Queen Emma's cause. In 1874, the newly elected King Kālakaua had him tried for high treason and sentenced him to hanging, but the sentence was commuted and he was released from prison in 1876; he died in 1878 (Day 1984:77).

"The Honouliuli church . . . had by the 1880s outlived its usefulness and become dilapidated. It was therefore abandoned and replaced by a simple structure close, too close to the mill" [at 'Ewa Village, south of the Project Area] (Schoofs 1978:111). However, "in 1891 Honouliuli was still important enough to acquire its own Catholic cemetery" (Schoofs 1978:110). Whether this cemetery or any other Catholic cemetery was on the grounds of the Kapalani Church in unknown. In the late 1920s, Bishop Alencastre exchanged land at Honouliuli with Campbell Estate for land at 'Ewa Village to establish a new church.

4.2.3 Honouliuli Māhele Awards to *Ali'i*

In 1855, the Land Commission awarded all of the unclaimed lands in Honouliuli, 43,250 acres, to Miriam Ke'ahikuni Kekau'ōnohi (Royal Patent #6971 in 1877; Parcel #1069 in the Land Court office), a granddaughter of Kamehameha I, and the heir of Kalanimōkū, who had been given the land by Kamehameha after the conquest of O'ahu (Indices of Awards 1929; Kame'eleihiwa 1992). Kekau'ōnohi was also awarded the *ahupua'a* of Pu'uloa, but she sold this land in 1849 to Isaac Montgomery, a British lawyer.

Kekau'ōnohi was one of Liholiho's (Kamehameha II's) wives, and after his death, she lived with her half-brother, Luanu'u Kahalai'a, who was governor of Kaua'i (Hammatt and Shideler 1990:19-20:20). Subsequently, Kekau'ōnohi ran away with Queen Ka'ahumanu's stepson, Keli'iahonui, and then became the wife of Chief Levi Ha'alelea. Upon her death on June 2, 1851, all her property was passed on to her husband and his heirs. A lawsuit (Civil Court Case No. 348) was brought by Ha'alelea in 1858, to reclaim the fishing rights of the Pu'uloa fisheries from Isaac Montgomery, and the court ruled in Ha'alaea's favor. In 1863, the owners of the *kuleana* lands deeded their lands back to Ha'alelea to pay off debts owed to him (Frierson 1972:12). In 1864, Ha'alelea died, and his second wife, Anadelia Amoe, transferred ownership of the land to her sister's husband John Coney (Yoklavich et al 1995:16).

4.2.4 Early Ranching on the 'Ewa Plain

John Coney rented the land to James Dowsett and John Meek in 1871, who used the land for cattle grazing. In 1877, the land, except for the *'ili* of Pu'uloa, was sold to James Campbell for $95,000. He drove off 32,237 head of stock belonging to Dowsett and Meek and to James Robinson and constructed a fence around the outer boundary of his property (Bordner and Silva 1983:C-12) (Figure 12). He let the land rest for one year and then began to restock the ranch, so that he had a head of 5,500 head after a few years (Dillingham 1885, cited in Frierson 1972:14). A 1880s photograph of James Campbell's residence in Honouliuli shows the open, sparsely vegetated plain of 'Ewa, likely an effect of the years of cattle grazing across the plain.

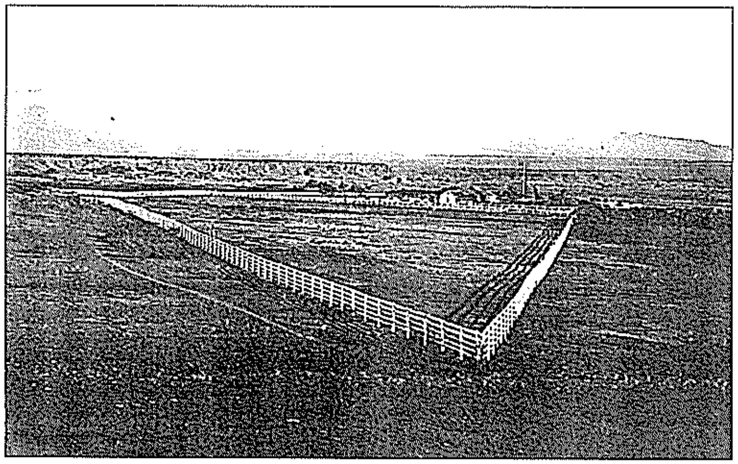

Figure 12. 1880s photograph of James Campbell's residence on the 'Ewa Plain (Bishop Museum Archives)

In 1880-81, the Honouliuli ranch was described as:

> . . . Acreage, 43,250, all in pasture, but possessing fertile soils suitable for agriculture; affords grazing for such valuable stock. The length of this estate is no less than 18 miles. It extends to within less than a mile of the sea coast, to the westward of the Pearl River inlet. . . . There are valuable fisheries attached to this estate . . . . [Bowser 1880:489].
>
> From Mr. Campbell's veranda, looking eastward, you have one of the most splendid sights imaginable. Below the house there are two lochs, or lagoons, covered with water fowl, and celebrated for their plentiful supply of fish, chiefly mullet. . . . Besides Mr. Campbell's residence, which is pleasantly situated and surrounded with ornamental and shade trees, there are at Honouliuli two churches and a school house, with a little village of native huts [Bowser 1880:495].

Most of Campbell's lands in Honouliuli were used exclusively for cattle ranching. At that time, one planter remarked "the country was so dry and full of bottomless cracks and fissures that water would all be lost and irrigation impracticable" (Ewa Plantation Co. 1923:6-7). In 1879, Campbell brought in a well-driller from California to search the 'Ewa plains for water, and the well, drilled to a depth of 240 feet near Campbell's home in 'Ewa, resulted in ". . . a sheet of pure water flowing like a dome of glass from all sides of the well casing" (The Legacy of James Campbell n.d., cited in Pagliaro 1987:3). Following this discovery, plantation developers and ranchers drilled numerous wells in search of the valuable resource. A Hawai'i Visitor Bureau,

marker, located in the southwestern portion of the Project Area, bears the inscription "Site of First Artesian Well in the Hawaiian Islands drilled by James Ashley for James Campbell owner of Honouliuli Ranch brought in on Sept. 22, 1879." Kuykendall (1967:III, 67) states that this well was "near Campbell's ranch house" but Campbell's ranch house, which is shown on Monsarrat's 1878 map, was located outside the Project Area.

4.3 History of the Ewa Sugar Plantation

4.3.1 General History of the Plantation

In 1886, Campbell and B. F. Dillingham put together the "Great Land Colonization Scheme," which was an attempt to sell Honouliuli land to homesteaders (Thrum 1886:74). This homestead idea failed, but with the water problem solved by the drilling of artesian wells, Dillingham decided that the area could be used instead for large-scale cultivation (Pagliaro 1987:4). During the last decade of the nineteenth century, the railroad would reach from Honolulu to Pearl City in 1890, to Wai'anae in 1895, to Waialua Plantation in 1898, and to Kahuku in 1899 (Kuykendall 1967:100). This railroad line eventually ran across the center of the 'Ewa Plain at the lower boundary of the sugar fields.

To attract business to his new railroad system, Dillingham subleased all land below 200 ft to William Castle, who in turn sublet the area to the newly-formed Ewa Plantation Company (Frierson 1972:15). Dillingham's Honouliuli lands above 200 ft that were suitable for sugar cane cultivation were sublet to the Oahu Sugar Company (Figure 13). Throughout this time, and continuing into modern times, cattle ranching continued in the area, and Honouliuli Ranch - established by Dillingham was - the "fattening" area for the other ranches (Frierson 1972:15).

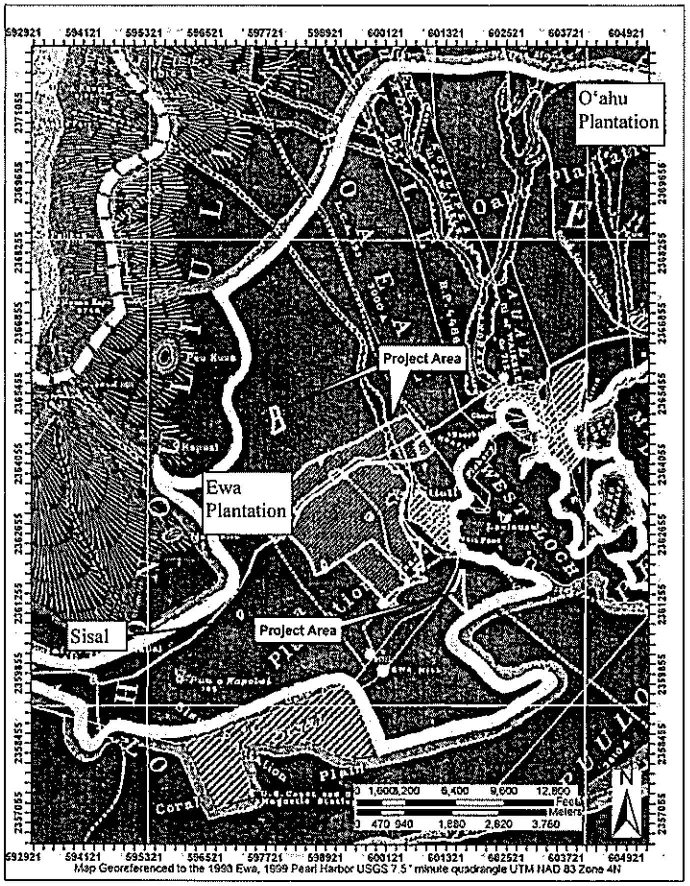

Figure 13. 1902 map showing relationship of Ewa Plantation and the Oahu Sugar Co. plantation; also note location of sisal growing area

4.3.2 History of the Ewa Sugar Plantation

Ewa Plantation Company (Figure 14) was incorporated in 1890 for sugar cane cultivation. The first crop, 2,849 tons of sugar, was harvested in 1892 at the Ewa Plantation. 'Ewa was the first all-artesian plantation, and it gave an impressive demonstration of the part artesian wells were to play in the later history of the Hawaiian sugar industry (Kuykendall 1967:69). As a means to generate soil deposition on the coral plain and increase arable land in the lowlands, the Ewa Plantation Company installed ditches running from the lower slopes of the mountain range to the lowlands. When the rainy season began, they plowed ground perpendicular to the slope so that soil would be carried down the drainage ditches into the lower coral plain. After a few years, about 373 acres of coral wasteland were reclaimed in this manner (Immisch 1964). By the 1920s, Ewa Plantation was generating large profits and was the "richest sugar plantation in the world" (*Paradise of the Pacific*, Dec. 1902:19-22, cited in Kelly 1985:171).

Just north of 'Ewa Plantation was the equally sprawling O'ahu Sugar Company which "covered some 20 square miles . . . ranging in elevation from 10 feet at the Waipio Peninsula . . . to 700 feet at the Waiahole Ditch" (Condé and Best 1973:313). The Oahu Sugar Company was incorporated in 1897. Prior to commercial sugar cultivation, the lands occupied by the Oahu Sugar Company were described as being "of near desert proportion until water was supplied from drilled artesian wells and the Waiahole Water project" (Condé and Best 1973:313). The Oahu Sugar Company took control of the Ewa Plantation lands in 1970 and continued operations until 1995, when they decided to shut down sugar cane production in the combined plantation area (Dorrance and Morgan 2000:45, 50).

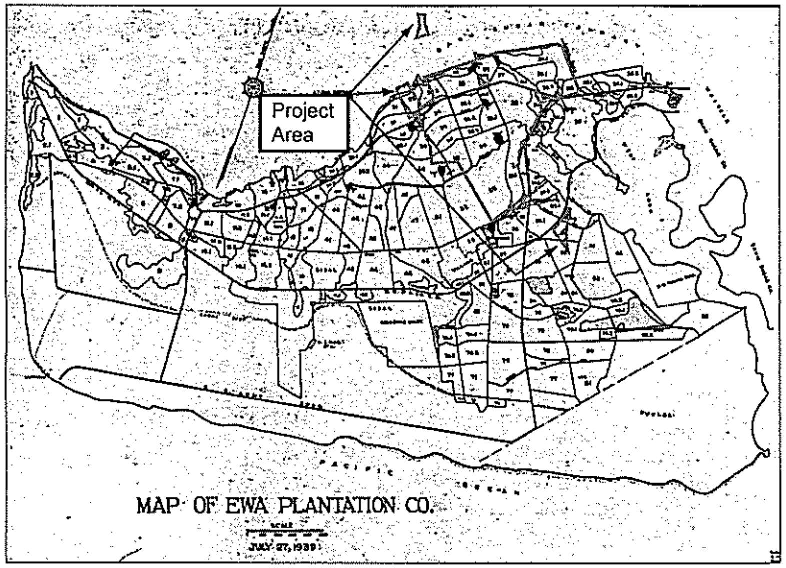

Figure 14. 1939 map of the Ewa Plantation Co. lands, showing Project Area and alignment of railroad.

During the subsequent decades of the twentieth century, sugar cane operations in 'Ewa phased out and, more recently, former cane lands have been rezoned for residential development. Structures in the area of the former plantation villages have fallen into disrepair or have been demolished. However, portions of the area - including Varona Village, Tenney Village, and Renton Village - have been designated the 'Ewa Villages Historic District (State site 50-80-12-9786), which has been nominated for National Historic Landmark status. Additionally, the still-existing O.R.&L. rail line through Honouliuli has been placed on the National Register of Historic Places (Site 50-80-12-9714).

4.3.3 History of PipeLine Village

During the twentieth century, the Ewa Plantation would continue to grow and, by the 1930s, would encompass much of the eastern half of Honouliuli Ahupua'a. This growth compelled the creation of plantation villages to house the growing immigrant labor force working the fields. In the decade of the 1890s, the plantation built 72 houses, cottages or dwellings; in the first decade of this century, 536; in the second decade, 132; in the 1920s, 285; in the 1930s, 168; and, in the 1940s, only 35. Censuses of the Ewa Plantation population record 4,967 persons in 1928, 4,477 in 1929, and 4,100 in 1932. After the outbreak of World War II, which siphoned off much of the

plantation's manpower, along with the changeover to almost complete reliance on mechanical harvesting in 1938, there was little need for the large multi-racial (Japanese, Chinese, Okinawan, Korean, Portuguese, Spanish, Hawaiian, Filipino, European) labor force that had characterized most of the early history of the plantation.

It is also important to note that in the history of construction, buildings were moved, demolished, and replaced all the time. As early as 1899, the plantation moved "the lower camp of thirty houses [believed to be duplexes built in 1890] to a position on the bluffs nearby . . . principally for sanitary reasons" (Ewa Plantation Company Annual Report for 1890).

The original location of these thirty houses is unknown. They probably were not in the area later known as "Lower Camp" and may have been in the Honouliuli Taro lands. It is also unknown where they moved to "on the bluffs," but it seems probable that they were moved to what became the west central portion of PipeLine Village near the present water pumping station in that vicinity. A 1908/1913 U.S. Army Fire Control map shows 47 houses in the area of Pipeline Village (Figure 15)

PipeLine Village was a major plantation community that lay in the central southern portion of the present Project Area and is shown in detail in a 1928 USGS map (Figure 16), which documents the location of about 160 houses, a church and a school. This was probably the great extent of PipeLine Village. An entry in the 1931 Annual Report of Ewa Plantation Company records that "The PipeLine Village of 162 cottages built in 1906" was dismantled and that "other cottages near [near the factory, south of the Project Area] were erected using the reclaimed lumber from the PipeLine Villages". Photos (Bishop Museum Visual Collection) (Figure 17) dated 1906 show what appear to be brand new single family residences at PipeLine Village, but the Annual Report for 1906 documents the construction of only 47 houses and many of there were probably not built in PipeLine Village. Some photos dated 1907 (Figure 18) show houses at PipeLine village with very well established gardens and tall banana, papaya, and many mango trees, suggesting that they are significantly older. Another photo dated January 1910 (Figure 19) shows a line of ten new cottages with the caption "Pipe Line Village (Family houses built during 1909)." One hundred and twenty-nine cottages were built for married laborers in that year and they well include the majority of the houses at PipeLine Village.

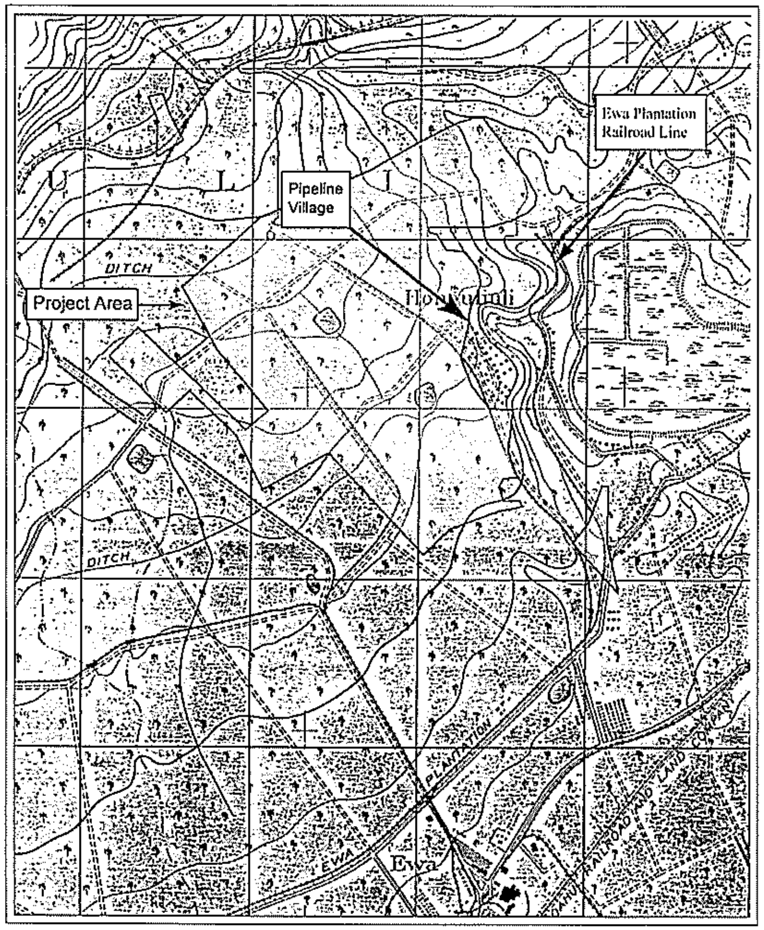

Figure 15. Portion of an 1908/1913 U.S. Army Fire Control map, showing 47 houses in Pipeline Village; map also shows the alignment for the Ewa Plantation railway

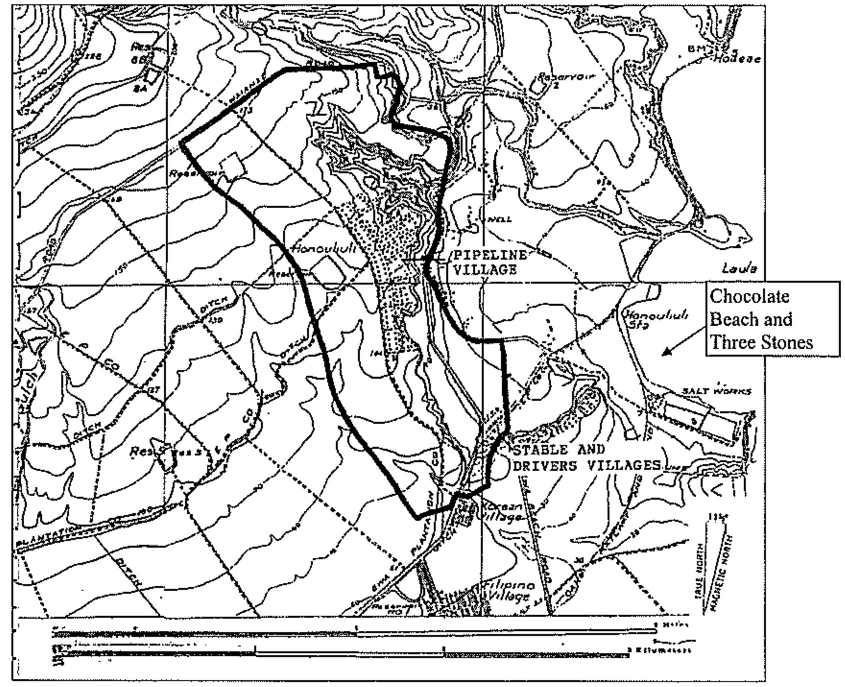

Figure 16. 1927/1928 US Geological Survey map, showing location of PipeLine Village, Stable Village, Drivers's Village, and other Ewa Plantation structures, Salt Works and location of Chocolate Beach and Three Stones.

In 1911 "60 new houses, principally for Spanish and Portuguese workmen with families" were erected. Thus, it seems highly probable that PipeLine village was largely constructed between 1906 and 1911, but may have incorporated a number of relocated structures dating to 1890. The demolition of 1931 was probably quite thorough, and not a trace of the structures was found on later maps.

Figure 17. Portuguese family residence at PipeLine Village. 1906

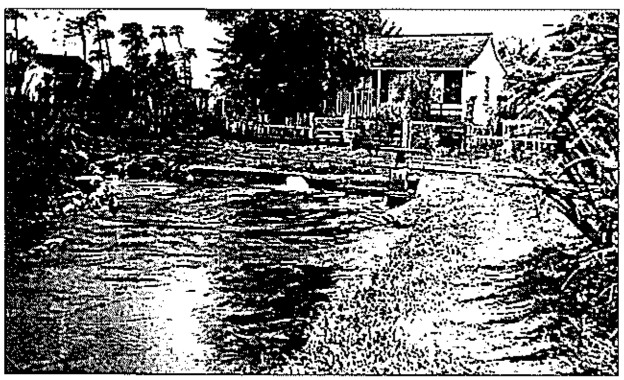

Figure 18 Discharge Pump No. 5, PipeLine Village 1907

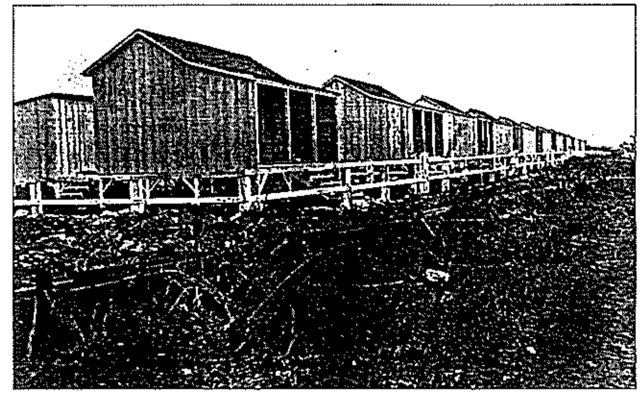

Figure 19. PipeLine Village, family houses built in 1909, photograph taken on January 1910

Figure 20. PipeLine Village, April 7, 1907; *forno* (Portuguese brick bread oven) at center of photograph

4.3.4 History of Stable Village and Drivers Village

The Ewa Plantation housing located in the southeastern corner of the Project Area, just north of the present Hale O Ulu School, is not well-documented. It appears that there were at least two small villages located here: "Stable Village" and "Drivers Village." The Ewa Plantation Company Annual Report for 1931 states that "The Drivers Village, located near the main stable was in such a bad location that it was decided to move all the fourteen cottages down to 'B" village near the factory." Drivers Village doubtlessly corresponds to the site of the 14 houses shown on the 1927/1928 map (see Figure 16), with Stable Village probably referring to the structures just to the south across the street. The date of construction of these villages is unknown. No houses are shown in this area on the 1908/1913 Fire Control map (see Figure 15). The villages were probably built in that flurry of construction in the first decade of this century. All of the structures of Stable Village and Drivers Village are shown on the War Department Map of 1943, but this map must be another example of a lack of military intelligence regarding the Pearl Harbor area; records indicate that the hosues were probably all demolished around 1931.

4.3.5 Other Enterprises in Honouliuli

One of the first enterprises in Honouliuli in the post-Contact period was the making of salt. Soon after Kekau'ōnohi sold the land of Pu'uloa to Isaac Montgomery in 1849, the king (Kamehameha III) and Montgomery entered into a partnership to run the salt works in Pu'uloa. Kamakau (1961:409) reported "The king and Isaac of Pu'uloa are getting rich by running the salt water into patches and trading salt with other islands." The salt was also sent to Russian settlements in the Pacific Northwest, where it was used to pack salmon (*Hawaiian Gazette,* January 29, 1897). An 1853 newspaper article (*Polynesian,* August 20, 1853) on the "Puuloa Salt Works" says that this was the only place "where large quantities of salt were manufactured. Kelly (1991:160) says that there was another salt works at Kualaka'i (Nimitz Beach), but does not give a reference for this claim.

There reference concerning salt works in 'Ewa by Carol Silva (1987:A-4):

> An extensive and antiquated system of salt works operated on the shore of the Honouliuli lobe of West Loch. Another salt works was situated further seaward at Puuloa. The Puuloa Salt Works had beginnings that were traceable to the 1820's and possibly even much earlier. By 1861, 100 acres had been devoted to the production of salt [*Pacific Commercial Advertiser* 4/18/1861:1].

A 1927/1928 US Geological Survey map (see Figure 16) shows several rectangles labeled "Salt Works" on the right side of the map.

The Chinese were involved in salt production around Pearl Harbor, usually in concert with their management of fishponds. One son of one Chinese resident of the area, Mau Yung Kui, the groundkeeper of the John 'Ī'ī estate on Waipi'o, remembered [for ca. 1900] the Chinese form of salt production for salt pans bordering the sea, which were continually fed seawater by the tides.

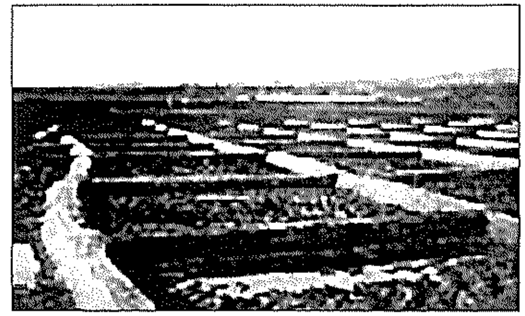

Figure 21. 1881 photo of salt pans near Kaunakakai, Moloka'i (Dorothe B. Curtis collection)

> Both the natural tides and the Chinese method of peddling a wooden wheel that transported water upward, helped to keep the salt beds damp with about three inches of water. After a few months, the senior Mau would drain off the remaining water and use a wooden rake with deep prongs to break up the salt. When the bed was dry a flat rake was used to flatten and smooth out the salt. Later it was raked into piles, packed in cloth bags and distributed. . . . Past the rice fields of Ho'ae'ae and the beginning of Honouliuli were a number of productive salt flats adjacent to the ancient fishponds operated by Chinese at the turn of the century [Chong 1988:108].

As noted above, part of Mr. Campbell's lands were also used to grow rice. By 1885, 200 acres in Honouliuli were used for rice and 50 acres were used to grow bananas (article in *Pacific Commercial Advertiser*, August 15, 1885, summarized in Silva 1987:A-12). These rice fields were planted in former taro fields or in undeveloped swamps, such as those in the Project Area in the former Honouliuli Taro lands. The rice fields in 1882 were described by Frank Damon, during a tour of the area.

> . . . Towards evening we reached Honouliuli, where the whole valley is leased to rice planters . . . This was one of the largest rice plantations we visited. Sometimes two or three men only, have a few fields which they cultivate for themselves, and we often too came upon houses where there were eight or ten men working their own land. But the larger plantations are owned by merchants in Honolulu, who have a manager acting for them. . . . [Damon 1882:37].

In 1890, Dillingham leased all land below 200 ft to William Castle, who used most of the land for sugar cane, but also leased some lands for rice cultivation, pasture, wood lots, bee-keeping, garden crops, and quarries. Some land above 650 ft was also leased for the cultivation of "canaigre", which may be a word used for pineapple (Frierson 1972:15-16).

An additional agricultural trial was conducted in the Honouliuli area for the cultivation of sisal, a plant used to make fibers for rope and other material. Some sisal was planted before 1898 and production continued until the 1920s (Frierson 1972:16). This was grown mainly on the coastal plain of Honouliuli in Kānehili, just *mauka* of Kualaka'i Beach (now Nimitz Beach). An article in the *Paradise of the Pacific* in 1902 described this venture in glowing terms.

> . . . The venture was made and a tract of land containing a large percentage of disintegrated coral, in the neighborhood of Ewa Plantation, where nothing else would grow, was chosen for the planting. . . . The Hawaiian Fiber Co., which Mr. Turner organized, and of which he is now manager, has 755 acres under fence, two and a half miles of which is stone wall with good gates at convenient places. . . . In a large field containing 130 acres, mauka of the Oahu Railway & Land Co. track, the first harvest is to be gathered in a few months. . . . Out of this section of 130 acres the company has figured on securing 50 tons of clean fiber, for which it is offered eight cents per pound in Honolulu or nine cents per pound in San Francisco . . . . [*Paradise of the Pacific* March 1902:17].

Although many of the fishponds at Pearl Harbor deteriorated from lack of care and lack of people to maintain them in the early nineteenth century, there was some action to reclaim these areas in the later part of the century. Some were converted to rice fields, but others were maintained as fish ponds or duck ponds. Records of the Minister of Public Instruction (1848) show that some ponds were maintained by local teachers and students, with the funds generated used for the upkeep of the school system. Some ponds as early as 1848 were also maintained by prisoners, possibly from the women's prison located at Honouliuli. In 1852, however, Levi Ha'alelea reasserted his claims to these neglected lands, when he claimed all of the mullet from this area be reserved to him (Hawaii Kingdom files, cited in Silva 1987:A-7 to A-9). During James Campbell's tenure of the land, fish ponds and Pu'uloa fishing rights were leased out to various entrepreneurs (Kelly 1985:175).

Into the early twentieth century, some Hawaiian families continued to live in Honouliuli and preserve the traditional lifestyle, including at the fishing village of Kualaka'I (see Figure 5). One resident, Mrs. Eli Williamson, recalled:

> In the Honouliuli area the train stopped among the *kiawe* (algaraboa) trees and *malina* (sisal) thickets. We disembarked with the assorted food bundles and water containers. Some of the Kualaka'i *'ohana* (family) met us to help carry the *'ukana* (bundles) along a sandstone pathway through the *kiawe* and *malina*. The distance to the frame house near the shore seemed long. When we departed our *'ukana* contained fresh lobsters, *limu* (algae), fish and *i'a malo'o* (dried fish) . . . [Williamson in Kelly 1985:160].

4.3.6 The Military and Modern Developments

In 1891, Russian explorer Otto Von Kotzebue tried to observe Pearl River, but his group could not obtain a canoe. What he was told, however, led him to speculate on the possible importance of Pearl Harbor to the future.

> In the mouth of this river are several islands; it is so deep, that the greatest ship of the line can lie at anchor a few fathoms from the shore; and so broad, that a

> hundred vessels can conveniently find room in it. The entrance into the Pearl Rivers is in the same situation as the harbour of Hana-rura [Honolulu]; but the windings between the reefs are, however, said to render a passage more difficult. If this place were in the hands of the Europeans, they would certainly employ means to make this harbour the finest in the world [Von Kotzebue 1821:338-348].

The early missionary Levi Chamberlain was able to take an outrigger canoe trip to Pearl River, and noted the difficulty of access for larger ships.

> Kawaa took passage in our canoe to go down the harbor to a place where oysters are abundant to give orders to his people to gather a mess. The sail down the harbor was delightful . . . The passage down the creek for a number of miles was very pleasant till we got down near the reef and our course altered. We then could sail no longer as the wind was against us. The sail was lowered the mast taken down and secured across the outrigger and the rowers plied their paddles [Journal of Levi Chamberlain 1822-1849, Hawaiian Mission Schools, Storage Case 4, p. 899, from Sterling and Summers 1978:51].

The first foreign attempt to survey Pearl Harbor was made in 1840 during the U.S. Exploring Expedition, led by Charles Wilkes.

> In this district is a large inlet of the sea, into which the river Ewa empties; at the entrance of this inlet is the village of Laeloa (at Kalaeloa Pont): the shore is known by the name of Pearl River or harbour, from the circumstance that the pearl oyster is found here; and it is the only place in these islands where it occurs.
>
> The inlet has somewhat the appearance of a lagoon that has been partly filled up by alluvial deposits. At the request of the king, we made a survey of it: the depth of water at its mouth was found to be only fifteen feet; but after passing this coral bar, which is four hundred feet wide, the depth of water becomes ample for large ships, and the basin is sufficiently extensive to accommodate any number of vessels. If the water upon the bar should be deepened, which I doubt not can be effected, it would afford the best and most capacious harbour in the Pacific. . . . [Wilkes 1970:79].

Although Wilkes was impressed by the harbor, he was not at this time thinking of how this survey could benefit the American government in the future. In fact, Wilkes (1970:79) concluded, "As yet there is no necessity for such an operation, for the port of Honolulu is sufficient for all the present wants of the islands, and the trade that frequents them."

This had changed in less than 30 years, however. The U.S. military had tried to make a coaling station on Midway Island in 1869 by blasting through the coral reef to make a harbor; this plan failed. In 1873, General Schofield presented a confidential report to the U.S Secretary of War, recommending that Pearl Harbor should be available to the U.S. Navy. Schofield wrote:

> In case it should become the policy of the Government of the United States to obtain the possession of this harbor for naval purposes, jurisdiction over all the

> waters of Pearl River with the adjacent shores to the distance of 4 miles from any anchorage should be ceded to the United States by the Hawaiian Government. . . .
>
> The cession of Pearl River could probably be obtained by the United States in consideration of the repeal of the duty of Sandwich Island sugar. Indeed, the sugar –planters are so anxious for a reciprocity treaty, or so anxious rather for free trade in sugar with the United States, that many of them openly proclaim themselves in favor of annexation of these islands of the United States [Sen. Ex. Docs, 52nd Cong. 2nd Sess. No. 77, pp. 150-154, reproduced in Judd 1971:Appendix 3].

This reciprocity treaty was concluded in 1876 with the provision that Hawai'i would not "lease or relinquish sovereignty to another country or any harbor, etc." In 1887, the treaty was renewed and amended and allowed the United States the "exclusive right to enter the harbor of Pearl River, in the Island of Oahu, at to establish and to maintain there a coaling and repair station for the use of vessels of the United States" (Judd 1971:128).

After annexation of the islands to the United States in 1899, development began in order to make a Pacific base that could be used as a staging area for the Spanish-American war (Coletta 1985:433). Dredging of the harbor began in 1901, and additional dredging to deepen and widen the channel was conducted in 1908 and again in the 1920s. Money for the funding of the construction of dry docks and other support facilities was approved in 1908. In 1931 the Navy built an ammunition depot at West Loch on a 213-acre parcel that it had bought from the Campbell Estate. Construction of a new depot in Lualualei Valley and at West Loch Harbor began in 1931.

In the early 1930s, the U.S. Navy leased 700 acres of the Campbell Estate to build 'Ewa Field, a base with a mooring mast for Navy dirigibles. Although the mast was completed, the program was abandoned before the *Akron*, the designated airship for the mast, was built. In 1937, 18 miles of roads were built in the coastal Honouliuli area, and in 1939-1940 the U.S. bought 3,500 acres of land in this area (Landrum et al 1997:62-67), to build several other military camps and installations, including Barbers Point Naval Air Station, at the site of the old mooring mast.

On December 7, 1941 the Japanese Navy launched the devastating surprise attack on the United States base at Pearl Harbor and other military facilities. Although the major battle damage to the US Pacific Fleet was at its base at Ford Island in the Middle Loch of Pearl Harbor, Honouliuli did not escape unscathed.

> The Waipahu and Ewa sugar plantation, next to Pearl Harbor and the town of Wahiawa, adjoining Schofield Barracks, saw more action than did Honolulu.
>
> At Waipahu, machine gun bullets, shrapnel, and shells started two cane fires, riddled the sugar mill, hit the plantation hospital in four places, went through the roof of the company store, exploding in an electric supply warehouse, and narrowly missed many houses. In nearly all of the fields of tall cane, many of which contained terrified women and children, shells buried themselves-dozens of them in some concentrated areas-blasting holes in the ground the size of barrels, and flattening cane for several square yards.

> At Ewa, after bombing the nearby Marine airfield [at Barbers Point], enemy planes machine-gunned the plantation's main street, the mill and power plant and some 30 houses and started two cane fires [Allen 1999:20].

The attack had consequences not only for the military, but also for the civilians, mostly Japanese, who lived around West Loch.

> Two permanent local evacuations were ordered in the first month of the war, partly to remove civilians from areas which might be dangerous in event of further attack and partly to protect installations from possible sabotage or espionage activities. On a Thursday less than two weeks after the bombing, farmers adjacent to West Loch at Pearl Harbor were ordered to leave their farms by sundown. The order was modified to allow two days to prepare and the men were permitted to return to their farms during daylight until livestock could be moved and crops harvested. The displaced farmers, who had only recently been established at West Loch by the Farm Security Administration, were forced to seek temporary housing with friends and relatives at Ewa Plantation. Since they had invested in the enterprises practically all of their life's savings and considerable money borrowed from the FSA as well, several suffered heavy losses [Allen 1999:122].

Section 5 Previous Archaeological Research

5.1 Early Archaeological Surveys

All archaeological projects previously conducted in Honouliuli and Pu'uloa are listed below in Table 2. Two archaeological features, a boundary *pōhaku* or rock and a *hōlua*, or sledding site, are recorded only in the Boundary Commission Reports establishing the division lines between the *ahupua'a* of Honouliuli and Hō'ae'ae (to the east). The surveyor wrote of the southern point of this boundary:

> In regard to Hoaeae . . . the point of commencement is Pōhaku Palahalaha, a well known rock, now marked by an arrow and the name "Honouliuli" on one side and "Hoaeae" on the other, which I have made the initial point of the survey . . . [Boundary Commission Vol. 1:243].

This rock is shown on the Sterling and Summer map as Pōhaku Palaha (see Figure 5). In another boundary survey, the *pōhaku* is called a "large, flat rock" (Boundary Commission Vol. 1:249), which may indicate the origin of the name from the Hawaiian word *pālaha*, which means "flattened, wide" (Pukui and Elbert 1986:307). As the surveyor continued to walk the Honouliuli/Hō'ae'ae boundary, he marked the northern point of the division as:

> The Kamaaaina took me to the corner of Pauhala (?)-Hoaeae and Honouliuli – there is an ancient holua or sleding [*sic*] place near this – which is agreed for the ancient corner. . . [Boundary Commission Vol. 1:243].

The earliest attempt to record archaeological remains in Honouliuli Ahupua'a was made by Thrum (1906:46). He reported the existence of a *heiau* located on Pu'uokapolei , west of the present Project Area. In a second monograph on *heiau*, Thrum (1917) called this *heiau* Palole'i (Kapolei). Emory mapped and photographed these structures in 1933 (field notes), but they were dismantled and destroyed sometime before McAllister's survey of the islands in the 1930s. According to legend, Pu'uokapolei was the location on which Kamapua'a, the pig-god, resided with his grandmother, Kamaunuahihio (McAllister 1933:108).

In his surface survey of the 1930s, archaeologist J. Gilbert McAllister recorded the specific locations of important sites, and the general locations of less important sites (at least at Honouliuli). McAllister recorded 14 specific sites at Honouliuli, numbered Sites 133-146 (McAllister 1933:107-108) Site 146, which McAllister used to denote the entire 'Ewa coral plains, is the only one of these sites in the Project Area. This "site," which is more of a general area covering all the coastal flatlands of 'Ewa would include portions of the current Project Area (all area outside the Honouliuli Gulch). Within Site 146, McAllister noted old ranching walls, salt work reminas, and coral pits used by the Hawaiians for cultivation of certain plants, such as bananas and sugar cane. The other thirteen sites are all outside of the Project Area.

The first six sites are in the upland section of Honouliuli, *mauka* of the 'Ewa coral plain and Pu'uokapolei . Site 133 is a possible *heiau*, a small enclosure at the foot of Pu'u Kānehoa. It was still standing during McAllister's day, and local residents informed him of its sacred nature. Site 134 is Pu'u Kuina Heiau, located in a gulch at the foot of Mauna Kapu. Only traces of a

largeterrace remained. Site 135 is a series of enclosures *makai* of Pu'u Kuina Heiau. McAllister believed that the walls marked *kuleana* lots. Site 136 is a small platform near Mauna Kapu, a sacred site, possibly an altar. Site 137 is Pu'u Ku'ua Heiau, plotted on a ridge near Pu'u Ku'ua; it had been modified for use as a cattle pen; some areas had been cleared for pineapple cultivation or planted with ironwoods. Site 138 is Pu'uokapolei Heiau, which had been on the *makai* side of the hill before it was destroyed. The stones of the structure had been crushed in a nearby rock crusher. McAllister was also told that there was once a cave on the hill, in which Kamapua'a and his grandmother lived (McAllister 1933:107-108).

The last eight sites recorded by McAllister are adjacent to Pearl Harbor or the coast. Site 139 is Kalanamaihiki Ko'a (fishing shrine) at Kapapapuhi Point (north of the current study area). McAllister described it as "two large rough stones about 2.5 feet in size, with six or seven smooth stones averaging 1 foot in size in a small pile adjoining the larger stones." Site 140 is a 4-5 acre fishpond on Laulaunui Island in West Loch, opposite Kapapapuhi Point. McAllister recorded the entire West Loch of Pearl Harbor as Site 141, Kaihuopala'ai. Although some versions of the legend of the traveling mullet (see Section 3.1, Mythological and Traditional Accounts) say that there was a fishpond called Kaihuopala'ai, McAllister recorded that local informants said there was never a fishpond by that name here; rather it was the name for the loch. Site 142 is Kapamuku, or Pamoku fishpond, a 3-acre fishpond, located south of the current study area, opposite the tip of Waipi'o peninsula. Site 143 is 'Oki'okiolepe fishpond, south of Loko Pamoku. The walls of this 6-acre fishpond were made of coral. As mentioned, Site 146 was used to represent the entire 'Ewa Plain.

McAllister records Site 144 as the location of fish traps and a fishing shrine described by Stokes in his study of the fishtraps of Pearl Harbor. This is the location of the fishtraps Kapākule (Pākule) and Kepo'okala, as described by Samuel Kamakau (1976:88). McAllister listed Site 145 as Pu'uloa, a legendary site where the first breadfruit was planted. It is not known whether Pu'uloa referred to is the '*ili* of Pu'uloa or the harbor of Pu'uloa, or an area within the '*ili* near the harbor. Site 146 covers the entire 'Ewa coral plain. This includes historic features, such as cattle walls and the walls near the Pu'uloa Salt Works, pre-Contact sites such as habitation, agricultural, and fishpond sites recorded by early European explorers, and paleontological sites, where in recent years many fossil bird bones have been discovered (McAllister 1933:108-110).

Between McAllister's 1930s study and the flurry of work that began in 1969, there are only a few sporadic pieces of research, which are not well documented. In 1933, Dr. Kenneth P. Emory recorded a well-preserved house site and a possible *heiau* (later destroyed by sugar cane cultivation) in the western part of the coral plains (Sinoto 1976:1). In 1959, William Kikuchi removed a number of burials from a burial cave site (Bishop Museum Site OA-B6-10) at the Standard Oil Refinery, which was subsequently destroyed (Barrera 1975:1). Kikuchi recovered 12-16 incomplete primary and/or secondary burials cached in a sinkhole or crevice exposed during construction activities near the big bend in Malakole Road (Kikuchi 1959; Davis 1990b: 146, 147). In 1960, Yoshi Sinoto and Elspeth Sterling visited a house site (BPBM. Site OA-B6-8) within 'Ēkaha Nui Gulch. "Around this elevation (1200 feet), along the sides of the stream, were seen remains of many terraces and some house sites" (Sterling and Summers 1978:37). In 1962, Lloyd Soehren recorded another secondary human burial in a sinkhole at the BarbersPoint Naval Air Station (Davis 1990a:147). In 1966, Lloyd Soehren carried out salvage excavations at a possible fishing shrine (BPBM. Site # 50-OA-B6-13). The site was reported as destroyed by construction (Barrera 1975:1), but Davis relocated the shrine and performed additional excavations in 1982 (Davis 1990a:148).

Table 2. Previous archaeological work in Honouliuli and Pu'uloa

Author	Report Type	Location
Thrum 1906	Heiau study	Hawaiian Islands
McAllister 1933	All island survey	O'ahu Island
Kikuchi 1959	Site letter report	Barbers Point
Bowen and Soehren 1962	Burial Discovery	Barbers Point
Soehren 1964	Site letter report	Waimanalo Gulch
Lewis 1970	Reconnaissance survey	Barbers Point (harbor area)
McCoy 1972	Survey	Pu'uloa Elementary School
Hommon 1973	Survey and Excavations	Honouliuli
Barrera 1975	Archaeological & reconnaissance	Barbers Point (harbor area)
Clark and Connolly 1975	Reconnaissance survey	Barbers Point (harbor area)
Oshima 1975	Reconnaissance survey	Barbers Point
Sinoto 1976	Cultural resources survey	Barbers Point (harbor area)
Bordner 1977a	Reconnaissance survey	Kalo'i Gulch
Bordner 1977b	Reconnaissance survey	Makaiwa Gulch
Clark 1977	Reconnaissance survey	Puu O Kapolei
Connolly and Clark 1977	Reconnaissance survey	Puu O Kapolei
Davis 1978	Scholarly paper	Barbers Point (harbor area)
Davis and Griffin 1978	Archaeological Survey	Barbers Point (harbor area)
Hawai'i Marine Research Inc.	Geoarchaeological reconnaissance	Barbers Point (harbor area)
Kirch 1978	Land snail study	Barbers Point (harbor area)
Sinoto 1978a	Reconnaissance Survey and Burial	NAVMAG -West Loch
Sinoto 1978b	Archaeological & Paleontological	Barbers Point (harbor area)
Barrera 1979	Archaeological survey	West Beach
Clark 1979	Reconnaissance survey	Barbers Point (harbor area)
Cleghorn 1979	Reconnaissance survey	Barbers Point
Davis 1979a	Emergency excavations	Barbers Point (harbor area)
Davis 1979b	Emergency excavations	Barbers Point (harbor area)
Davis 1979c	Archaeological survey	'Ewa Marina Community
Jourdane 1979	Reconnaissance Survey	'Ewa Marina Community
Komori and Dye 1979	Archaeological testing	West Beach
Sinoto 1979	Cultural resources survey	Barbers Point (harbor area)
Ahlo 1980	Reconnaissance survey	Solid Waste Processing
Davis 1980	Research design	Barbers Point
Kirch and Christensen 1980	Land snail study	Barbers Point (harbor area)
Christensen and Kirch 1981	Land snail study	Barbers Point (harbor area)
Hammatt and Folk 1981	Archaeological and Paleontological	Barbers Point (harbor area)
Davis 1982	Academic paper	Barbers Point
McCoy et al. 1982	Proposal for investigations	Barbers Point (harbor area)
Neller 1982	Scholarly study	Barbers Point
Ahlo and Hommon 1983	Reconnaissance survey	Barbers Point (harbor area)
Bordner and Silva 1983	Reconnaissance survey	Waimānalo Gulch

Author	Report Type	Location
Davis 1983	Archaeological & Paleontological Excavations	Barbers Point
Ahlo and Hommon 1984	Test excavations	Barbers Point (harbor area)
Hammatt 1984a	Reconnaissance survey	Kahe Point
Hammatt 1984b	Reconnaissance survey	Ewa Marina Community
Haun and Kelly 1984	Research resign	Naval Air Station
Tuggle 1984	Survey report	Naval Air Station
Barrera 1985	Archaeological survey	West Beach
Neller 1985	Review and evaluation	West Beach
Barrera 1986	Archaeological Investigations	West Beach
Davis and Haun 1986	Intensive survey and test excavations	West Beach
Davis et al. 1986a, b	Research design	West Beach
Haun 1986a	Reconnaissance survey	Kapolei Town
Haun 1986b	Reconnaissance survey	Kapolei Town
Athens & Pietrusewsky 1987	Burial documentation	Iroquois Point
Davis and Haun 1987	Intensive survey & test excavations	West Beach
Dicks et al. 1987	Reconnaissance survey	West Loch
Rosendahl 1987a	Reconnaissance survey	Kapolei Town
Rosendahl 1987b	Reconnaissance survey	Ko Olina Resort
Rosendahl 1987c	Reconnaissance survey	West Loch
Rosendahl 1987d	Reconnaissance survey	Kapolei Golf Course
Welch 1987	Reconnaissance survey	Naval Air Station
Davis 1988a	Subsurface Survey	'Ewa Gentry
Davis 1988b	Reconnaissance survey	Barbers Point HECO
Kennedy 1988a	Reconnaissance survey	'Ewa Gentry
Kennedy 1988b	Field Report	Waiau-Campbell Industrial
Rosendahl 1988	Reconnaissance survey	Camp Malakole
Sinoto 1988a	Reconnaissance survey	'Ewa Golf Course
Sinoto 1988b	Reconnaissance survey	Makakilo Golf Course
Bath 1989a	Petroglyph study	Waimānalo Gulch
Bath 1989b	Burial documentation	Kahe
Bath 1989c	Burial documentation	West Loch – Hō'ae'ae
Burgett and Rosendahl 1989	Subsurface archaeological testing	North of O.R.&L.
Hammatt and Shideler 1989a	Archaeological assessment	Barbers Point (harbor area)
Hammatt and Shideler 1989b	Reconnaissance survey	Kahe Point
Carlson and Rosendahl 1990	Inventory survey	Kaomi Loop Subdivision
Cleghorn and Davis 1990	Archaeological and paleontological	Barbers Point (harbor area)
Collin and Kennedy 1990	Burial documentation	Pu'uloa Golf Course
Davis 1990a	Archaeological and paleontological	Barbers Point (harbor area)
Davis 1990b	Archaeological and paleontological	Barbers Point (HECO area)
Davis et al. 1990	Survey and Test Excavations	Ewa Marina Community
Hammatt and Shideler 1990	Inventory survey	West Loch Bluffs
Hammatt, Robins, et al. 1990	Inventory survey	Makaiwa Hills
Hammatt, Shideler, et al. 1990	Inventory Survey	'Ewa Villages
Kawachi 1990	Inadvertent Burial find	Campbell Industrial Park
Miller 1990	Inadvertent Burial find	Barber's Point, Nimitz
Rosendahl 1990a	Letter report	Kapolei Golf Course

Author	Report Type	Location
Rosendahl 1990b	Archaeological Survey and Test	ʻEwa Marina Community
Davis and Burtchard 1991	Inventory Survey	NAVMAG-West Loch
Dunn et al. 1991	Inventory Survey and Test	ʻEwa Marina Community
Folk 1991	Reconnaissance Survey	Kapolei Town
Goodman and Cleghorn 1991	Surface Survey	Laulani Fairways Housing
Kennedy 1991	Subsurface testing	Puʻuokapolei
Hammatt 1991	Reconnaissance Survey	Honouliuli Livestock Park
Hammatt and Shideler 1991a	Archaeological assessment	Barbers Point (harbor area)
Hammatt and Shideler 1991b	Inventory Survey	St. Francis Medical Center
Haun et al. 1991	Survey report	Naval Air Station
Burgett and Rosendahl 1992	Inventory survey	Barbers Point (harbor area)
Charvet-Pond and Davis 1992	Data Recovery	West Beach
Cleghorn and Anderson 1992	Inventory survey	Kahe Point
Hammatt and Folk 1992	Subsurface testing	Barbers Point (harbor area)
Erkelens 1992	Archaeological survey	Naval Air Station
Folk 1992	Subsurface Testing	Barbers Point
Hammatt 1992	Inventory Survey	Palikea
Jayatilaka et al. 1992	Survey and Test Excavations	Hawaiʻi Prince Golf
Kennedy et al. 1992	Inventory Survey	Puʻuloa Golf Course
Shideler et al. 1992	Assessment	Kahe Point
Trembly et al. 1992	Burial documentation	West Beach
Davis 1993	Archaeological and paleontological	Barbers Point (harbor area)
Glidden et al. 1993	Data recovery excavations	Paradise Cove
Goodman et al. 1993	Reconnaissance Survey	20-acre Commercial
Jones 1993	Fossil coral reefs study (Ph.D.	Hawaiian Islands
Landrum and Schilz 1993	Reconnaissance and subsurface	Naval Air Station
Miller 1993	Data recovery	Barbers Point (harbor area)
Nakamura et al. 1993	Inventory survey	Makakilo
Pantaleo and Sinoto 1993	Inventory survey	Ewa Gentry
Hammatt and Shideler 1994	Archaeological assessment	Barbers Point (harbor area)
Hammatt et al. 1994	Inventory survey	Barbers Point (harbor area)
Tuggle 1994	Inventory survey	Barbers Point
Davis et al. 1995	Archaeological & Paleontological	Barbers Point (harbor area)
Dye 1995	Burial documentation	Barbers Point
Franklin 1995	Data Recovery	Ewa Marina Community
Hammatt and Shideler 1995	Data recovery plan	Barbers Point (harbor area)
Jourdane 1995	Burial documentation	Paradise Cove
Yoklavich et al. 1995	CRM Overview	Barbers Point
Corbin et al. 1996	Reconnaissance Survey	Laulaunui Island
O'Hare et al. 1996	Intensive survey and testing	Naval Air Station
Athens et al. 1997	Cultural resources,	ʻEwa Plain:Naval Air
Schilz and Landrum 1996	Test Excavations	Barbers Point
Spear 1996	Reconnaissance Survey	Kapolei Town
Borthwick 1997	Archaeological assessment	Palehua, Honouliuli
Hammatt 1997	Inventory survey	Puʻuloa
Hammatt and Chiogioji 1997	Reconnaissance Survey	Corridor in Honouliuli
Jensen and Head 1997	Reconnaissance Survey	NAVMAG-West Loch

Author	Report Type	Location
Tuggle 1997a	Cultural resource inventory	Naval Air Station
Tuggle 1997b	Synthesis	ʻEwa Plain
Tuggle and Tomonari 1997a,b	Cultural resource inventory survey	Naval Air Station
Wickler and Tuggle 1997	Cultural resources, Inventory Survey	Naval Air Station
Wolforth and Wulzen 1997	Data Recovery	West Loch Estates
Wulzen and Rosendahl 1997	Data Recovery	Barbers Point Nimitz
Goodfellow et al. 1998	Data Recovery	West Loch
Hammatt and Shideler 1999	Inventory survey	Waimanalo Gulch
Magnuson 1999	Reconnaissance Survey	Farrington Hwy.
McDermott et al. 2000	Data recovery	Barbers Point (harbor area)
Elmore et al. 2001	Honouliuli	Puʻu Kapolei/Fort Barrette
Ostroff et al. 2001	Inventory survey	Puʻuokapolei
Tulchin et al. 2001	Inventory survey	ʻEwa Shaft Renovation
McIntosh and Cleghorn 2003	Inventory survey	ʻEwa Gentry Makai
Cordy and Hammatt 2003	Archaeological assessment	Barbers Point, North of
O'Hare et al. 2005	Field Check	Kapolei Property
O'Hare et al. 2004	Documentation of Plantation	North of O.R.&L.
Terry et al. 2004	Archaeological Inventory Survey of	North of O.R.&L.
Hoffman et al. 2004	Archaeological Inventory Survey	Between OR&L and

5.2 Previous Archaeological Work near Honouliuli town

Beginning in the late 1970s, archaeological research has been conducted in Honouliuli in the general vicinity of the present study area (Figure 22). Work has been focused on the West Loch Estates (east of the current Project Area), Pearl Harbor Naval Magazine (NAVMAG) – West Loch (east of the current Project Area), the 'Ewa Gentry project (south of the Project Area), and 'Ewa Villages (south of the Project Area).

5.2.1 West Loch Estates

An archaeological reconnaissance survey (Rosendahl 1987c) was conducted in association with the development of the 232-acre "West Loch Estates" Residential Increments I and II (including golf course and parks) project, which lies to the east of the present study area, in the section of the Honouliuli Taro lands adjacent to Pearl Harbor. This project covered portions of the old town of Honouliuli, the focus of population in the early historic period (and possibly earlier). This study identified a modern cemetery (Site 3319) with a remnant pre-Contact deposit, two historic sites of minimal integrity with some possible pre-Contact deposits (Site 3318 and 3320) at Kapapapuhi Point, a significant pre-Contact deposit with trash pits, fire pits and at least one human burial (Site 3321), a buried fishpond (Site 3322), an historic fishpond (Site 3323) built in the 1890s during the construction of the OR& L railroad, and a buried pond field system (Site 3324) (Rosendahl 1987c:7, 9). It was noted that some artifacts "indicate the possibility of pre-1900 occupation" (Rosendahl. 1987c:8). As noted in the final reconnaissance survey report (Dicks et al. 1987:28) for the surface and subsurface reconnaissance survey, an effort was also made to relocate McAllister's Site 139, Kalanamaihiki Ko'a (fishing shrine). The archaeologists found a small boathouse and dock in the area and concluded that the shrine had been destroyed since McAllister's survey in the 1930s.

A total of 21 radiocarbon dates were determined; at Site 3321, the cultural deposit, the age of a lower cultural deposit was dated to A.D. 540-880, while an upper deposit was dated to A.D. 1327-1640. For the buried fishpond (Site 3322), ages ranged from A.D. 70-610 in the lowest layer to A.D. 1160-1410 in the upper layer. For the buried pond field systems (Site 3324), ages ranged from B.C. 400-A.D. 240 (interpreted as the original surface of the upper valley) in the lowest layers to A.D. 1430-1952 in the upper layers of upper valley area and A.D. 1020-1280 in lower valley area. In summary, the authors (Dicks et al. 1987:78-79) concluded that agricultural use of the Honouliuli Stream floodplain for pondfield cultivation of taro may have begun in the lower valley segment as early as A.D. 1000, while cultivation of the upper valley pondfields may have begun as early as the thirteenth and fourteenth centuries. Site 3321in the upper valley may have been a habitation locus established as early as the mid-sixth to mid-ninth century (Wolforth et al. 1998).

In 1989, a burial was found on Ho'ae'ae Point (formerly called Papapuhi Point), when someone was digging under a mango tree on a residential property. There is no follow-up report (Bath 1989) to whether the bones were left in place or disinterred. The burial was given the site designation 50-80-13-4816.

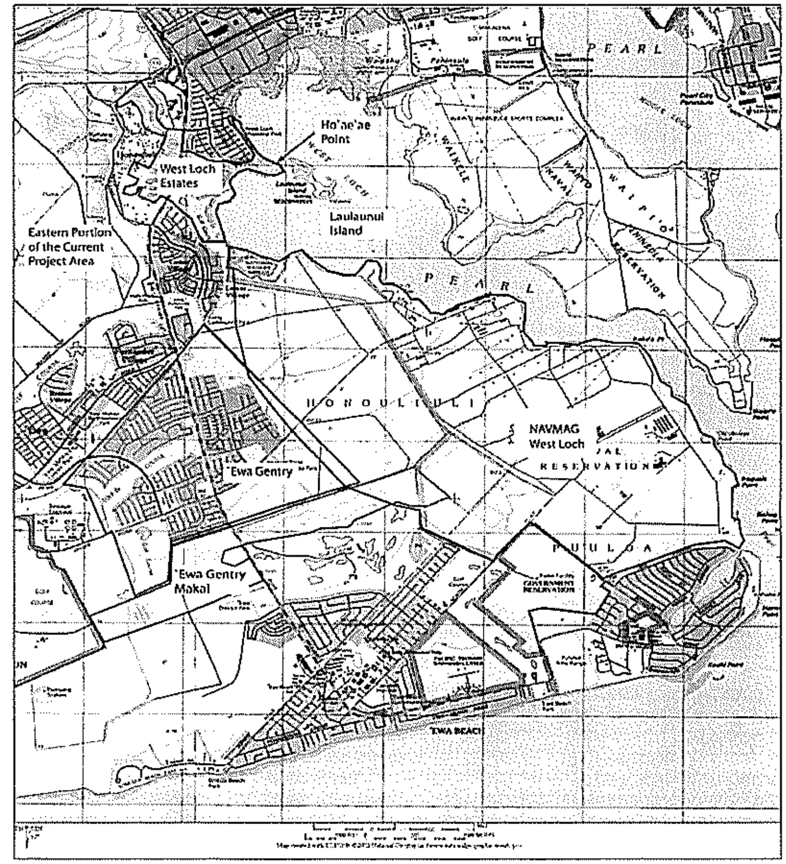

Figure 22. U.S. Geological Survey topographic map, showing previous archaeological survey areas in relation to the Project Area

5.2.2 NAVMAG – West Loch

In 1978, Sinoto conducted an archaeological reconnaissance survey on a 32-acre portion of NAVMAG-West Loch. A sinkhole 200 miles inland and northwest of 'Oki'okiolepe Fishpond was found, containing ten human burials (Site 50-80-13-2310). The historic artifacts found in the pit, indicated that the pit was probably used by the Chinese in the historic period as a family crypt (Sinoto 1978a).

Davis and Burtchard (1991) conducted an archaeological inventory survey of a 36-acre lot for a proposed housing area in the Pu'uloa portion of NAVMAG-West Loch in 1991. No archaeological sites were found. They concluded that extensive alteration to the landscape due to military land disturbance had erased all surface traces of pre-Contact habitation.

In 1992, a crew from Archaeological Consultants of Hawai'i, Inc. (ARCH) conducted an archaeological inventory survey with subsurface testing, and later data recovery at the proposed Pu'uloa Golf Course (Kennedy et al. 1992). A total of 72 sites were identified, 47 from the pre-Contact/early historic period and 25 sites associated with ranching, military training, and modern quarrying. Radiocarbon dates of these habitation, agricultural, and ceremonial sites indicate that traditional Hawaiian use extended from A.D. 1090 to 1695.

An overview survey of the NAVMAG Lualualei was completed by Ogden Environmental and Energy Services in 1977 (Landrum et al. 1977). A total of ten sites had been previously recorded during the West Loch survey, three in the Honouliuli section, one within Pearl Harbor (Site 140, Laulaunui Island), five on Waipi'o peninsula, one in both (salt works), and one encompassing all lands (Pearl Harbor Navy Base). In Honouliuli, the sites were Site 141, Kaihuopala'ai (West Loch), Site 142, Loko Pamoku or Kapamuku, Site 143, 'Oki'okiolepe Fishpond, and salt works at Honouliuli (no site designation). NAVMAG-West Loch is considered part of the Pearl Harbor Navy Base (Site 50-80-13-9992) due to its importance during World War II. The site was listed as a National Historic Landmark in 1966, on the National Register of Historic Places (NRHP) in 1966, on the State Inventory of Historic Places (SIHP), in 1971, and on the State Register of Historic Places in 1971 (Landrum et al. 1977:160).

In 1996, a crew from Paul H. Rosendahl, Ph.D., Inc. (PHRI) completed a Phase I archaeological reconnaissance survey of the 1,483 acres of land at the U.S. Naval Magazine – West Loch Branch (Jensen and Head 1997). This survey covered the southern section of Waipi'o peninsula on the east side of West Loch, Laulaunui Island, the Naval Reservation on the west side of West Loch, and the West Loch Outleased Cultivated Lands, which included the National Wildlife Refuge. Only 25% of the outleased lands were actually surveyed. The PHRI crew found that most of the outleased area had been bulldozed for sugarcane cultivation. Only a small strip adjacent to West Loch was unmodified. In the West Loch Outleased Lands, eight features were recorded; all but one was associated with military use of the area. The seven military sites consisted of six concrete slabs (Sites 50-80-13-5040, 5080, 5081, 5133, 5134), a metal container (5080), and a pressure tank (5133). The one non-military site (4971) was a cave with a partially blocked (blocked with roof fall) entrance that the crew members believed should be investigated in the future to see if it at one time was used as a pre-Contact or historic burial site (Jensen and Head 1997:85).

In 1996, a field reconnaissance of Laulaunui Island and fishpond was conducted by the State Historic Preservation Division (Corbin et al. 1996) to determine if restoration of the fishpond was possible and if the site would be a good candidate to be used as an educational tool. The crew simply walked to the island from the West Loch Waterfront Park; water depth varied from one to four feet. Five concrete structures, probably built by the military, were observed. The fishpond was surrounded by mangroves and was silted in; portions of a coral wall (about 500 ft long) around the pond were still intact, and a concrete gate allowed water to circulate into the pond.

5.2.3 'Ewa Villages

In 1990, Cultural Surveys Hawaii conducted an archaeological reconnaissance survey of a 616-acre area, which included three extant plantation villages, (Renton, Tenney, and Varona Village), the sites of three former plantation villages (C Village, Mill Village, Middle Village), and other sites associated with the Ewa Plantation infrastructure (Hammatt, Shideler, et al. 1990:i). The survey found no evidence of any pre-Contact activity within the survey area and recommended further documentation of some of the ruined plantation structure sites.

In 1996, Scientific Consultant Services (Spear 1996) conducted an archaeological survey in an area west of the Tenney and Varona plantation villages and north of the Honouliuli Treatment Plant. No archaeological sites were identified.

5.2.4 'Ewa Gentry Project

In the initial reconnaissance (Kennedy 1988a) of the 1,016 acre 'Ewa Gentry survey area, no surface evidence of potentially significant pre-Contact remains was found. The old OR&L railroad bed/right of way (Site 50-80-12-9714) did form a portion of the *mauka* boundary. According to historic maps, a Filipino Camp for sugarcane workers once existed near the intersection of the OR&L bed and a cane road near Ft. Weaver Road, but the archaeologists did not find any surface remains for this camp.

A subsequent subsurface exploration was undertaken. Eighteen backhoe trenches were excavated; however, "no evidence of past in situ cultural activity was found anywhere in the 'Ewa Gentry Project Area" (Davis 1988).

An inventory survey was conducted in 1993 by Aki Sinoto Consulting (ASC) (Pantaleo and Sinoto 1993) for the 'Ewa Gentry Off-Site Drainage System. This proposed drainage Project Area is a narrow strip that extends along the western boundary of NAVMAG West Loch, and is adjacent to the southern non-contiguous parcel (TMK 9-1-010:002) for the current Project Area. An 1897 map of Pearl Harbor indicated that the OR&L railroad, salt pans, and a fishpond were within this Project Area; only the railroad bed was found during the ASC survey. Iron flumes and concrete culverts (one with an inscribed date of July 1935) used for sugarcane irrigation were found bulldozed to the edge of the sugar cane fields near the dropoff to the shoreline of Pearl Harbor. These were not considered historically significant due to the absence of structural and locational integrity. No further archaeological work was recommended for this project prior to commencement of construction of the drainage system.

In 2003, Pacific Legacy (McIntosh and Cleghorn 2003) conducted an archaeological survey of the proposed 'Ewa Gentry Makai Development Project Area, which is adjacent to the southern (*makai*) boundary of the 'Ewa Gentry Project Area for the 1988 surface and subsurface inventory surveys (Kennedy 1988a; Davis 1988).

5.2.5 Previous Archaeology in the Current Project Area

As noted previously, and as discussed in more detail in the next section, a 546-acre portion of the current Project Area (the southeastern section) was previously surveyed in 1990 by a crew from Cultural Surveys Hawai'i. In 2005, a field assessment was conducted over the entire current Project Area by archaeologists from the firm Archaeological Consultants of the Pacific, Inc. (Elison and Kouneski 2005). The archaeologists found one "stone-faced hill" in the northern section of the Project Area (north of Farrington Highway), but did not describe it further. The report presents recommendations for field work in the different sections of the Project Area, concluding that the majority of the Project Area is farm land and did not need to be surveyed. Only the area around Honouliuli Gulch, and other areas of natural vegetation in the northern section needed to be surveyed.

Section 6 Traditional Land Use In Honouliuli Ahupua'a

The *ahupua'a* of Honouliuli is the largest traditional land unit on the island of O'ahu. Honouliuli includes all the land from the western boundary of Pearl Harbor (West Loch) westward to the 'Ewa/Wai'anae District Boundary with the exception of the west side of the harbor entrance, which is in the *ahupua'a* of Pu'uloa (the 'Ewa Beach/Iroquois Point area). This comprises approximately 12 miles of open coastline from One'ula westward to Pili O Kahe. The *ahupua'a* extends *mauka* (almost pie-shaped) from West Loch nearly to Schofield Barracks, and the western boundary is the Wai'anae Mountain crest running *makai* to the east ridge of Nānākuli Valley.

Not only is there a long coastline fronting the normally calm waters of leeward O'ahu, but there are also four miles of waterfront along West Loch. The land immediately *mauka* of the Pacific coast consists of a flat karstic raised limestone reef forming a level nearly featureless "desert" plain marked in pre-contact times (previous to sugar cultivation) by a thin or non-existent soil mantle. The microtopography is notable in containing countless sinkholes in some areas caused by chemical weathering (dissolution) of the limestone shelf.

Along the eastern flank of the Wai'anae Mountains, numerous gulches have contributed to the alluvial deposits over the coastal limestone shelf. The largest of the gulches is Honouliuli Gulch, which drains into West Loch. The gulches are generally steep-sided in the uplands and generally of a high gradient until they emerge onto the flat 'Ewa plain. The alluvium they have carried has spread out in delta fashion over the *mauka* portions of the plain, which comprises a dramatic depositional environment at the stream gradient change. These gulches are generally dry, but during seasonal Kona storms carry immense quantities of runoff onto the plain and into the ocean. As typical drainages in arid slopes they are either raging uncontrollably, or are dry and, as such, do not form stable water sources for traditional agriculture in their upper reaches. The Honouliuli gulches generally do not have valleys suitable for extensive irrigated agriculture; however, this lack is more than compensated for by the rich watered lowlands near West Loch.

Honouliuli Ahupua'a, as a traditional land unit, had abundant and varied resources available for exploitation by early Hawaiians. The "karstic desert" and marginal characterization of the limestone plain, which is the most readily visible terrain, does not do justice to the *ahupua'a* as a whole. The richness of this land unit is marked by the following available resources:

1) 12 miles of coastline with continuous shallow fringing reef, which offered rich marine resources.

2) Four miles of frontage on the waters of West Loch, which offered extensive fisheries (mullet, *awa*, shellfish), as well as frontage suitable for development of fishponds.

3) The lower portion of Honouliuli Valley in the 'Ewa plain offered rich level alluvial soils with plentiful water for irrigation from the stream as well as abundant springs. This land would have stretched well up the valley.

4) A broad limestone plain, which because of innumerable limestone sinkholes, offered a nesting home for a large population of avifauna. This resource may have been one of the early attractions to human settlement.

5) An extensive upland forest zone extending as much as 12 miles inland from the edge to the coastal plain. As Handy and Handy (1972:469) have pointed out, the forest was much more distant from the lowlands here than it was on the windward side, but on the leeward side was more extensive. Much of the upper reaches of the *ahupua'a* would have had species-diverse forest with *kukui*, *'ōhia*, sandalwood, *hau*, *ti*, banana, etc.

Within this natural setting, archaeological and traditional sources show a general pattern of three main areas of settlement within the *ahupua'a*: a coastal zone, the Honouliuli taro lands, and inland settlement at Pu'u Ku'ua.

6.1.1 The Coastal Zone - Kalaeloa (Barbers Point), Ko'olina (West Beach)

Kalaeloa (Barbers Point)

Archaeological research at Barbers Point has focused on the areas in and around the newly constructed Deep Draft Harbor (Barrera 1975; Davis and Griffin, 1978; Hammatt and Folk, 1981, McDermott et al. 2000). Series of small clustered shelters, enclosures and platforms show limited but recurrent use at the shoreline zone for marine-oriented exploitation. This settlement covers much of the shoreline with more concentrated features around small marshes and wet sinks. Immediately behind the shoreline, under a linear dune deposit, is a buried cultural layer believed to contain some of the earliest habitation evidence in the area.

The attraction of the area to early Hawaiians was the plentiful and easily exploited bird population. Particular evidence for taking of petrels occurs at Site -2763 (Hammatt and Folk, 197:213). Initial heavy exploitation of nesting seabirds and other species in conjunction with habitat destruction probably led to early extinction. There is some indication of limited agriculture in mulched sinkholes and limited soil areas. Considering rainfall, this activity would have been limited, but probably involved tree crops and roots (sweet potatoes). The archaeological content of the sites indicates a major focus on marine resources.

Davis and Griffin (1978) distinguish functional classes of sites, based on surface area size and argues that the Barbers Point settlement consists of functionally integrated multi-household residence groups. Density contours of midden (by weight) and artifacts (by numbers) plotted for residence sites by Hammatt and Folk (1981) generally indicate narrowly defined spatial foci of discard, possibly indicating continuous use, or at least with no refurbishing or additions to the structures through time (Hammatt and Folk 1981). The focus is small habitation sites, typically lacking the full range of features found in large permanent residence complexes such as high platforms, complex enclosures, and ceremonial sites.

Ko'ōlina (West Beach)

There are three available studies on the Ko'ōlina Project Area (Davis et a. 1986a; Davis et al. 1986b; and Davis and Haun 1987).

Davis documents around 180 component features at 48 sites and site complexes consisting of habitation sites, gardening areas, and human burials. Chronologically the occupation covers the

entire span of Hawaiian settlement, in what Davis and Haun describe as "one of the longest local sequences in Hawaiian prehistory" (Davis and Haun 1987:37). The earliest part of the sequence relates to the discovery of an inland marsh, and early dates were also obtained for the beachfront site and an inland rock shelter.

6.1.2 Honouliuli Taro Lands

Centered around the west side of Pearl Harbor at Honouliuli Stream and its broad outlet into the West Loch are the rich irrigated lands of the *'ili* of Honouliuli, which give the *ahupua'a* its name. The major archaeological reference to this area is Dicks, Haun, and Rosendahl (1987) who documented remnants of a once-widespread wetland system (*lo'i* and fishponds) as well as dryland cultivation of the adjacent slopes. The Project Area is within this environmental zone.

The area bordering West Loch was clearly a major focus of population within the Hawaiian Islands, and this was a logical response to the abundance of fish and shellfish resources in close proximity to a wide expanse of well-irrigated bottomland suitable for wetland taro cultivation. The earliest detailed map (Malden 1825) shows all the roads of southwest O'ahu coalescing and descending the *pali* (cliff) as they funnel into the locality (i.e. Honouliuli Village). Dicks et al. (1987:78-79) conclude, on the basis of 19 carbon isotope dates and 3 volcanic glass dates that "Agricultural use of the area spans over 1,000 years." Undoubtedly, Honouliuli was a locus of habitation for thousands of Hawaiians. Pre-Contact population estimates are a matter of some debate but it is worth pointing out that in the earliest mission census (Schmitt 1973:19) 1831-1832, the land (*'āina*) of Honouliuli contained 1026 men, women, and children. It is not clear whether this population relates to Honouliuli Village or the entire *ahupua'a*, but the village probably contained the vast majority of the district's population. The nature of the reported population structure for Honouliuli (less than 20% children under 12 years of age) and the fact that the population decreased more than 15% in the next 4 years (Schmitt 1973:22) suggests that the prehistoric population of Honouliuli Village may well have been significantly greater than it was in 1831-1832. A conservative estimate would be that tens of thousands of Hawaiians lived and died at Honouliuli Village.

6.1.3 Pu'uku'ua: Inland Settlement

Documentation of inland settlement in Honouliuli Ahupua'a is more problematic in that there are relatively few documented archaeological sources. However, it is probable that the area around Pu'uku'ua, on the east side of the Wai'anae Ridge seven miles inland of the coast, was a Hawaiian place of some importance.

In 1899, Hawaiian Newspaper *Ka Loea Kālai'āina* relates a story of Pu'uku'ua as "a place where chiefs lived in ancient times" and a "battle field," "thickly populated." The article summarizes:

> There were two important things concerning this place. (1) This place was entirely deserted and left uninhabited and it seems that this happened before the coming of righteousness to Hawai'i Nei. Not an inhabitant is left. (2) The descendants of the people of this place were so mixed that they were all of one class. Here the gods became tired and returned to Kahiki [Sterling and Summers 1978:33].

McAllister recorded three sites in this area, two *heiau* (134, 137) (Pu'u Kuina and Pu'uku'ua, both destroyed) and a series of enclosures in Kukuilua which he called "kuleana sites" (McAllister 1933). On the opposite side of the Wai'anae range, along the trail to Pōhākea Pass, Cordy (2002:36) states "Kākuihihewa was said to have built (or rebuilt) Nōi'ula, a *pō'okanaka heiau* (1,300 sq. m.) in Hālona in upper Lualualei, along the trail to Pōhākea Pass leading into 'Ewa, ca. A.D. 1640-1660" (Cordy 2002:36). There is no direct archaeological evidence available to the authors' knowledge that intensive Hawaiian settlement occurred here, but it is considered as a place of high probability, based on the above indications. John Papa 'Ī'ī (1959) described a journey that Liholiho took which led him and an entourage through inland Honouliuli and over Pōhākea Pass. Geographically, the area receives sufficient quantities of water and would have had abundant locally available forest resources.

6.1.4 Summary

On the basis of archaeological studies, informed by historic records, the following may be concluded:

1) There are three areas of Hawaiian settlement in the *ahupua'a*; two are well-documented and one is problematic:
   a. the extensive limestone plain with recurrent use habitations for fishermen and gatherers and sometime gardeners;
   b. the rich cultivated lands of Honouliuli 'ili for extensive wetland taro and clearly the *ahupua'a* population center; and,
   c. the uplands around Pu'uku'ua associated with *kauwā* residence but probably used for agriculture and forest resources.

2) Honouliuli is designed as a unit to contain all the geographic elements of a typical Hawaiian valley *ahupua'a*, except they are arranged geomorphically in an atypical relationship. The *ahupua'a* is not organized around a single drainage network but shares the west portions of Waikele drainage in its upper reaches. A typical and highly advantageous characteristic for human subsistence is included in a vast coastline and fringing reef, an extensive limestone plain which would support only limited agriculture but would be excellent for bird catching in early times, and a huge expanse of sloping forest land. The richest forest land for foraging for wood, birds, feathers, etc. would have been the east slope of the Wai'anae Range. The surveys by Bordner (1983) and Hammatt and Shideler (1999) at Waimānalo Gulch indicated no evidence of Hawaiian occupation, but the gulch has been impacted in modern times (Bordner 1983).

3) The *makai* slope was not a major thoroughfare. We can see some very limited evidence of part-time agriculture in and around gulches and two foci of sparse habitation. The first is limited to *makai* portions of gulches and lava flats. This habitation is considered a *mauka* component or continuing of the Ko'ōlina coastal settlement rather than an independent focus. The second focus, separated from the first by a barren zone, is generally above the 800-foot elevation. This *mauka* habitation which could have been supported by seasonal dry land planting and forest foraging may be the lower portion of a

thinly scattered, but widespread zone of settlement which stretches eastward and northeast along the east Wai'anae Range slopes and may increase in intensity along the more watered lands forming the *mauka* western boundary of Honouliuli.

4) There is to date no archaeological evidence of high status residence in Honouliuli. Large residential structures are not present along the Pacific shoreline where they would be expected. The late prehistoric occurrence of chiefs' houses is not apparent, perhaps because the ocean shoreline, although rich in marine resources, is uninviting for sport and unsuitable for fishponds. The chiefly focus of 'Ewa District was Waipi'o. Whatever activities of this class occurred in Honouliuli would have been in or near the rich lands fronting West Loch (the *'ili* of Honouliuli). Concerning status associations with Honouliuli, it is interesting to note the connection of the Pu'uku'ua settlement with slaves (*kauwā*), the lowest class of Hawaiians (Sterling and Summers 1978:33).

5) The focus of population and agriculture within the *ahupua'a* of Honouliuli was the *'ili* of Honouliuli. There is good reason to assume, given the lack of intensive agricultural resources in other prehistoric times, all other habitation zones were economically and socially co-dependent.

Section 7 Community Consultation

Throughout the course of this study, an effort was made to contact and consult with Hawaiian cultural organizations, government agencies, and individuals who might have knowledge of and/or concerns about traditional cultural practices associated with the Project Area. CSH contacted the individuals listed on Table 3 by letter, e-mail, telephone, and in personal contact. In the majority of cases, a letter along with a TMK map and a USGS topographical map of the Project Area were mailed with the following text:

> In collaboration with Environmental Communications, Inc., Cultural Surveys Hawai'i (CSH) is conducting a Cultural Impact Assessment for the proposed East Ho'opili Project, 'Ewa District, Honouliuli Ahupua'a, O'ahu Island (TMK: [1] 9-1-010:002; 9-1-017:004, 059; 9-1-018:001, 004, 072; 9-2-001:001). A map of the Project Area is enclosed for your reference.
>
> The purpose of this assessment is to identify any traditional cultural practices associated with the Project Area, past or present, pursuant to Hawaii revised Statutes 343. We are seeking your *kokua* and guidance regarding the following aspects of our study:
>
> General history and present and past land use of the study area;
>
> Knowledge of cultural sites that may be impacted by the project, for example historic sites, archaeological sites, and burials;
>
> Knowledge of traditional gathering practices in the study area, both past and on-going;
>
> Cultural associations with the study area through legends, traditional use or otherwise;
>
> Referrals of *kūpuna* or anyone else who might be willing to share their general cultural knowledge of the study area, and the surrounding *ahupua'a* lands.
>
> Any other cultural concerns the community might have related to cultural practices within or in the vicinity of the Project Area.
>
> The focus of this study is to document the potential impacts to cultural practices or resources of the proposed Project Area. If you wish to voice any cultural concerns or provide input on any of the above, please contact Kēhaulani Souza of Cultural Surveys Hawai'i at (808) 262-9972. Ms. Souza may also be contacted by e-mail at ksouza@culturalsurveys.com.

The individuals, organizations, and agencies attempted to be contacted and the results of any consultations are presented in Table 3: Community Contact List

Cultural Surveys Hawai'i Inc.
Archaeological and Cultural Impact Studies
Hallett H. Hammatt, Ph.D., President

Providing Excellence in Cultural Resource Management

O'ahu: P.O. Box 1114, Kailua, HI 96734, Ph.: (808) 262-9972, Fax.: (808) 262-4950
Maui: 16 S. Market St., #2N, Wailuku, HI 96793, Ph.: (808) 242-9882, Fax.: (808) 244-1994
Kaua'i: P.O. Box 498, Lawai, HI 96765, Ph.: (808) 245-4883

(November 17, 2005 date first sent)
January 26, 2006

Subject: **Cultural Impact Assessment for the East Kapolei Community Project, Honouliuli Ahupua'a, 'Ewa District, O'ahu Island [TMK9-1-010:001, 9-1-017:004, 059, 072; 9-1-018:001, 004, 9-2-001:001] approximately 1,585-acres**

Aloha:

At the request of D. R. Horton-Schuler Division, Cultural Surveys Hawai'i is conducting a Cultural Impact Assessment (CIA) for the East Kapolei Community Project, Honouliuli Ahupua'a, 'Ewa District, O'ahu (TMK: 9-1-010:001, 9-1-017:004, 059, 072; 9-1-018:001, 004, 9-2-001:001) (Figure 1 and 2).

The purpose of the Cultural Impact Assessment is to assess potential impacts to traditional cultural practices as a result of future development of the proposed East Kapolei Community Project. The development will include residential, commercial, educational and recreational facilities.

We are seeking your *kōkua* or help and guidance regarding the following aspects of our study:

- **General history and present and past land use of the project area.**
- **Knowledge of cultural sites which may be impacted by future development of the project area - for example, historic sites, archaeological sites, and burials.**
- **Knowledge of traditional gathering practices in the project area – both past and ongoing.**
- **Cultural associations of the project area, such as legends and traditional uses.**
- **Referrals of *kūpuna* or elders who might be willing to share their cultural knowledge of the project area and the surrounding *ahupua'a* lands.**
- **Any other cultural concerns the community might have related to Hawaiian cultural practices within or in the vicinity of the project area.**

I invite you to contact me, Kēhaulani Souza at (808) 262-9972 or send me an e-mail at ksouza@culturalsurveys.com if you have any information you would like to share.

Me ka ha'aha'a,

Kēhaulani Souza

www.culturalsurveys.com | info@culturalsurveys.com

Figure 23: Contact letter sent to organizations and individuals in Table 3

Table 3: Community Contact List

Name	Affiliation	Comments
Ailā Willliam	Hui Mālama I Nā Kūpuna O Hawai'i Nei, Wai'anae Representative	Made referral: Shad Kane
Cayan, Coochie	Former O'ahu Island Burial Council member	Made referrals: Shad Kane, Nettie Tiffany, and the Neighborhood Board.
Crail, Gail	Former resident of Honouliuli	Mrs. Crail remembers the Project Area always covered with sugar cane. She suggested that we contact the Murata and the Iwata families who have lived in Honouliuli a long time.
Eaton, Arline	*Kupuna* at Iroquois Elementary School	See Traditional Cultural Practices below for response.
Futoshi, Shinogi	Resident of Honouliuli	Mr. Futoshi mentioned that the east side of old Fort Weaver Road was all wetlands. He also mentioned that this area was well know for artesian wells and the current site of the first artesian well is not the original site, it was further back near the current *lo'i* (taro pond).
Hirata, Richard "Dickey"	President of Hawaii Plantation Village; Raised at the 'Ewa Plantation	Made referral: Arakawa family.
Iwata, Tom	Resident of Honouliuli for 90 years	Mr. Iwata has lived in Honouliuli all his life and remembers Pipeline Village above old Fort Weaver Road; *lo'i* behind his house; and the entire Project Area being covered with sugar cane.
Ka'eliwai, George	Hawaiian Civic Club of 'Ewa/Pu'uloa	Mr. Ka'eliwai would gather oysters from Pu'uloa.
Kalili, Christina	Raised in Tenney Village	Made referral: Soma 'Ohana
Kane, Shad	Makakilo, Kapolei, Honokai Hale Neighborhood Board Member	Made referral
Malama, Tesha	Former 'Ewa Neighborhood Board member	Made referrals: Mary Serrao, Arline Eaton.
Murakami, Mae	Raised in Honouliuli. Grandparents and parents owned Honouliuli Shokai Store	Mrs. Murakami's grandfather Katsuhei Murata started the Honouliuli Shokai store on Old Fort Weaver road. She noted: "the store was like a little Wal-Mart with its own tailor, butcher and groceries. They also

Name	Affiliation	Comments
		imported and exported to Japan. It was "ahead if its time." She also mentioned that her grandfather set up a credit system for the people in the community. Mae also added that Chocolate Beach was a childhood place where they would often go to gather clams, and fish from the ocean.
Nāmu'o, Clyde	Administrator at Office of Hawaiian Affairs	In a letter to CSH dated 2-20-06 Office of Hawaiian Affairs stated that they had no comment at this time.
Nakamatsu, Charles	Raised in the 'Ewa Plantation in "C" Village.	See Traditional Cultural Practices below for response
Oshiro, Richard	Former 'Ewa Plantation employee	See Traditional Cultural Practices below for response
Paishon, Frank	Raised in Tenney Village	Mr. Paishon mentioned east of the Project Area was a great place to go fishing AT Chocolate Beach. They would catch oysters, clams, and all types of crabs.
Ramos, Rodolfo	Chair of 'Ewa Task Force	Mr. Ramos mentioned that they would go fishing at Chocolate Beach, east of the Project Area, and they would catch all types of crabs and pick oysters and clams. He said as far as he remembers that area was always sugar cane.
Sato, Melvin	Raised in Ewa Plantation "C" Village	Mr. Sato mentioned that Chocolate Beach was a great place to fish and gather oysters and clams. He said his uncle Charles Nakamatsu would know more about the Project Area.
Soma, Kenneth	Retired 'Ewa Plantation and current resident	See Traditional Cultural Practices below for response
Soma, Millie	Raised in 'Ewa Plantation Tenney Village	Mrs. Soma was born in 1935 and has lived in 'Ewa Plantation ever since. She has no major concerns.
Tiffany, Nettie	O'ahu Island Burial Council, Kahu for Lanikuhonua	Mrs. Tiffany commented the land has been altered over the years by the plantation. She suggested that consultation be conducted with people from the plantation
Quintal, Leti	Raised in 'Ewa Plantation, Secretary for the Immaculate Conception Church in 'Ewa	Mrs. Quintal remembers the Project Area always covered with sugar cane. She also made referrals of people in the community Mr. Kojima and his wife, Shgeru Yawata, and Lida and Pio Barbieto.

7.1.1 Biographical Sketches of the Interview Informants

Aunty Arline Wainaha Pu'uloa Eaton

Aunty Arline Eaton is 79 years old, born in 1927. She was raised in the old traditional Hawaiian style, speaking her native language (Hawaiian) and traveling by canoe. She was raised in the area known as Keahi and Kūpaka, now known as Iroquois Point/'Ewa. She also lived for a short time in Kalihi before moving to Keahi. Her Papa Brede was the head of operations for the Dowsett Ranch. She has been the *kupuna* at Iroquois Elementary School for 19 years. Aunty Arline is one of the oldest and most knowledgeable Hawaiians for this area of O'ahu.

Richard "Dickey" Hirata

Mr. Hirata is 72, born in 1934 at the 'Ewa Plantation with the assistance of a midwife. He was raised in one of the many 'Ewa Plantation Villages called Lower Village, which was adjacent to the Project Area. Mr. Hirata's parents came to O'ahu to work in the plantation. Mr. Hirata worked for the 'Ewa Plantation for nine months then went into the army for three years. He then graduated from North Carolina State with a Bachelors Degree in Electrical Engineering. He later returned home and accepted a job with the State of Hawai'i as a Development Manager. He retired from the State of Hawai'i and now is the President of the Hawai'i Plantation Village, located in Waipahū.

Charles Yosei Nakamatsu

Mr. Nakamatsu is 85 years old, born in 1920. He was raised in the Ewa Plantation in "C" Village. He is second generation Okinawan and his parents came to Hawaii to work in the plantation. Mr. Nakamatsu worked for the plantation for 18 years as a welder then went to work for an air conditioning company.

Richard Oshrio

Mr. Oshiro is 78, born in 1928. His parents, Guikichi and Kamado Oshiro, were first generation immigrants from Okinawa. They came to Hawaii to work at the 'Ewa Plantation. Mr. Oshiro has a long history with the 'Ewa Plantation; for 77 years he has lived and worked in 'Ewa. He first lived in the Waimānalo Village, which is now known as the Ko'ōlina area, then in 1943 his family moved closer to the plantation's "C" Village, then to Tenney Village where he resides today. He retired in 1990 from the plantation.

Kenneth Soma

Mr. Soma is 80, born in 1926. He is full-blooded Japanese. His parents came from Japan to work at the 'Ewa Plantation. He was raised in the plantation and later worked for the plantation as a heavy equipment operator. After the Ewa Plantation closed, Oahu Sugar took over so he retired from Oahu Sugar. He also worked as a director at the Mililani Mortuary for 26 years. Today he enjoys his life in the same area that he was raised in 'Ewa.

Section 8 Traditional Cultural Practices

The northern portion of the Project Area is adjacent to Farrington Highway and the east end of the Project Area is on the boundary of the Honouliuli Taro Lands; a once-widespread wetland used for the cultivation of taro (*lo'i* and fishponds), as well as dryland cultivation of the adjacent slopes, which may have been utilized as early as A.D. 1000 (Dicks et al. 1987:78-79). East of the Project Area is West Loch (Kaihuopala'ai) of Pearl Harbor, which offered extensive fishponds (mullet, milkfish, shellfish), as well as shoreline frontage suitable for development of more fishponds. However, the majority of the Project Area is plateau land which would not have been as extensively modified or utilized based on environmental factors.

Discussions of specific aspects of traditional Hawaiian culture during information gathering interviews and "talk story" sessions are incorporated throughout this section as they may relate to the Project Area. The interviewees are represented by first and last initials with CSH denoting the Cultural Surveys Hawai'i interviewer. Some interviewees gave permission for CSH to include pertinent excerpts from interviews on Honouliuli conducted by CSH in the past for this assessment.

8.1 Gathering for Plant Resources

In the Māhele records it was documented that taro was primarily abundantly grown on the eastern edge of the Project Area (see Figure 9 & 10). Also, according to a documentation included in a study of land use in Honouliuli, it was mentioned that Kukui trees were abundant in the area, "...and of an 'old kukui tree' which was one of the boundary markers between Honouliuli and Hoaeae. This boundary runs along the present Kunia Road, and the tree is another indication that there was once a forest at this point" (Frierson 1972:12).

Given the ecosystem diversity of coastal lowland, transition, and upland forest zones in Honouliuli Ahupua'a, it is likely that one of the primary traditional cultural practices associated with the present project area would have been the gathering of native plant resources. Table 4 lists Honouliuli lowland plants and uses with columns for "common/Hawaiian name", "scientific name" and "use" based on research conducted by Barbara Frierson (1973) on native plant species present in Honouliuli before 1790, in addition to plant use recorded by Isabella Abbott (1992).

Table 4. Native Plants in Honouliuli

Hawaiian/Common Name	Scientific Name	Use
Hala, pandanus	*Pandanus odoratissimus*	Weaving
Hau, hibiscus	*Hibiscus tiliaceus*	Cordage
Milo	*Thespesia paradisiaca*	Wood used for bowls
Neneleau, Sumac	*Rhus sandwicensis* *Rhus chinensis*	Unknown
'Ilima	*Sida cordifolia*	Leis, medicine

Hawaiian/Common Name	Scientific Name	Use
Kou	*Cordia subcordata*	Bowls
Makaloa, sedge	*Cyperus laevigatus*	Mats (Abbott)
Pili grass	*Heteropogon contortus*	Thatch
Kakonakona, grass	*Panicum torridum*	Unknown
Honohonowai	*Commelina nudiflora*	Unknown
Ma'o, cotton	*Gossypium tomentosum* *Abutilon incanum*	Flowers used as dye for kapa (Abbott)
'Ūlei	*Osteomeles anthyllidifolia*	Branches used for fishing nets (Abbott)
'Uhaloa	*Waltheria americana*	Medicine (Abbott)
Koali'ai	*Ipomoea cairica*	Cordage (Abbott)
Pā'ū o Hiiaka	*Jacquemontia sandwicensis*	Unknown
Ko'oko'olau	*Bidens* sp.	Used as tea (Abbott)
'Ulu, breadfruit	*Artocarpus incisus*	Food
Taro	*Colocasia esculenta*	Food
Niu, coconut	*Cocos nucifera*	Food, liquid

The accessibility of Honouliuli lands, including the present Project Area, to the Hawaiians for gathering or other cultural purposes would be radically curtailed during the second half of the nineteenth century. As noted above in this evaluation, by the 1870s, herds of cattle grazing across the 'Ewa Plain likely denuded the landscape of much of the native vegetation. Subsequently, during the last decade of the nineteenth century, the traditional Hawaiian landscape was further altered by the introduction and rapid development of commercial sugar cane cultivation. Throughout the twentieth century, sugar cane cultivation was the dominating land use activity within the Project Area. Cane cultivation. –and the sense that the Project Area was private property– made it difficult for employees of the 'Ewa Plantation to get access inside the Project Area, restricting right of entry. .

Based on the evidence gathered for this evaluation, at present no contemporary or continuing cultural practices occur within the Project Area specifically.

8.2 Taro in Hawaiian Culture in Regards to the Project Area

It has been documented that taro was grown in the wetlands adjacent to the Project Area and a few interviewees remembered those times as well. In this section, the cultural connections of Hawaiians to taro will be discussed.

Taro has an intimate connection to the Hawaiian culture. Taro (*kalo*; *Colocassia esculenta*) was probably brought to Hawai'i by the earliest Polynesian voyagers and has been a staple crop on the islands ever since. Taro is intimately connected through myth to the origins of Hawaiians as a people. There are different versions of this myth, but all of them make the connection between the first-born Hawaiian and the taro plant, according to Mary Kawena Pukui:

> The first Hāloa, born to Wākea and Ho'ohoku-ka-lani, became a taro plant. His younger brother, also named Hāloa, became the ancestor of the people. In this way, taro was the elder brother and man the younger-both being children of the same parents [Handy and Handy 1972:80].

The physical attributes, the growth patterns, and the propagation of taro all reflect the structure of Hawaiian kinship and an obvious relationship to the human body. The main plant in the center is the *makua* (parent), the smaller plants budding out of the *makua* are the *'ohā* (offspring). The center of the leaf where it connects to the stem is the growth center of the veins of the leaf and is called the *piko* (belly button). The stem is called *ha*, which is also a word for breath, the basis of life. The cycle of planting is a reflection of the human life cycle. When the taro is harvested the *kalo* (corm) is cut right below the green top, the cut top is called the *huli* (turning, returning or transforming). The *huli* is replanted and the family of taro once again continues its growth cycle. The generations of taro are thought of interchangeably with the generations of Hawaiians as reflected in the saying "*Kalo kanu o ka 'āina*"-literally "taro planted on the land" but figuratively referring to successive generations of natives (Pukui 1983:157). Both the *'ohā* and the *makua* can be used as *huli*, but as in a family, the *'oha* (child) must be separated to become independent of the parent and – to become a parent itself. If it is not, it remains a dependent attachment, overshadowed by the leaves of the *makua*. Another saying, *I makika'I kekalo I ka 'ohā*-"the goodness of the taro is judged by the young plant it produces" (Pukui 1983:133), is a metaphor for the parents being judged by the behavior of their children.

All parts of the taro plant are used for food: the corm is cooked and eaten as table taro or steamed and pounded into *poi*; the stem can be steamed and used in various soup and stew dishes; the young leaves are used for *laulau* and *lū'au* dishes mixed with fish, squid, pork, chicken or beef. Generally, the leaves are not harvested from the plants designated for corm production because continuous cutting makes the corms soft and tasteless (*loli*). Taro growers who grow leaf for home use or commercial purpose always have specially designated *lū'au* patches. It is traditional Hawaiian practice to use all the coarse green cuttings that are the by-product of the harvesting of the corns as food for the pigs. This green material, when cooked and fed to the animals, is highly nutritious. For this reason, raising pigs is traditionally is symbiotic relationship to taro production. In a traditional taro field, no space is wasted. The *lo'i* are used for the taro and any extra space on the banks is used for subsistence, utilitarian and medicinal plants, such as bananas, *noni*, and *ti*.

The practice of taro cultivation most resembles gardening in its scale and methods. Much of the work is undertaken by an individual or family, and is performed by hand. The *lo'i* and banks are beautifully manicured, ostensibly for weed control but the result is aesthetically like a garden. Yet, taro production remains viable even on this small scale because of its high per-acre productivity.

Nowhere else in the world was taro cultivation more developed than in Hawai'i (Kirch 1985:215). It was the staple for the hundreds of thousands of Hawaiians before European contact. It was grown in areas with sufficient rainfall (above 30-50 inches per annum) or under dryland management. In areas of suitable water sources extensive and sophisticated irrigated systems were developed for its cultivation. The social requirement for the planning, development, and maintenance of theses irrigated systems was a stable political system and community cooperation. Although the cultivation and maintenance of individual fields could be the purview of single families or individuals, the maintenance of the water supply system on which the entire system depended had to be organized on a community level.

Although less than 100 varieties of taro survive today, there may have been, at one time, as many as 300 varieties in the islands, distinguished by leaf shape, corm, morphology, color and use. The labels of wetland and dryland taro do not refer to different taro varieties, but only to different cultivation practices. All varieties of taro can be grown in dryland fields and all but a few in *lo'i* (flooded fields). Today there are only a few widely-grown commercial varieties. Mechanical devices are used, such as tillers and small tractors; in some cases PVC pipes have replaced earthen or stone lined *'auwai* or waterways, and commercial fertilizers are routinely used. A typical taro crop will take from 10 to 14 months to mature. With modern farming methods taro is one of the most productive per-acre staple crops in the world. However, in spite of these modern overlays, the bulk of the labor is done by hand in the context of the family and the essence of a traditional taro growing community. Cooperation in management of water and land resources remains an integral part of this lifestyle.

In pre-contact Hawaii, during the late prehistoric era, as documented by archaeological studies, taro cultivation was practiced in virtually every suitable locality, including floodplains in windward valleys with perennial streams, open lava and beach flats near stream systems, and moist leeward slopes. Taro was such an important crop it was even grown in artificial microenvironments created by mulching pits in lava fields.

Since European contact there has been a slow but steady decline in taro cultivation. In the late nineteenth and early twentieth centuries, many of the large taro growing areas were given over to rice planting. Taro cultivation returned on a smaller scale to these areas after development of the California rice industry. Today, commercial Hawaiian taro cultivation is confined to a few areas in the islands: Hānalei/Waioli, Hanapēpē and Waimea on Kaua'i, Waikāne/Waiāhole and Haleiwa on O'ahu, Honokohau, Ke'anae/Wailuanui on Maui, and Waipi'o Valley on the island of Hawai'i.

Taro cultivation was a recurrent theme of the LCA testimonies for individual kuleana in Honouliuli. There were four individual kuleana LCAs in the Project Area. The testimonies indicated that these LCA's contained at least one *lo'i* as well as house lots, *kula* and fishponds (see Figure 10 and Table 1). The LCA's and assorted taro patches are depicted on a 1878 map of Honouliuli Taro Lands (see Figure 9)

'Ewa was well known for its rare *kai* variety of taro that was very flavorful as well as the ability to reproduce itself over a ten year span. The taro of 'Ewa was poetically referred to a man's love for a 'Ewa women that was so strong he would never leave:

> "The *kai* was native to 'Ewa and was often referred to as Kai o 'Ewa. . . . An 'Ewa *kama'āina* described this in 1899: When planted, it sends up shoots, more shoots and still more shoots. Again and again it will send up new shoots, filling the mounds until they mixed with the taro of other mounds. . . . This description (*Ka Loea Kalani'āina*), June 3, 1899) indicates that in the flat, wet lowlands of 'Ewa this famous taro was grown in mounds (*pu'epu'e*) as in marshy localities. The article quoted above says that '*Kai koi* multiplies itself over and over with one planting and often last as long as ten years. No other variety or locality can equal this. This fragrant taro was likened to a woman with whom a man falls in love, and it was said that anyone who married a native of 'Ewa would come and settle there and would never leave, because of the *kai koi* of 'Ewa. Our Hawaiian writer describes two other varieties of *kai: Kai 'ele'ele*, black *kai*, has a black stalk, with dark skin on stems and leaves; its corm was tough and hard to pound. *Kai kea*, white *kai*, had a light-colored stem and leaves; the skin (of the corm) was red, but the flesh was dark like that of black *kai*, the corm likewise tough. In 1931 we collected four varieties of *kai: kai koi*, whose corm was white, vase of stalk pink, petiole pink, with a pink edge on the leaf; *kai kea* or *keokeo* with white corm, white base, whitish stalk with red margin, and a leaf with white edge and white center and pinkish veins; *kai 'ula'ula* (red *kai*) with corm flesh purplish white, and cortex of corm reddish purple, base red, stalk green with black streaks becoming light green and pink above, and finally, *kai-uliuli* (dark-*kai)* with white corm and lavender cortex, red to pink base, whitish and dusky green petiole with red and white margin, and leaf with a slightly reddish center. It was the *kai keokeo* which was described as being fragrant *('ala)*. From this was made the *poi* reserved for the chiefs *(poi ali'i)* [Handy and Handy 1972:471].

As indicated earlier the traditional settlement patterns as depicted in mid 1800s, *Mahele* documents was focused on taro cultivation in the wetlands of Honouliuli Ahupua'a.

Mr. Soma and Mr. Oshiro both mentioned a *lo'i* near Korean Camp (see Figure 19), which was adjacent to the south end of the Project Area. Aunty Arline Eaton shared her memories of gathering taro in the Honouliuli taro lands while looking at an 1825 (see Figure 7) map during the interview:

> AE: Oh, well then I wasn't even born but I know it (taro) was there, because even up to my time we had to go up there. Even though they had over there, they also had it down here, this was dry land taro. And everybody said, taste good to me. You know I never died, I'm still here. . . . All this has to do with water, fresh water, because this is where they used to have the *lo'i* . . . that's why these areas, were well water, but people don't use the names. Hey, have certain *kalo*, cause when you pick the ones over here it's a reddish color, and if you go up here (Project Area) it's a more purple color. It's the soil I think, and each one has a different taste. It's still *ono* [good], its *poi*! Yeah and the purple. I remember they having all these different *kine* [kinds] like *ulaula kalo*, *poneia*, I like the *poniponi* [taro varieties] one. But people never know, you tell them and they tell you its

something else. I don't like to explain because people don't understand. But now that your coming with this stuff [maps], now you know that its there.

Currently there is no taro cultivation in the Honouliuli Taro Lands that is within the Project Area.

8.3 Pa'akai (Salt Making)

Pa'akai (salt) was one of the condiments used by Hawaiians for curing fish and other foods. Out of all Polynesia, Hawaiians were the only group of people to produce salt from the sea by properly constructing salt pans. These salt pans were noticed and described by Reverend William Ellis:

> We saw a number of their pans, in the disposition of which they display great ingenuity. They have generally one large pond near the sea, into which the water flows by a channel cut through the rocks, or is carried thither by natives in large calabashes. After remaining there some time, it is conducted into a number of smaller pans, about six to eight inches in depth, which are made with great care, and frequently lined with large evergreen leaves, in order to prevent absorption. Along the narrow banks or partitions between the different pans, we saw a number of large evergreen leaves placed. They were tied up at each end, so as to resemble a shallow dish, and filled with sea water, in which the crystals of salt were abundant [Ellis 1839 in Buck 1964:71].

Salt making was abundant through out the 'Ewa district as documented on old maps. Mr. Oshiro mentioned that there was a Chinese man that would gather salt near the shore, at Chocolate Beach. He stated "there were 12 salt beds, the man would let the water in and trap the salt, then the salt would dry up and he would shovel the salt." Aunty Arline Eaton also mentioned that they never had to worry about not having enough salt growing up as a child:

> AE: During that period of time they had salt works in the area (looking at the 1927 map see figure 16). . . . yeah that's what it was, and there's that flume. We used to ride on this thing . . .you go right under here . . . but they don't have the salt works anymore, sad yeah? Yeah, that had the salt pans, all the way down to Ku'alaka'i, all the way to Kalaeloa, the whole thing. From Pu'uloa, which is Pearl Harbor, working all the way around pass Keone'ula, all the way down past where Ku'alaka'i is. That's almost the ending, though they maybe had one or two close to Kalaeloa. Because a lot of the boats came in there. I think, like how they have, [on the map]. That's true, exactly what you have over there. See it has Ewa Plantation, but there was water all in this area. The salt pans are really, actually, no more pan, but its coral, and you can see. But they called it that ["salt pans"]. But now that's all made out of the reef, the coral, all in that area.
>
> CSH: *So your family would gather salt?*
>
> AE: Oh, yeah. We never worried about salt, because it's right there. And had the '*alaea* [type of ocherous earth, mixed with the salt] down at Keone'ula, we go

> pick that up too. Because the water comes all in here it [the map] doesn't show you that. But water used to come all in that area. I tell people, this whole area here had water before we even had the *paniolo* here.

The most coastal portion of the Project Area is approximately 600 m (2,000 feet) from the West Loch of Pearl Harbor and the environment is not conducive to the "old" style of salt making.

8.4 Marine Resources

The sea and West Loch was a rich resource and the Hawaiian people were traditionally expert fishermen. Fish, shellfish, and other invertebrates of all types supplied the Hawaiian diet with a rich source of protein. The gathering of seaweed and salt was practiced by Hawaiian women. Today many people continue to fish along the shoreline south of the Project Area. In traditional Hawaiian times, Hawaiians going to and from marine resources at the coast, fishery resources of West Loch and its fishponds, and the low-lying mud-flats used for salt production may have crossed the present Project Area.

All the interviewees shared information about the abundant marine life just east of the Project Area, at Pu'uloa. They (Arline Eaton, Richard Oshiro, Kenneth Soma, Charles Nakamatsu and Dickey Hirata and many others) all mentioned a beach called Chocolate Beach and a well-known place to go fishing called Three Stones (see figure 16). At these places, they would often catch *pāpio*, mullet, oysters, clams, and all types of crab such as Hawaiian crab and *haole* crab and *limu* as well. They would use shrimp for bait, or as Mr. Soma mentioned "we would often get guts from the slaughter house and use that for bait." Mr. Nakamatsu also added " we would go get meat or slop from Kahuā Ranch or the Hawaiian Meat Market then we would go catch crab, such as Haole Crab, Kanaka Crab which is the reddish brown Crab and we would dig for clams and oysters". Mr. Nakamatsu and Mr. Soma both mentioned that on the way to the beach they would cut the Koa Haole tree before they would go fishing to use as a fishing pole". Below, Aunty Arline Eaton expresses her *mana'o* (thoughts) on different fishing resources:

> . . .That was beautiful, because you can get like *'ō'io* [bonefish], *u'u* [soldierfish], *enenue* [pilotfish], *kala* [surgeonfish], *manini* [surgeonfish], *moano* [goatfish], *he'e* [octopus], *pāpa'i* [crabs], and many others. And it was clean, and nowadays I don't know about what you'd get. . . . Moku'ume'ume we called it, Ford Island. And had oysters, you know they said never had, but they had oysters over there. But you know we never went over there and took a lot, we'd just take what you want, that's all. Why you need plenty, you don't need them all. You want some more, then you could always go back over there and go get some more. Each area had its own certain kind. . . . It's different from the one over here, because of the kind of *limu* [seaweed] they eat. Cause over here is lots of *līpo'a* [brown seaweed], so you can smell them [in the fish, yeah?]. Yeah, and you could smell it at high tide too. But now, you no can smell the *limu*. And when you open up *manini* you can look inside what they eat. They only eat *limu*, they only eat certain kinds, and they're clean. That's why you can just take 'em and throw them on the fire, you no need clean 'em. *Manini* don't eat just any kind stuff, still *ono*.

> CSH: *I remember last time I talked to you, you said your tutu papa would go to Waikiki in a canoe?*
>
> AE: . . . and go out to Kou, to Waikiki, yeah, to Kahanamoku's place. Bernice Kahanamoku and I are good friends, that's Duke's only sister. He only had one sister out of all of them. When we went down there we couldn't come home, cause it would take time to get over there. So, we would sleep over night over there.
>
> CSH: *He would paddle all the way over there in a four man canoe?*
>
> AE: Well, I was young, but yeah I would just go with him, and he would paddle. I guess he would take stuff over there, not that they didn't have fish over there, but certain places get certain kinds. We have all different kinds of *limu* over here, any kind you could think of, but if you want to get *limu kohu*, good *kine*, you go Kaua'i. We have over here, but not as *ono*, you know what I'm saying? Like here the *'ō'io* was known to be one of the best in Pu'uloa, so that's why *tutu papa* would bring. That's what Duke's papa used to like.

Limu was very important in the Hawaiian diet and is defined by Pukui & Elbert (1971) "A general name for all kinds of plants living under water, both fresh and salt, also algae growing in any damp place in the air, as on the ground, on rocks and other plants." Aunty Arline spoke of the different types of *limu* in the 'Ewa area:

> This whole area was known as the house of the *limu*. You can imagine the smell, but we never bothered. And now no more *limu*. Had plenty . . . and now no more. Well you know, there was a heavy influx of immigrants coming in. First they look at it, oh this is plenty, lets pick em *(limu)* all up, and they'd go and sell em. They'd never think about just pick their part, no they'd take the whole thing. So when they'd go, they'd pick up everything. Oh no, had in the locks, in Hō'ae'ae, had to have *limu* over here, all the way out. You know, maybe not as much as you see out there, but they did have *limu* in there because you had the fish. As long as you have the fish inside there, gotta have the *limu* inside there. That's why I said the *limu* is very important. That's why we were teaching the children. Had *līpo'a*, plentiful, but not as much as you would find in Pu'uloa, because of the changing of the ocean and the tide.
>
> You need to have lots of running water back and forth, like waves coming in, going out. That's how that *limu* is strong and fresh. But we also had it in here too, all into this area. Mostly, the kind of *limu* you would find in here is *'ele'ele*. They had, cause of the water, there was a lot of fresh water that went in there. You would find it close up into an area where there is a lot of running water. That's how we knew there had fresh water coming out, can't live without fresh water, all of it needs it.

The Project Area is approximately 600 m (2,000 feet) back from the coast therefore marine resources will not be affected.

8.5 Burials

East of the Project Area, a pre-contact Native Hawaiian burial was found at Hō'ae'ae Point (Papapūhi Point) in West Loch Estates, and a historic Chinese crypt was found in a cave in the NAVMAG-West Loch area, (see Figure 22). Though none of the interviewees knew of any burials in the Project Area or in the vicinity, Aunty Arline did suggest that if people were living in the area, there is a possibility of burials:

> My only thought is that for every person that lives in that area, that's where they bury their people . . .We never said anything. if people died, we'd go over there and they'd bury them right there where the house is. We'd never go four-hundred-million-miles away, its right there. All your *'ohana* stay right in the same area. We never went afar, not in the rural areas.

8.6 Historic Properties

CSH previously performed an assessment of 546-acres of the Project Area in 1990 as part of theWest Loch Bluffs project, which was postponed. During the previous survey CSH identified the following historic features:

Sites 50-80-12-4344 (plantation infrastructure), -4345 (railroad berm), -4346 (northern pumping station), -4347 (central pumping station), and -4348 (southern pumping station).

8.7 Stream Resources

William Puleloa of the DLNR, Division of Aquatic Resources summarizes the importance of streams as a traditional Native Hawaiian cultural resource:

> From the earliest days, streams were among the most important natural resources sought after by native Hawaiians. Battles were fought and lives sacrificed for the right to use stream water. The Hawaiians called freshwater wai, and considered it to be sacred. People using wai from streams took only what was absolutely necessary. They were expected to share the wai with others. This was done without greed or selfishness. Such practices gave Hawaiians their word for law, which is kanawai, or the "equal sharing of water." Water was so valuable to Hawaiians that they used the word "wai" to indicate wealth. Thus to signify abundance and prosperity, Hawaiians would say waiwai.

The Honouliuli Stream passes through the northeastern side of the Project Area (north of Farrington Highway), extends through the Honouliuli Taro Lands east of the Project Area and then empties into Pearl Harbor. The stream was the main water source for the lo'i in the Honouliuli Taro Lands. Aunty Arline spoke about the days that her *tutupa* and herself would go up stream in his four-man canoe. The canoe was filled with *i'a* (fish) and *limu* to trade with the people who lived near Honouliuli Stream who cultivated taro. She mentioned that as children they would often gather *'ōpae* and *'o'opu* from the stream. Aunty Arline also stated, "my *tutupa* would visit these people and he would chant in Hawaiian and the people on shore would chant back." This was a common practice of asking for permission to come ashore, visit, and trade. She also mentioned that the same thing would happen when people would come and visit her and her family in Keahi (Keahi Point in Pu'uloa; see Figure 5). At this time we have not found evidence of any cultural activity currently being practiced within the stream.

8.8 Trails

Trails served to connect the various settlements throughout the District of 'Ewa. Based on nineteenth and twentieth century maps, the primary transportation routes *mauka/makai* and cross-*ahupua'a* correlated closely to the existing major roadways (see Figure 6). John Papa 'Ī'ī describes a network of Leeward O'ahu trails that in later historic times encircled and crossed the Wai'anae Range, allowing passage from West Loch to the Honouliuli lowlands, past Pu'uokapolei and Waimānalo Gulch to the Wai'anae coast and onward, circumscribing the shoreline of O'ahu ('Ī'ī 1959:96-98). It seems clear that a major east/west artery from 'Ewa and Kona O'ahu to Wai'anae was the pre-cursor trail that 'Ī'ī was referring to, and what could possibly be the current Farrington High Way. However, today no remnants of the trail remain. (Figure 6). Trails in relation to the Project Area

8.9 *Wahi Pana* (Storied Places)

The concept of *wahi pana* (a place with a story or legend attached to it) is very important in the Hawaiian culture because it is a connection to the past and, therefore, the ancestors. From the name of a place one can know intimate details about the people who lived there, the environment, cultural practices, and historical events that took place. In Hawaiian culture, if a particular spot is given a name, it is because an event occurred there that has meaning for the people of that time. Because Hawaiian culture was based on oral traditions, place names and their stories were an important way of remembering these traditions and ensuring these stories would be passed on to future generations. In Hawaiian thinking, the fact that a place has a name deems it important. Often, spiritual power or *mana* is attached to a place, which increases its importance. On the subject of *wahi pana*, Edward Kanahele writes:

> As a native Hawaiian, a place tells me who I am and who my extended family is. A place gives me my history, the history of my clan, and the history of my people. I am able to look at a place and tie in human events that affect me and my loved ones. A place gives me a feeling of stability and of belonging to my family, those living and dead. A place gives me a sense of well-being and of acceptance of all who have experienced that place [Kanahele, in James 1995:6].

Aunty Arline agrees that it is very important to use the old place names that were given by Hawaiian people because it gives meaning to a specific area (see Figure 5):

> CSH: *How come they don't have Kūpaka on the map? Here's Ke'ahi and Kūpaka, so you lived near the beach then?*
>
> AE: [showing on map] right here, in this area, 'Ewa beach road. Kūpaka goes all the way up to where Parish Drive is. And it was named after Mr. Dowsett and the Parish's, cause they're related, they were the ones that came with Kamehameha. So he lived here, in Ke'ahi, and it was him who gave that name, Kūpaka, for that

> area. So that's why he named that area, and yet there was nothing [nothing there], These people came and they gave all that land to the Dowsetts and the Parish's. [CSH: Liholiho] Yeah, he gave it to them.
>
> CSH: *What did you call this beach?*
>
> AE: Keone O Keahi and Keone O Kūpaka, all of this is Pu'uloa. All the way down till you come to Keone'ula. Actually, it's Keone'ula because that's where that *'alaea* was. A lot of people don't know, but that's the reason why it was named that. It should not be One'ula, it should be Keone'ula. I keep saying that over and over they say, why you have to put that, Keone'ula?
>
> CSH: *So, it's the beach-that-is-red, the red beach?*
>
> AE: Yeah. But of course it doesn't show it now, but at that time, even when I was young, I remember seeing that big mound. Because all of this was fishponds. All in this area, this whole place all the way going down to, I don't like to say, Pearl Harbor the name should be Pu'uloa, until even Manana, all of that had fishponds. This whole area was like that, and salt pans.

Kapapapūhi is a point just east of the Project Area and Aunty Arline Eaton shared a story about this special place that was told to her as a child:

> Oh yeah, you talking about the outside area. Had *pūhi* [eel] all over, but mainly they used that point. There's a *mo'olelo* [story] that goes with that. There was this *pūhi* who is supposed to be, like, king of the area, and the *Tutukane* and the *Tutuwahine* came over there, and the *pūhi* looked and said oooh that *wahine*, I like that one. Well so the *pūhi* make sure plenty *i'a* [marine creatures] around, and one day the *Tutukane* never came, only her went over there, and she was picking *'opihi* [limpets]. Pretty soon she went underneath the water, and he saved her. . . . He loved her, he fell in love with her [*pūhi* king]. And he didn't want to let her go. And she said, Oh please I want to go home, and he said, no you stay with me, don't go, I'll give you everything you want, and you don't have to worry. And she cried, and she cried. Then he found out that boy that came down was not her sweet heart or anything, that was her brother. But you know Hawaiian style! And together they would always go out and go fishing because the father had gone out fishing and got lost, and only had the mama. And the mama wasn't feeling well. So these two [the brother and sister] would help out the grandmama and grandfather and go out. And the *pūhi* felt so sorry, so he said okay but anytime you need help I will always be here. And so every time I see this place and see this name I think of that. I could imagine him just standing over there and looking at her and thinking, oh how he loved her. Yeah that's one of the stories that they had about that. And that was told to me, I don't see it in a book. My papa told me that so I always remembered that. Then there was a song . . . that they would sing, it was so pretty.

Section 9 Conclusion and Recommendations

9.1 Conclusion

Honouliuli is associated with a number of legendary accounts. Many of these concern the actions of gods or demi-gods such as Kāne, Kanaloa, *Māui*, Kamapuaʻa, the reptile deity (*mo'o*) Maunauna, the shark deity Ka'ahupāhau, and the demigod hero Palila. While there are several references to chiefly lineages and references to the ruling chiefs Hilo-a-Lakapu and Kūali'i, there is no clear reference to powerful chiefs living permanently in Honouliuli.

The accessibility of Honouliuli lands, including the proposed Project Area, to the Hawaiians for gathering or other cultural purposes was radically curtailed during the second half of the nineteenth century. As noted above in this assessment, by the 1870s, herds of cattle grazing across the 'Ewa Plain likely denuded the landscape of much of the native vegetation. Subsequently, during the last decade of the nineteenth century, the traditional Hawaiian landscape was further distorted by the introduction and rapid development of commercial sugar cane cultivation. Throughout the twentieth century, sugar cane cultivation was the dominating land use activity within the Project Area. Cane cultivation – and the sense that the Project Area was private property – restricted access inside the Project Area to employees of 'Ewa Plantation.

Hawaiian organizations, government agencies, community members, and cultural and lineal descendants with ties to 'Ewa were contacted to: (1) identify potentially knowledgeable individuals with cultural expertise and knowledge of the Project Area and its surroundings, and (2) identify cultural concerns and potential impacts within the Project Area. An effort was made to locate informants with ties to 'Ewa and neighboring *ahupua'a* who live, or had lived in the region or who, in the past, used the area for traditional and cultural purposes. For this assessment, Arline Eaton, Richard Hirata, Richard Oshiro, Kenneth Soma, Charles Nakamatsu and other *kūpuna* were interviewed. They mentioned that in the past there was traditional gathering of taro and salt, along with fish such as *pāpio*, mullet, as well as oysters, clams and a variety of crab near the Project Area. They all referred to this area of rich marine resources as Chocolate Beach and Three Stones. The people contacted were not aware of any on-going cultural practices, archaeological sites, trails, or burials within the Project Area. Most of the people contacted mentioned that the Project Area was heavily altered by plantation activities.

Based on what was gathered from the consultation process and the evidence of LCA's and lack of resources, the vast majority of the Project Area was utilized less intensively during traditional times. Additionally the years of sugar cane cultivation left no reason for access. Most of the resources such as taro farming and gathering of marine resources were on the fringing edge or outside of the Project Area. Based on the evidence gathered for this evaluation, at present no contemporary or continuing cultural practices occur within the Project Area specifically.

9.2 Recommendations

No contemporary or continuing cultural practices currently occur within the proposed Project Area. It should be noted that subsurface historic properties associated with former traditional Hawaiian activities in the project area, such as artifacts and cultural layers, may be present despite the decades of modern activities such as ranching and sugar cane. As a precautionary measure, personnel involved in future development should be informed of the possibility of inadvertent cultural finds, and should be made aware of the appropriate notification measures to follow.

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APPENDIX G

Environmental Noise Assessment

D. L. ADAMS ASSOCIATES, LTD.
Consultants in Acoustics and Performing Arts Technologies

Environmental Noise Assessment Report
Ho'opili
Ewa, Oahu, Hawaii

February 2008

DLAA Project No. 06-34

Prepared for:
PBR Hawaii
Honolulu, Hawaii

970 N. KALAHEO AVE. • SUITE A311 • KAILUA, HAWAII 96734
808/254-3318 • FAX 808/254-5295
www.dlaa.com • hawaii@dlaa.com

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1.0 EXECUTIVE SUMMARY

1.1 The project area is currently exposed to varying daytime ambient noise levels, depending on the proximity to major roadways. The areas adjacent to H-1 Freeway and Farrington Highway experience high ambient noise levels during peak traffic hours. Ambient noise levels range from 59 to 72 dBA adjacent to the H-1 Freeway and 44 to 59 dBA adjacent to Farrington Highway. The ambient noise environment is relatively low in areas that are far from the major roadways, where ambient noise levels range from 37 to 60 dBA. The dominant noise sources are traffic, wind, birds, occasional distant aircraft flyovers, and farm equipment.

1.2 Development of project areas will involve excavation, grading, and other typical construction activities. The Ho'opili project is not expected to impact adjacent properties, however, residences from the initial phases may be impacted by construction noise from subsequent phases due to their proximity to the construction site. Noise from construction activities should be short term and must comply with State Department of Health noise regulations.

1.3 The proposed land uses may include noise generating activities which could impact adjacent residences. Noise mitigation measures should be incorporated into the project design to prevent such impacts, such as creating buffer zones, installing mufflers and/or erecting barriers around noisy equipment. Consideration should also be given to the layout of the commercial areas to meet State Department of Health noise regulations and reduce the noise impact. Restrictions may need to be placed on commercial uses allowed in the commercial areas in order to strictly control development of potential noise producing industries.

1.4 Increases in peak hour traffic noise along Fort Weaver Road due to the project are estimated to be less than 1 dB. Increases in peak hour traffic noise along Old Fort Weaver Road due to the project are estimated to be between 3 and 8 dB. This is a significant increase for homes currently located along Old Fort Weaver Road.

1.5 Vehicular traffic noise from the H-1 Freeway may significantly impact the proposed development. Traffic noise mitigation will be necessary to satisfy the FHWA maximum exterior L_{eq} noise limit of 67 dBA for parcels adjacent to H-1 Freeway. Because of its vicinity to the H-1, much of the project site will be impacted by noise from the freeway. The construction of a noise barrier wall, as well as the construction of buildings, along H-1 will mitigate traffic noise for most of the impacted area. However, the parcels that are very close to the H-1 are the most impacted by traffic noise. Homes and schools that are built within 120 feet of the H-1 Freeway will not satisfy the FHWA maximum exterior L_{eq} noise limit of 67 dBA, even if noise mitigation (i.e., noise barrier wall) are implemented. To limit the noise impact on the project, the 120 foot buffer zone is best suited for structures that are less sensitive to noise, such as commercial and light industrial uses. The FHWA noise criterion is less stringent for commercial and light industrial uses. However, even for these uses located within 120 feet from the H-1 Freeway, noise mitigation (i.e., noise barrier wall) will be needed to

meet the FHWA maximum exterior Leq noise limit of 72 dBA. Although the FHWA criteria is not a regulatory requirement for this project, as it has no authority to enforce land use, its noise limit criteria is recommended by the FHWA to be used as a guideline for consideration of land use and the impact of traffic noise.

1.6 Vehicular traffic noise from Farrington Highway and Fort Weaver Road may significantly impact the proposed development. Any homes, schools, or parks within 80 feet of Farrington Highway and 70 feet of Fort Weaver Road will require traffic noise mitigation to meet the FHWA maximum exterior L_{eq} noise limit of 67 dBA.

1.7 The addition of the proposed transit system is not expected to cause a significant change in traffic noise levels from roadways within the project site.

1.8 Aircraft noise due to operations at nearby Kalaeloa Airport and the Honolulu International Airport may be audible at the project site. However, flights directly above the site are infrequent and the project site is outside of the L_{dn} 55 noise contour for both airports. Therefore, a significant noise impact due to aircraft noise is not expected.

1.9 The proposed alignments of the future Honolulu rail transit system run along Farrington Highway and North-South Road and may include two transit stations. Design of the Ho'opili development should include a minimum setback distance between the nearest residences and the transit guideway and stations to minimize the impact due to transit system related noise. The City and County of Honolulu is currently developing an Environmental Impact Statement for the proposed transit system. We assume that transit noise mitigation measures and appropriate setback distances will be addressed in the EIS.

1.10 Exterior noise levels at two school sites (H-1 Freeway/Kunia Road and Farrington Highway) will exceed the Hawaii State Board of Education (BOE) Policy 6700 noise limit of $L_{10} = 65$ dBA. Policy 6700 requires that air conditioning be provided to schools that are exposed to exterior noise levels in excess of the noise limit. The layout and construction of the school should be carefully designed such that exterior noise will not disturb learning activities and interfere with speech intelligibility. To reduce ambient noise levels at the school site, traffic noise mitigation measures may also be necessary, such as an earthen berm or noise barrier wall.

2.0 PROJECT DESCRIPTION

The Ho'opili project is a proposed Transit-Oriented-Development (TOD) that is a mixed-use, transit-ready community including residential (approx. 11,750 units, including affordable housing), business and commercial areas (approx. 145 acres), light industrial/business areas (approx. 50 acres), transit stops, schools and other public facilities (approx. 100 acres), parks (approx. 60 acres), and large amounts of open space (approx. 150 acres). The project area is located in the Ewa District, on the island of Oahu and is bounded by several major roadways: H-1 Freeway, the proposed North-South Road, and Fort Weaver Road. Other major roadways contained within the site include Farrington Highway, Old Fort Weaver Road and the proposed East-West Road.

Historically, the site was cultivated in sugarcane and is currently utilized for diversified agriculture. The proposed project involves the reclassification of approximately 1,554 acres from the Agricultural District to the Urban District.

3.0 NOISE STANDARDS

Various local and federal agencies have established guidelines and standards for assessing environmental noise impacts and have set noise limits as a function of land use. A brief description of common acoustic terminology used in these guidelines and standards is presented in Appendix A.

3.1 State of Hawaii, Community Noise Control

The State of Hawaii, Community Noise Control Rule [Reference 1] defines three classes of zoning districts and specifies corresponding maximum permissible sound levels due to *stationary* noise sources such as air-conditioning units, exhaust systems, generators, compressors, pumps, etc. The Community Noise Control Rule does not address most *moving* sources, such as vehicular traffic noise, air traffic noise, or rail traffic noise. However, the Community Noise Control Rule does regulate noise related to agricultural, construction, and industrial activities, which may not be stationary.

The maximum permissible noise levels are enforced by the State Department of Health (DOH) for any location at or beyond the property line and shall not be exceeded for more than 10% of the time during any 20-minute period. The specified noise limits which apply are a function of the zoning and time of day as shown in Figure 1. With respect to mixed zoning districts, the rule specifies that the primary land use designation shall be used to determine the applicable zoning district class and the maximum permissible sound level. In determining the maximum permissible sound level, the background noise level is taken into account by the DOH.

3.2 U.S. Federal Highway Administration (FHWA)

The FHWA defines four land use categories and assigns corresponding maximum hourly equivalent sound levels, $L_{eq(h)}$, for traffic noise exposure [Reference 2], which are listed in Figure 2. For example, Category B, defined as picnic and

recreation areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals, has a corresponding maximum exterior L_{eq} of 67dBA and a maximum interior L_{eq} of 52 dBA. These limits are viewed as design goals, and all projects meeting these limits are deemed in conformance with FHWA noise standards. Calculation of traffic noise levels should be conducted using a Federal Highway Administration traffic noise model [Reference 3].

3.3 State of Hawaii Department of Transportation (HDOT)

The HDOT has adopted FHWA's design goals for traffic noise exposure in its noise analysis and abatement policy [Reference 4]. According to this policy, a traffic noise impact occurs when the predicted traffic noise levels "approach" or exceed FHWA's design goals or when the predicted traffic noise levels "substantially exceed the existing noise levels." The policy also states that "approach" means at least 1 dB less than FHWA's design goals and "substantially exceed the existing noise levels" means an increase of at least 15 dB.

3.4 U.S. Environmental Protection Agency (EPA)

The U.S. EPA has identified a range of yearly day-night equivalent sound levels, L_{dn}, sufficient to protect public health and welfare from the effects of environmental noise [Reference 5]. The EPA has established a goal to reduce exterior environmental noise to an L_{dn} not exceeding 65 dBA and a future goal to further reduce exterior environmental noise to an L_{dn} not exceeding 55 dBA. Additionally, the EPA states that these goals are not intended as regulations as it has no authority to regulate noise levels, but rather they are intended to be viewed as levels below which the general population will not be at risk from any of the identified effects of noise.

3.5 U.S. Department of Housing and Urban Development (HUD)

HUD's environmental noise criteria and standards in 24 CFR 51 [Reference 6] were established for determining housing project site acceptability. These standards are based on day-night equivalent sound levels, L_{dn}, and are not limited to traffic noise exposure. However, for project sites in the vicinity of highways, the L_{dn} may be estimated to be equal to the design hour $L_{eq(h)}$, provided "heavy trucks (vehicles with three or more axles) do not exceed 10 percent of the total traffic flow in vehicles per 24 hours and the traffic flow between 10:00 p.m. and 7:00 a.m. does not exceed 15 percent of the average daily traffic flow in vehicles per 24 hours." For these same conditions, L_{dn}, may also be estimated as 3 dB less than the design hour L_{10}.

HUD site acceptability criteria rank sites as Acceptable, Normally Unacceptable, or Unacceptable. "Acceptable" sites are those where exterior noise levels do not exceed an L_{dn} of 65 dBA. Proposed housing projects on "Acceptable" sites do not require additional noise attenuation other than that provided by customary building techniques. "Normally Unacceptable" sites are those where the L_{dn} is above 65 dBA, but does not exceed 75 dBA. Housing on "Normally

Unacceptable" sites requires some form of noise abatement, either at the property line or in the building construction, to ensure the interior noise levels are acceptable. "Unacceptable" sites are those where the L_{dn} is 75 dBA or higher. The term "Unacceptable" does not necessarily mean that housing cannot be built on those sites; however, more elaborate sound attenuation will likely be needed.

3.6 Federal Aviation Administration (FAA)

The FAA addresses guidelines for compatible land use that surrounds airports [Reference 7]. Noise contour maps are expressed in terms of yearly day-night average sound levels, L_{dn}, due to aircraft operations. The FAA states that residences outside of the L_{dn} 65 noise contour are compatible without restrictions. Residences between the L_{dn} 65 and 75 contours are only compatible if noise mitigation measures are incorporated into the building structure. Residences inside of the L_{dn} 75 noise contour are generally not compatible. The compatibility of other land uses, such as commercial, manufacturing, public, and recreation, are shown in Table 1.

3.7 State of Hawaii Department of Transportation (HDOTA), Airports Division

The State of Hawaii, Department of Transportation, Airports Division has adopted noise restrictions that are similar to the FAA's, but more stringent [Reference 8]. Similar to the FAA, HDOTA expresses land use compatibility guidelines based on yearly day-night average sound levels, L_{dn}, due to aircraft operations. In most cases, the HDOTA states maximum noise limits that are 5 dB lower than the FAA. For example, the HDOTA states that residences outside of the 60 L_{dn} noise contour are compatible. Residences between 60 and 70 L_{dn} contours are only compatible if noise mitigation treatments are implemented. However, HDOTA states:

> "Where the community determines that these uses must be allowed, Noise Level Reduction (NLR) measures to achieve interior levels of 45 L_{dn}, or less should be incorporated into building codes and be considered in individual approvals. Normal local construction employing natural ventilation can be expected to provide an average NLR of approximately 9 dB. Total closure, plus air conditioning, may be required to provide additional outdoor to indoor NLR, and will not eliminate outdoor noise problems."

The HDOTA guidelines also specify 60 dBA as the maximum allowable L_{dn} level for school, day care center, and church uses without any mitigation measures. Commercial uses such as retail shops, restaurants, shopping centers, etc. are compatible with L_{dn} levels up to 65 dBA without any mitigation measures. With noise mitigation measures implemented, such commercial uses are allowed in areas exposed to an L_{dn} as high as 75 dBA. The compatibility of other land uses, such as manufacturing, public, and recreation, are shown in Table 2.

In addition to the HDOTA compatibility guidelines, The Hawaii Revised Statutes, Chapter 0508D, Section 15 states a notification is required to the buyer for real estate property that lies,

> "Within the boundaries of the noise exposure area shown on maps prepared by the department of transportation in accordance with Federal Aviation Regulation Part 150-Airport Noise Compatibility Planning (14 Code of Federal Regulations Part 150) for any public airport;"

The FAR Part 150 noise exposure area boundary is defined as the 55 L_{dn} noise contour. Therefore, a notification to the buyer is required for all real estate transactions within the 55 L_{dn} noise contour.

3.8 Federal Transit Administration (FTA)

The FTA defines three land use categories and provides guidance in the assessment of noise and vibration due to transit systems based on an increase in cumulative noise. Methods for determining noise and vibration impacts and possible mitigation measures for typical transit projects are provided in the Transit Noise and Vibration Impact Assessment report [Reference 9]. One set of criteria defined in the report applies to all rail projects (including light rail transit, rapid rail transit, etc.) and their fixed facilities. The criteria, specified in maximum hourly equivalent sound levels, $L_{eq(h)}$, and day-night equivalent sound levels, L_{dn}, varies according to the existing noise levels, the predicted transit system project noise levels, and the land use category, as shown in Figure 3. The area between the two curves labeled as "Impact" is a transitional area where the change in cumulative noise level will be noticeable to most individuals, but may not be sufficient to cause adverse reactions from the community.

The FTA criteria were developed to recognize the heightened community annoyance caused by late night and early morning transit service and the varying sensitivity of communities to transit systems under different background noise conditions and is concurrent with various noise standards defined by other Federal agencies. It is important to note that the criteria are not enforceable regulations, but design goals that are useful tools for assessing the noise environment.

3.9 State of Hawaii State Board of Education (BOE)

BOE policy 6700 [Reference 10] sets four classroom noise level requirements:

1. Soundproofing design shall be used to reduce the noise level whenever the internal noise level exceeds 50 dBA.

2. Noise control shall be provided for all school facilities which generate exterior noise levels at the property line exceeding DOH standards.

3. Noise control measures shall be installed in classrooms and administration/staff facilities (excluding shop classrooms) whenever 50 percent of the intruding noise level measurements exceed 55 dBA when inside the classroom with windows and doors open and the room empty.

4. Air conditioning shall be provided to facilities exposed to exterior noise levels greater than L_{10} = 65dBA.

4.0 EXISTING ACOUSTICAL ENVIRONMENT

Two types of noise measurements were conducted to assess the existing acoustical environment in the vicinity of the project location. The first noise measurement type consisted of continuous long-term ambient noise level measurements (Locations L1, L2, L3 and L4), as shown in Figure 4. The second type of noise measurement was short-term and included traffic counts (Locations S1, S2, S3, and S4), also shown in Figure 4. The purpose of the short-term noise measurements and corresponding traffic counts were to calibrate a traffic noise prediction model. The noise measurements were conducted between October 9, 2006 and October 15, 2006.

4.1 Noise Measurement Procedures

Long-Term Noise Measurements

Continuous, hourly, statistical sound levels were recorded for approximately 3 days at each location. The measurements were taken using a Larson-Davis Laboratories, Model 820, Type-1 Sound Level Meter together with a Larson-Davis, Model 2560 Type-1 Microphone. Calibration was checked before and after the measurements with a Larson-Davis Model CAL200 calibrator. Both the sound level meter and the calibrator have been certified by the manufacturer within the recommended calibration period. The microphone was mounted on a tripod, approximately 6 feet above grade. A windscreen covered the microphone during the entire measurement period. The sound level meter was secured in a weather resistant case.

Short-Term Noise Measurements

An approximate 30-minute equivalent sound level, L_{eq}, was measured at each location. Vehicular traffic counts and traffic mix were documented during the measurement period. The noise measurement was taken using a Larson-Davis Laboratories, Model 824, Type-1 Sound Level Meter together with a Larson-Davis, Model 2541 Type-1 Microphone. Calibration was checked before and after the measurements with a Larson-Davis Model CAL200 calibrator. Both the sound level meter and the calibrator have been certified by the manufacturer within the recommended calibration period. The microphone and sound level meter were mounted on a tripod, approximately 5 feet above grade. A windscreen covered the microphone during the entire measurement period.

4.2 Noise Measurement Locations

Long-Term Noise Measurements

Location L1: Approximately 200 feet makai of the H-1 Freeway. The dominant noise source was vehicular traffic from the H-1 Freeway. Secondary noise sources included aircraft flyovers, birds, wind, and farm equipment.

Location L2: Approximately 150 ft makai of Farrington Highway near the HECO Station. The dominant noise source was vehicular traffic from Farrington Highway. Secondary noise sources included farm equipment, birds, wind, and aircraft flyovers.

Location L3: Near the eastern edge of the project area, approximately 0.7 miles makai of Farrington Highway. The dominant noise sources were birds, wind, aircraft flyovers, and farming equipment that may have been operated in the vicinity of the sound meter.

Location L4: Near the western edge of the project, approximately 0.9 miles makai of Farrington Highway and 0.25 miles east of the proposed North-South Road. The dominant noise sources were birds, wind, aircraft flyovers, and farming equipment that may have been operated in the vicinity of the sound meter.

Short-Term Noise Measurement Locations

Location S1: Positioned adjacent to Old Fort Weaver Road, approximately 40 feet west of the edge-of-pavement.

Location S2: Positioned adjacent to Fort Weaver Road, approximately 50 feet west of the edge-of-pavement.

Location S3: Positioned adjacent to Farrington Highway, approximately 35 feet makai of the edge-of-pavement.

Location S4: Positioned adjacent to H-1 Freeway, approximately 50 feet makai of the edge-of-pavement.

4.3 Long-Term Noise Measurement Results

The ambient sound levels at locations L1 and L2 are relatively dynamic and depend significantly on the vehicular traffic patterns of the surrounding roadways. Thus, the areas adjacent to H-1 Freeway and Farrington Highway experience high ambient noise levels during peak traffic hours. The ambient noise environment is relatively low in areas that are far from the major roadways, i.e. locations L3 and L4, where ambient sound levels do not vary significantly during the daytime hours but drop off at night. The measured equivalent sound levels, L_{eq}, in A-weighted decibels (dBA) are graphically presented in Figures 5 for locations L1 and L2 and Figure 6 for locations L3 and L4. Noise measurement results are also summarized in Table 3.

Adverse weather was experienced between October 12, 2006 and October 17, 2006. The sound level meter experienced several overloads, likely due to rainfall. The portions of data from the meters at location L3 and L4 that may be erroneous have been indicated on Figure 6. However, the overall trend in noise levels is still apparent.

4.4 Project Vicinity

Existing residential developments immediately surrounding the project site include Waipahu and West Loch to the east and Ewa Villages to the south. Vehicular noise from Fort Weaver Road, Farrington Highway and the H-1 Freeway dominate the ambient environment in the vicinity of these roadways. The future UH West Oahu and DHHL sites, west of the Ho'opili project site, experience an acoustical environment similar to the project site with wind and occasional aircraft flyovers being dominant noise sources. In addition, a quarry and a recycling plant located west of the project site may contribute to some of the ambient noise. Heavy trucks, which generate more noise than automobiles, travel to and from the quarry and recycling plant and constitute 10% of the AM peak hour traffic total on Farrington Highway. Heavy trucks also constitute 10% of the AM peak hour traffic total on H-1 Freeway.

4.5 Kalaeloa Airport and Honolulu International Airport Noise Contours

The project is several miles northeast of the Kalaeloa Airport and west of Honolulu International Airport. Therefore, the project site was assessed for aircraft noise using airport noise contour maps. The Kalaeloa Master Plan [Reference 11] includes year 2020 projections of airport operations and noise contour maps for airport alternates. Also included in the airport noise contour maps is the effect of the Honolulu International Airport operations [Reference 8]. A complete description of the Kalaeloa Airport alternatives can be found in the Kalaeloa Master Plan. The Ho'opili project site is outside of the L_{dn} 55 noise contours for both airports.

5.0 POTENTIAL NOISE IMPACTS

5.1 Project Construction Noise

Development of project areas will involve excavation, grading, and other typical construction activities during construction. The various construction phases of the project will generate significant amounts of noise. Depending on when construction occurs, the Ho'opili development and construction of the transit corridor may impact existing adjacent properties, such as the homes adjacent to Fort Weaver Road and Old Fort Weaver Road. Future developments such as UH West Oahu and DHHL on adjacent properties that are completed before the Ho'opili development may also be impacted by construction noise. Similarly, residences from the initial phases may be impacted by construction noise from

subsequent phases due to their proximity to the construction site. The actual noise levels produced during construction will be a function of the methods employed during each stage of the construction process. Typical ranges of construction equipment noise are shown in Figure 7. Pile driving, if employed, and earthmoving equipment, e.g., bulldozers and diesel-powered trucks, will probably be the loudest equipment used during construction.

5.2 Project Generated Stationary Mechanical Noise and Compliance with State of Hawaii Community Noise Control Rule

The Ho'opili project is proposed to be a mixed-use development of which 80 percent of the residential units will be multi-family. Approximately 195 acres of the project site is proposed for commercial, business, or light industrial development which will be distributed throughout the residential and open space areas located within the project site. Noise emanating from these commercial uses could significantly impact the proposed adjacent noise sensitive residential areas. The various phases in the long range development plan will incorporate stationary mechanical equipment that is typical for residential and commercial buildings. Expected mechanical equipment may include air handling equipment, condensing units, refrigeration units, etc.

Noise from this mechanical equipment and other equipment must meet the State noise rules, which stipulate maximum permissible noise limits at the property line. For multi-family dwellings, business, and commercial areas, the noise limits are 60 dBA during the day and 50 dBA during the night, as shown in Figure 1. For residential areas (i.e., single-family homes), noise limits are 55 dBA during the day and 45 dBA during the night. For industrial areas, the noise limit is 70 dBA during the day and night. For mixed zoning districts, the primary land use designation is used to determine the maximum permissible noise limits. However, the DOH takes into consideration background noise levels when assessing noise infractions. Mitigation of mechanical noise to meet the State DOH noise rules should be incorporated into the project design.

5.3 Compliance with FHWA/HDOT Noise Limits

A vehicular traffic noise analysis was completed using the FHWA Traffic Noise Model Look-up Tables Software Version 2.5 (2004) [Reference 12] for the existing conditions, future year 2030 projections with the "No Build" condition, and future year 2030 projections with the "Build" condition under Scenario A (with Transit) and Scenario B (without Transit). The traffic noise analysis is based on the peak hour traffic volumes provided by the Traffic Consultant [Reference 13]. Intersection geometric configurations and future speed limits were also provided by the traffic consultant.

Vehicular traffic noise levels were calculated for 7 locations, Locations A, B, C, D, E, F, and G as shown in Figure 8. Table 4 summarizes the constraints used in the traffic noise analysis. The short-term noise measurement and corresponding traffic counts were used to validate the software at noise prediction locations A, B, C, and D. Only future noise level predictions were made for Locations E, F, and G. The results of the traffic noise analysis for the existing and future year projections are described below and summarized in Tables 5 and 6.

5.3.1 Vehicular Traffic Noise Impacts on the Surrounding Community

Noise Prediction Location A - Old Fort Weaver Road

Existing residences located adjacent to Old Fort Weaver Road currently experience traffic noise levels well below the FHWA maximum noise limit of 67 dBA. Future improvements to roadways in the area (under the "no build" condition) will actually reduce the traffic volume on Old Fort Weaver Road, thereby reducing traffic noise by 1 to 3 dB. A 3 dB change or less in noise level is not considered to be significant. Traffic noise is expected to increase by 3 to 8 dB in the future due to the project, which is a significant noise increase.

Noise Prediction Location B - Fort Weaver Road

Existing residences located adjacent to Fort Weaver Road currently experience high traffic noise levels. Residences located farther than 70 feet from the edge-of-pavement (EOP) experience traffic noise levels that satisfy the FHWA maximum noise limit of 67 dBA. Residences that are located closer than 70 feet from the EOP exceed the FHWA noise limit. There is currently a noise barrier wall along Fort Weaver Road that shields the adjacent homes from traffic noise such that the FHWA noise limit is satisfied. However, the barrier has no effect on the upper levels of two story homes that still have a line-of-sight to Fort Weaver Road.

Future improvements to roadways in the area will reduce the traffic volume slightly on Fort Weaver Road, thereby reducing traffic noise by less than 1 dB. The future increase due to the project is an insignificant increase of less than 1 dB.

5.3.2 Vehicular Traffic Noise Impacts on the Project

Noise Prediction Location A - Old Fort Weaver Road

Future year traffic projections show that the FHWA maximum noise limit of 67 dBA will be satisfied for residences or schools that are built on the project site more than 25 feet from the EOP of Old Fort Weaver Road.

Noise Prediction Location B - Fort Weave Road

Future year traffic projections show that the FHWA maximum noise limit of 67 dBA will not be satisfied for the parks that are located within 70 feet from the EOP of Fort Weaver Road. In order to reduce the impact of traffic noise, the park should be designed such that a buffer zone (e.g., a parking lot) is constructed between the roadway and the park area.

The FHWA maximum noise limit of 72 dBA will be satisfied for commercial areas adjacent to Fort Weaver Road.

Noise Prediction Location C - Farrington Highway

For the parcels adjacent to Farrington Highway, vehicular traffic noise levels are expected to increase by up to 2 dB in the future under the "No Build" condition. The increase in traffic noise due to the Ho'opili project is 4 to 6 dB. A 3 dB change or more in noise level is considered significant.

Future year traffic projections show that the FHWA maximum noise limit of 67 dBA will not be satisfied for residences or schools that are built within 80 feet from the EOP of Farrington Highway unless noise mitigation treatments are implemented.

Noise Prediction Location D - H-1 Freeway

For the parcels adjacent to the H-1 Freeway, vehicular traffic noise levels are expected to increase by up to 3 dB in the future. The increase in traffic noise due to the Ho'opili project is less than 1 dB which is insignificant.

Because of its vicinity to the H-1, much of the project site will be impacted by noise from the freeway. Future year traffic projections show that the FHWA maximum exterior L_{eq} noise limit of 67 dBA will not be satisfied for parcels adjacent to the H-1 Freeway without traffic noise mitigation. Possible mitigation measures are described in Section 6.3.2. However, the parcels that are very close to the H-1 are the most impacted by traffic noise. Homes and schools that are built within 120 feet of the H-1 Freeway will not satisfy the FHWA maximum exterior Leq noise limit of 67 dBA, even if noise mitigation is implemented.

To limit the noise impact on the project, the 120 foot buffer zone is best suited for structures that are less sensitive to noise, such as commercial and light industrial uses. The FHWA noise criterion is less stringent for commercial and light industrial uses. However, even for these uses located within 120 feet from the H-1 Freeway, noise mitigation will be needed to meet the FHWA maximum exterior Leq noise limit of 72 dBA.

Although the FHWA criteria is not a regulatory requirement for this project, as it has no authority to enforce land use, its noise limit criteria is recommended by the FHWA to be used as a guideline for consideration of land use and the impact of traffic noise.

Noise Prediction Locations E and F - Road B and East-West Road

The Ho'opili development will provide single and multi-family housing, schools, and commercial businesses, all which will create vehicular traffic on minor roadways in the project area. Noise levels due to vehicular traffic were predicted for locations 25 feet from Roads B and East-West Road, noise prediction location E and F, respectively, and are below the FHWA maximum noise limit of 67 dBA.

Noise Prediction Location G - Fort Weaver/Kunia Road

Future year traffic projections show that the FHWA maximum noise limit of 67 dBA will be satisfied for schools that are built on the project site more than 40 feet from the EOP of Fort Weaver/Kunia Road.

Commercial areas located adjacent to Fort Weaver/Kunia Road are not expected to experience traffic noise levels that exceed the FHWA maximum noise limit of 72 dBA.

5.3.3 Effect of Rail Transit on Vehicular Traffic Noise

The vehicular traffic noise analysis for future year 2030 projections with the "Build" condition under Scenario A (with Transit) was compared to the Scenario B (without Transit) condition in order to evaluate the effect of the proposed high capacity transit service between Kapolei and Ala Moana Shopping Center. Rows "i" and "f" of Tables 5 and 6, respectively, show the change in noise level due to the proposed transit system. As shown in the tables, there is not a significant difference in traffic noise due to the addition of transit in the area.

5.4 Compliance with EPA and HUD Noise Guidelines

The results from the long-term noise measurements conducted at the proposed Ho'opili site show calculated day-night levels, L_{dn}, that vary between 48 dBA and 74 dBA, as shown in Table 3. As described in the section above, noise levels at the proposed project site are predicted to increase due to the projected increase in vehicular traffic along all roadways. Day-night noise levels are expected to exceed the HUD noise guidelines, which state an exterior design goal of $L_{dn} \leq 65$ dBA, for homes adjacent to the following roadways:

- Within 100 feet from Fort Weaver Road
- Within 125 feet from Farrington Highway
- Within 350 feet from the H-1 Freeway
- Within 25 feet from any minor roadway within the project site, e.g., 1st Ave, A Street, as well as Old Fort Weaver Road.

Traffic noise mitigation measures should be considered to reduce the aforementioned setback distances or to satisfy HUD noise guidelines within the setbacks. Traffic noise mitigation options such as noise barrier walls are discussed in detail in section 6.3.2 below.

It is important to note that the HUD and EPA noise guidelines are design goals and not enforceable regulations, although the HUD noise guidelines must be satisfied for projects involving HUD or federal financing. However, these guidelines and design goals are useful tools for assessing the noise environment.

5.5 Compliance with FAA and HDOT Airports Division Guidelines

The Ho'opili project site is outside of the 55 L_{dn} noise contours of both Honolulu International Airport and Kalaeloa Airport. Therefore, the project will not be impacted by aircraft noise. However, aircraft flyovers may be audible at the project site at times. These flyovers should be infrequent, and therefore, should not significantly impact the proposed development.

5.6 Honolulu High Capacity Transit Project and Compliance with FTA Guidelines

The City and County of Honolulu, Department of Transportation Services has evaluated alternatives for a high capacity transit service between Kapolei and Ala Moana Shopping Center. The most current alignment alternative runs along Farrington Highway and the proposed North-South Road and may include more than one station in the vicinity of the Ho'opili project site. A complete description of the most recent alignment and current planning documents can be found on the Honolulu High Capacity Transit Project website [Reference 15]. Typical sound exposure levels of various transit systems are shown in Table 7.

The day-night level, L_{dn}, along Farrington Highway is estimated to be 64 dBA at the project site due to increased traffic noise levels, not including rail transit noise. The FTA noise impact criteria shown in Figure 3 shows that an impact will occur if the rail transit project noise exceeds 60 dBA and a severe impact will occur if the transit project noise exceeds 66 dBA. This means the overall noise level increase of 1 dB due to the transit line will become noticeable to residents closest to the transit line. Residents will likely complain if the overall noise levels increase by more than 4 dB.

5.7 Compliance with State of Hawaii BOE Noise Guidelines

The State of Hawaii, Board of Education (BOE) Policy 6700 [Reference 10] requires that air conditioning be installed for schools exposed to an exterior noise level of L_{10}=65dBA. There are 5 schools planned within the Ho'opili project site. Most schools sites will experience L_{10} less than 65 dBA if they are located adjacent to minor roadways such as B Street and East-West Road. The school site located adjacent to Fort Weaver/Kunia Road and the H-1 Freeway and the school site adjacent to Farrington Highway are both expected to exceed the exterior noise BOE Policy 6700 of L_{10}=65dBA unless traffic noise mitigation is included. Noise mitigation options are discussed in detail in Section 6.6.

6.0 NOISE MITIGATION

6.1 Mitigation of Construction Noise

In cases where construction noise exceeds, or is expected to exceed the State's "maximum permissible" property line noise levels [Reference 1], a permit must be obtained from the State DOH to allow the operation of vehicles, cranes, construction equipment, power tools, etc., which emit noise levels in excess of the "maximum permissible" levels.

In order for the State DOH to issue a construction noise permit, the Contractor must submit a noise permit application to the DOH, which describes the construction activities for the project. Prior to issuing the noise permit, the State DOH may require action by the Contractor to incorporate noise mitigation into the construction plan. The DOH may also require the Contractor to conduct noise monitoring or community meetings inviting the neighboring residents and business owners to discuss construction noise. The Contractor should use reasonable and standard practices to mitigate noise, such as using mufflers on diesel and gasoline engines, using properly tuned and balanced machines, etc. However, the State DOH may require additional noise mitigation, such as temporary noise barriers, or time of day usage limits for certain kinds of construction activities.

Specific permit restrictions for construction activities [Reference 1] are:

> "No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels ... before 7:00 a.m. and after 6:00 p.m. of the same day, Monday through Friday."
>
> "No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels... before 9:00 a.m. and after 6:00 p.m. on Saturday."
>
> "No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels on Sundays and on holidays."

The use of hoe rams and jack hammers 25 lbs. or larger, high pressure sprayers, chain saws, and pile drivers are restricted to 9:00 a.m. to 5:30 p.m., Monday through Friday. In addition, construction equipment and on-site vehicles or devices whose operations involve the exhausting of gas or air, excluding pile hammers and pneumatic hand tools weighing less than 15 pounds, must be equipped with mufflers [Reference 1].

The DOH noise permit does not limit the noise level generated at the construction site, but rather the times at which noisy construction can take place. Therefore, noise mitigation for construction activities should be addressed using project management, such that the time restrictions within the DOH permit are followed.

Temporary noise mitigation measures will be required if construction activities occur in the vicinity of the schools. Construction and/or occupancy of the schools should occur after other construction activities near the school sites are completed.

6.2 Mitigation of the Ho'opili Development Noise

The design of the new development should give consideration to controlling the noise emanating from stationary mechanical equipment so as to comply with the State Department of Health *Community Noise Control* rules [Reference 1]. In order for the commercial areas to be compatible with the adjacent residential areas, noise mitigation measures should be implemented. Typical noise mitigation for stationary equipment such as air-conditioning and ventilation equipment, refrigerators, compressors, etc, includes mufflers, silencers, acoustical enclosures, noise barrier walls, etc. However, other noise sources may include non-stationary equipment such as trucks loading and unloading supplies. Additional light industrial and commercial noise sources may include ambulance sirens and backup alarms on trucks and forklifts, which are exempt from DOH noise regulations. Consideration could also be given to the layout of the commercial areas to meet DOH noise regulations and reduce the noise impact. For example, noisier activities, such as traffic access and loading areas, should be located away from adjacent residential areas. Enclosed mechanical rooms may be required for some equipment.

Restrictions may need to be placed on all commercial uses allowed in the commercial areas in order to strictly control development of potential noise producing industries. For example, sale and lease documents for the commercial property should disclose and emphasize the significance of the DOH noise regulations with respect to the abutting residential areas. With respect to mixed zoning districts, the DOH regulations specifies that the primary land use designation shall be used to determine the applicable zoning district class and the maximum permissible sound level. However, zoning district class B includes commercial, business, multi-family dwellings, and apartments with the corresponding maximum permissible sound level listed in Figure 1.

6.3 FHWA Traffic Noise Mitigation

Vehicular traffic noise from Farrington Highway, Fort Weaver Road, and the H-1 Freeway may significantly impact the proposed development unless noise mitigation is considered.

6.3.1 Mitigation Through Setbacks or Buffer Zones

According to the FHWA's Highway Traffic Noise Analysis and Abatement Policy and Guidance [Reference 15], "the FHWA encourages State and local governments to practice compatible land use planning and control in the vicinity of highways. Local governments should use their power to regulate land development in such a way that noise-sensitive land uses are either prohibited from being located adjacent to a highway, or that the developments are planned, designed, and constructed in such a way that noise impacts are minimized." Although the FHWA criteria is not a regulatory requirement for this project, as it has no authority to enforce land use, its noise limit criteria is recommended by the FHWA to be used as a guideline for consideration of land use and the impact of traffic noise. The following setback distances are recommended to minimize traffic noise impact and are based on calculated traffic noise levels and compliance with the FHWA's maximum exterior L_{eq} noise limit of 67 dBA for homes, parks, and schools and 72 dBA for commercial areas.

Fort Weaver Road

Parks constructed adjacent to Fort Weaver Road should be at least 70 feet from the edge of pavement so as not to exceed the FHWA's maximum exterior noise limit. The use of parking lots as noise buffer zones is recommended.

Farrington Highway

Residences and schools constructed on parcels that border Farrington Highway should be at least 80 feet from the edge of pavement so as not to exceed the FHWA's maximum exterior L_{eq} noise limit of 67 dBA. Any homes within 80 feet of Farrington Highway will require noise mitigation, as discussed in Section 6.3.2, to meet the criteria.

H-1 Freeway

Vehicular traffic noise from the H-1 Freeway will significantly impact the proposed development. The calculated traffic noise levels show that residences and schools constructed on parcels within 120 feet from the H-1 Freeway will exceed the FHWA's maximum exterior L_{eq} noise limit, even with some form of traffic noise mitigation. To limit the noise impact on the project, the 120 foot buffer zone is best suited for structures that are less sensitive to noise, such as commercial and light industrial uses. The layout of these buildings should be carefully designed to block or shield adjacent residential buildings from freeway noise. Commercial areas constructed within 120 feet from the H-1 Freeway will require noise mitigation to meet the FHWA criteria.

6.3.2 Additional Noise Mitigation Options

A comprehensive traffic noise and barrier analysis using roadway layout data and the FHWA Traffic Noise Model Software was not performed. The guidelines listed below are general in nature and should be applied where residential housing, schools, parks, and commercial areas are constructed within the setback limits listed above and noise mitigation

becomes necessary. The following are effective noise mitigation measures.

- Construct barrier walls and/or earth berms along roadways.
- Air-condition buildings instead of relying on natural ventilation.
- Acoustically soften interior spaces by the addition of thick carpeting with a padding underlayment, an acoustical tile ceiling, louvered closet doors, etc.
- Use exterior wall constructions which exhibit high noise reductions.

Typical exterior-to-interior noise reductions for naturally ventilated homes, i.e., with open windows, are approximately 9 dB. Adding absorption to interior spaces, (acoustically softening), can further reduce the noise levels 1 to 5 dB, depending upon the absorption initially present, and the amount of absorption added to the space. Air-conditioned or mechanically ventilated homes will also typically exhibit higher exterior-to-interior noise reductions achieved by several types of building constructions. Estimating the noise reduction provided by a barrier, however, is more difficult to generalize. Factors such as distances to roadways and setbacks, intervening ground conditions, barrier construction, barrier height, roadway elevations, etc., will determine the noise reduction afforded by a traffic noise barrier. In general, a 5 to 10 dB reduction can be expected.

6.4 Mitigation of Aircraft Noise

The Ho'opili project site is well outside the L_{dn} 55 dBA noise contour. Therefore, noise mitigation to attenuate aircraft noise is not necessary.

6.5 Mitigation of Rail Transit Noise

The FTA's impact assessment report has identified appropriate "screening" distances, i.e. minimum setback distances, within which a transit project has little possibility of creating a noise impact. The screening distances for various fixed guideway systems and facilities are listed in Table 8.

If a transit system noise impact has been determined, noise mitigation may be required. The City and County of Honolulu is currently developing an Environmental Impact Statement for the proposed transit system. We assume that transit noise mitigation measures will be addressed in the EIS.

6.6 Board of Education Noise Mitigation

6.6.1 Proposed H-1/Kunia School Site

Exterior noise levels at the school site located adjacent to the H-1 Freeway and Fort Weaver/Kunia Road will exceed the BOE Policy 6700 noise limit of L_{10} = 65 dBA. The BOE policy requires that air conditioning be provided for this school in order to reduce the impact of traffic noise on the school.

Furthermore, the layout and construction of the school should be carefully designed such that exterior noise will not disturb learning activities and interfere with speech intelligibility. The following design parameters should be considered during the design phase of the school:

- To reduce traffic noise at the school site, an earthen berm or noise barrier walls should be included in the design of the new school.
- Noise buffer zones should be provided between the roadway and the noise sensitive school buildings. Parking lots should be located in this noise buffer zone.
- The exterior shell of the school should be constructed with materials such that interior noise levels are reduced to 50 dBA or less. Rooms facing the major roadways should not have operable windows and may require sound rated or double glazed windows.
- Arrange the rooms and buildings such that noise sensitive classrooms, libraries, lecture halls, offices, and all other rooms used for speech are buffered from traffic noise by rooms with noisier activities such as the gymnasium, cafeteria, shop, music.
- The school building should be used as a noise barrier to athletic fields or other school activities that take place outdoors.

6.6.2 Proposed Farrington School Site

Exterior noise levels at the school site located adjacent to Farrington Highway will exceed the BOE Policy 6700 noise limit of L_{10} = 65 dBA. The FHWA noise limit of 67 dBA will also be exceeded. In order to comply with the BOE Policy, one of the following options are necessary:

- As required by the BOE, provide air conditioning to the school facility. A substantial exterior shell construction may also be required to reduce interior noise levels to 50 dBA or less.
- Provide noise barrier walls along Farrington Highway to reduce the exterior noise levels at the school site.

6.6.3 Other School Sites

The three remaining school sites will not require noise mitigation.

REFERENCES

1. Chapter 46, *Community Noise Control*, Department of Health, State of Hawaii, Administrative Rules, Title 11, September 23, 1996.
2. *Department of Transportation, Federal Highway Administration Procedures for Abatement of Highway Traffic Noise,* Title 23, CFR, Chapter 1, Subchapter J, Part 772, 38 FR 15953, June 19, 1973; Revised at 47 FR 29654, July 8, 1982.
3. *Federal Highway Administration's Traffic Noise Model,* FHWA-RD-77-108; U.S. Department of Transportation, December 1978.
4. *Noise Analysis and Abatement Policy,* Department of Transportation, Highways Division, State of Hawaii, June 1977.
5. *Toward a National Strategy for Noise Control*, U.S. Environmental Protection Agency, April 1977.
6. *Department of Housing and Urban Development Environmental Criteria and Standards*, Title 24, CFR, Part 51, 44 FR 40860, July 12, 1979; Amended by 49 FR 880, January 6, 1984.
7. *FAA Regulations on Airport Noise Compatibility Planning Programs,* Code of Federal Regulations, Title 14, Chapter 1, Subchapter I, Part 150; Issued by 49 FR 49269, December 18, 1984; corrected by 50 FR 5063, February 6, 1985; amended by 53 FR 8723, March 16, 1988; corrected by 53 FR 9726, March 24, 1988.
8. *Honolulu International Airport Master Plan Update and Noise Compatibility Program*, State of Hawaii Department of Transportation, Airports Division, Vol. 2, December 1989.
9. *Transit Noise and Vibration Impact Assessment*, Office of Planning, Federal Transit Administration, April 1995.
10. *Policies and Standards for School Facilities Design*, Board of Education, Policy 6700, Appendix A, Acoustical and Environmental Control, March 1995.
11. *Kalaeloa Airport Master Plan,* State of Hawaii Department of Transportation, Airports Division, November 1998.
12. *Federal Highway Administration's Traffic Noise Model Look-up Tables Software*, Ver. 2.5; U.S. Department of Transportation, December 17, 2004.
13. *Traffic Impact Analysis Report - Ho'opili,* Wilbur Smith Associates, December, 2007.
14. Honolulu High Capacity Transit Corridor Project, www.honolulutransit.org.
15. *Highway Traffic Noise Analysis and Abatement Policy and Guidance*, US Department of Transportation Federal Highway Administration, June 1995.

TABLE 1:
FAR Part 150 Recommendations for Land Use Compatibility in Yearly Day-Night Average Sound Levels

TYPE OF LAND USE	Yearly Day-Night Average Sound Level (L_{dn})					
	< 65	65-70	70-75	75-80	80-85	> 85
RESIDENTIAL:						
Residential (except mobile homes & transient lodgings)	Y	N(1)	N(1)	N	N	N
Mobile home parks	Y	N	N	N	N	N
Transient lodgings	Y	N(1)	N(1)	N(1)	N	N
PUBLIC USE:						
Schools	Y	N(1)	N(1)	N	N	N
Hospitals and nursing homes	Y	25	30	N	N	N
Churches, auditoriums, and concert halls	Y	25	30	N	N	N
Government services	Y	Y	25	30	N	N
Transportation	Y	Y	Y(2)	Y(3)	Y(4)	Y(4)
Parking	Y	Y	Y(2)	Y(3)	Y(4)	N
COMMERCIAL USE:						
Offices, business and professional	Y	Y	25	30	N	N
Wholesale/Retail:(bldg. Mater., hardware, & farm equip.)	Y	Y	Y(2)	Y(3)	Y(4)	N
Retail trade – general	Y	Y	25	30	N	N
Utilities	Y	Y	Y(2)	Y(3)	Y(4)	N
Communication	Y	Y	25	30	N	N
MANUFACTURING AND PRODUCTION:						
Manufacturing, general	Y	Y	Y(2)	Y(3)	Y(4)	N
Photographic and optical	Y	Y	25	30	N	N
Agriculture (except livestock) and forestry	Y	Y(6)	Y(7)	Y(8)	Y(8)	Y(8)
Livestock farming and breeding	Y	Y(6)	Y(7)	N	N	N
Mining and fishing, resource production and extraction	Y	Y	Y	Y	Y	Y
RECREATIONAL USE:						
Outdoor sports arenas and spectator sports	Y	Y(5)	Y(5)	N	N	N
Outdoor music shells, amphitheaters	Y	N	N	N	N	N
Nature exhibits and zoos	Y	Y	N	N	N	N
Amusements, parks, resorts and camps	Y	Y	Y	N	N	N
Golf courses, riding stables and water recreation	Y	Y	25	30	N	N

Note: Numbers in parentheses refer to the following notes.

(1) Where the community determines that residential or school uses must be allowed, measures to achieve outdoor-to-indoor Noise Level Reduction (NLR) of at least 25 dB and 30 dB should be incorporated into building codes and be considered in individual approvals. Normal residential construction can be expected to provide a NLR of 20 dB, thus, the reduction requirements are often stated as 5, 10, or 15 dB over standard construction and normally assume mechanical ventilation and closed windows year round. However, the use of NLR criteria will not eliminate outdoor noise problems.

(2) Measures to achieve NLR 25 must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

(3) Measures to achieve NLR 30 must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

(4) Measures to achieve NLR 35 must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

(5) Land use compatible provided special sound reinforcement systems are installed.

(6) Residential buildings require a NLR of 25.

(7) Residential buildings require a NLR of 30.

(8) Residential buildings are not permitted.

Abbreviations:

Y(Yes) = Land Use and related structures compatible w/o restrictions.

N(No) = Land Use and related structures are not compatible and should be prohibited.

NLR = Noise Level Reduction (outdoor-to-indoor) to be achieved through incorporation of noise attenuation into the design and construction of the structure.

25, 30, or 35 = Land use and related structures general compatible; measures to achieve NLR of 25, 30, or 35 dB must be incorporated into design and construction of structures.

Regulatory Note.

The designations contained in this table do not constitute a Federal determination that any use of land covered by the program is acceptable or unacceptable under Federal, State, or local law. The responsibility for determining the acceptable and permissible land uses and the relationship between specific properties and specific noise contours rests with the local authorities. FAA determinations under Part 150 are not intended to substitute federally determined land uses for those determined to be appropriate by local authorities in response to locally determined needs and values in achieving noise compatible land uses.

Source: FAR Part 150, Appendix A, Table 1. "Land Use Compatibility with Yearly Day-Night Average Sound Levels."

TABLE 2:
State Department of Transportation Airports Division Recommendations for Local Land Use Compatibility in Yearly Day-Night Average Sound Levels (Ldn)

TYPE OF LAND USE	Yearly Day-Night Average Sound Level (L_{dn}) < 60	60-65	65-70	70-75	75-80	80-85
RESIDENTIAL:						
Low density residential, resorts, & hotels (w/ outdoor fac)	Y(a)	N(b)	N	N	N	N
Low density apartment w/ moderate outdoor use	Y	N(b)	N	N	N	N
High density apartment with limited outdoor use	Y	N(b)	N(b)	N	N	N
Transient lodgings (w/limited outdoor use)	Y	N(b)	N(b)	N	N	N
PUBLIC USE:						
Schools, day care centers, libraries, and churches	Y	N(c)	N(c)	N(c)	N	N
Hospitals, nursing homes, clinics, and health facilities	Y	Y(d)	Y(d)	Y(d)	N	N
Indoor auditoriums, and concert halls	Y(c)	Y(c)	N	N	N	N
Government services and offices serving the public	Y	Y	Y(d)	Y(d)	N	N
Transportation and parking	Y	Y	Y(d)	Y(d)	Y(d)	Y(d)
COMMERCIAL USE:						
Offices - government, business and professional	Y	Y	Y(d)	Y(d)	N	N
Wholesale/Retail: bldg. Mater., hardware, & heavy equip	Y	Y	Y(d)	Y(d)	Y(d)	Y(d)
Airport businesses - car rental, ticketing, lei stands, etc	Y	Y	Y(d)	Y(d)	N	N
Retail trade, restaurants, shp. Centers, financial inst., etc	Y	Y	Y(d)	Y(d)	N	N
Power plants, sweage treatment plants, & base yards	Y	Y	Y(d)	Y(d)	Y(d)	N
Studios w/o outdoor sets, broadcasting & Production fac	Y(c)	Y(c)	N	N	N	N
MANUFACTURING AND PRODUCTION:						
Manufacturing, general	Y	Y	Y(d)	Y(d)	Y(d)	N
Photographic and optical	Y	Y	Y(d)	Y(d)	N	N
Agriculture (except livestock) and forestry	Y	Y(e)	Y(c)	Y(e)	Y(e)	Y(c)
Livestock farming and breeding	Y	Y(e)	Y(e)	N	N	N
Mining and fishing, resource production and extraction	Y	Y	Y	Y	Y	Y
RECREATIONAL USE:						
Outdoor sports arenas and spectator sports	Y	Y(f)	Y(f)	N	N	N
Outdoor music shells, amphitheaters	Y(f)	N	N	N	N	N
Nature exhibits and zoos, neighborhood parks	Y	Y	Y	N	N	N
Amusements, beach parks, active playgrounds, etc	Y	Y	Y	Y	N	N
Public golf courses, riding stables, cemeteries, gardens, etc	Y	Y	N	N	N	N
Professional/resort sports facil., media event facil., etc	Y(f)	N	N	N	N	N
Extensive natural wildlife and recreation areas	Y(f)	N	N	N	N	N

Note: Letters in parentheses refer to the following notes.

(a) A noise level of 60 L_{dn} does not eliminate all risks of adverse noise impacts from aircraft noise. However, the 60 L_{dn} planning level has been selected by the State Airports Division as an appropriate compromise between the minimal risk of level of 55 L_{dn} and the significant risk level of 65 L_{dn}.

(b) Where the community determines that these uses should be allowed, Noise Level Reduction (NLR) measures to achieve interior levels of 45 L_{dn} or less should be incorporated into building codes and be considered in individual approvals. Normal local construction employing natural ventilation can be expected to provide an average NLR of approximately 9 dB. Total closure plus air conditioning may be required to provide additional outdoor-to-indoor NLR, but will not eliminate outdoor noise problems.

(c) Because the L_{dn} noise descriptor system represents a 24-hour average of individual aircraft noise events, each of which can be unique in respect to amplitude, duration, and tonal content, the NLR requirements should be evaluated for the specific land use, interior acoustical requirements, and properties of the aircraft noise events. NLR requirements should not be based solely upon the exterior L_{dn} exposure level.

(d) Measures to achieve required NLR must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

(e) Residential buildings require NLR. Residential buildings should not be located where exterior noise is greater than 65 L_{dn}.

(f) Impact of amplitude, duration, frequency, and tonal content of aircraft noise events should be evaluated.

Abbreviations:
Y(Yes) = Land Use and related structures compatible without restrictions.
N(No) = Land Use and related structures are not compatible and should be prohibited.

Source: Airports Division, Department of Transportation, State of Hawaii

TABLE 3:
Long Term Noise Measurement Results

	AM L_{eq}	PM L_{eq}	L_{dn} (Calculated)
L1	63 - 72 dBA	59 - 72 dBA	74 dBA
L2	48 - 58 dBA	44 - 59 dBA	59 dBA
L3	40 - 60 dBA	37 - 50 dBA	53 dBA
L4	39 - 55 dBA	33 - 45 dBA	48 dBA

TABLE 4:
Vehicular Traffic Noise Analysis Constraints

Noise Prediction Location	A	B	C	D	E	F	G
Roadway	Old Fort Weaver	Fort Weaver	Farring-ton	H-1	B Street	East-West	Kunia
Distance to EOP+ (existing) ft.	25	85	90	120	N/A	N/A	N/A
Distance to EOP (future) ft.	25	70*	80*	120	25	25	40
Total Lanes (existing)	2	4	2	6	N/A	N/A	N/A
Total Lanes (2030)	2	6	4	6	2	2	4
Speed Limit (existing) mph	25	45	35	60	N/A	N/A	N/A
Speed Limit (2030) mph	30	40	40	60	30	40	40

Notes:
+ EOP - Edge-of-Pavement
* Future widening of the roadway will result in a reduced distance between the roadway and the prediction location.

TABLE 5:
Predicted Traffic Noise Levels With and Without the Project and Resulting Increases Due to the Project at Locations A, B, C, and D[+]

Noise levels shown in the table are based on peak-hour traffic volumes, and are expressed in A-weighted decibels (dBA).

Row ID	Traffic Analysis Conditions	Location A[*]		Location B[*]		Location C[*]		Location D[*]	
		AM	PM	AM	PM	AM	PM	AM	PM
A	Existing (Calculated)	58.6	62.7	66.0	66.3	61.6	59.8	76.8	75.5
B	Future Without Project (2030)	57.3	59.7	65.0	65.3	61.6	61.8	79.1	77.7
C	Future With Project Scenario A (w Transit) (2030)	65.1	63.0	65.3	66.3	66.1	66.1	79.6	78.3
D	Future With Project Scenario B (wo Transit) (2030)	64.1	62.5	65.4	66.3	67.1	66.5	79.6	78.3
B-A	Future Increase Without Project (2030)	-1.3	-3.0	-1.0	-1.0	0.0	2.0	2.3	2.2
C-A	Future Increase With Project Scenario A (2030)	6.5	0.3	-0.7	0.0	4.5	6.3	2.8	2.8
D-A	Future Increase With Project Scenario B (2030)	5.5	-0.2	-0.6	0.0	5.5	6.7	2.8	2.8
C-B	**Future Increase Due to Project Scenario A (2030)**	7.8	3.3	0.3	1.0	4.5	4.3	0.5	0.6
D-B	**Future Increase Due to Project Scenario B (2030)**	6.8	2.8	0.4	1.0	5.5	4.7	0.5	0.6
D-C	**Effect of Transit on Project**	-1.0	-0.5	0.1	0.0	1.0	0.4	0.0	0.0

Notes:
[+] The noise level calculations were based on the traffic study provided by the Traffic Consultant [Reference 12].
[*] Location A - 25 feet east of Old Fort Weaver Road edge-of-pavement
Location B - 85 feet and 70 feet east of Fort Weaver Road edge-of-pavement for the existing and future conditions, respectively
Location C -90 feet and 80 feet south of Farrington Highway edge-of-pavement for the existing and future conditions, respectively
Location D - 120 feet south of H-1 Freeway edge-of-pavement

TABLE 6:
Predicted Traffic Noise Levels With the Project and Resulting Increases Due to the Project at Locations E, F, and G[+]

Noise levels shown in the table are based on peak-hour traffic volumes, and are expressed in A-weighted decibels (dBA).

Row ID	Traffic Analysis Conditions	Location E[*]		Location F[*]		Location G[*]	
		AM	PM	AM	PM	AM	PM
A	Existing (Measured)[†]	55.3	50.4	53.5	48.2	N/A	N/A
B	Future With Project Scenario A (w Transit) (2030)	64.9	64.6	64.3	64.8	62.3	65.8
C	Future With Project Scenario B (wo Transit) (2030)	65.4	65.4	64.5	65.5	64.0	66.2
B-A	**Future Increase Due to Project Scenario A (2030)**	9.6	14.2	10.8	16.6	N/A	N/A
C-A	**Future Increase Due to Project Scenario B (2030)**	10.1	15.0	11.0	17.3	N/A	N/A
C-B	**Effect of Transit on Project**	0.5	0.8	0.2	0.7	1.7	0.4

Notes:
[+] The noise level calculations were based on the traffic study provided by the Traffic Consultant [Reference 12].
[†] The existing noise levels at Locations E and F are based on the long-term noise measurements conducted at Locations L3 and L4.
[*] Location E - 25 feet west of the proposed Street B edge-of-pavement
Location F - 25 feet west of the proposed East-West Road edge-of-pavement
Location G - 40 feet west of Kunia Road edge-of-pavement

TABLE 7:
Federal Transit Administration Transit System Source Reference Sound Exposure Level (SEL)

Source/Type		Reference Conditions	Reference SEL* (dBA)
Commuter Rail, At-Grade	Locomotives	Diesel-electric, 3000 hp, throttle 5	92
		Electric	90
	Cars	Ballast, welded rail	82
Rail Transit		At-grade, ballast, welded rail	82
AGT	Steel Wheel	Aerial, concrete, welded rail	80
	Rubber Tire	Aerial, concrete guideway	78
Monorail		Aerial, straddle beam	82
Maglev		Aerial, open guideway	72
Automobiles and Vans		Normal roadway surface conditions	73
City Buses		Normal roadway surface conditions	84
Commuter Buses		Normal roadway surface conditions	88
Rail System	Yards and Shops	20 train movements in peak activity hour	118
	Layover Tracks (commuter rail)	One train with diesel locomotive idling for one hour	116
Bus System	Storage Yard	100 buses accessing facility in peak activity hour	111
	Operating Facility	100 buses accessing facility, 30buses serviced and cleaned in peak activity hour	114
	Transit Center	20 buses in peak activity hour	101
Parking Garage		1000 cars in peak activity hour	92
Park and Ride Lot		12 buses, 1000 cars in peak activity hour	101

Note: Measured 50 feet from centerline of guideway/roadway for mobile sources at 50 mph; 50 feet from center of noise-generating activity for stationary sources..

Source: Chapter 5: General Noise Assessment, Table 5-1, 5-3, 5-5. *Transit Noise and Vibration Impact Assessment*, Office of Planning, Federal Transit Administration, April 1995.

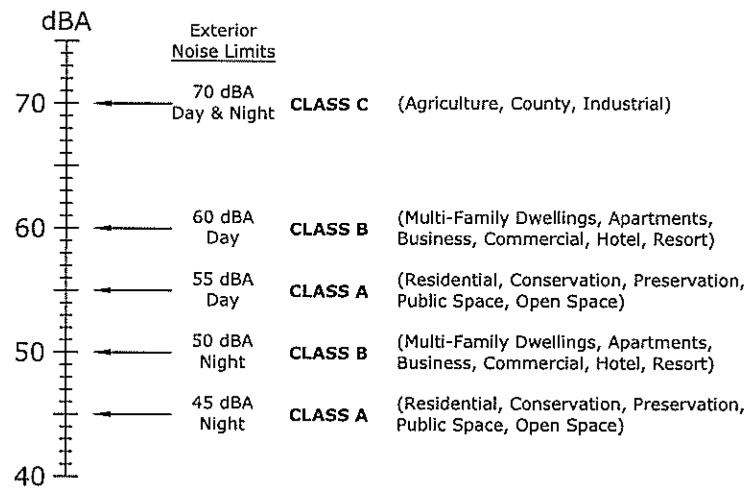
TABLE 8:
Federal Transit Administration Screening Distances for Noise Assessments

Type of Project		Screening Distance* (ft) Unobstructed	Intervening Buildings
Fixed Guideway Systems:			
Commuter Rail Mainline		750	375
Commuter Rail Station		450	225
Rail Transit Guideway		700	350
Rail Transit Station		200	100
Access Roads		100	50
Low-and Intermediate-Capacity Transit	Steel Wheel	200	100
	Rubber Tire	125	75
	Monorail	300	150
Yards and Shops		2000	1000
Parking Facilities		150	75
Access Roads		100	50
Ancillary Facilities			
Ventilation Shafts		200	100
Power Substations		250	125

Note: Measured from centerline of guideway/roadway for mobile sources; from center of noise-generating activity for stationary sources.

Source: Chapter 4: Noise Screening Procedure, Table 4-1. *Transit Noise and Vibration Impact Assessment*, Office of Planning, Federal Transit Administration, April 1995.

Zoning District	Day Hours (7 AM to 10 PM)	Night Hours (10 PM to 7 AM)
CLASS A Residential, Conservation, Preservation, Public Space, Open Space	55 dBA (Exterior)	45 dBA (Exterior)
CLASS B Multi-Family Dwellings, Apartments, Business, Commercial, Hotel, Resort	60 dBA (Exterior)	50 dBA (Exterior)
CLASS C Agriculture, Country, Industrial	70 dBA (Exterior)	70 dBA (Exterior)



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Hawaii Maximum Permissible Sound Levels for Various Zoning Districts

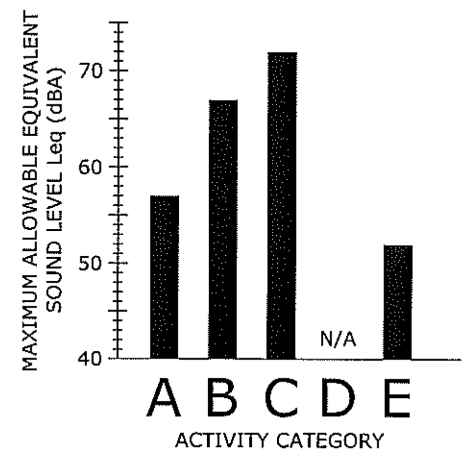
Ho'opili

Not to Scale

Date February 2008 | Project No. 06-34 | Drawn By TRB

Figure No 1

ACTIVITY CATEGORY	ACTIVITY CATEGORY DESCRIPTION	MAXIMUM EQUIVALENT SOUND LEVEL $L_{eq(h)}$
A	LANDS ON WHICH SERENITY AND QUIET ARE OF EXTRAORDINARY SIGNIFICANCE AND SERVE AN IMPORTANT PUBLIC NEED AND WHERE THE PRESERVATION OF THOSE QUALITIES IS ESSENTIAL IF THE AREA IS TO CONTINUE TO SERVE ITS INTENDED PURPOSE.	57 dBA (EXTERIOR)
B	PICNIC AREAS, RECREATION AREAS, PLAYGROUNDS, ACTIVE SPORT AREAS, PARKS, RESIDENCES, MOTELS, HOTELS, SCHOOLS, CHURCHES, LIBRARIES, AND HOSPITALS.	67 dBA (EXTERIOR)
C	DEVELOPED LANDS, PROPERTIES, OR ACTIVITIES NOT INCLUDED IN ACTIVITY CATEGORIES A OR B ABOVE.	72 dBA (EXTERIOR)
D	UNDEVELOPED LAND	N/A
E	RESIDENCES, MOTELS, HOTELS, PUBLIC MEETING ROOMS, SCHOOLS, CHURCHES, LIBRARIES, HOSPITALS, AND AUDITORIUMS.	52 dBA (INTERIOR)



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Federal Highways Administration Recommended Equivalent Hourly Sound Levels Based on Land Use

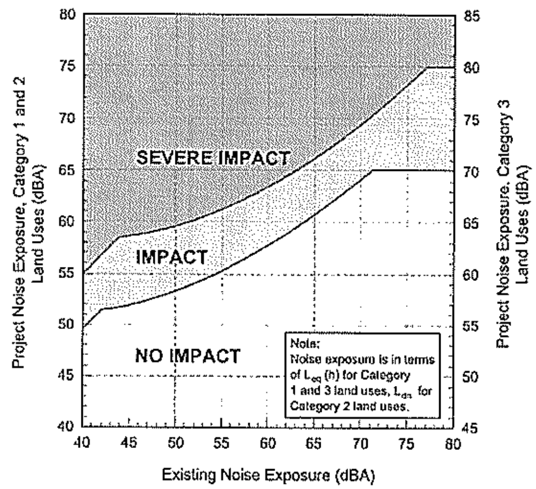
Ho'opili

Not to Scale

Date February 2008 | Project No. 06-34 | Drawn By TRB

Figure No 2

LAND USE CATEGORY	LAND USE CATEGORY DESCRIPTION	NOISE METRIC (dBA)
1	TRACTS OF LAND WHERE QUIET IS AN ESSENTIAL ELEMENT IN THEIR INTENDED PURPOSE. THIS CATEGORY INCLUDES LANDS SET ASIDE FOR SERENITY AND QUIET, AND SUCH LAND USES AS OUTDOOR AMPHITHEATERS AND CONCERT PAVILIONS, AS WELL AS NATIONAL HISTORIC LANDMARKS WITH SIGNIFICANT OUTDOOR USE.	OUTDOOR Leq(h)
2	RESIDENCES AND BUILDINGS WHERE PEOPLE NORMALLY SLEEP. THIS CATEGORY INCLUDES HOMES, HOSPITALS AND HOTELS WHERE A NIGHTTIME SENSITIVITY TO NOISE IS ASSUMED TO BE OF UTMOST IMPORTANCE.	OUTDOOR Ldn
3	INSTITUTIONAL LAND USES WITH PRIMARILY DAYTIME AND EVENING USE. THIS CATEGORY INCLUDES SCHOOLS, LIBRARIES, AND CHURCHES WHERE IT IS IMPORTANT TO AVOID INTERFERENCE WITH SUCH ACTIVITIES AS SPEECH, MEDITATION, AND CONCENTRATION ON READING MATERIAL. BUILDINGS WITH INTERIOR SPACES WHERE QUIET IS IMPORTANT, SUCH AS MEDICAL OFFICES, CONFERENCE ROOMS, RECORDING STUDIOS AND CONCERT HALLS FALL INTO THIS CATEGORY. PLACES FOR MEDITATION OR STUDY ASSOCIATED WITH CEMETERIES, MONUMENTS, MUSEUMS. CERTAIN HISTORICAL SITES, PARKS, AND RECREATIONAL FACILITIES ARE ALSO INCLUDED.	OUTDOOR Leq(h)



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Federal Transit Administration Noise Impact Criteria for Transit Projects

Ho'opili

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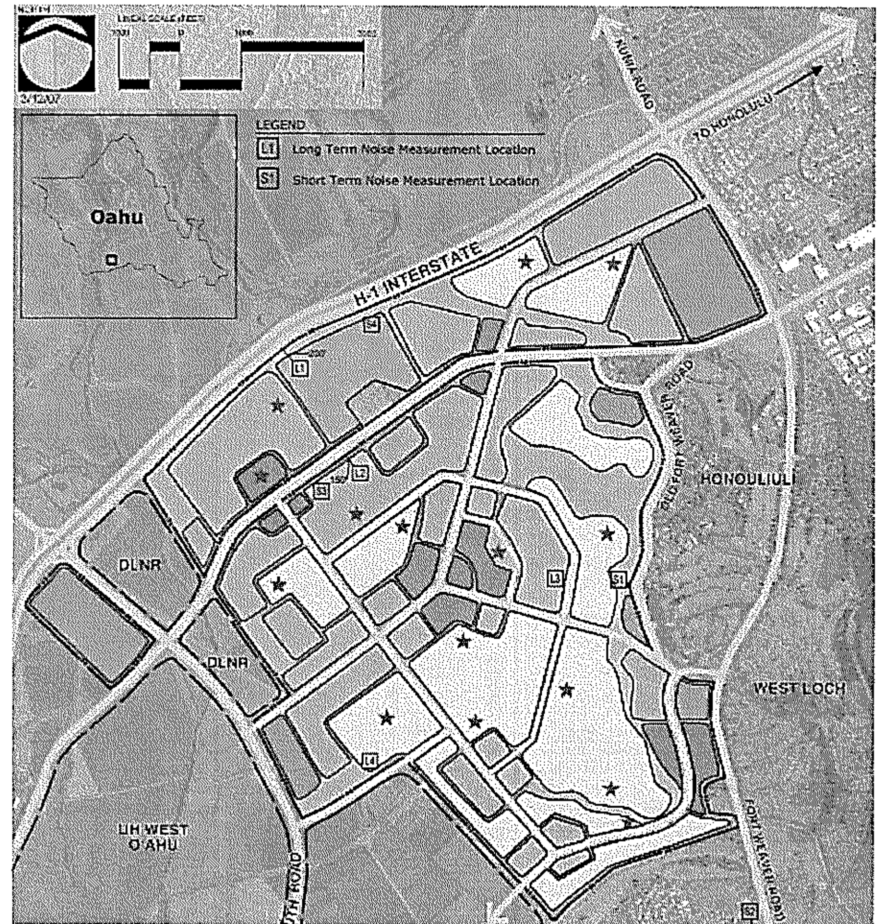
Figure No 3



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Project Site and Noise Measurement Locations

Ho'opili

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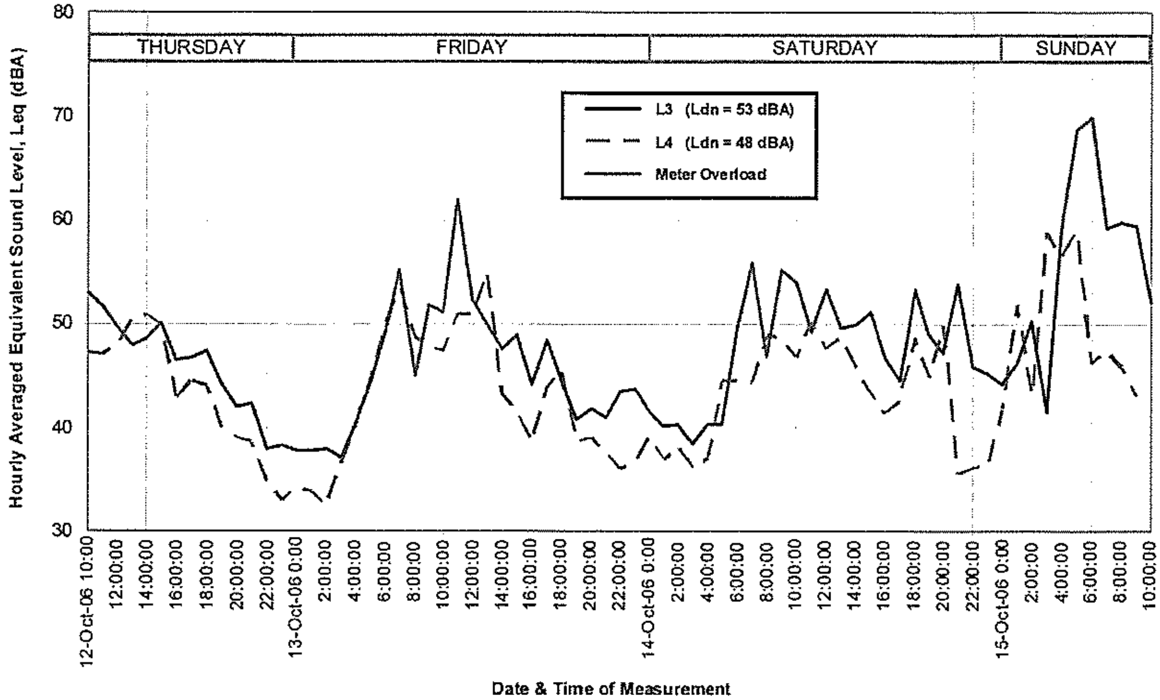
Date February 2008 | Project No. 06-34 | Drawn By DFD

Figure No 4



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Graph of Long Term Noise Measurements (L3 and L4)

Ho'opili

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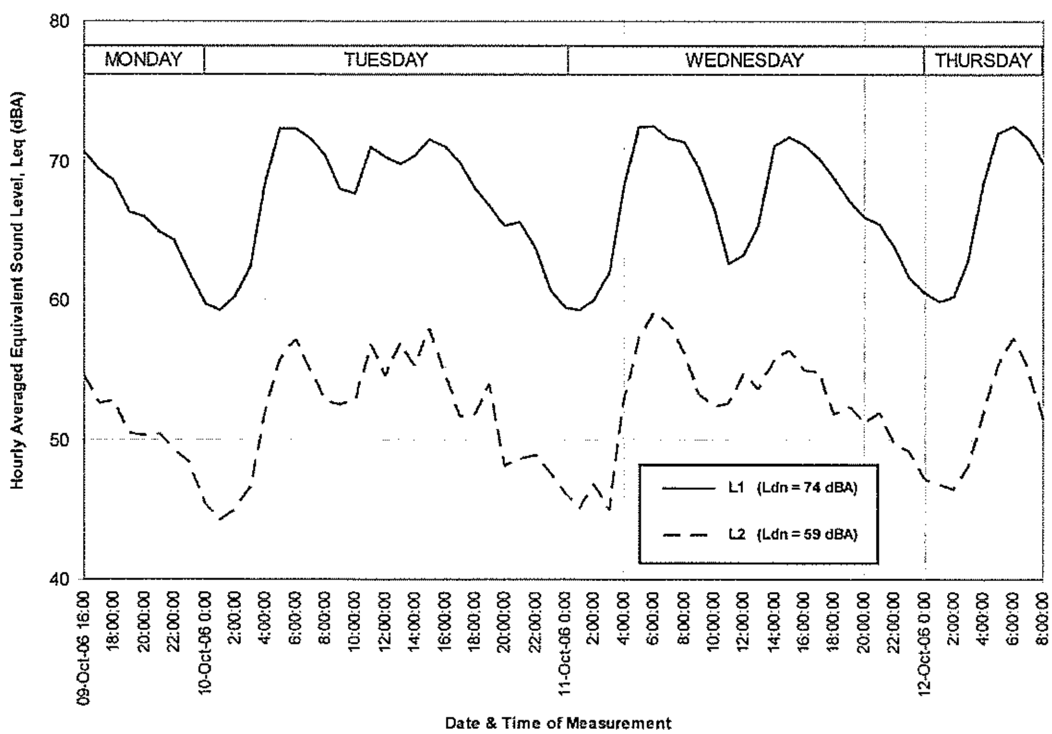
Date	Project No.	Drawn By	Figure No
February 2008	06-34	DFD	6



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Graph of Long Term Noise Measurements (L1 and L2)

Ho'opili

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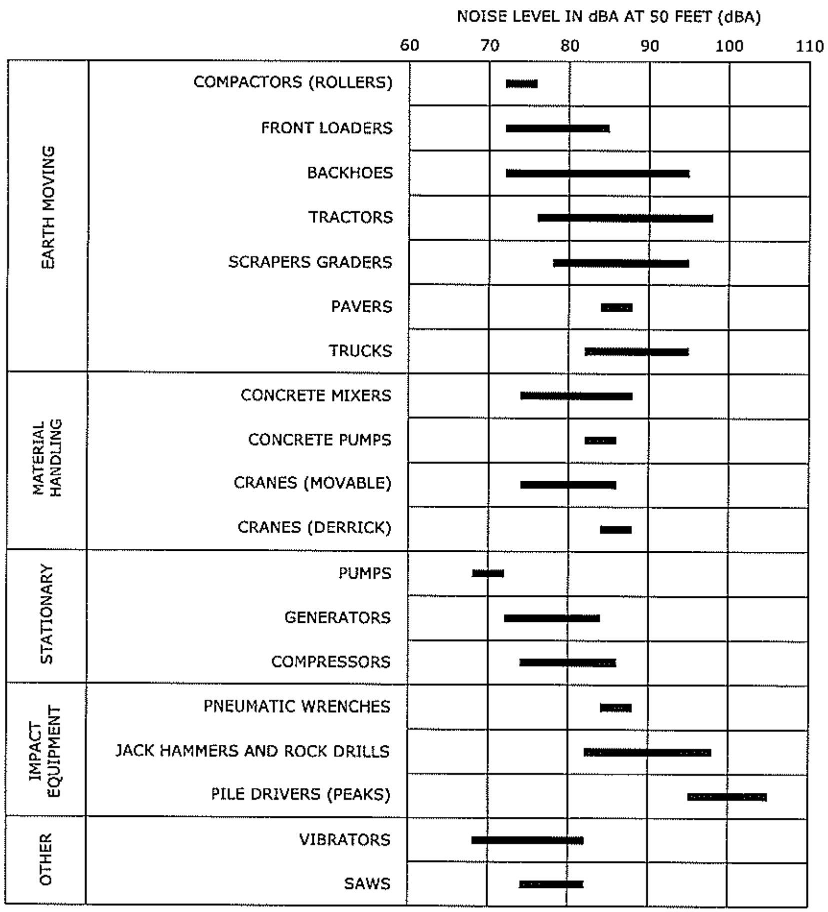
Date	Project No.	Drawn By	Figure No
February 2008	06-34	DFD	5



NOTE: BASED ON LIMITED AVAILABLE DATA SAMPLES

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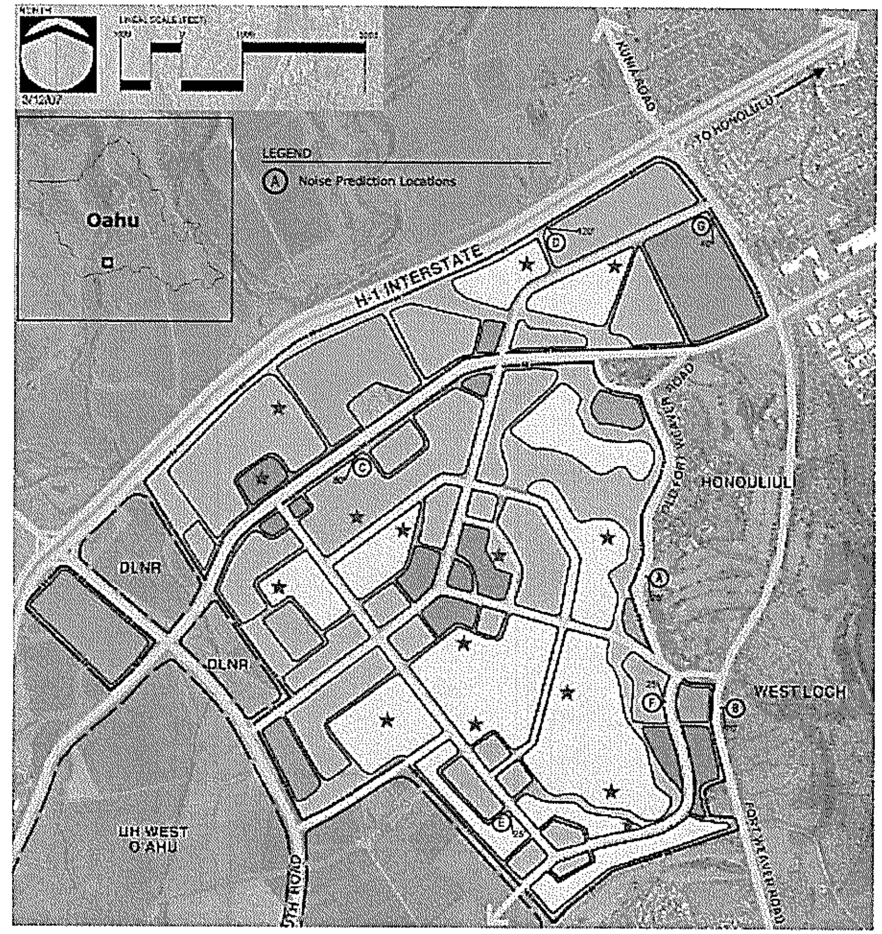
Typical Sound Levels from Construction Equipment

Ho'opili

Not to Scale

Date	Project No.	Drawn By	Figure No
February 2008	06-34	TRB	7



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Noise Prediction Locations

Ho'opili

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Date	Project No.	Drawn By	Figure No
February 2008	06-34	DFD	8

APPENDIX A

Acoustic Terminology

Acoustic Terminology

Sound Pressure Level

Sound, or noise, is the term given to variations in air pressure that are capable of being detected by the human ear. Small fluctuations in atmospheric pressure (sound pressure) constitute the physical property measured with a sound pressure level meter. Because the human ear can detect variations in atmospheric pressure over such a large range of magnitudes, sound pressure is expressed on a logarithmic scale in units called decibels (dB). Noise is defined as "unwanted" sound.

Technically, sound pressure level (SPL) is defined as:

$$SPL = 20 \log (P/P_{ref}) \text{ dB}$$

where P is the sound pressure fluctuation (above or below atmospheric pressure) and P_{ref} is the reference pressure, 20 μPa, which is approximately the lowest sound pressure that can be detected by the human ear. For example:

If P = 20 μPa, then SPL = 0 dB
If P = 200 μPa, then SPL = 20 dB
If P = 2000 μPa, then SPL = 40 dB

The sound pressure level that results from a combination of noise sources is not the arithmetic sum of the individual sound sources, but rather the logarithmic sum. For example, two sound levels of 50 dB produce a combined sound level of 53 dB, not 100 dB. Two sound levels of 40 and 50 dB produce a combined level of 50.4 dB.

Human sensitivity to changes in sound pressure level is highly individualized. Sensitivity to sound depends on frequency content, time of occurrence, duration, and psychological factors such as emotions and expectations. However, in general, a change of 1 or 2 dB in the level of sound is difficult for most people to detect. A 3 dB change is commonly taken as the smallest perceptible change and a 6 dB change corresponds to a noticeable change in loudness. A 10 dB increase or decrease in sound level corresponds to an approximate doubling or halving of loudness, respectively.

A-Weighted Sound Level

Studies have shown conclusively that at equal sound pressure levels, people are generally more sensitive to certain higher frequency sounds (such as made by speech, horns, and whistles) than most lower frequency sounds (such as made by motors and engines)[1] at the same level. To address this preferential response to frequency, the A-weighted scale was developed. The A-weighted scale adjusts the sound level in each frequency band in much the same manner that the

---

[1] D.W. Robinson and R.S. Dadson, "A Re-Determination of the Equal-Loudness Relations for Pure Tones," *British Journal of Applied Physics*, vol. 7, pp. 166 - 181, 1956. (Adopted by the International Standards Organization as Recommendation R-226.

human auditory system does. Thus the A-weighted sound level (read as "dBA") becomes a single number that defines the level of a sound and has some correlation with the sensitivity of the human ear to that sound. Different sounds with the same A-weighted sound level are perceived as being equally loud. The A-weighted noise level is commonly used today in environmental noise analysis and in noise regulations. Typical values of the A-weighted sound level of various noise sources are shown in Figure A-1.

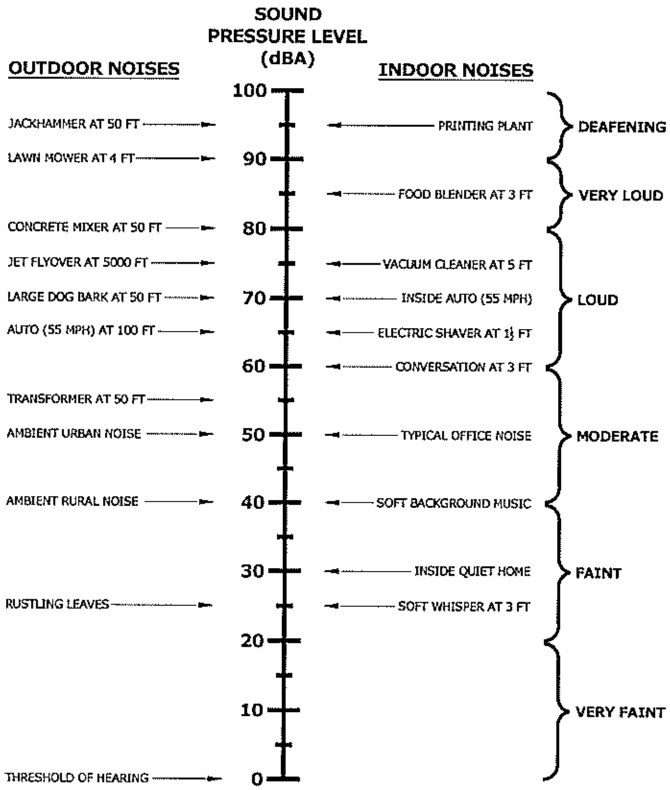


Figure A-1. Common Outdoor/Indoor Sound Levels

Equivalent Sound Level

The Equivalent Sound Level (L_{eq}) is a type of average which represents the steady level that, integrated over a time period, would produce the same energy as the actual signal. The actual *instantaneous* noise levels typically fluctuate above and below the measured L_{eq} during the measurement period. The A-weighted L_{eq} is a common index for measuring environmental noise. A graphical description of the equivalent sound level is shown in Figure A-2.

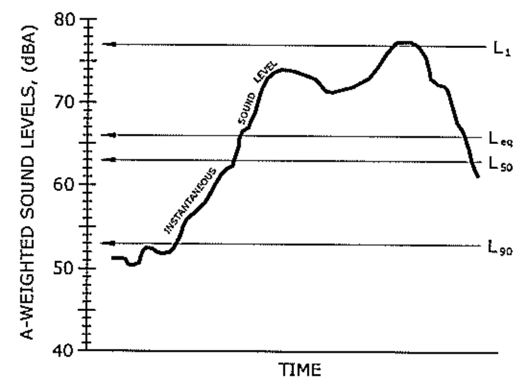


Figure A-2. Example Graph of Equivalent and Statistical Sound Levels

Statistical Sound Level

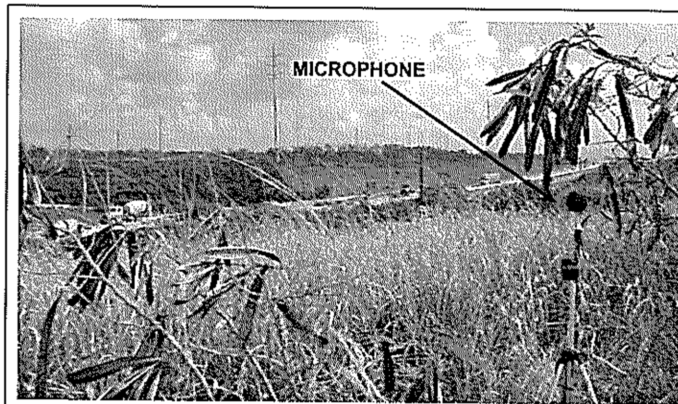
The sound levels of long-term noise producing activities such as traffic movement, aircraft operations, etc., can vary considerably with time. In order to obtain a single number rating of such a noise source, a statistically-based method of expressing sound or noise levels has been developed. It is known as the Exceedence Level, L_n. The L_n represents the sound level that is exceeded for n% of the measurement time period. For example, L_{10} = 60 dBA indicates that for the duration of the measurement period, the sound level exceeded 60 dBA 10% of the time. Typically, in noise regulations and standards, the specified time period is one hour. Commonly used Exceedence Levels include L_{01}, L_{10}, L_{50}, and L_{90}, which are widely used to assess community and environmental noise. A graphical description of the equivalent sound level is shown in Figure A-2.

Day-Night Equivalent Sound Level

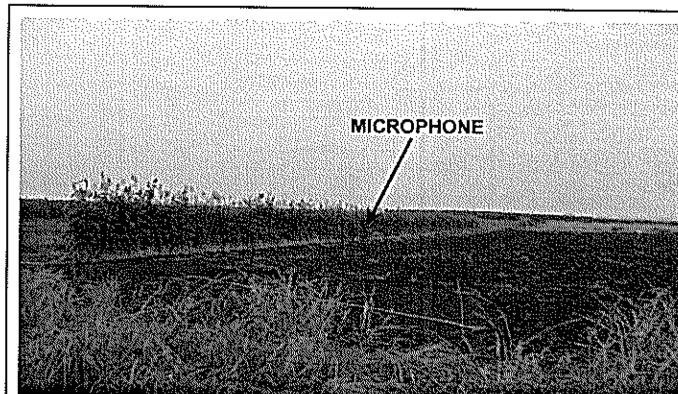
The Day-Night Equivalent Sound Level, L_{dn}, is the Equivalent Sound Level, L_{eq}, measured over a 24-hour period. However, a 10 dB penalty is added to the noise levels recorded between 10 p.m. and 7 a.m. to account for people's higher sensitivity to noise at night when the background noise level is typically lower. The L_{dn} is a commonly used noise descriptor in assessing land use compatibility, and is widely used by federal and local agencies and standards organizations.

APPENDIX B

Photographs at Projçct Site

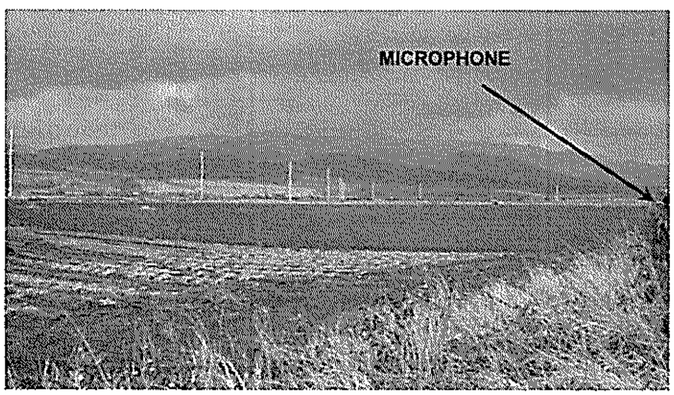


Location L1
Located 200 feet south of the H-1 Freeway



Location L2
Located 150 feet south of Farrington Highway

Location L3
Located at the southeastern edge of Ho'opili project site



Location L4
Located at the southwestern edge of Ho'opili project site nearby the future North-South Road

APPENDIX H
Air Quality Study

AIR QUALITY STUDY

FOR THE PROPOSED

HO'OPILI PROJECT

EWA, OAHU, HAWAII

Prepared for:

D.R. Horton – Schuler Division

February 2008

B.D. NEAL & ASSOCIATES

Applied Meteorology • Air Quality • Computer Science

P.O. BOX 1808 • KAILUA-KONA, HAWAII 96745 • TELPHONE (808) 329-1627 • FAX (808) 325-6739
EMAIL: bdneal@bdneal.com

CONTENTS

FIGURES

TABLES

TABLES (cont.)

1.0 SUMMARY

D.R. Horton-Schuler Division is proposing to develop the Ho'opili Project on approximately 1,555 acres of land at Ewa, Oahu. The proposed project will include approximately 11,750 dwelling units, 2.8 million square feet of retail/office space, and 0.9 million square feet of industrial floor area. Development of the project is expected to be completed and fully occupied by 2030. This study examines the potential short- and long-term air quality impacts that could occur as a result of construction and use of the proposed facilities and suggests mitigative measures to reduce any potential air quality impacts where possible and appropriate.

Both federal and state standards have been established to maintain ambient air quality. At the present time, seven parameters are regulated including: particulate matter, sulfur dioxide, hydrogen sulfide, nitrogen dioxide, carbon monoxide, ozone and lead. Hawaii air quality standards are comparable to the national standards except those for nitrogen dioxide and carbon monoxide which are more stringent than the national standards.

Regional and local climate together with the amount and type of human activity generally dictate the air quality of a given location. The climate of the Ewa area is very much affected by its leeward and coastal situation. Winds are predominantly trade winds from the east northeast except for occasional periods when kona storms may generate strong winds from the south or when the trade winds are weak and landbreeze-seabreeze circulations may develop. Wind speeds typically vary between about 5 and 15 miles per hour providing relatively good ventilation much of the time. Temperatures in the leeward Oahu area are generally very moderate with average daily temperatures ranging from about 65°F to 84°F.

The extreme minimum temperature recorded at the nearby (former) Ewa Plantation is 47°F, while the extreme maximum temperature is 93°F. This area of Oahu is one of the drier locations in the state with rainfall often highly variable from one year to the next. Monthly rainfall has been measured to vary from as little as a trace to as much as 15 inches. Average annual rainfall amounts to about 21 inches with summer months being the driest.

The present air quality of the project area appears to be reasonably good based on nearby air quality monitoring data. Air quality data from the nearest monitoring stations operated by the Hawaii Department of Health suggest that all national air quality standards are currently being met, although occasional exceedances of the more stringent state standards for carbon monoxide may occur near congested roadway intersections.

If the proposed project is given the necessary approvals to proceed, it may be inevitable that some short- and/or long-term impacts on air quality will occur either directly or indirectly as a consequence of project construction and use. Short-term impacts from fugitive dust will likely occur during the project construction phase. To a lesser extent, exhaust emissions from stationary and mobile construction equipment, from the disruption of traffic, and from workers' vehicles may also affect air quality during the period of construction. State air pollution control regulations require that there be no visible fugitive dust emissions at the property line. Hence, an effective dust control plan must be implemented to ensure compliance with state regulations. Fugitive dust emissions can be controlled to a large extent by watering of active work areas, using wind screens, keeping adjacent paved roads clean, and by covering of open-bodied trucks. Other dust control measures could include limiting the area that can be disturbed at any given time and/or mulching or chemically

stabilizing inactive areas that have been worked. Paving and landscaping of project areas early in the construction schedule will also reduce dust emissions. Monitoring dust at the project boundary during the period of construction could be considered as a means to evaluate the effectiveness of the project dust control program. Exhaust emissions can be mitigated by moving construction equipment and workers to and from the project site during off-peak traffic hours.

After construction, motor vehicles coming to and from the proposed development could potentially result in a long-term increase in air pollution emissions in the project area. To assess the impact of emissions from these vehicles, an air quality modeling study was undertaken to estimate current ambient concentrations of carbon monoxide at roadway intersections in the project vicinity and to predict future levels both with and without the proposed project. During worst-case conditions, model results indicated that present 1-hour and 8-hour carbon monoxide concentrations in the project area are within the national ambient air quality standards, but they may occasionally exceed the more stringent state standards at some locations. In the year 2030 without the project, carbon monoxide concentrations were predicted to decrease (improve) in the project area despite the increase in traffic volumes that is expected. This is primarily due to the assumed retirement of older motor vehicles that emit more air pollution. With the project in the year 2030 and assuming that the roadway improvements recommended in the project traffic study are implemented, carbon monoxide concentrations were estimated to increase substantially at many locations in the project area. With the transit corridor alternative, the increase would be smaller at many of the locations studied. However, with or without the transit corridor, worst-case concentrations with the project should remain within both national and state standards through the year 2030.

Options available to mitigate long-term, traffic-related air pollution are generally to further improve roadways, to reduce traffic or to reduce individual vehicular emissions. Based on the air quality modeling results, worst case carbon monoxide concentrations in the future with the project should be lower (better) than the existing levels and within the national and state standards. Thus, implementing mitigation measures for traffic-related air quality impacts is probably unnecessary and unwarranted.

Depending on the demand levels, long-term impacts on air quality are also possible due to indirect emissions associated with a development's electrical power and solid waste disposal requirements. Quantitative estimates of these potential impacts were not made, but based on the estimated demand levels and emission rates involved, any impacts will likely be negligible.

2.0 INTRODUCTION

D.R. Horton-Schuler Division is proposing to develop the Ho'opili Project on approximately 1,555 acres of vacant lands in Ewa on the island of Oahu (see Figure 1 for project location). The project site is located adjacent to and south of the H-1 Freeway and west of Fort Weaver Road. The development will include approximately 11,750 dwelling units, 2.8 million square feet of retail/office space, and 0.9 million square feet of industrial building floor area. Construction of the project is expected to commence during 2009, and full development and occupancy is planned by 2030.

The purpose of this study is to describe existing air quality in the project area and to assess the potential short- and long-term direct and indirect air quality impacts that could result from construction and use of the proposed facilities as planned. Measures to mitigate impacts by the project are suggested where possible and appropriate.

3.0 AMBIENT AIR QUALITY STANDARDS

Ambient concentrations of air pollution are regulated by both national and state ambient air quality standards (AAQS). National AAQS are specified in Section 40, Part 50 of the Code of Federal Regulations (CFR), while State of Hawaii AAQS are defined in Chapter 11-59 of the Hawaii Administrative Rules. Table 1 summarizes both the national and the state AAQS that are specified in the cited documents. As indicated in the table, national and state AAQS have been established for particulate matter, sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone and lead. The state has also set a standard for hydrogen sulfide. National AAQS are stated in terms of both primary and secondary standards for most of the regulated air pollutants. National primary standards are designed to protect the public health with an "adequate margin of safety". National secondary standards, on the other hand, define levels of air quality necessary to protect the public welfare from "any known or anticipated adverse effects of a pollutant". Secondary public welfare impacts may include such effects as decreased visibility, diminished comfort levels, or other potential injury to the natural or man-made environment, e.g., soiling of materials, damage to vegetation or other economic damage. In contrast to the national AAQS, Hawaii State AAQS are given in terms of a single standard that is designed "to protect public health and welfare and to prevent the significant deterioration of air quality".

Each of the regulated air pollutants has the potential to create or exacerbate some form of adverse health effect or to produce environmental degradation when present in sufficiently high concentration for prolonged periods of time. The AAQS specify a maximum allowable concentration for a given air pollutant for one or more averaging times to prevent harmful effects. Averaging times vary from one hour to one year depending on the pollutant and type of exposure necessary to cause adverse effects. In the case of the short-term (i.e., 1- to 24-hour) AAQS, both national and state standards allow a specified number of exceedances each year.

The Hawaii AAQS are in some cases considerably more stringent than the comparable national AAQS. In particular, the Hawaii 1-hour AAQS for carbon monoxide is four times more stringent than the comparable national limit. The U.S. Environmental Protection Agency (EPA) is currently working on a plan to phase out the national 1-hour ozone standard in favor of the new (and more stringent) 8-hour standard.

The Hawaii AAQS for sulfur dioxide were relaxed in 1986 to make the state standards essentially the same as the national limits. In 1993, the state also revised its particulate standards to follow those set by the federal government. During 1997, the federal government again revised its standards for particulate, but the new standards were challenged in federal court. A Supreme Court ruling was issued during February 2001, and as a result, the new standards for particulate were implemented during 2005. To date, the Hawaii Department of Health has not updated the state particulate standards. In September 2001, the state

vacated the state 1-hour standard for ozone and an 8-hour standard was adopted.

4.0 REGIONAL AND LOCAL CLIMATOLOGY

Regional and local climatology significantly affects the air quality of a given location. Wind, temperature, atmospheric turbulence, mixing height and rainfall all influence air quality. Although the climate of Hawaii is relatively moderate throughout most of the state, significant differences in these parameters may occur from one location to another. Most differences in regional and local climates within the state are caused by the mountainous topography.

Hawaii lies well within the belt of northeasterly trade winds generated by the semi-permanent Pacific high pressure cell to the north and east. On the island of Oahu, the Koolau and Waianae Mountain Ranges are oriented almost perpendicular to the trade winds, which accounts for much of the variation in the local climatology of the island. The site of the proposed project is located on the Ewa Plain, which is generally leeward of the Koolau Range at an elevation of about 50 ft.

Wind frequency data for Honolulu International Airport (HIA), which is located about 7 miles to the southeast of the project site, are given in Table 2. These data can be expected to be only semi-representative of the project area due to the differences in exposure and terrain effects. Wind frequency for HIA show that the annual prevailing wind direction for this area of Oahu is east northeast. On an annual basis, 34.7 percent of the time the wind is from this direction, and more than 70 percent of the time the wind is in the northeast quadrant. Winds from the south are infrequent occurring only a few days during the year and mostly in winter in association with kona storms. Wind speeds average about 10 knots (12 mph) and mostly vary between about 5 and 15 knots (6 and 17 mph).

Air pollution emissions from motor vehicles, the formation of photochemical smog and smoke plume rise all depend in part on air temperature. Colder temperatures tend to result in higher emissions of contaminants from automobiles but lower concentrations of photochemical smog and ground-level concentrations of air pollution from elevated plumes. In Hawaii, the annual and daily variation of temperature depend to a large degree on elevation above sea level, distance inland and exposure to the trade winds. Average temperatures at locations near sea level generally are warmer than those at higher elevations. Areas exposed to the trade winds tend to have the least temperature variation, while inland and leeward areas often have the most. The project's inland, higher-elevation location results in a relatively moderate temperature profile compared to other coastal locations around Oahu and the state. Based on more than 50 years of data collected at the former Ewa Plantation a few miles away, average annual daily minimum and maximum temperatures in the Ewa Plain area are 65°F and 84°F, respectively [1]. The extreme minimum temperature on record is 47°F, and the extreme maximum is 93°F at this location. Temperatures at the project site can be expected to be a few degrees cooler due to the higher elevation.

Small scale, random motions in the atmosphere (turbulence) cause air pollutants to be dispersed as a function of distance or time from the point of emission. Turbulence is caused by both mechanical and thermal forces in the atmosphere. It is oftentimes measured and described in terms of Pasquill-Gifford stability class. Stability class 1 is the most turbulent and class 6 the

least. Thus, air pollution dissipates the best during stability class 1 conditions and the worst when stability class 6 prevails. In the project area, stability class 5 or 6 is generally the highest stability class that occurs, developing during clear, calm nighttime or early morning hours when temperature inversions form due to radiation cooling and mountain drainage flows. Stability classes 1 through 4 occur during the daytime, depending mainly on the amount of cloud cover and incoming solar radiation and the strength of the trade winds.

Mixing height is defined as the height above the surface through which relatively vigorous vertical mixing occurs. Low mixing heights can result in high ground-level air pollution concentrations because contaminants emitted from or near the surface can become trapped within the mixing layer. In Hawaii, minimum mixing heights tend to be high because of mechanical mixing caused by the trade winds and because of the temperature moderating effect of the surrounding ocean. Low mixing heights may sometimes occur, however, at inland locations and even at times along coastal areas early in the morning following a clear, cool, windless night. Coastal areas also may experience low mixing levels during sea breeze conditions when cooler ocean air rushes in over warmer land. Mixing heights in Hawaii typically are above 3000 feet (1000 meters).

Rainfall can have a beneficial affect on the air quality of an area in that it helps to suppress fugitive dust emissions, and it also may "washout" gaseous contaminants that are water soluble. Rainfall in Hawaii is highly variable depending on elevation and on location with respect to the trade wind. The Ewa Plain is one of the driest areas on Oahu due to its leeward and near sea level location. Average annual rainfall amounts to about 21 inches but may vary from about 10 inches during a dry year to more than 40 inches during a wet year [1]. Most of the rainfall usually occurs during the winter months. Monthly rainfall may vary from as little as a trace to as much as 15 inches or more.

5.0 PRESENT AIR QUALITY

Present air quality in the project area is mostly affected by air pollutants from motor vehicles, industrial sources, agricultural operations and to a lesser extent by natural sources. Table 3 presents an air pollutant emission summary for the island of Oahu for calendar year 1993. The emission rates shown in the table pertain to manmade emissions only, i.e., emissions from natural sources are not included. As suggested in the table, much of the particulate emissions on Oahu originate from area sources, such as the mineral products industry and agriculture. Sulfur oxides are emitted almost exclusively by point sources, such as power plants and refineries. Nitrogen oxides emissions emanate predominantly from industrial point sources, although area sources (mostly motor vehicle traffic) also contribute a significant share. The majority of carbon monoxide emissions occur from area sources (motor vehicle traffic), while hydrocarbons are emitted mainly from point sources. Based on previous emission inventories that have been reported for Oahu, emissions of particulate and nitrogen oxides may have increased during the past several years, while emissions of sulfur oxides, carbon monoxide and hydrocarbons probably have declined.

The H-1 Freeway, which passes through the project area to the north, is a major arterial roadway that presently carries moderate to heavy levels of vehicle traffic during peak traffic hours. Emissions from motor vehicles using this roadway, primarily nitrogen oxides and carbon monoxide, will tend to be carried away from the project site by the prevailing winds.

Several sources of industrial air pollution are located in the Campbell Industrial Park, which is located at Barbers Point about 6 miles to the southwest of the project site. Industries currently operating there include the Chevron and BHP refineries, H-Power, Kalaeloa Partners, Applied Energy Services, Hawaiian Cement and others. Hawaiian Electric Company's Waiau Generating Station is located a few miles to the south at Pearl City. These industries emit large amounts of sulfur dioxide, nitrogen oxides, particulate matter, carbon monoxide and other air pollutants. Prevailing winds from the east or northeast will carry these emissions away from the project site most of the time.

Until recently, air pollution in the project area originating from agricultural sources could mainly be attributed to sugar cane operations in the Ewa area and to pineapple cultivation in the central Oahu area. Emissions from both the sugar mill and the canefield operations in the area have now been eliminated with the closure of the Oahu Sugar Company, and much of the former sugarcane lands are currently being used as pastureland or for diversified agriculture. Pineapple cultivation has been significantly reduced. Thus, air pollution from agricultural sources in the project area has been substantially reduced during the past several years.

Natural sources of air pollution emissions that also could affect the project area but cannot be quantified very accurately include the ocean (sea spray), plants (aero-allergens), wind-blown dust, and perhaps distant volcanoes on the island of Hawaii.

The State Department of Health operates a network of air quality monitoring stations at various locations on Oahu. Each station, however, typically does not monitor the full complement of air quality parameters. Table 4 shows annual summaries of air quality measurements that were made nearest to the project area for several of the regulated air pollutants for the period 2001 through 2005. These are the most recent data that are currently available.

During the 2001-2005 period, sulfur dioxide was monitored by the State Department of Health at an air quality station located at Kapolei, which is about 2 miles southwest of the project site. Concentrations monitored were consistently low compared to the standards. Annual second-highest 3-hour concentrations (which are most relevant to the air quality standards) ranged from 12 to 28 $\mu g/m^3$, while the annual second-highest 24-hour concentrations ranged from 6 to 9 $\mu g/m^3$. Annual average concentrations were only about 1 to 2 $\mu g/m^3$. There were no exceedances of the state/national 3-hour or 24-hour AAQS for sulfur dioxide during the 5-year period.

Particulate matter less than 10 microns in diameter (PM-10) is measured at Pearl City, about 5 miles to the east of the project site. Annual second-highest 24-hour PM-10 concentrations ranged from 27 to 100 $\mu g/m^3$ between 2001 and 2005. Average annual concentrations ranged from 15 to 16 $\mu g/m^3$. One exceedance each of the 24-hour standard was reported in 2001 and 2005. These exceedances were related to fireworks activity on New Years Day.

Carbon monoxide measurements were also made at the Kapolei monitoring station. The annual second-highest 1-hour concentra-

tions ranged from 1.6 to 2.0 mg/m^3. The annual second-highest 8-hour concentrations ranged from 0.8 to 1.8 mg/m^3. No exceedances of the state or national 1-hour or 8-hour AAQS were reported.

Nitrogen dioxide is also monitored by the Department of Health at the Kapolei monitoring station. Annual average concentrations of this pollutant ranged from 8 to 9 $\mu g/m^3$, safely inside the state and national AAQS.

The nearest available ozone measurements were obtained at Sand Island (about 11 miles southeast of the project area). The second-highest 8-hour concentrations for the period 2002 through 2005 ranged between 77 and 108 $\mu g/m^3$, which is well inside the state and federal standards. The 8-hour standard for ozone did not exist prior to 2002. Prior to 2002, the now obsolete state 1-hour standard was typically exceeded several times each year.

Although not shown in the table, the nearest and most recent measurements of ambient lead concentrations that have been reported were made at the downtown Honolulu monitoring station between 1996 and 1997. Average quarterly concentrations were near or below the detection limit, and no exceedances of the state AAQS were recorded. Monitoring for this parameter was discontinued during 1997.

Based on the data and discussion presented above, it appears likely that the State of Hawaii AAQS for sulfur dioxide, nitrogen dioxide, ozone and lead are currently being met at the project site. Concentrations of particulate matter normally comply with the standards except possibly during holiday fireworks activity. While carbon monoxide measurements at the Kapolei monitoring station suggest that concentrations are within the state and national standards, local "hot spots" may exist near traffic-congested intersections. The potential for this within the project area is examined later in this report.

6.0 SHORT-TERM IMPACTS OF PROJECT

Short-term direct and indirect impacts on air quality could potentially occur due to project construction. For a project of this nature, there are two potential types of air pollution emissions that could directly result in short-term air quality impacts during project construction: (1) fugitive dust from vehicle movement and soil excavation; and (2) exhaust emissions from on-site construction equipment. Indirectly, there also could be short-term impacts from slow-moving construction equipment traveling to and from the project site, from a temporary increase in local traffic caused by commuting construction workers, and from the disruption of normal traffic flow caused by lane closures of adjacent roadways.

Fugitive dust emissions may arise from the grading and dirt-moving activities associated with site clearing and preparation work. The emission rate for fugitive dust emissions from construction activities is difficult to estimate accurately. This is because of its elusive nature of emission and because the potential for its generation varies greatly depending upon the type of soil at the construction site, the amount and type of dirt-disturbing activity taking place, the moisture content of exposed soil in work areas, and the wind speed. The EPA [2] has provided a rough estimate for uncontrolled fugitive dust emissions from construction activity of 1.2 tons per acre per month under conditions of "medium" activity, moderate soil silt content (30%), and precipitation/evaporation (P/E) index of 50. Uncontrolled

fugitive dust emissions at the project site would likely be somewhere near that level, depending on the amount of rainfall that occurs. In any case, State of Hawaii Air Pollution Control Regulations [3] prohibit visible emissions of fugitive dust from construction activities at the property line. Thus, an effective dust control plan for the project construction phase is essential.

Adequate fugitive dust control can usually be accomplished by the establishment of a frequent watering program to keep bare-dirt surfaces in construction areas from becoming significant sources of dust. In dust-prone or dust-sensitive areas, other control measures such as limiting the area that can be disturbed at any given time, applying chemical soil stabilizers, mulching and/or using wind screens may be necessary. Control regulations further stipulate that open-bodied trucks be covered at all times when in motion if they are transporting materials that could be blown away. Haul trucks tracking dirt onto paved streets from unpaved areas is often a significant source of dust in construction areas. Some means to alleviate this problem, such as road cleaning or tire washing, may be appropriate. Paving of parking areas and/or establishment of landscaping as early in the construction schedule as possible can also lower the potential for fugitive dust emissions. Monitoring dust at the project property line could be considered to quantify and document the effectiveness of dust control measures.

On-site mobile and stationary construction equipment also will emit air pollutants from engine exhausts. The largest of this equipment is usually diesel-powered. Nitrogen oxides emissions from diesel engines can be relatively high compared to gasoline-powered equipment, but the standard for nitrogen dioxide is set on an annual basis and is not likely to be violated by short-term construction equipment emissions. Carbon monoxide emissions from diesel engines, on the other hand, are low and should be relatively insignificant compared to vehicular emissions on nearby roadways.

Project construction activities will also likely obstruct the normal flow of traffic at times to such an extent that overall vehicular emissions in the project area will temporarily increase. The only means to alleviate this problem will be to attempt to keep roadways open during peak traffic hours and to move heavy construction equipment and workers to and from construction areas during periods of low traffic volume. Thus, most potential short-term air quality impacts from project construction can be mitigated.

7.0 LONG-TERM IMPACTS OF PROJECT

7.1 Roadway Traffic

After construction is completed, use of the proposed facilities will result in increased motor vehicle traffic in the project area, potentially causing long-term impacts on ambient air quality. Motor vehicles with gasoline-powered engines are significant sources of carbon monoxide. They also emit nitrogen oxides and other contaminates.

Federal air pollution control regulations require that new motor vehicles be equipped with emission control devices that reduce emissions significantly compared to a few years ago. In 1990, the President signed into law the Clean Air Act Amendments. This legislation requires further emission reductions, which have been phased in since 1994. More recently, additional restrictions were signed into law during the Clinton administration, which will

begin to take effect during the next decade. The added restrictions on emissions from new motor vehicles will lower average emissions each year as more and more older vehicles leave the state's roadways. It is estimated that carbon monoxide emissions, for example, will go down by an average of about 30 to 40 percent per vehicle during the next 10 years due to the replacement of older vehicles with newer models.

To evaluate the potential long-term indirect ambient air quality impact of increased roadway traffic associated with a project such as this, computerized emission and atmospheric dispersion models can be used to estimate ambient carbon monoxide concentrations along roadways leading to and from the project. Carbon monoxide is selected for modeling because it is both the most stable and the most abundant of the pollutants generated by motor vehicles. Furthermore, carbon monoxide air pollution is generally considered to be a microscale problem that can be addressed locally to some extent, whereas nitrogen oxides air pollution most often is a regional issue that cannot be addressed by a single new development.

For this project, four scenarios were selected for the carbon monoxide modeling study: (1) year 2007 with present conditions, (2) year 2030 without the project, (3) year 2030 with the project and with the transit corridor alternative, and (4) year 2030 with the project but without the transit corridor. To begin the modeling study of the four scenarios, critical receptor areas in the vicinity of the project were identified for analysis. Generally speaking, roadway intersections are the primary concern because of traffic congestion and because of the increase in vehicular emissions associated with traffic queuing. For this study, several of the key intersections identified in the traffic study were also selected for air quality analysis. These included the following intersections:

- Farrington Highway at Fort Weaver Road northbound ramps
- Farrington Highway at Leoku Street
- Fort Weaver Road at Old Fort Weaver Road
- Fort Weaver Road at Renton Road
- Farrington Highway at Fort Barrette Road
- North-South Road at H-1 eastbound ramps
- North-South Road at Farrington Highway
- North-South Road at Kapolei Parkway

The traffic impact report for the project [4] describes the projected future traffic conditions and laneage configurations of these intersections in detail. In performing the air quality impact analysis, it was assumed that all recommended traffic mitigation measures would be implemented.

The main objective of the modeling study was to estimate maximum 1-hour average carbon monoxide concentrations for each of the four scenarios studied. To evaluate the significance of the estimated concentrations, a comparison of the predicted values for each scenario can be made. Comparison of the estimated values to the national and state AAQS was also used to provide another measure of significance.

Maximum carbon monoxide concentrations typically coincide with peak traffic periods. The traffic impact assessment report evaluated morning and afternoon peak traffic periods. These same periods were evaluated in the air quality impact assessment.

The EPA computer model MOBILE6 [5] was used to calculate vehicular carbon monoxide emissions for each year studied. One of the key inputs to MOBILE6 is vehicle mix. Unless very detailed information is available, national average values are typically assumed, which is what was used for the present study. Based on national average vehicle mix figures, the present vehicle mix in the project area was estimated to be 39.5% light-duty gasoline-powered automobiles, 47.6% light-duty gasoline-powered trucks and vans, 3.6% heavy-duty gasoline-powered vehicles, 0.2% light-duty diesel-powered vehicles, 8.5% heavy-duty diesel-powered trucks and buses, and 0.6% motorcycles. For the future scenarios studied, the vehicle mix was estimated to change somewhat with fewer light-duty gasoline-powered automobiles and more light-duty gasoline-powered trucks and vans.

Ambient temperatures of 59 and 68 degrees F were used for morning and afternoon peak-hour emission computations, respectively. These are conservative assumptions since morning/afternoon ambient temperatures will generally be warmer than this, and emission estimates given by MOBILE6 generally have an inverse relationship to the ambient temperature.

After computing vehicular carbon monoxide emissions through the use of MOBILE6, these data were then input to an atmospheric dispersion model. EPA air quality modeling guidelines [6] currently recommend that the computer model CAL3QHC [7] be used to assess carbon monoxide concentrations at roadway intersections, or in areas where its use has previously been established, CALINE4 [8] may be used. Until a few years ago, CALINE4 was used extensively in Hawaii to assess air quality impacts at roadway intersections. In December 1997, the California Department of Transportation recommended that the intersection mode of CALINE4 no longer be used because it was thought the model has become outdated. Studies have shown that CALINE4 may tend to over-predict maximum concentrations in some situations. Therefore, CAL3QHC was used for the subject analysis.

CAL3QHC was developed for the U.S. EPA to simulate vehicular movement, vehicle queuing and atmospheric dispersion of vehicular emissions near roadway intersections. It is designed to predict 1-hour average pollutant concentrations near roadway intersections based on input traffic and emission data, roadway/receptor geometry and meteorological conditions.

Although CAL3QHC is intended primarily for use in assessing atmospheric dispersion near signalized roadway intersections, it can also be used to evaluate unsignalized intersections. This is accomplished by manually estimating queue lengths and then applying the same techniques used by the model for signalized intersections.

Input peak-hour traffic data were obtained from the traffic study cited previously. This included vehicle approach volumes, saturation capacity estimates, intersection laneage and signal timings. All emission factors that were input to CAL3QHC for free-flow traffic on roadways were obtained from MOBILE6 based on assumed free-flow vehicle speeds corresponding to the posted speed limits.

Model roadways were set up to reflect roadway geometry, physical dimensions and operating characteristics. Concentrations predicted by air quality models generally are not considered valid within the roadway-mixing zone. The roadway-mixing zone is

usually taken to include 3 meters on either side of the traveled portion of the roadway and the turbulent area within 10 meters of a cross street. Model receptor sites were thus located at the edges of the mixing zones near all intersections that were studied for all scenarios. This implies that pedestrian sidewalks either already exist or are assumed to exist in the future. All receptor heights were placed at 1.8 meters above ground to simulate levels within the normal human breathing zone.

Input meteorological conditions for this study were defined to provide "worst-case" results. One of the key meteorological inputs is atmospheric stability category. For these analyses, atmospheric stability category 6 was assumed for the morning cases, while atmospheric stability category 4 was assumed for the afternoon cases. These are the most conservative stability categories that are generally used for estimating worst-case pollutant dispersion within suburban areas for these periods. A surface roughness length of 100 cm and a mixing height of 1000 meters were used in all cases. Worst-case wind conditions were defined as a wind speed of 1 meter per second with a wind direction resulting in the highest predicted concentration. Concentration estimates were calculated at wind directions of every 5 degrees.

Existing background concentrations of carbon monoxide in the project vicinity are believed to be at relatively low levels. Thus, background contributions of carbon monoxide from sources or roadways not directly considered in the analysis were accounted for by adding a background concentration of 1.0 ppm to all predicted concentrations for 2007. Although increased traffic is expected to occur within the project area during the next several years with or without the project, background carbon monoxide concentrations may not change significantly since individual emissions from motor vehicles are forecast to decrease with time. Hence, a background value of 1.0 ppm was assumed to persist for the future scenarios studied.

Predicted Worst-Case 1-Hour Concentrations

Table 5 summarizes the final results of the modeling study in the form of the estimated worst-case 1-hour morning and afternoon ambient carbon monoxide concentrations. These results can be compared directly to the state and the national AAQS. Estimated worst-case carbon monoxide concentrations are presented in the table for each of the four study scenarios: year 2007 with existing traffic, year 2030 without the project, year 2030 with the project and with the transit corridor alternative, and year 2030 with the project but without the transit corridor. The locations of these estimated worst-case 1-hour concentrations all occurred at or very near the indicated intersections.

As indicated in the table, the highest estimated 1-hour concentration within the project vicinity for the present (2007) case was 12.1 mg/m^3. This was projected to occur during the morning peak traffic hour near the intersection of Fort Weaver Road and Renton Road. Concentrations at other locations and times studied ranged downward from 11.0 mg/m^3 during the morning at intersection of Fort Weaver Road and Old Fort Weaver Road to 4.6 mg/m^3 during the afternoon at Farrington Highway and the Fort Weaver Road northbound ramps. All predicted worst-case 1-hour concentrations for the 2007 scenario were within the national AAQS of 40 mg/m^3, but concentrations exceeded the more stringent state standard of 10 mg/m^3 at two locations in the project area (Fort Weaver Road at Renton Road and Fort Weaver Road at Old Fort Weaver Road).

In the year 2030 without the proposed project, the highest worst-case 1-hour concentration was predicted to occur during the morning at the intersection of Farrington Highway and Fort Barrette Road. A value of 7.7 mg/m^3 was predicted to occur at this location and time. Peak-hour worst-case values at the other locations and times studied for the 2030 without project scenario ranged between 3.2 and 7.4 mg/m^3. Compared to the existing case, concentrations decreased despite the higher traffic volumes, reflecting the reduced emissions from more effective vehicular emission controls. All projected worst-case concentrations for this scenario remained within both the state and the national standards.

In the year 2030 with the proposed project and with the transit corridor alternative, the predicted highest worst-case 1-hour concentration occurred during the morning at the intersection of the North-South Road and Farrington Highway with a value of 8.2 mg/m^3. Other concentrations for this scenario ranged between 4.6 and 7.8 mg/m^3. With the project and with the transit corridor (and assuming the recommended roadway improvements), carbon monoxide concentrations were predicted to increase substantially at several of the intersections studied compared to the without project scenario. At some locations, such as Farrington Highway at Fort Barrette Road, concentrations would remain about the same or decrease slightly. However, even with the predicted increase in concentrations at several of the study intersections, all locations were predicted to remain within the state and the national standards.

In the year 2030 with the project but without the transit corridor, concentrations would remain about the same or increase somewhat compared to the alternative with the project and with the transit corridor. Worst-case 1-hour concentrations in the project area were predicted to range between 4.6 and 8.9 mg/m^3 for this alternative. Although concentrations would be somewhat higher in this alternative, the values would comply with the state and the national standards.

Predicted Worst-Case 8-Hour Concentrations

Worst-case 8-hour carbon monoxide concentrations were estimated by multiplying the worst-case 1-hour values by a persistence factor of 0.5. This accounts for two factors: (1) traffic volumes averaged over eight hours are lower than peak 1-hour values, and (2) meteorological conditions are more variable (and hence more favorable for dispersion) over an 8-hour period than they are for a single hour. Based on monitoring data, 1-hour to 8-hour persistence factors for most locations generally vary from 0.4 to 0.8 with 0.6 being the most typical. One study based on modeling [9] concluded that 1-hour to 8-hour persistence factors could typically be expected to range from 0.4 to 0.5. EPA guidelines [10] recommend using a value of 0.7 unless a locally derived persistence factor is available. Recent monitoring data for locations on Oahu reported by the Department of Health [11] suggest that this factor may range between about 0.2 and 0.6 depending on location and traffic variability. Considering the location of the project and the traffic pattern for the area, a 1-hour to 8-hour persistence factor of 0.5 will likely yield reasonable estimates of worst-case 8-hour concentrations.

The resulting estimated worst-case 8-hour concentrations are indicated in Table 6. For the 2007 scenario, the estimated worst-case 8-hour carbon monoxide concentrations for the five locations studied ranged from 3.1 mg/m^3 at Farrington Highway and Fort Weaver Road northbound ramps to 6.0 mg/m^3 at the intersection of Fort Weaver Road and Renton Road. The estimated worst-case

concentrations for the existing case were within the national limit of 10 mg/m^3 but exceeded the state standard of 5 mg/m^3 at three of the five intersections studied.

For the year 2030 without project scenario, worst-case concentrations ranged between 2.0 and 3.7 mg/m^3, with the highest concentration occurring at Fort Weaver Road and Renton Road. All predicted concentrations were within both the national and the state standards.

For the 2030 with-project scenario and with the transit corridor alternative, worst-case concentrations increased at all locations studied except at Fort Weaver Road and Renton Road where a moderate decrease was predicted. The analysis assumes all traffic mitigation measures recommended in the project traffic study would be implemented. The worst-case concentrations ranged from 2.8 to 4.1 mg/m^3. All predicted 8-hour concentrations for this scenario were within both the national and the state AAQS.

With the project in the year 2030 and without the transit corridor, worst-case concentrations at intersections in the project area would likely increase slightly at most locations with concentrations ranging from 2.8 to 4.4 mg/m^3. However, all predicted 8-hour concentrations remained within both the national and the state AAQS.

Conservativeness of Estimates

The results of this study reflect several assumptions that were made concerning both traffic movement and worst-case meteorological conditions. One such assumption concerning worst-case meteorological conditions is that a wind speed of 1 meter per second with a steady direction for 1 hour will occur. A steady wind of 1 meter per second blowing from a single direction for an hour is extremely unlikely and may occur only once a year or less. With wind speeds of 2 meters per second, for example, computed carbon monoxide concentrations would be only about half the values given above. The 8-hour estimates are also conservative in that it is unlikely that anyone would occupy the assumed receptor sites (within 3 m of the roadways) for a period of 8 hours.

7.2 Electrical Demand

The proposed project also will cause indirect air pollution emissions from power generating facilities as a consequence of electrical power usage. The peak electrical demand of the project when fully developed is expected to reach about 140 megawatts [12]. Assuming the average demand is approximately one-half the peak demand, the annual electrical demand of the project will reach approximately 612 million kilowatt-hours. Electrical power for the project will most probably be provided mainly by oil-fired generating facilities located on Oahu, but some of the project power could also come from sources burning other fuels, such as H-Power and the AES coal-fired power plant at Campbell Industrial Park. In order to meet the electrical power needs of the proposed project, power generating facilities will be required to burn more fuel and hence more air pollution will be emitted at these facilities. Given in Table 7 are estimates of the indirect air pollution emissions that would result from the project electrical demand assuming all power is provided by burning more fuel oil at Oahu's power plants. These values can be compared to the island-wide emission estimates for 1993 given in Table 3. The estimated indirect emissions from project electrical demand amount to less than 1 percent of the present air pollution emissions occurring on Oahu. If power is

supplied instead or in part by coal or solid waste burning facilities, emissions will likely be higher than the values given in Table 7.

7.3 Solid Waste Disposal

Solid waste generated by the proposed development when fully completed and occupied is not expected to exceed about 60 tons per day [13]. Most project refuse will likely be hauled away and burned at the H-Power facility at Campbell Industrial Park to generate electricity. Burning of the waste to generate electricity will result in emissions of particulate, carbon monoxide and other contaminants, but these will be offset to some extent by reducing the amount of fuel oil that would be required to generate electricity for the project. Table 8 gives emission estimates assuming all project solid waste is burned at H-Power. These values can be compared to the island-wide emission estimates for 1993 given in Table 3. The estimated potential indirect emissions from project solid waste disposal demand amount to less than 0.1 percent of the present air pollution emissions occurring on Oahu.

8.0 CONCLUSIONS AND RECOMMENDATIONS

The major potential short-term air quality impact of the project will occur from the emission of fugitive dust during construction. Uncontrolled fugitive dust emissions from construction activities are estimated to amount to about 1.2 tons per acre per month, depending on rainfall. To control dust, active work areas and any temporary unpaved work roads should be watered at least twice daily on days without rainfall. Use of wind screens and/or limiting the area that is disturbed at any given time will also help to contain fugitive dust emissions. Wind erosion of inactive areas of the site that have been disturbed could be controlled by mulching or by the use of chemical soil stabilizers. Dirt-hauling trucks should be covered when traveling on roadways to prevent windage. A routine road cleaning and/or tire washing program will also help to reduce fugitive dust emissions that may occur as a result of trucks tracking dirt onto paved roadways in the project area. Paving of parking areas and establishment of landscaping early in the construction schedule will also help to control dust. Monitoring dust at the project boundary during the period of construction could be considered as a means to evaluate the effectiveness of the project dust control program and to adjust the program if necessary.

During construction phases, emissions from engine exhausts (primarily consisting of carbon monoxide and nitrogen oxides) will also occur both from on-site construction equipment and from vehicles used by construction workers and from trucks traveling to and from the project. Increased vehicular emissions due to disruption of traffic by construction equipment and/or commuting construction workers can be alleviated by moving equipment and personnel to the site during off-peak traffic hours.

After construction of the proposed project is completed and it is fully occupied and assuming the transit corridor alternative is implemented, carbon monoxide concentrations in the project area will likely increase substantially at several locations in the project area compared to the without-project case. This assumes that the roadway improvements recommended in the project traffic study are implemented. Without the transit corridor but with the recommended project traffic mitigation measures, worst-case concentrations would increase slightly at several locations in the project area compared to without the transit corridor. However, with or without the transit corridor, worst-case

concentrations should remain within both the state and the national ambient air quality standards.

Aside from further improving roadways, air pollution impacts from motor vehicle emissions could conceivably be mitigated by reducing traffic volumes through the promotion of bus service and car pooling and/or by adjusting local school and business hours to begin and end during off-peak times. However, this mitigation measure is generally considered only partially successful. Reduction of emissions from individual vehicles would have to be achieved through the promulgation of county, state or federal air pollution control regulations. For example, Hawaii currently does not require annual inspections of motor vehicle air pollution control equipment. At the present time, there is no indication that the state is contemplating adopting such rules.

Another potential mitigation measure would be to provide added buffer zones between walkways and roadways in areas where space is available. Technically, however, the public would have to somehow be excluded from the buffer zones. The predicted worst-case concentrations in this report are based on a separation distance of 3 m (10 ft) between walkways and roadways. Doubling this distance to about 6 m (20 ft) would in many cases reduce maximum concentrations by about 10 to 15 percent.

While carbon monoxide concentrations in the project area will likely increase with the project, the worst-case concentration levels should be lower than the existing levels and within both the state and national ambient air quality standards. Thus, implementing any air quality mitigation measures for long-term traffic-related impacts is probably unnecessary and unwarranted.

Any long-term impacts on air quality due to indirect emissions from supplying the project with electricity and from the disposal of waste materials generated by the project will likely be negligible based on the magnitudes of the estimated emissions compared to the current island-wide emissions.

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13. Personal communication via email, Vincent Shigekuni, PBR Hawaii, to Barry Neal, B.D. Neal & Associates, November 20, 2007.

Figure 1 - Project Location

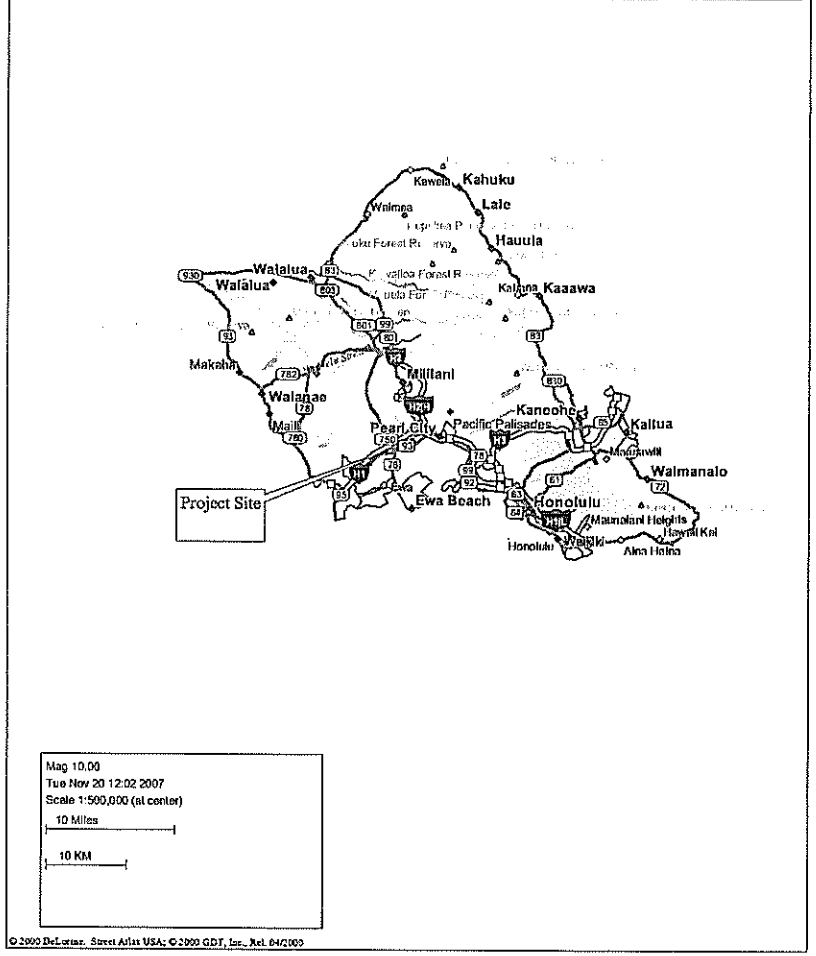

Table 1

SUMMARY OF STATE OF HAWAII AND NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Units	Averaging Time	Maximum Allowable Concentration		
			National Primary	National Secondary	State of Hawaii
Particulate Matter (<10 microns)	µg/m³	Annual	50[a]	50[a]	50
		24 Hours	150[b]	150[b]	150[c]
Particulate Matter (<2.5 microns)	µg/m³	Annual	15[a]	15[a]	-
		24 Hours	65[d]	65[d]	-
Sulfur Dioxide	µg/m³	Annual	80	-	80
		24 Hours	365[c]	-	365[c]
		3 Hours	-	1300[c]	1300[c]
Nitrogen Dioxide	µg/m³	Annual	100	100	70
Carbon Monoxide	mg/m³	8 Hours	10[c]	-	5[c]
		1 Hour	40[c]	-	10[c]
Ozone	µg/m³	8 Hours	157[e]	157[e]	157[e]
		1 Hour	235[f]	235[f]	-
Lead	µg/m³	Calendar Quarter	1.5	1.5	1.5
Hydrogen Sulfide	µg/m³	1 Hour	-	-	35[c]

[a] Three-year average of annual arithmetic mean.

[b] 99th percentile value averaged over three years.

[c] Not to be exceeded more than once per year.

[d] 98th percentile value averaged over three years.

[e] Three-year average of fourth-highest daily 8-hour maximum.

[f] Standard is attained when the expected number of exceedances is less than or equal to 1.

Table 2

ANNUAL WIND FREQUENCY FOR HONOLULU INTERNATIONAL AIRPORT (%)

Wind Direction	Wind Speed (knots)									Total
	0-3	4-6	7-10	11-16	17-21	22-27	28-33	34-40	>40	
N	0.5	2.5	1.3	0.5	0.0	0.0	0.0	0.0	0.0	4.8
NNE	0.3	1.2	1.6	1.5	0.2	0.0	0.0	0.0	0.0	4.7
NE	0.3	2.1	6.1	11.0	3.2	0.3	0.0	0.0	0.0	23.0
ENE	0.2	2.5	10.9	16.6	4.1	0.3	0.0	0.0	0.0	34.7
E	0.1	1.0	2.5	2.8	0.5	0.0	0.0	0.0	0.0	7.0
ESE	0.0	0.3	0.4	0.3	0.0	0.0	0.0	0.0	0.0	1.1
SE	0.0	0.3	0.8	1.0	0.1	0.0	0.0	0.0	0.0	2.2
SSE	0.1	0.4	1.2	0.7	0.1	0.0	0.0	0.0	0.0	2.4
S	0.1	0.5	1.4	0.6	0.1	0.0	0.0	0.0	0.0	2.7
SSW	0.0	0.3	0.8	0.3	0.0	0.0	0.0	0.0	0.0	1.5
SW	0.0	0.2	0.8	0.4	0.0	0.0	0.0	0.0	0.0	1.5
WSW	0.0	0.3	0.5	0.4	0.0	0.0	0.0	0.0	0.0	1.2
W	0.1	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.1
WNW	0.2	1.4	0.3	0.1	0.0	0.0	0.0	0.0	0.0	2.0
NW	0.4	2.3	0.8	0.1	0.0	0.0	0.0	0.0	0.0	3.8
NNW	0.5	2.3	0.8	0.2	0.0	0.0	0.0	0.0	0.0	3.8
Calm	2.5									2.5
Total	5.4	18.3	30.6	36.5	8.5	0.7	0.0	0.0	0.0	100.0

Source: Climatography of the United States No. 90 (1965-1974), Airport Climatological Summary, Honolulu International Airport, Honolulu, Hawaii, U.S. Department of Commerce, National Climatic Center, Asheville, NC, August 1978.

Table 3

AIR POLLUTION EMISSIONS INVENTORY FOR ISLAND OF OAHU, 1993

Air Pollutant	Point Sources (tons/year)	Area Sources (tons/year)	Total (tons/year)
Particulate	25,891	49,374	75,265
Sulfur Oxides	39,230	nil	39,230
Nitrogen Oxides	92,436	31,141	123,577
Carbon Monoxide	28,757	121,802	150,559
Hydrocarbons	4,160	421	4,581

Source: Final Report, "Review, Revise and Update of the Hawaii Emissions Inventory Systems for the State of Hawaii", prepared for Hawaii Department of Health by J.L. Shoemaker & Associates, Inc., 1996

Table 4

ANNUAL SUMMARIES OF AIR QUALITY MEASUREMENTS FOR MONITORING STATIONS NEAREST HO'OPILI PROJECT

Parameter / Location	2001	2002	2003	2004	2005
Sulfur Dioxide / Kapolei					
3-Hour Averaging Period:					
No. of Samples	2511	2420	2461	2504	2396
Highest Concentration (µg/m^3)	24	47	26	17	64
2nd Highest Concentration (µg/m^3)	15	19	19	12	28
No. of State AAQS Exceedances	0	0	0	0	0
24-Hour Averaging Period:					
No. of Samples	359	344	351	355	333
Highest Concentration (µg/m^3)	7	9	9	7	21
2nd Highest Concentration (µg/m^3)	6	7	9	6	9
No. of State AAQS Exceedances	0	0	0	0	0
Annual Average Concentration (µg/m^3)	2	2	1	1	2
Particulate (PM-10) / Pearl City					
24-Hour Averaging Period:					
No. of Samples	354	243	329	335	336
Highest Concentration (µg/m^3)	167	66	30	32	195
2nd Highest Concentration (µg/m^3)	100	63	27	31	99
No. of State AAQS Exceedances	1	0	0	0	1
Annual Average Concentration (µg/m^3)	15	15	15	15	16
Carbon Monoxide / Kapolei					
1-Hour Averaging Period:					
No. of Samples	8577	8354	8559	8507	8556
Highest Concentration (mg/m^3)	2.3	2.2	2.2	2.4	1.7
2nd Highest Concentration (mg/m^3)	1.9	2.0	1.6	1.7	1.6
No. of State AAQS Exceedances	0	0	0	0	0
8-Hour Averaging Period:					
No. of Samples	1073	1044	n/a	n/a	8551
Highest Concentration (mg/m^3)	1.6	1.8	0.8	1.0	1.0
2nd Highest Concentration (mg/m^3)	1.3	1.8	0.8	1.0	1.0
No. of State AAQS Exceedances	0	0	0	0	0
Nitrogen Dioxide / Kapolei					
Annual Average Concentration (µg/m^3)	8	9	9	9	9
Ozone / Sand Island					
8-Hour Averaging Period:					
No. of Samples	-	8549	8641	8474	8670
Highest Concentration (mg/m^3)	-	89	79	110	92
2nd Highest Concentration (mg/m^3)	-	88	77	108	92
No. of State AAQS Exceedances	-	0	0	0	0

Source: State of Hawaii Department of Health, "Annual Summaries, Hawaii Air Quality Data, 2001 - 2005"

Table 6

ESTIMATED WORST-CASE 8-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR HO'OPILI PROJECT (milligrams per cubic meter)

Roadway Intersection	Year/Scenario			
	2007/Present	2030/Without Project	2030/With Project[a]	2030/With Project[b]
Farrington Highway at Fort Weaver Rd NB Ramps	3.1	2.0	2.9	3.3
Farrington Highway at Leoku Street	3.7	2.4	2.8	2.8
Fort Weaver Road at Old Fort Weaver Road	5.5	2.7	3.9	4.2
Fort Weaver Road at Renton Road	6.0	3.7	3.2	3.2
Farrington Highway at Fort Barrette Road	5.0	3.4	3.8	3.9
North-South Road at H-1 EB Ramps	-	3.0	3.7	3.8
North-South Road at Farrington Highway	-	3.0	4.1	4.4
North-South Road at Kapolei Parkway	-	3.0	3.6	3.4

[a]Assumes transit corridor and mitigation recommended in traffic study
[b]Assumes mitigation recommended in traffic study (but without transit corridor)

Table 5

ESTIMATED WORST-CASE 1-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR HO'OPILI PROJECT (milligrams per cubic meter)

Roadway Intersection	Year/Scenario							
	2007/Present		2030/Without Project		2030/With Project[a]		2030/With Project[b]	
	AM	PM	AM	PM	AM	PM	AM	PM
Farrington Highway at Fort Weaver Rd NB Ramps	6.2	4.6	3.9	3.8	5.8	5.0	6.6	5.1
Farrington Highway at Leoku Street	7.4	6.9	4.8	4.7	5.6	5.5	5.6	5.5
Fort Weaver Road at Old Fort Weaver Road	11.0	6.3	5.4	5.1	7.8	6.2	8.3	6.3
Fort Weaver Road at Renton Road	12.1	7.8	7.4	5.1	6.3	5.4	6.4	5.3
Farrington Highway at Fort Barrette Road	10.0	7.2	7.7	5.2	7.6	5.4	7.8	5.4
North-South Road at H-1 EB Ramps	-	-	6.1	3.2	7.4	4.6	7.6	4.6
North-South Road at Farrington Highway	-	-	5.9	4.8	8.2	5.9	8.9	6.9
North-South Road at Kapolei Parkway	-	-	5.9	4.6	7.2	6.0	6.8	6.0

[a]Assumes transit corridor and mitigation recommended in traffic study
[b]Assumes mitigation recommended in traffic study (but without transit corridor)

Table 7

ESTIMATED INDIRECT AIR POLLUTION EMISSIONS FROM HO'OPILI PROJECT ELECTRICAL DEMAND[a]

Air Pollutant	Emission Rate (tons/year)
Particulate	17
Sulfur Dioxide	210
Carbon Monoxide	17
Volatile Organics	1
Nitrogen Oxides	87

[a]Based on U.S. EPA emission factors for utility boilers [2]. Assumes electrical demand of 612 million kilowatt-hrs per year and low-sulfur oil used to generate power.

Table 8

ESTIMATED INDIRECT AIR POLLUTION EMISSIONS FROM HO'OPILI PROJECT SOLID WASTE DISPOSAL DEMAND[a]

Air Pollutant	Emission Rate (tons/year)
Particulate	1
Sulfur Dioxide	5
Carbon Monoxide	21
Nitrogen Oxides	55
Lead	<1

[a]Assumes solid waste disposal demand of 60 tons per day and that solid waste is burned in a refuse-derived fuel-fired power plant equipped with spray dryer and fabric filter. Emission rates based on U.S. EPA emission factors for refuse-derived fuel-fired combustors [2].

APPENDIX I
Social Impact Assessment

BeltCollins

July 9, 2008
2006.33.8500 / 08P-248

VIA ELECTRONIC MAIL and U.S. MAIL
vshigekuni@pbrhawaii.com

Mr. Vincent Shigekuni, Vice President
PBR Hawaii & Associates, Inc.
ASB Tower, Suite 650
1001 Bishop Street
Honolulu, Hawaii 96813

Dear Mr. Shigekuni:

Social Impact Assessment (November 2007)

Per comments received from the Leeward – Central Community Roundtable (aka Leeward – Central Community Forum) during the public review period of the Ho'opili Draft Environmental Impact Assessment, we concur that the fourth paragraph of Section 4.4, *Community Development on the Ewa Plain* of the Social Impact Assessment (November 2007) could be clarified with the sentence underlined below.

> Ho'opili will contribute to the growth of the urban community life in 'Ewa by providing new job locations, recreational areas, and schools as well as housing. It is designed as a community in which many residents will not need to drive to Honolulu often. Its transportation planning will work to address the region's serious traffic congestion problems. It will help to link existing and new communities, serving its neighbors as well as its residents.

Honolulu
Bangkok
Boulder
Guam
Hong Kong
Manila
Seattle
Shenzhen
Singapore

Should you have any questions, please do not hesitate to contact me.

Sincerely,

BELT COLLINS HAWAII LTD.

John Kirkpatrick
Senior Socio-Economic Analyst

JK:lf

SOCIAL IMPACT ASSESSMENT

HO'OPILI
'EWA, O'AHU, HAWAI'I

Prepared for

D.R. Horton – Schuler Division
PBR Hawaii

Prepared by

Belt Collins Hawaii Ltd.

November 2007

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ACRONYMS AND ABBREVIATIONS

CDPs	Census Designated Places
DHHL	Department of Hawaiian Homelands
EIS	Environmental Impact Statement
HCDA	Hawai'i Community Development Authority
msl	mean sea level
NAS	Naval Air Station
TMK	Tax Map Key
UHWO	University of Hawai'i, West O'ahu

CHAPTER ONE
INTRODUCTION

1.1 PROPOSED ACTION

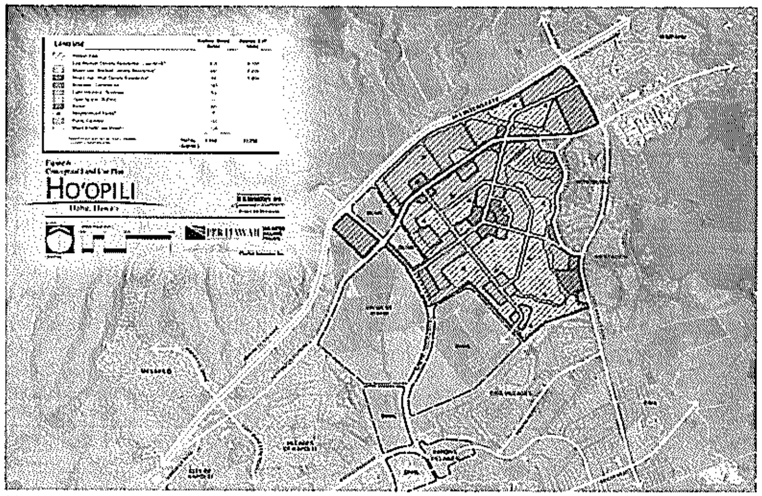
The Ho'opili project site consists of approximately 1,555 acres of land on the 'Ewa Plain, in the 'Ewa Development Plan area, City and County of Honolulu. The land has long been owned by the Estate of James Campbell but was acquired by D.R. Horton - Schuler Division in 2006. Figure 1 shows the project location. The site is *makai* (seaward) of the H-1 Freeway, and extends along Farrington Highway and old Fort Weaver Road. To the west, between the site and the Villages of Kapolei, lies an area that the State plans to develop. The State acreage will include the University of Hawai'i, West O'ahu (UHWO) campus, Department of Hawaiian Home Lands (DHHL) housing areas, and other facilities supporting the UHWO development.

The D.R. Horton - Schuler Division project will include about 11,750 residential units, as well as commercial and industrial uses, parks, schools, public facilities, roads, and open space. Figure 1 shows the project's conceptual plan, and acreages to be devoted to major land uses. Table 1 specifies the proposed housing unit count and square footage for commercial and industrial uses.

The Ho'opili project is intended to respond to the continuing strong demand for affordable housing on O'ahu. It has been designed to encourage urban community life, with residents relying far less on their automobiles than residents of more conventional residential subdivisions in the region.

Schuler Homes, Inc., now a division of D.R. Horton, proposed reclassification of some 793 acres of land owned by the Campbell Estate and the State of Hawai'i in 1996. That petition was withdrawn. The current proposed action incorporates planning concepts derived in part from "Transit-Oriented Development," "New Urbanism," and "Smart Growth" initiatives, and have not yet been implemented in O'ahu communities.

Figure 1: Project Concept Plan



SOURCE: PBR Hawaii, 2006.

Table 1: Major Land Uses

	Homes	Space
Residential		
Low-Medium Density Residential/Live-Work (Combined R5 & AMX2)	5,100	
Mixed Use/Medium Density Residential	5,200	
Mixed Use/High Density Residential	1,450	
Total	11,750	
Retail		2,240,000 sq. ft.
Office		720,000 sq. ft.
Industrial		800,000 sq. ft.

SOURCE: PBR Hawaii, 2007.

PURPOSE AND SCOPE OF THIS STUDY

This study is written for review by stakeholders, public agencies, and decision-makers. It will appear as part of the Environmental Impact Statement (EIS) on the proposed Ho'opili development.

The report deals with the social impacts of the project. It takes into account both existing conditions and likely future trends. It deals both with direct impacts and the cumulative impact of the project and other likely developments. The report is organized in four sections:

1. This introduction;
2. An account of the socio-economic context of the project;
3. A discussion of community issues and concerns; and
4. An analysis of social impacts, followed by discussion of mitigation measures and processes, to the extent that these are justified.

1.2 STUDY AREA

The project is planned as a major mixed-use project, responding to a lack of housing for residents of many income levels throughout O'ahu, and the need to further realize the vision of a secondary urban center. It is widely recognized that the island forms a single real estate market, so the potential impact area is islandwide. The most general study area for this report is the City and County of Honolulu, i.e., the island of O'ahu.

Impacts can also be anticipated for the region. The project site lies at the northeastern corner of the 'Ewa Development Plan area. Its area of potential influence is larger, inasmuch as it is close to the town of Waipahu. On a broader scale, it is sometimes argued that residential growth in any part of the 'Ewa region affects traffic on the H-1 Freeway to and from Honolulu, and hence can affect the entire Leeward region (including Central O'ahu and, arguably, Wai'anae and the North Shore).

The application of particular impacts to particular areas will be specified in the course of the analysis. (Figure 2 shows the Development Plan areas.)

The name "'Ewa" is used in overlapping ways in Hawai'i. The 'Ewa Plain, between Waipahu and Kalaeloa, makes up about half of the 'Ewa Development Plan area. The Development Plan Area includes two Neighborhood Board areas, which elect separate advisory boards. After the Makakilo/Kapolei/Honokai Hale Neighborhood Board was created for western 'Ewa, the existing board, serving the communities along Fort Weaver Road, retained the name "'Ewa Neighborhood Board." (In Figure 3, Ho'opili is shown as in the 'Ewa Neighborhood Board area.) The State's 'Ewa Judicial

District, however, is much larger and includes most of Central O'ahu. No further reference is made here to the judicial district.

Because 'Ewa has been an area of rapid growth, it is difficult to compare the population of smaller communities over time. Census tract boundaries have shifted from count to count. Demographic data for Census Designated Places (CDPs) are useful to characterize parts of the region, but important sites, such as Kapolei, were not identified as CDPs by the year 2000. (Figure 1 shows the location of 'Ewa CDPs.)

The term "East Kapolei" has also been used in several ways. In the mid-1990s, Schuler Homes (now a division of D.R. Horton) proposed development of approximately 793 acres within the site designated in this study as Ho'opili (Helber, Hastert & Fee, Planners 1996). The State of Hawai'i has also termed its development area, where the UHWO and DHHL subdivisions are being planned, as "East Kapolei" (PBR Hawaii, 1998). The City and County of Honolulu Department of Planning and Permitting has identified a "subarea" of the 'Ewa Development Plan area as "Kapolei East," including the Ho'opili project site, adjacent DHHL lands, and the UHWO site between Ho'opili and the Villages of Kapolei.

Figure 2: Development Plan Areas

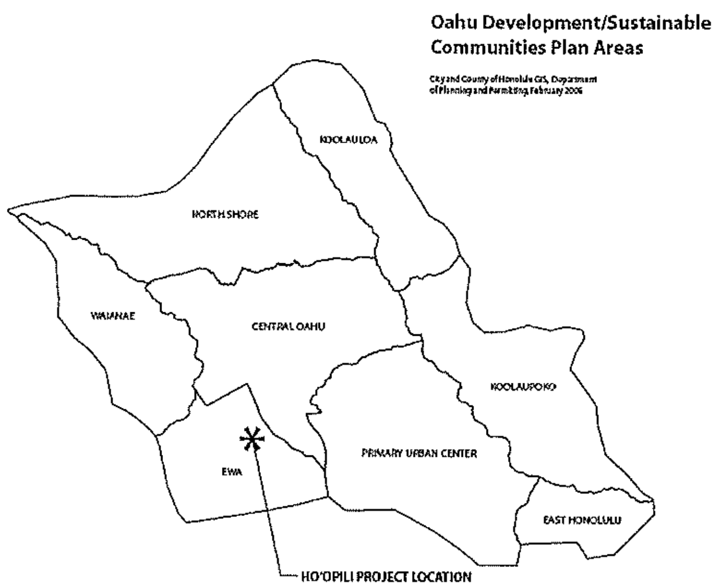
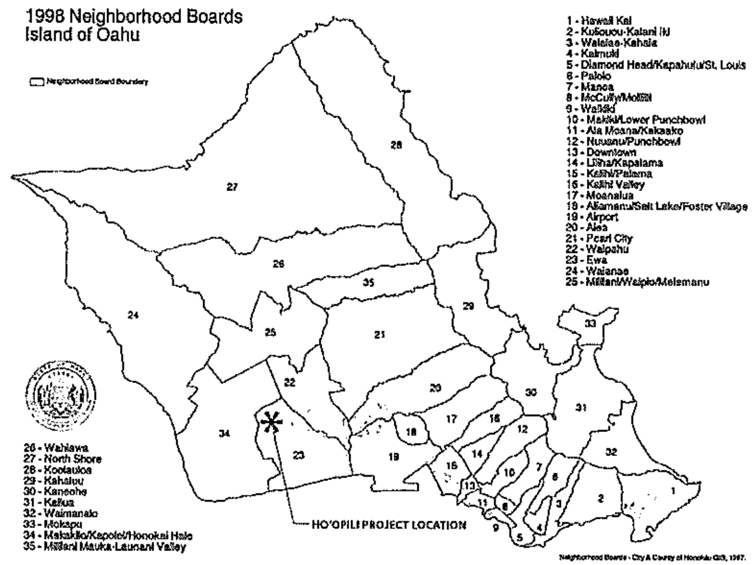


Figure 3: Neighborhood Board Areas



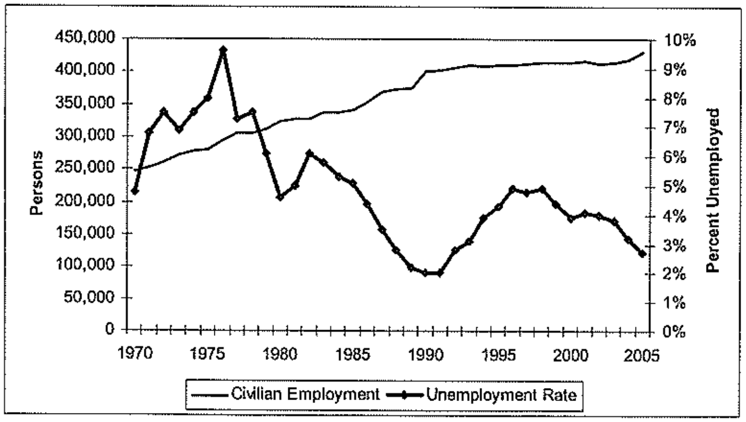
CHAPTER TWO
SOCIAL AND ECONOMIC CONTEXT

2.1 ISLAND AND REGIONAL ECONOMY

O'ahu is the economic and demographic center of Hawai'i. As such, it has seen steady economic growth over recent decades. It gained in population at the expense of other counties immediately after World War II. More recently, economic and population growth have picked up in the Neighbor Islands.

The 1990s were a difficult economic period for Hawai'i. Job growth slowed and housing starts and prices declined. O'ahu was not affected as much as other areas, as the low unemployment rates shown in Figure 4 indicate. O'ahu and Hawai'i have emerged with much lower unemployment rates than for the nation as a whole.

Figure 4: Island Economic Trends, 1970 through 2005



SOURCE: Historical and current statistics; State Department of Labor and Industrial Relations available through http://www.hiwi.org.

The island economy depended on a mix of tourism, military activity, construction, and plantation agriculture at the beginning of the 1970s. Since then, military activity declined but remained an important factor in the local economy. Plantation agriculture declined throughout the period. For the region surrounding Ho'opili, this development has been important.

- The O'ahu Sugar Company had used much of the 'Ewa Plain for sugar cultivation. As it closed operations (by 1995), land became available for urban development.
- With the closing of the plantation, many families in Waipahu and the 'Ewa Villages lost a major source of income. Many older workers retired. Others have retrained for other jobs.
- With the land and water released from sugar cultivation, 'Ewa has become a truck farming area, with Aloun Farms operating in the project site, emerging as the island's leading producer of vegetables.

The Kapolei area was designated as O'ahu's "Second City" decades ago. James Campbell Industrial Park was created as the island's leading heavy industrial area. The urban center was slower to develop. Commercial areas began to be built in the 1990s, and construction of residential areas began. Residential and retail growth has boomed since 2000. The major landowner in the region, Campbell Estate,[1] reports nearly 25,000 jobs in the 'Ewa Development Plan area, and expects that number to grow to about 65,000 by 2025 (http://www.kapolei.org). The industrial park has seen significant recent growth, including construction of a new *Honolulu Advertiser* printing plant. The resort area of Ko 'Olina now includes a hotel, a timeshare resort, and high-end vacation homes and condos. Kapolei itself has office buildings with State, City, and Bank of Hawai'i workers, as well as extensive retail areas.

In 2000, the workforce in the 'Ewa Development Plan Area was modest. Naval Air Station (NAS) Barbers Point had recently closed. The civilian job count in the Development Plan area (the combined 'Ewa and Makakilo/Kapolei/Honokai Hale Neighborhood Board areas) totaled about 15,000. The largest industry cluster, in terms of the number of local jobs, was education and health services, as shown in Table 2. About four-fifths of the jobs were on the western side of the 'Ewa Development Plan area. In Waipahu, which is closer to the Primary Urban Center, retail trade is the largest job sector.

[1] The Estate of James Campbell has been converted into successor firms including Aina Nui corporation and the James Campbell Company LLC.

Table 2: Jobs on O'ahu and Selected Neighborhood Board Areas, 2000

	City and County of Honolulu	Ewa	Makakilo, Kapolei, Honokai Hale	Waipahu
Total Workers, 2000	393,245	3,010	11,560	11,165
Agriculture, forestry, mining	3,664	20	573	60
Construction	17,954	174	1,495	950
Manufacturing	12,671	59	1,160	453
Wholesale trade	11,468	20	684	944
Retail trade	43,506	265	834	2,378
Transportation, warehousing, utilities	22,476	109	718	509
Information	9,897	30	90	120
Finance, insurance, real estate	27,335	160	879	505
Professional, management, administrative services	34,416	179	749	574
Educational, health and social services	72,262	1,210	1,760	2,200
Entertainment, accommodations, food services	49,541	369	1,365	1,215
Other services (except public)	16,063	125	235	835
Public administration	34,905	165	810	419
Armed forces	36,927	135	194	0

SOURCE: US Census, Census Transportation Planning Package, organized by Census Tract by University of Wisconsin, Milwaukee; tracts combined to Neighborhood Board areas by Belt Collins (http://www.uwm.edu/Dept/ETI/drilldowns/index.html).

The island economy has grown steadily. Unemployment continues at very low rates (2.3% for the City and County of Honolulu, for the year 2006, according to the State Department of Labor and Industrial Relations, www.hiwi.org.) State tax revenues grew by 11% in FY2006, compared to FY2005 (Department of Taxation, 2006).

In 'Ewa, the expanding economy is visible in new store openings, construction in industrial areas, and investment by U.S. mainland real estate investors in industrial and commercial properties in the region.

2.2 ISLAND AND REGIONAL DEMOGRAPHICS

As a matter of policy, the Primary Urban Center, 'Ewa, and Central O'ahu have been identified as "development" areas, and the other Development Plan areas are termed "sustainable communities." New housing and population are to be channeled in the three development areas. 'Ewa has had the fastest growth, while the population has increased by larger numbers in Central O'ahu, as shown in Table 3.

Table 3: Historical Population Growth, O'ahu and Development Plan Areas

	1980	1990	2000	Average Annual Increase, 1980 - 2000
Primary Urban Center	417,240	432,023	419,338	0.0%
Ewa	35,523	42,931	68,718	3.4%
Central Oahu	101,685	130,526	148,186	1.9%
East Honolulu	43,213	45,654	46,735	0.4%
Koolaupoko	109,373	117,694	117,994	0.4%
Koolauloa	10,983	14,263	14,546	1.4%
North Shore	13,061	15,729	18,380	1.7%
Waianae	31,487	37,411	42,259	1.5%
Total Population	762,565	836,231	876,156	0.7%

SOURCE: Honolulu Department of Planning and Permitting, 2005.

In 2000, residential areas in the 'Ewa Development Plan Area were largely inhabited by young families. In the newer subdivisions, home ownership is much higher than for the island as a whole. However, military housing areas – Kalaeloa, which used to be NAS Barbers Point, and Iroquois Point – stand out as areas where housing is rented. Throughout these communities, vacation housing, for rent or sale, is rare. (However, it is becoming common in Ko 'Olina.)

Table 4: County and Local Demographics, 2000

	City and County of Honolulu	Ewa CDPs: Ewa Villages	Ewa Gentry	Ewa Beach	Iroquois Point	Barbers Point	Makakilo	Central Oahu CDPs (selected): Waipahu	Village Park	Waipio
Population										
Total	876,156	4,741	4,939	14,650	2,462	67	13,156	33,108	9,625	11,672
Age										
Under 5 years	56,849	347	512	1,052	392	14	1,128	2,271	699	756
5-17 years	151,909	971	899	3,221	703	20	2,885	6,483	2,227	2,302
18-64 years	549,651	2,770	3,319	8,789	1,365	33	8,343	19,111	6,190	7,852
65 years and over	117,737	653	209	1,568	2	-	800	5,243	509	762
Median age (years)	35.7	33.3	31.9	32.7	25.5	17.8	32.4	35.5	31.4	33.9
In households	96.5%	99.9%	100.0%	99.1%	100.0%	100.0%	99.8%	96.6%	99.9%	99.4%
In group quarters	3.5%	0.1%	0.0%	0.9%	0.0%	0.0%	0.2%	3.4%	0.1%	0.6%
Households										
Total	286,450	1,178	1,734	3,305	675	16	3,898	7,566	2,628	3,974
Family households	205,672	1,004	1,239	2,841	660	16	3,225	6,430	2,280	2,873
With own children under 18	91,022	466	770	1,251	564	14	1,360	2,740	1,308	1,535
With persons under 18	108,247	613	814	1,830	566	14	2,005	3,831	1,484	1,735
With persons 65 and over	80,464	477	21	1,099	2	-	589	3,181	392	545
Average household size	2.95	4.02	2.85	4.39	3.65	4.19	3.37	4.23	3.66	2.92
Housing units										
Total	315,988	1,274	1,843	3,315	1,035	127	4,119	8,033	2,776	4,110
Occupied	286,450	1,178	1,734	3,305	675	16	3,898	7,566	2,628	3,974
Owner	54.6%	81.0%	68.3%	68.9%	1.3%	0.0%	70.5%	53.4%	72.1%	64.3%
Renter	45.4%	19.0%	31.7%	31.1%	98.7%	100.0%	29.5%	46.6%	27.9%	35.7%
Vacant	29,538	96	109	210	360	111	221	467	148	136
Seasonal, recreational use	6,855	1	4	10	-	-	8	4	3	2
Seasonal, etc., as % of all units	2.2%	0.1%	0.2%	0.3%	0.0%	0.0%	0.2%	0.0%	0.1%	0.0%

NOTE: For more on the CDPs, see section 2.4.2.

SOURCE: US Census, compiled in community profiles, accessed through http://www.hawaii.gov/dbedt/census2k/profile-honolulu/index.html.

While about 9% of the island workforce is in the military, the military share of most communities in the 'Ewa Development Plan Area was much smaller in 2000, except for Barbers Point and Iroquois Point, where the military formed the majority of the workforce. Agricultural workers were numerous in the 'Ewa Villages, but not elsewhere in the region.

Table 5: County and Local Workforce Distribution by Place of Residence, 2000

	City and County of Honolulu	Ewa CDPs: Ewa Villages	Ewa Gentry	Ewa Beach	Iroquois Point	Barbers Point	Makakilo	Central Oahu CDPs (selected): Waipahu	Village Park	Waipio
Employment status										
Population 16 and over	691,015	3,538	3,759	10,985	1,440	42	9,523	25,349	7,081	8,989
In labor force	447,320	1,988	2,820	6,877	961	24	7,014	14,603	5,354	7,030
Civilian	408,638	1,982	2,555	6,718	359	2	6,698	14,448	5,095	6,442
Employed	55.4%	52.0%	65.5%	56.8%	20.9%	4.8%	68.7%	51.8%	68.3%	69.1%
Unemployed	3.7%	4.0%	2.4%	4.4%	4.0%	0.0%	3.6%	5.2%	3.6%	3.5%
Armed Forces	38,682	6	265	159	602	52	316	155	259	588
Industry										
Agriculture, forestry, mining	1.1%	30.0%	0.8%	0.8%	3.0%	0.0%	0.5%	1.9%	0.6%	0.0%
Construction	8.1%	7.2%	5.1%	5.6%	2.3%	0.0%	8.5%	6.6%	6.9%	5.3%
Manufacturing	3.8%	7.6%	6.0%	8.2%	2.7%	0.0%	4.3%	6.2%	3.3%	4.3%
Wholesale trade	3.4%	3.8%	1.1%	4.1%	0.0%	0.0%	2.8%	4.4%	4.4%	3.6%
Retail trade	12.1%	14.8%	10.3%	17.5%	16.6%	0.0%	13.7%	13.1%	16.8%	13.3%
Transportation, utilities	6.5%	6.2%	8.1%	6.0%	0.0%	0.0%	8.8%	5.8%	5.9%	8.0%
Information	2.7%	0.0%	2.5%	1.8%	0.0%	0.0%	2.6%	1.8%	2.2%	4.1%
Finance, insurance, real estate	7.5%	4.1%	5.0%	5.7%	6.3%	0.0%	6.8%	5.8%	6.6%	7.7%
Professional, management, waste services	9.9%	9.5%	6.5%	9.9%	7.0%	0.0%	9.1%	8.1%	9.4%	8.2%
Educational, health, social services	19.9%	16.7%	18.8%	17.5%	38.9%	0.0%	16.9%	16.4%	18.3%	16.0%
Accommodation, food, recreation services	13.8%	15.7%	15.5%	13.6%	1.7%	100.0%	8.4%	18.7%	12.2%	13.0%
Other services (except public)	4.5%	7.4%	4.9%	4.9%	0.0%	0.0%	3.2%	5.4%	2.5%	3.3%
Public administration	9.3%	6.7%	12.4%	6.3%	21.6%	0.0%	12.5%	5.7%	11.0%	13.0%

SOURCE: US Census, compiled in community profiles, accessed through http://www.hawaii.gov/dbedt/census2k/profile-honolulu/index.html.

2.3 ISLAND AND REGIONAL HOUSING DEMAND

Hawai'i is recognized as struggling with a housing crisis. It is marked by a surge in prices in recent years, followed by rental increases. New housing production goes far toward meeting demand for housing for sale, but little new rental housing is being built. At the same time, some older low-income rental projects can now convert to market rentals or condominiums, reducing the inventory within reach of low-income families.

In 2000, the local housing market was sluggish. In much of the 'Ewa Development Plan Area, the cost of home ownership was below the island average. Still, the share of homeowners paying a large share of income for housing was as high or higher than the average. Rents in 'Ewa communities varied greatly, with the old plantation community of 'Ewa Villages offering low rents for retired workers, and other communities having higher rents on average than islandwide. (The 'Ewa Development Plan Area inventory also includes a much larger share of single-family rentals than in most areas of O'ahu.)

Table 6: County and Local Housing Indicators, 2000

	City and County of Honolulu	Ewa CDPs: Ewa Villages	Ewa Gentry	Ewa Beach	Iroquois Point	Barbers Point	Makakilo	Central Oahu CDPs (selected): Waipahu	Village Park	Waipio
Household income in 1999										
Less than $25,000	21.3%	22.4%	8.4%	18.5%	15.2%	0.0%	9.0%	25.8%	5.8%	8.8%
$25,000 to $49,999	26.5%	24.7%	25.8%	24.5%	44.5%	27.3%	22.8%	24.7%	25.5%	30.6%
$50,000 to $74,999	20.6%	29.2%	32.8%	26.5%	20.3%	40.9%	28.0%	20.5%	25.3%	25.0%
$75,000 to $99,999	13.4%	16.9%	20.4%	16.3%	15.5%	0.0%	20.2%	11.5%	24.5%	15.0%
$100,000 or more	18.1%	6.8%	12.7%	18.2%	4.4%	31.8%	20.0%	17.5%	18.8%	20.7%
Median household income	$51,914	$51,451	$61,462	$57,073	$44,200	$65,625	$67,267	$49,444	$70,302	$61,276
Poverty status (below poverty level)										
Individuals	83,937	403	131	1,430	45	-	653	4,478	491	471
Related children under 18	25,090	134	13	505	20	-	281	1,387	191	150
Persons 65 and over	8,614	97	-	98	-	-	31	722	8	56
Crowding (share of households)										
1.01 to 1.50 persons/room	7.9%	18.6%	9.4%	16.4%	4.8%	0.0%	9.3%	17.0%	15.6%	8.3%
1.51 or more	8.2%	18.4%	11.0%	11.6%	-	-	7.3%	15.6%	12.1%	4.8%
Housing costs										
Owners, with a mortgage	81,606	778	618	1,583	-	-	1,754	2,443	1,497	1,747
Median owner costs, with mortgage	$1,653	$1,300	$1,713	$1,517	$0	$0	$1,653	$1,622	$1,657	$1,669
Owner costs as share of income										
30 to 34.9%	7.9%	17.5%	12.3%	10.8%	0.0%	0.0%	12.5%	6.4%	18.5%	9.2%
35% or more	22.0%	24.9%	37.6	23.6%	0.0%	0.0%	26.4	22.0%	25.9%	23.6%
Rented units										
Median gross rent	$802	$244	$957	$931	$1,162	$1,542	$1,056	$654	$1,016	$931
Gross rent as share of income										
30 to 34.9%	7.5%	10.0%	14.6%	8.1%	1.3%	0.0%	9.9%	8.6%	17.1%	7.9%
35% or more	28.9%	13.4%	33.1%	33.3%	3.8%	17.6%	32.6	27.8%	31.8%	29.0%

SOURCE: US Census, compiled in community profiles, accessed through http://www.hawaii.gov/dbedt/census2k/profile-honolulu/index.html

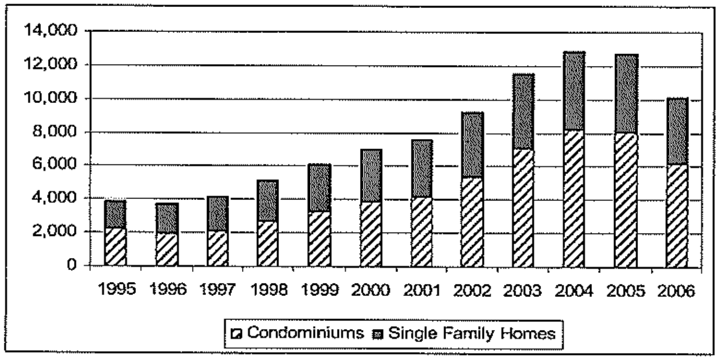
On O'ahu, the housing market typically includes about twice as many single-family home sales as condominium sales each year. Single-family homes form an even larger share of the market in Tax Map Key (TMK) Zone 9, the region including 'Ewa and Central O'ahu, where most new housing construction occurs.

Hawai'i housing prices typically have a boom phase followed by a plateau or slow retreat, as Figure 7 illustrates. In the mid-1990s, new housing production continued strong well after housing prices reached the plateau. Developers had unsold inventory. As a result, they are now much less willing to expand supply in response to short-term demand, and housing production has not returned to former levels.[2]

2 Figure 8 and subsequent tables based on the SMS study of historical residential real property sales depend on analysis of a large sample of fee-simple units, not the entire housing inventory. The volume shown hence is not the total volume of new housing sales on O'ahu (used in Figure 7). The volume of total sales in the longer-term analysis excludes leasehold sales and some sales that may simply be ownership transfers, rather than new market transactions.

Housing prices respond to several factors, including mortgage rates, which affect the amount that families can borrow. While rates can go up or down, and buyers' resources can shrink or increase, construction costs have moved steadily upwards, limiting developers' ability to respond to changes in the market.[3]

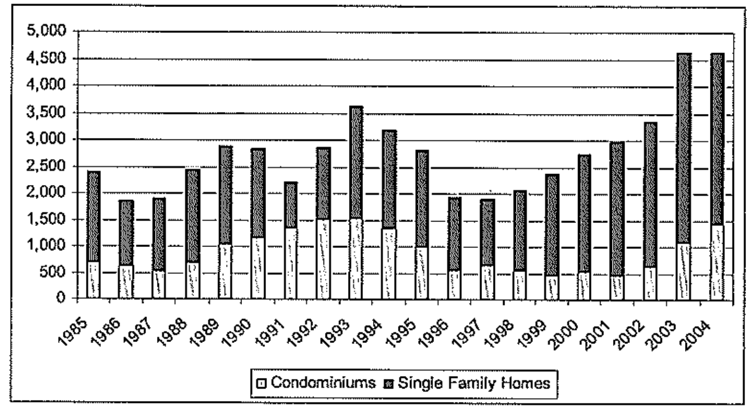
Figure 5: Volume of Residential Sales, O'ahu, 1995-2006



SOURCE: DBEDT (2007).

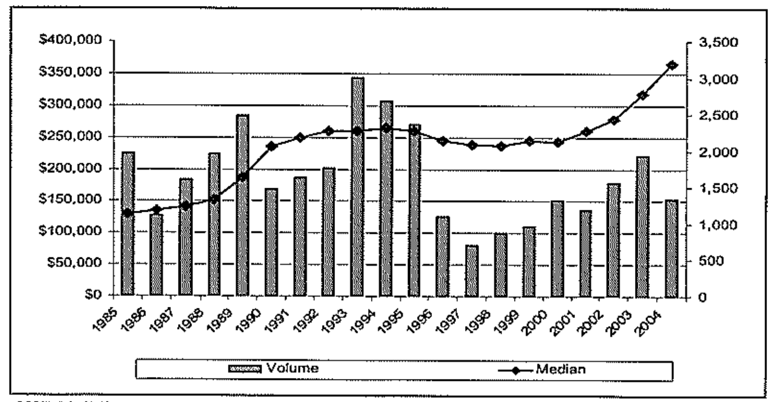
[3] The annual "affordable price" shown in Figure 8 is an estimate of the amount that a family with the median *income* could afford at prevailing interest rates in each year. It is not equivalent to the median price, i.e., the point at which half the units sold in the market are above, and half below.

Figure 6: Volume of Residential Sales, O'ahu Zone 9, 1985-2004



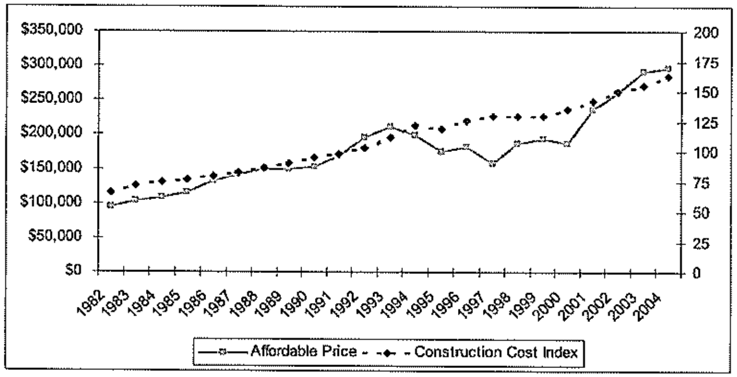
SOURCE: SMS (2005a).

Figure 7: Median Housing Prices and Volume of New Housing, O'ahu



SOURCE: SMS (2005a).

Figure 8: Affordable Housing Prices and Construction Cost Index, Honolulu

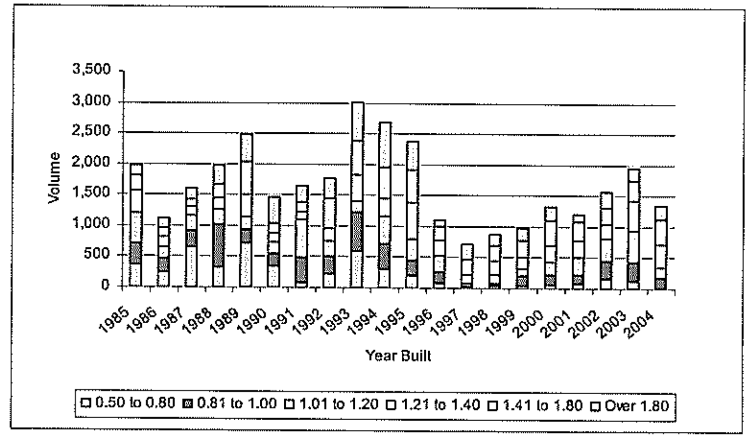


SOURCE: SMS (2005a).

When housing prices are converted to ratios of the annual affordable price, it is possible to compare the distribution of housing brought on the market from year to year. Figure 9 shows three major trends in new housing on O'ahu:

1. Nearly all new housing is being produced at prices that families with incomes higher than the median can afford. Units for sale at 80% of the affordable price have all but disappeared.
2. New housing is being produced for all sectors of the market above the 80% mark.
3. On O'ahu, the share of new units priced for families with 180% or more of the median income was highest in the early 1990s. More housing is produced for the 121% to 140% and the 141% to 180% segments.

Figure 9: Annual Distribution of New Housing by Affordability Level, O'ahu



NOTE: "Affordability level" is calculated in terms of what a household can afford to spend to pay for a mortgage on a home, in relation to the median household income for the County in a given year. The "0.50 to 0.80" entries refer to the number of units built that could be afforded by families earning 50% to 80% of the median income.
SOURCE: SMS (2005a).

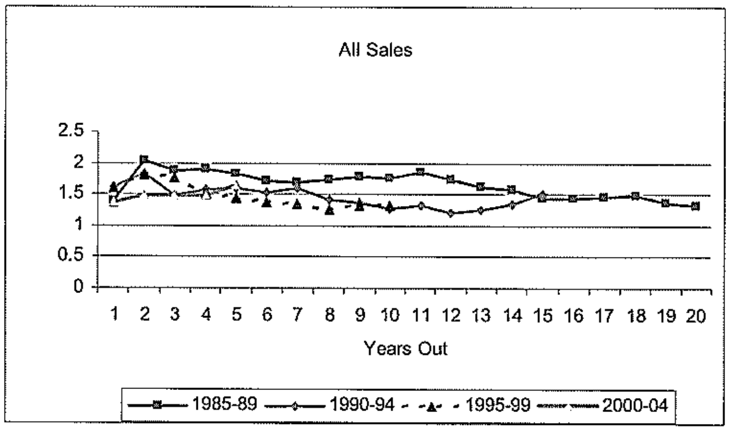
SMS used this methodology to look at resales as well as new housing production, asking whether resales increased in value (expressed in terms of housing affordability). In an active market, older homes can be expected to decline in value compared to new units. In a tight market, older homes will likely increase in value, if new units are not being produced to meet demand. Figure 10 tracks resale values for four "cohorts" of homes that first sold (within the twenty-year time frame of the study) at different times. In the short term, resale values increase. Few resales of homes occur within a year or so, unless an opportunity for a short-term profit arises. Within two or three years, this factor disappears, and the slow decline in value to be expected in an active market follows.[4] (This analysis deals with value, not price. Over the twenty years studied, the price that families can afford has risen. Consequently, a home can resell for a much higher price, but lower value, than its initial sale price.)

[4] Markets on Kaua'i and Maui show increases in value characteristic of tight markets, unlike the long-term trends reported here for O'ahu. The analysis discussed here was conducted separately for various affordability levels, as well as for the total inventory of resales. The data showed the same trends for segments as for the total inventory.

In 'Ewa and Central O'ahu (Zone 9), the long-term trend for the value of existing homes to decline over time has been stronger than for the island as a whole. However, recent sales show an increase in value over as much as five years, not just one or two. This suggests that current market conditions are tight in the area.

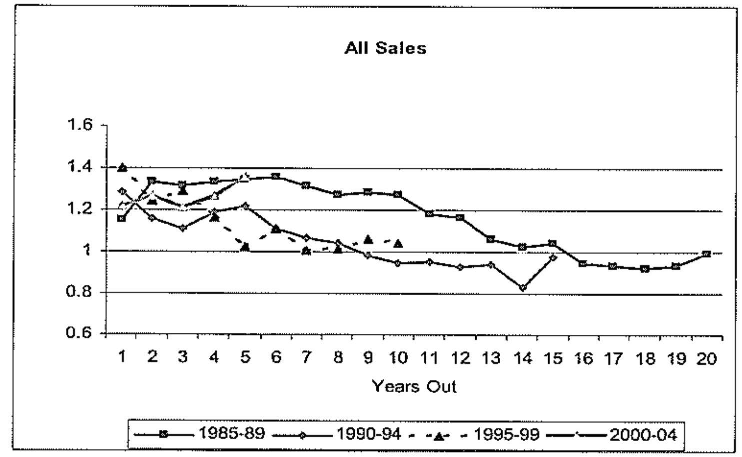
The average value of housing units sold in 'Ewa and Central O'ahu tends to be lower than for the island as a whole.

Figure 10: Resale Affordability, All Units, O'ahu, 1985-2004



SOURCE: SMS (2005a).

Figure 11: Resale Affordability, All Units, O'ahu Zone 9



SOURCE: SMS (2005a).

2.4 DEVELOPMENT OF 'EWA REGION

2.4.1 Geography and History

The two major land forms in the 'Ewa region are the 'Ewa Plain and Makakilo upland. The H-1 Freeway and Farrington Highway run along the boundary between the two land areas. The 'Ewa Plain is an elevated coral reef covered by alluvium. Elevations vary from about 50 feet above mean sea level (msl) near the southern boundary at Kalaeloa (formerly NAS Barbers Point), to 2,300 feet msl at Pu'u Manawahua, the highest peak in the 'Ewa region.

The climate is dry in 'Ewa. However, the land was arable in earlier times. There were once large terraced areas near West Loch referred to as 'Ewa taro lands. Hawaiians used pits in the coral for planting. Before contact with Europeans, settlement and agriculture on the plain were concentrated on the eastern, Pearl Harbor side.

Kamehameha III awarded the 'ahupua'a of Hono'uli'uli – including nearly all of the 'Ewa Development Plan area – to Chief Miriam Ke'ahikuni Kekau'onohi in 1848. She in turn leased it to ranchers. James Campbell bought Hono'uli'uli from a rancher in 1878. Campbell had the first artesian well drilled on his ranch in 1879, and subsequently developed well systems which allowed the cultivation of sugar cane in Hono'uli'uli. Campbell leased approximately 2,000 acres of land to Castle and Cooke in 1890 to grow sugar. A plantation settlement was established around the mill site on Renton Road and 'Ewa became a plantation community. 'Ewa's sugar and plantation communities flourished for decades.

After World War II, no new investment was made in the plantation villages. Castle and Cooke dissolved the Ewa Sugar Company in 1970 and sold its operations to AMFAC, thus merging 'Ewa Plantation with O'ahu Sugar Company. Cane cultivation continued but processing was done at O'ahu Sugar's Waipahu mill. O'ahu Sugar Company's lease with Campbell Estate, and sugar production in 'Ewa ended in 1995.

Harland Bartholomew and Associates prepared the first 'Ewa Master Plan in 1955 for Campbell Estate. The plan was revised in the early 1960s, and updated in 1974. By then, the concept of a self-contained city evolved. In 1986, Campbell Estate proposed a detailed implementation plan for a city center, bordered by Makakilo, Campbell Industrial Park, and NAS Barbers Point and renamed it Kapolei. The city center concept accorded with General Plan policies to develop a secondary urban center in west O'ahu.

The closure of O'ahu Sugar Company opened up land on both sides of the 'Ewa plain for redevelopment. Major developers on the east side were the City and County of Honolulu, the Gentry Companies, and HASEKO. On the western side, the State of Hawai'i housing development agency took the lead as master developer of the Villages of Kapolei, while the Campbell Estate developed its commercial and industrial lands. The Ko 'Olina resort area was planned and its key infrastructure was built by a consortium headed by Hawai'i developer Herbert Horita. When the economy slowed, the project stalled, and the Ko 'Olina lands were acquired by others. Recently, Aina Nui Corporation has petitioned for redesignation of "Kapolei West," land in Ko 'Olina on which the Ko 'Olina resort did not exercise options to develop. The City and County has withdrawn from the role of housing developer. The State's role is much reduced. The U.S. Navy had maintained NAS Barbers Point, housing areas at Iroquois Point and Pu'uloa, and ammunition storage areas in Pu'uloa. It has transferred limited rights to Iroquois Point to a private development partner. In 2002, the Hawai'i Community Development Authority was designated as responsible for redevelopment of Kalaeloa (Barbers Point). It recently completed a Master Plan for the site (2005).

2.4.2 Communities Surrounding the Ho'opili Project Area

This section provides brief accounts of the surrounding communities, with an emphasis on their role in the emerging Leeward O'ahu urban area. Existing

communities include Waipahu, Central O'ahu, a series of developments along Fort Weaver Road, and the residential areas to the west, reached from the H-1 Freeway via the current Makakilo/Kapolei interchange.

Most of the area in the eastern and western sections of the 'Ewa Plain is currently either in interim use as crop land or pasturage. Above the H-1 Freeway, Grace Pacific has one of the island's few major working quarries, reached by way of Farrington Highway.

2.4.2.1 Waipahu

The term "Waipahu" originally applied to a spring in the Waikele ahupua'a. The term was applied to land areas ('ili) surrounding the spring by the mid-nineteenth century (Nedbalek 1984), and later to the mill up the hill from the spring and to the town that spread around the mill.

Waipahu grew as a mill town. However, many residents took service and professional jobs in Pearl City and Honolulu by the 1980s. As sugar lands were taken out of agriculture, new residential and commercial development has surrounded the older town. Land at the mill site has been redeveloped and includes a Filipino Community Center, the Leeward headquarters of the YMCA, and an industrial park. The mill's smokestack remains as a landmark.

In 2000, the Waipahu CDP included more than 33,000 residents. The average household size, 4.23, is large, in part due to multifamily and multigenerational households.

2.4.2.2 West Loch

The first phase of this 491-acre City-sponsored project was completed in 1990 at the northern end of Fort Weaver Road. West Loch contains single and multifamily housing, a golf course, and parks. Some 60% of the homes were developed as "affordable" for families earning 120% of the median county income or less at the time of sale. This community is fully built out, with mature landscaping.

2.4.2.3 'Ewa Villages

The 'Ewa mill was built on Renton Road in the 1890s, and plantation villages were built nearby over the next decades. At one time there were eight villages, housing immigrant plantation workers from Portugal, Spain, Korea, Japan, and the Philippines. Some 1,200 housing units were built. Four of the newer villages – Renton, Tenney, Varona, and Fernandez – are still standing, while "C," Mill, Middle, and Lower Villages have been razed.

Renton Village, built between 1913 and 1938, is the core of the villages. It included the mill, post office, school, and hospital. Churches built in the plantation era are still standing.

In 1990, this was an old plantation community. Almost half of the Village households received Social Security income, and one-third received retirement income. Since then, the Villages have been redeveloped through a mixture of renovation, infill development, and creation of new subdivisions. Still, 35% of households in the 'Ewa Villages CDP were mildly or severely crowded in 2000. The 2000 Census showed that nearly half the residents had moved into 'Ewa Villages after 1995.

The City's housing development efforts were reduced before 2000. First, the slow economy curtailed housing prices and sales of new units. Next, embezzlement by City officials responsible for moving residents and shops in the existing Villages was uncovered. In the City's reorganization in 1998, the Department of Housing and Community Development was dissolved, and the City is no longer active as a developer.

2.4.2.4 'Ewa by Gentry

The Gentry Companies have approvals for approximately 9,000 housing units, most of which have been built. Soda Creek, the first subdivision within the area, opened in 1988. By 2000, nearly 5,000 persons lived in 'Ewa by Gentry. Its elementary school, Holomua, opened in 1996, now has the largest K-6 enrollment in Hawai'i, with 1,444 students in 2007 (DOE Press Release, September 20, 2007, available at http://lilinote.k12.hi.us/STATE /COMM/DOEPRESS.NSF.)

2.4.2.5 'Ewa Beach

'Ewa Beach began as a weekend recreational area in the 1940s and eventually became a permanent residential community. It contained 3,426 housing units in 1990, and 3,315 is 2000 – the community has not grown while the nearby subdivisions have come into being. As in 'Ewa Villages, crowding is much more prevalent than islandwide or in the newer 'Ewa communities.

'Ewa Beach is home to 'Ilima Intermediate and Campbell High School. These served all of the 'Ewa Development Plan area until the corresponding Kapolei schools were opened in 1999 and 2000.

2.4.2.6 Ocean Pointe

Located at the southwestern end of Fort Weaver Road, Ocean Pointe has long been planned by HASEKO Hawaii. It has been developed to date as a

residential community, with 2,850 units built by mid-2004 (City and County of Honolulu, 2005), but it will also include a marina, as well as commercial and resort acreage. Ke'one'ula Elementary School opened its doors in January 2007.

2.4.2.7 Iroquois Point

Located east of 'Ewa Beach, the Iroquois Point and Pu'uloa housing areas long served the military population based at Pearl Harbor. Under the Ford Island redevelopment process, these areas are now leased to a private developer, which is renovating much of the housing stock and leasing units both to military and civilian tenants.

2.4.2.8 Kapolei

Kapolei is both the term used for much of the development area in 'Ewa and an urban center on the western side of the plain. Major components are:

- The City of Kapolei, with office buildings developed by the Estate of James Campbell and its successor firms, and by Bank of Hawaii, the State of Hawai'i, and the City and County of Honolulu.
- Extensive retail areas – shopping centers, a K-Mart, and a movieplex.
- The Villages of Kapolei, to the east of Fort Barrette Road, with 4,300 units planned. The first increments opened in 1990. As of mid-2005, more than two-thirds of the project had been built. The remaining increments are largely committed to development by DHHL for Native Hawaiians.
- Additional housing areas – Kapolei Knolls and the planned Mehana project – by D.R. Horton - Schuler Division.
- A senior housing village, Leihano, is being planned by Brookfield Homes and Kisco Senior Living.
- Public elementary, middle, and high schools, preschools, and a new non-sectarian private school.
- James Campbell Industrial Park and the Kapolei Business Park, with space for industrial, light industrial, and commercial development. The industrial park includes power plants and Hawai'i's two refineries, as well as a mix of other uses. Additional industrial space is being planned in the 345-acre Kapolei Harborside project.

Kalaeloa Harbor, located between Campbell Industrial Park and Ko 'Olina, is O'ahu's second deep-draft harbor. Previously named Barbers Point Harbor, it began development in 1990, and already handles more cargo than any Neighbor Island port. The harbor and the Industrial Park are included in Foreign Trade Zone No. 9.

The City's transit plans call for a fixed guideway alignment serving the Kapolei area.

2.4.2.9 Makakilo

Makakilo opened for occupancy in 1962, with single and multifamily, mid-priced homes. Finance Realty was the major developer at Makakilo, which encompasses 1,202 acres located above Kapolei. Makakilo stands out as the most affluent of the 'Ewa CDPs.

Makakilo had 9,828 residents in 1990 and 13,156 in 2000. It continued to grow while the older communities in eastern 'Ewa did not.

2.4.2.10 Ko 'Olina

Ko 'Olina is a planned resort community at the southwest end of the 'Ewa region. It currently has a hotel, the first increments of a timeshare complex, and residential areas. While the oldest residential area, a townhouse project, serves residents, more recent subdivisions have attracted second-home buyers. A marina has been built and is in use.

2.4.2.11 Kalaeloa (NAS Barbers Point)

Barbers Point became a major Navy air facility during World War II. The base was listed for closure in the 1993 Base Realignment and Closure process. It closed in 1999, although the Navy retained much of the land at that time. Transfer of the land has stalled. Local government agencies have reconsidered their earlier proposals for development on the site. The former base includes an airport, now managed by the State Department of Transportation, the Coast Guard's Hawai'i airwing, the National Guard's Youth ChalleNGe program, housing for homeless veterans and families, and facilities retained by military agencies. Due in part to the cost of replacing infrastructure, redevelopment rather than simply reusing the existing facilities has been limited.

The 2000 Census data in this report reflects the closure. In 1990, the base had 2,200 residents and supported 1,600 civilian jobs. Since the closure, airport operations have been transferred to the State of Hawai'i, and the Hawai'i Community Development Authority (HCDA) has been charged with redevelopment. The Navy transferred some housing parcels to a private developer, and on-base housing is now available for civilian rentals. Transfer of much of the land area is stalled. Redevelopment will demand extensive work on infrastructure. HCDA has long-term plans for a mixed-use community on site.

2.4.3 Mobility

Two distinct sorts of mobility deserve note: movement of new households into the region and daily movement to and from work or school. Over the economic slowdown of the 1990s, residents of many communities in 'Ewa established themselves. However, jobs have not moved west as quickly as households, so long-distance commuting is common.

As of 2000, more than half the population in most 'Ewa communities had lived in the same house for five years or more. This figure is about the same as for the island as a whole (the exceptions are the two military areas, where most residents moved in the preceding year or two). However, the share of residents who had lived in the same house for a decade or more was well below the island average, except in 'Ewa Beach.

The CDP communities do not include some of the major development sites, and new residential development in 'Ewa has climbed since 2000.

Table 7: Geographic Mobility, 2000

	City and County of Honolulu	Ewa CDPs: Ewa Villages	Ewa Gentry	Ewa Beach	Iroquois Point	Barbers Point	Makakilo	Central Oahu CDPs (selected): Waipahu	Village Park	Waipio
Geographic Mobility										
Where lived in 1995 --										
Population age 5 and over										
Same house in 1995	56.3%	56.7%	51.9%	64.5%	6.9%	4.3%	55.4%	58.6%	63.4%	60.3%
Different house, same county	26.1%	37.4%	32.1%	27.7%	4.5%	27.1%	32.9%	31.3%	26.5%	26.1%
Different county, same state	1.2%	0.0%	0.2%	1.2%	0.5%	0.0%	0.8%	1.1%	0.8%	1.2%
Different state	11.7%	0.8%	10.7%	4.0%	80.6%	52.9%	7.8%	2.3%	6.4%	8.7%
Elsewhere	4.7%	5.1%	5.1%	2.5%	7.5%	15.7%	3.1%	6.7%	2.9%	3.7%
When moved into unit --										
Householders										
1999 to March 2000	20.1%	20.9%	27.8%	15.3%	49.9%	82.4%	19.5%	17.0%	21.4%	22.6%
1995 to 1998	26.5%	32.4%	23.9%	18.0%	47.6%	17.6%	30.0%	22.6%	20.7%	23.2%
1990 to 1994	14.4%	9.4%	39.5%	14.0%	2.6%	0.0%	20.2%	12.7%	23.7%	17.5%
1980 to 1989	15.2%	19.5%	7.3%	18.5%	0.0%	0.0%	14.1%	14.9%	33.2%	28.4%
before 1980	23.8%	17.9%	1.6%	34.0%	0.0%	0.0%	16.1%	32.8%	1.1%	8.3%

SOURCE: US Census (www.census.gov).

Census data show the majority of 'Ewa workers as commuting to work in 2000. Use of public transportation was higher than the island average among workers from 'Ewa Villages, 'Ewa Beach, and Iroquois Point. Again, most workers with jobs in the leeward region commuted in their own cars.

Planning for the Second City envisaged residents as working near home, so that long-distance commuting could be minimized. A recent study suggests that no more than 29% of 'Ewa and Wai'anae Coast workers have jobs in their own home region. More residents work in Pearl City and Central O'ahu than in their home area.

Table 8: Commuting Patterns by Place of Residence, 2000

	City and County of Honolulu	Ewa CDPs: Ewa Villages	Ewa Gentry	Ewa Beach	Iroquois Point	Barbers Point	Makakilo	Central Oahu CDPs (selected): Waipahu	Village Park	Waipio
Commuting to Work										
Drove alone	61.4%	61.2%	67.5%	62.8%	52.8%	79.2%	69.3%	57.7%	65.1%	70.6%
Carpooled	19.4%	19.6%	21.3%	20.6%	14.1%	20.8%	22.3%	21.1%	24.6%	21.0%
Public transportation	8.3%	16.3%	7.9%	11.2%	19.3%	0.0%	4.3%	16.0%	6.9%	5.1%
Mean travel time to work (minutes)	27.3	35.6	37	39.6	38.0	25.4	35.3	33.2	33.3	31.7

SOURCE: US Census (www.census.gov).

Table 9: Commuting Patterns, by Place of Work and Mode of Transport, 2000

	City and County of Honolulu	Ewa NB	Makakilo/Kapolei/ Honokai Hale NB	Waipahu NB
Total Workers, 2000	393,245	3,010	11,560	11,165
Drove Alone	61.4%	62.0%	75.4%	71.3%
Carpool	19.3%	17.0%	15.3%	16.4%
Mass Transit	8.1%	3.9%	3.1%	4.7%
Other	11.2%	17.2%	6.1%	7.6%

SOURCE: US Census, compiled by the City and County of Honolulu Department of Planning and Permitting. Available at http://honoluludpp.org/planning/demographics2/2000/NA/economic.pdf

Table 10: Inter-regional Commuting Patterns, 2005

Residential Areas (1)	Residents	Share of residents working in: Pearl City + Central	Downtown + Kaka'ako	E Honolulu + Waikiki	Windward Oahu	Rest of Oahu
Ewa / Wai'anae DP Areas	39,286	55.1%	13.0%	1.9%	0.8%	29.2%
Central Oahu / N. Shore / Pearl City	107,024	40.4%	16.1%	4.2%	2.0%	37.3%
Windward Oahu	52,219	19.1%	13.4%	0.6%	36.9%	30.0%
East Honolulu and Waikiki	59,464	18.9%	31.4%	30.8%	1.7%	17.4%
Rest of Primary Urban Center	108,630	33.2%	25.0%	7.6%	1.9%	32.3%

NOTE: Based on survey data, weighted to estimate population size. Residential and worksite areas are close to, but may not be precisely aligned with, the regions used to label them.
SOURCE: SMS Market Study, as reported in SMS 2005b.

2.4.4 Community Amenities and Facilities

To develop a new urban center, the City and State have relocated agencies to Kapolei. Residents are served by local police and fire stations, a satellite city hall office, and a public library.

Commercial development has proceeded quickly in Kapolei and along Fort Weaver Road. Kapolei has shopping centers, medical offices, and a movie theater. The Fort Weaver Road area has a medical center, a social service complex, and neighborhood malls. Neither has a regional mall, although Kapolei has "power centers" at K-Mart and Home Depot. The Waikele shopping center and outlet center, in Waipahu, is the nearest regional mall serving the area.

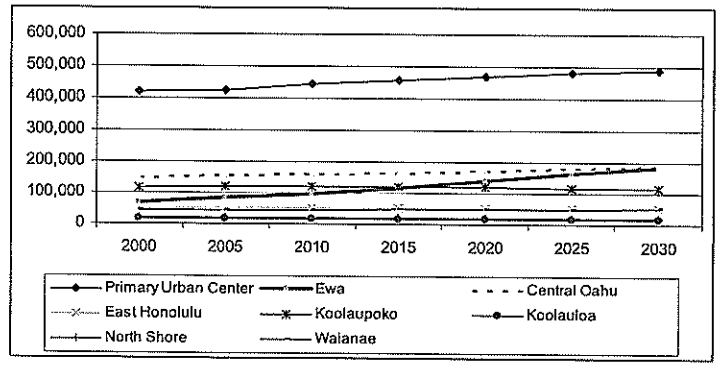
Kapolei has O'ahu's largest private recreation area, Hawaiian Waters Adventure Park. Community parks and golf courses are scattered throughout the 'Ewa region. Kalaeloa has extensive areas which have been designated for park development. However, funds for further development have not been programmed. The sand beaches are now accessible to the general public. Beaches at Ko 'Olina and 'Ewa Beach are also used by 'Ewa residents.

2.5 EMERGING TRENDS

Population and job growth are expected to continue. The 'Ewa Development Plan area is expected to see a growth rate far higher than in any other area of O'ahu over the next twenty years. To accomplish that growth, more than 34,600 housing units would be needed in 'Ewa between 2000 and 2025.

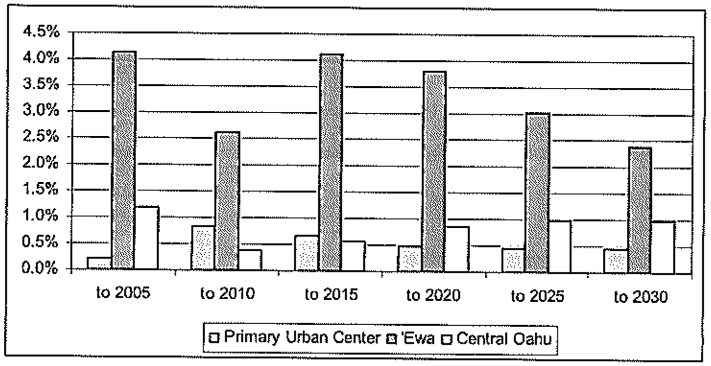
For a detailed analysis of housing demand in relation to the proposed Ho'opili project, see the market study for Ho'opili (Mikiko Corporation, 2007).

Figure 12: Forecast Population Increase



SOURCE: Honolulu Department of Planning and Permitting. Available at http://honoluludpp.org/planning/demographics2/Projections/2030byDP.pdf

Figure 13: Annual Forecast Rate of Increase in Housing, 2000 to 2030, for Major Development Plan Areas



While Kapolei was planned as an urban center second to Honolulu, large facilities serving the larger region have tended to be located on its outskirts. Home Depot, for example, is located west of the urban center. More importantly, two projects being planned for the center of 'Ewa, the UHWO campus and a Ray and Joan Kroc Community Center, will be located east of the Villages of Kapolei on the new North-South Road. Commercial areas have also been proposed next to the campus and on DHHL land near the community center.

CHAPTER THREE
COMMUNITY ISSUES AND CONCERNS

3.1 SOURCES

Major sources for understanding community viewpoints in Leeward O'ahu include Neighborhood Board discussions and public reactions to planning reported in City planning documents, EISs, and the newspapers. For the island as a whole, survey information is also available.

D.R. Horton – Schuler Division has convened a series of discussions with community stakeholders to help the developer shape the project to meet regional needs and avoid unwanted impacts. For this report, Belt Collins has reviewed minutes, attended meetings, and followed up with selected community stakeholders on issues raised in the meetings. Table 11 lists the members of the Ho'opili Community Task Force advisory group.

Table 11: Ho'opili Community Task Force

HOOPILI COMMUNITY TASK FORCE	
Maureen Andrade	Village Park Community Association
Gary Bautista	'Ewa Neighborhood Board
Dick Beamer	"Honorary Mayor" of Ewa Beach
Scott Belford	HOSEFF Non-profit
John Condello	Hawaii Theological Institute
Kurt Fevella	'Ewa Neighborhood Board
Pearlyn Fukuba	Hawaii Community Development Authority, Kalaeloa
Frank Genadio	Makakilo resident
Kevin Gilbert	Hawaii Theological Institute
Michael Golojuch	Palehua Community Association
Carolyn Golojuch	Makakilo resident
Sharon Har	Kapolei resident
Teri Ikehara	West Loch Estates Board President
Coby Lynn	Ewa Beach Lions Club
Eileen Lynn	Ewa Beach resident
Tesha Malama	Ewa Beach resident
Richard Oshiro	Waipahu Neighborhood Board
Rodolpho Ramos	'Ewa Task Force
Frances Rivero	Ewa Beach Boys and Girls Club
Ross Rolirad	Rotary Club
Georgette Stevens	West Oahu Economic Development Association
Summer Thompson	Ewa Beach Boys and Girls Club
Keith Timson	Makakilo resident
Maeda Timson	Kapolei Neighborhood Board
Karen Wenke	'Ewa resident; small business owner
Chuck Wheatley	Guardian Angels, Waipahu
Lance Widner	Royal Kunia Community Association
Stephanie Widner	Royal Kunia resident
George Yakowenko	Waipahu Neighborhood Board
Annette Yamaguchi	Waipahu Business Association
Linda Young	Kapolei Neighborhood Board; Malanai Iki Assoc.

NOTE: List taken from Ho'opili Community Task Force Vision Statement. Members may have attended some, but not all, meetings. Several others, not listed, attended only one meeting.

Belt Collins also interviewed local stakeholders, complementing the process organized by the developer. Informants were asked to share ideas -- both their own and those of others in the community. Affiliations are listed as an indicator of their experience and knowledge of the community. Neither informants nor community groups should be viewed as taking a position for or against the project because they are listed in the table.

Table 12: Informants Contacted for this Report

Patti Bates	Child & Family Service
Bob Campbell	West Loch Fairways Board of Directors
Donna Campbell	West Loch homeowner
Lincoln Chan	West Loch Fairways Board of Directors
Robert Creps	Grace Pacific Corporation
Yvonne Dembinski	West Loch Fairways Board of Directors
David Ellis	Kahi Mohala
Stanton Enomoto	Hawaii Community Development Authority, Kalaeloa; now with Office of Hawaiian Affairs
Larry Jefts	Sugarland Farms
Leonard Licino	Kahi Mohala
Laurie Murphy	West Loch Fairways Board of Directors
Mark Mitchell, MD	Kahi Mohala
Richard Oshiro	Waipahu Neighborhood Board
Diane L. Reece	Child & Family Service
Alec Sou	Aloun Farms
Chris Steele	Grace Pacific Corporation
Maeda Timson	Kapolei Neighborhood Board

NOTE: The persons listed were asked to provide information about concerns and views of the community, not to speak on behalf of their agencies or groups. Affiliations are listed to indicate the range of persons interviewed, not to claim that the organizations in question have taken any particular stance in relation to the Ho'opili project.

3.2 ISSUES AND CONCERNS VOICED IN COMMUNITY PLANNING

The Department of Planning and Permitting reviewed Neighborhood Board minutes for 2000 through 2003 from the two 'Ewa Development Plan area boards and analyzed the frequency of concerns voiced in the meetings. The leading topics were:

- Transportation infrastructure: 43% of concerns;
- Public facilities (primarily schools, parks and parking): 29%;
- Development projects: 13%; and
- Environmental infrastructure (solid waste, water supply, sewerage): 10%.

Residents expressed concerns with both regional circulation and inter-regional movement, i.e., mass transit. (The analysis was prepared for discussion with community stakeholders. It was accessed in December 2005 at http://honoluludpp.org/Planning/ewa/ewa5yr/StatusReportApril12.pdf.)

The Neighborhood Board minutes for 2004 and 2005 show continuing interest and concern about these themes. However, a shift of concern is apparent. Less time has been spent recently on plans for new roadways, and more on traffic flow on major streets, such as Makakilo Drive and Fort Weaver Road. Interest in ease of movement and connectivity is balanced by concern for pedestrian safety.

Major local development topics discussed included new roads, schools, the UHWO and DHHL projects in mid-'Ewa, a new electrical generating plant in Campbell Industrial Park, and plans to close Waimanalo Gulch landfill. Residents sought information about community benefits offered by Hawaiian Electric and by the city in connection with the electrical plant and landfill.

In a 2005 survey, residents of 'Ewa and Central O'ahu stood out as having longer average commuting times – 44 minutes – than residents of other O'ahu regions, and as seeing weekday traffic as "a lot worse" in the last year (57% of respondents).[1] Traffic emerged as the second "most important issues facing the State" in this poll, after education, for the first time in 2005. (The question was first asked for this poll in 1999.) This viewpoint was expressed even more strongly in a poll for the O'ahu Regional Transportation Plan (Ward Research, 2006). Some 94% of 'Ewa and Wai'anae respondents felt that traffic was a serious problem for their region.

All stakeholders expressing viewpoints at the community advisory group meetings for Ho'opili, and in interviews for this report, emphasized problems of traffic congestion and slow infrastructure development. Most mentioned their support for rail transit to help address the region's traffic problems, but added that it will not be sufficient to ease the region's traffic problems. Additional actions – movement of many jobs to Leeward O'ahu, a ferry system, and new bridges and roads between 'Ewa Beach and Honolulu – were cited as needed or worth further consideration to improve residents' quality of life.

In the O'ahu Regional Transportation Plan survey, 55% of 'Ewa/Wai'anae respondents said that they would use rail rapid transit regularly when it becomes available.

[1] The "People's Pulse" poll of January 2005 had a sample of 400 from O'ahu, 700 statewide. The "Ewa/Leeward" category reported here is distinguished from four other O'ahu areas (Honolulu, Windward, North Shore, Wai'anae) and presumably is equivalent to 'Ewa and Central O'ahu combined (accessed at http://www.prp-hawaii.com/prp/marketing/news.jsp, January 4, 2006).

'Ewa residents see the State and City as lagging far behind developers in providing for new residential areas. As a result, they would like to see developers insuring that needed infrastructure – roads, schools, parks – is in place early, not after a development is nearly built out. Some wanted the developers to pay for infrastructure, and then recoup others' share of the cost as other new developments are built.

3.3 Issues and Concerns with Regard to the Ho'opili Project

At the Ho'opili Community Task Force meetings, some local stakeholders said explicitly that the Ho'opili project had their support. They cited the project's ability to help to mitigate regional traffic problems and its contribution to regional land use planning as crucial (in the course of several meetings, they found that the project's commitment to transit, its bike trails, and its overall plan were a contribution to the region). Others recognized that the development was already within the planned urban area, but still wanted to hear how the project would help to alleviate traffic problems.

During group discussions of amenities in the project, considerable interest was expressed in features that could attract residents of the surrounding area. The park area located along Fort Weaver Road interested some as an amenity serving the Fort Weaver Road communities. The proposed town center was seen as attractive, especially if designed to allow farmers' markets or street fairs.

Interviewees included (a) a few of the stakeholders who had participated in the task force meetings and (b) persons knowledgeable about nearby institutions. Interviewees were asked about their general impressions and expectations of the project. They were then shown a preliminary map of land uses in the Ho'opili project area (Figure 2).

All stakeholders spoke about traffic and infrastructure issues. They stressed the impact of the project on the area's traffic congestion as a major issue. Some noted that, while state agencies were responsible for supplying highways and schools needed by residents, members of the regional community would be opposed to development if it worsens congestion. Respondents tended to discuss traffic as affecting the larger community, and schools as affecting future residents of Ho'opili.

Several stakeholders had heard that the developer was reserving space for a private school. They supported an increase in the number of private schools in the region. Participants in the community task force meetings favored this idea on several occasions.

A few stakeholders discussed the withdrawal of agricultural land due to urbanization of the property. They recognized that the process has long been anticipated. Community members expressed interest in seeing developers solve regional drainage problems, which have led to flooding in 'Ewa Villages in the past.

The idea of a walkable community was welcomed by some stakeholders, both as reducing dependence on automobiles and as encouraging a valued lifestyle. A few cautioned that it will be important to provide attractive streetscapes, with shade trees, to encourage walking.

Several stakeholders viewed Ho'opili as an extremely large development. In the community task force meetings, participants came to agree that the size of the project was understandable in relation to expected population growth on O'ahu. They also saw the project as being large enough to make up for the limitations of current development in the area. Still, when respondents were interviewed individually or in small groups, they were more likely to remark on the size of the project, the number of residents, and the potential traffic generated.

Some stakeholders with properties nearby expressed concern that young people from Ho'opili would add to traffic through their areas, not just along the main roads. They were concerned about both automobile and bicycle traffic.

Some stakeholders anticipated that the Ho'opili project would bring at least one more traffic light on Fort Weaver Road, and at least one on Farrington Highway. They saw this, along with population growth in the project, as adding to the major traffic problems experienced in the region.

Some informants were concerned that the project's residents would begin to experience parking and traffic problems on side streets as Ho'opili families mature, and have several cars in each household. They pointed to side streets in Makakilo as examples of roads that once seemed adequate but now are crowded.

One local resident pointed out that the proposed rail system would only be completed after the first generation of homebuyers in Ho'opili have lived there for at least a decade. As a result, children in those families would grow up in auto-dependent households, and would tend not to rely on bus and rail transportation. Later, perhaps, Ho'opili residents would come to prefer mass transit.

CHAPTER FOUR
IMPACTS AND MITIGATIONS

4.1 INTRODUCTION

This chapter deals with impacts of the Ho'opili project on social life. "Impacts" are distinguished from "issues," discussed in the last chapter. Impacts are, in the professional judgment of the analyst, likely consequences of project development, attributable at least in part to the development. "Issues" are identified as of concern to members of the community; they may point to impacts, but do not necessarily do so.

An impact makes a difference: if an issue is already felt to be a problem, and it will continue after development of a project, it is not an impact unless the project makes it happen more often or more severely. In this report, attention is paid to both beneficial and adverse impacts – in part because impacts viewed as beneficial to some may be seen as adverse to others. Where impacts appear to be adverse, ways to mitigate the impact are considered in Section 4.5.

As a major urban development, Ho'opili will affect its immediate neighbors, other communities on or near its major access roads, and the island as a whole.

Impacts may arise during planning, construction, or the operational lifetime of a project. Some impacts are likely to be transitory: construction impacts on traffic and nearby homes are limited by government regulations and usually only occur for a period of weeks or months. Others may increase over time, as the developed area becomes larger and community residents come to use facilities in the new project.

4.2 AFFECTED PARTIES

Stakeholders who may be especially affected by the Ho'opili project fall into six groups:

- Future residents and businesses in the project: These are the most immediate beneficiaries of project development, and the persons most extensively affected.
- On-site agricultural operations and employees: Two firms hold the major leases on the property, and additional farmers are sub-lessees. The two firms are the largest suppliers of truck crops (locally grown fresh produce) on O'ahu, Sugarland Farms and Aloun Farms. As development proceeds, lands now leased short-term for agricultural

use will be withdrawn, and the tenants will need to consolidate their operations and relocate them. The impact is discussed in detail in a separate report (Decision Analysts Hawaii Inc., 2007). The social impacts involve disruption of activities and, with higher production costs as agricultural operations move from the ʻEwa Plain, eventual increases in the cost of production, and hence the price of produce for consumers.[1]

Withdrawals will involve acreage larger than the land to be immediately developed. The tenants will need to provide buffers between agricultural and residential areas. While agricultural activities have constitutional protection in Hawaiʻi, the major agricultural operators seek to avoid confrontations with neighbors over dust, insecticides and the like. Accordingly, withdrawal of agricultural operations from the Hoʻopili project land will be completed well before the project buildout (also, withdrawal of sites crucial in water distribution could affect all areas dependent on these for irrigation).

The two major tenants emphasized that land on the ʻEwa Plain is used in conjunction with other agricultural land to assure delivery of produce to Honolulu markets throughout the year. The ʻEwa lands have lower rainfall in winter months than fields at higher altitudes in Central Oʻahu and, hence, are preferred for production in that period. Also, crop and variety choices depend on the specific characteristics of fields used. Relocation of agricultural operations will demand a careful review of varieties planted and cultivation techniques.

- Residents and operations on adjoining parcels: Properties adjoining or across the road from the project include two social service agencies (Child and Family Service and Kahi Mohala), older homes and small businesses along Old Fort Weaver Road, a Hawaiian Electric transformer substation, and lands to be developed by the DHHL. Much of the land on the *mauka* side of Farrington Highway is largely in agricultural use. Parts of ʻEwa Villages are directly south of Hoʻopili, separated from it by part of that community's golf course.
- Residents of communities along Fort Weaver Road: This area has seen continuing growth since the early 1990s. Traffic congestion is a grave problem and concern. The communities were developed as plantation towns (ʻEwa Villages, ʻEwa Beach), military housing areas (Iroquois Point and Puʻuloa), or residential subdivisions (ʻEwa by Gentry, newer parts of ʻEwa Villages, West Loch, Ocean Pointe). None provides a center for activity or organization of the region as a whole.

[1] While agricultural operations will be disrupted by being moved off-site, this change has been long anticipated. The lands at the Ho'opili site were opened for truck farming only on limited-term leases, in the expectation of urban development in the near future.

- Operations on Farrington Highway: Currently, two commercial activities are located on Farrington Highway between the project site and Fort Barrette Road: the Gentry Pacific quarry and the Kapolei Golf Course. Both loaded and unloaded trucks use the highway to travel to and from the quarry. The golf course depends on the highway for access by golfers.
- Residents and other stakeholders of the larger Leeward area. Drivers from Waiʻanae and Kapolei will take the H-1 Freeway past Hoʻopili, and will form part of the customer and workforce base for the project. For Waipahu residents, Hoʻopili will be a new development close to home.

In addition, all participants in the Oʻahu housing market will be affected by the development of a new community at Hoʻopili. The island economy, and construction workers in particular, will benefit from the jobs and income created throughout construction.

4.3 SOCIAL IMPACTS

Table 13 provides a listing of specific social impacts. The table organizes impacts by phase, and then describes them as actions leading to effects felt by particular groups with implications for social life. The key social impacts are in most cases due to the implications of and reactions to activities at Hoʻopili, not the immediate effect. Over time, the development of Hoʻopili will help to bring about a complex process of community development and integration on the ʻEwa Plain. That process will be discussed after attention is paid to more specific impacts.

Table 13: Major Socio-Economic Impacts of Ho'opili Project *(continued)*

Phase	Action	Effect	Affected	Implications
Operations – approximately 2012 to 2062 (continued)				
			Region as a whole	Secondary urban center, both FWR and NSR corridors meet local needs
		Contributions to 'Ewa Traffic Impact Fund	SDOT, DTS, area residents	Help to improve roadways for 'Ewa
		Urbanization along Farrington Highway	Regional residents, businesses	Connectivity, UHWO to FWR, alternatives to Farrington Hwy; alternative access from FWR to the H-1 Freeway
	Roadways planned to allow connectivity	Increase routes available across 'Ewa	Regional residents	More choices for in-region trips; lessen impact of regional urbanization on traffic congestion
	Planning for transit, bus, bike use	Encourage alternatives to automobiles, ridership for public transit	Residents, workers in project, O'ahu	Lower impact of population growth on traffic congestion Set an example of a planned community that encourages alternative transportation
	Schools in project	Serve residents and nearby communities	Resident of project and nearby areas	New high school may link Ho'opili, Kunia, West Loch areas. Private school would expand educational choices, opportunity for regional residents.
	Proposed District Park site off FWR	Offer new park amenity	Residents along FWR	Serve as a shared resource for FWR communities.

Notes: Abbreviations:
FWR: Fort Weaver Road
NSR: North-South Road

Table 13: Major Socio-Economic Impacts of Ho'opili Project

Phase	Action	Effect	Affected	Implications
Planning – approximately 2006 to 2009				
	Notification, meetings, and permit process	Collaborative planning	Agricultural tenants on-site	Given ample warning of eventual phased withdrawal, can plan for relocation of affected operations
			Other developers	Collaborate on plans, infrastructure
			Community	Raise concerns about impacts, explore way to mitigate impacts and create community amenities
Construction – approximately 2010 to 2030				
	Phased clearing of lands	Withdrawal of leased agricultural lands	Agricultural tenants	Consolidate operations and/or move
		Dust, noise	Adjacent properties	Irritants, controlled by State and County regulations
	Phased on-site construction	Truck and worker traffic	Adjacent properties; FWR communities	Dust, nose, truck traffic
	Road construction	Reduced road area	Other road users	Congestion; can be limited to off-peak hours
	Construction	Employment	Construction workers throughout O'ahu	Income, jobs in Leeward area.
Operations – approximately 2012 onwards				
	Housing development	Increase supply of new products	Island housing market	Housing provided in response to local demand; Increases to inventory tend to control price increases
	Mixed-use, mixed density planning	Distinctive community identity	Residents	Encourage loyalty to community; moving up over time; Facilitate bike, bus commutes; reduce car trips
	Planning for transit, bus, bicycles, pedestrian use	Less reliance on automobiles	Residents	Lead to improved health
	Urbanization of site	Further withdrawals	Agricultural tenants	Relocate, consolidate operations. Less dust and soil erosion.
		Loss of open space	Wai'anae, Kapolei	Change in view during part of commute on the H-1 Freeway; change on *makai* side of road - *mauka* still open.
		More population, traffic in 'Ewa	Area residents	Congestion on FWR, Farrington Highway, North-South Road
		New commercial, industrial space	Area residents	Jobs, shopping nearby, reduced need for commuting towards the Primary Urban Center.
		Medical park space	Area residents	Increased access to health providers
			Local industry	Complaints about noise, dirt, spills from residents

4.3.1 Planning Phase

During planning and permitting, the developer has consulted with lessees currently on-site, with other developers, with members of the surrounding community, and with government agencies. For the agricultural tenants, the discussions deal with operations, long-term coordination, and planning. These meetings will eventually give notice of when fields will no longer be available for cultivation, and allow lessees to schedule future planting and harvests. Discussions with other developers and public agencies help in coordinating plans, notably in encouraging connectivity between future DHHL, UHWO, and D.R. Horton projects. These discussions have helped developers and local community leaders give input together on regional roadways and planning for O'ahu's future mass transit system.

The Ho'opili Community Task Force has offered ideas concerning development choices and ways in which the Ho'opili project can be integrated with the surrounding area. It provides a channel for the developer to share facts and viewpoints with the community. Topics have included regional transportation, public and private schooling for the region, employment, and public spaces in Ho'opili for gatherings and recreation. Participants have identified community concerns and criticism of development, and discussed ways in which Ho'opili can be designed to correct or mitigate problems and contribute to the larger regional community.

4.3.2 Construction Phase

Construction will bring physical irritants such as noise, dust, slow traffic on roadways around the project, which can be controlled through adherence to regulations established by the State Department of Health and the City and County of Honolulu, and directing construction traffic to off-peak hours. Impacts are most likely to affect Ho'opili residents, residents of the new UHWO and DHHL East Kapolei area, and perhaps golfers on the 'Ewa Villages course located directly *makai* of Ho'opili. For the agricultural tenants, construction will continue the phased withdrawal of lands from agricultural use.

For construction firms and workers, development at Ho'opili will bring income. With steady work at Ho'opili over many years, construction workers will be increasingly likely to live in Leeward O'ahu.

4.3.3 Operations Phase

The Ho'opili project will include approximately 11,750 homes. That number amounts to approximately 4.5 years' supply of new housing for O'ahu.[2] The project is located in an area in which new housing is expected to serve the needs of O'ahu's middle-income residents, rather than the mix of upper income residents and part-time residents found in established upscale neighborhoods.

New housing production increased through 2003; housing price increases continued through 2005. Figure 9 shows that the number and share of new units produced for middle-income families – 80% to 120% of the County median income – declined after 2003. Production for lower-income households disappeared.

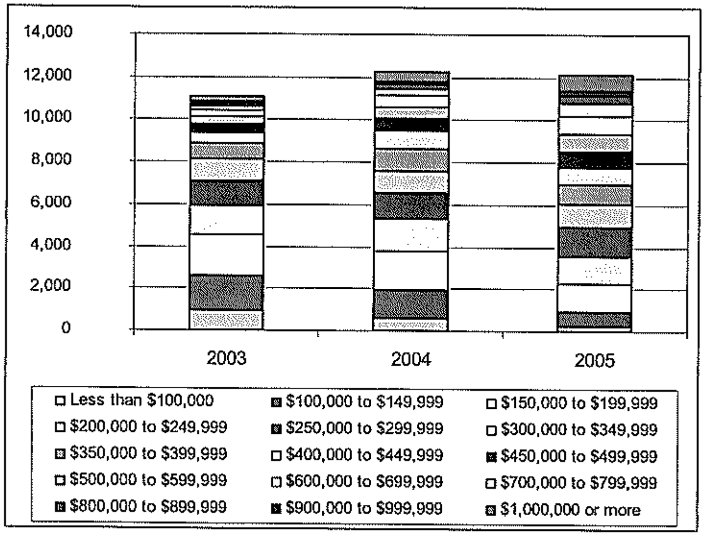
When sales data from the Multiple Listings Service – i.e., resales of existing homes – are compared, it is clear that the distribution of units sold by price range has changed in two ways. Fewer units are sold at the lower price ranges, and the number of units sold in each price range tends to be about the same. Buyers who can pay higher prices are finding homes; families with limited resources have less choice or no opportunity to enter the 'for sale' housing market.

O'ahu needs housing for middle-income families. By developing new housing for the middle-income group, Ho'opili is responding to that need. Moreover, new housing construction will help to limit price increases for both new and resale housing.

The proposed housing will be in neighborhoods that integrate low- and medium-density or medium- and high-density residential areas. As a result, Ho'opili will include a range of income levels, and will likely include mixed-income neighborhoods. In this respect, it will resemble Hawai'i Kai and Mililani: planned communities that have become home to thousands of O'ahu residents who choose to move up within their community as they grow older, rather than move to other communities. However, Ho'opili will differ in several ways from existing subdivisions. It is being planned as part of a regional community. It is designed to encourage walking, bicycling, and use of public transport. Live/work units will be integrated into the development.

[2] The average number of new units built on O'ahu was 2,588 for the years 2000 through 2005 (DBEDT 2006). There is clearly demand for a larger number of units; the most recent Housing Policy Study estimates new demand for about 3,050 new units annually as of 2007, growing to about 4,280 units by 2024 (SMS 2003).

Figure 14: O'ahu Sales on Multiple Listings Service, by Price Range, 2003-2005



The presence of industrial and commercial areas will work to make Ho'opili a community, and not just a bedroom subdivision, for many residents. Some will be able to live and work within the community. Moreover, bus routes and bike paths connecting to every school in the project will encourage residents to live and work within the project with less dependence on their automobiles than in other developments. The project's design for alternative means of transportation will increase the number of young people who can reach their schools by bicycle – again, lowering automobile traffic.

Planning for Ho'opili will encourage community identity and encourage trips within, rather than outside, the development. The commercial core of the development will be a focus for socializing, shopping, and for special events.

Urbanization of the site will have mixed consequences. The first is continuing withdrawal of land from agriculture.[3] Agricultural tenants note that they will have to withdraw land to buffer new development from cultivation, as well as the land actually developed in early phases. Consequently, more land will be

[3] For discussion of the impacts of Ho'opili on agriculture, see Decision Analysts Hawaii, Inc. (2007).

withdrawn from agriculture during the early years of project development than will be urbanized. As noted earlier, the withdrawal will force agricultural tenants to move, and may increase operating costs. However, the land was slated for urban development even before truck crops and seed corn were planted on-site. Tenants had reason to know that cultivation was an interim use of the site.

From the H-1 Freeway, the major route used by residents of the Wai'anae Coast and the Kapolei area, the *mauka* view will remain open. *Makai,* drivers now see a berm, with occasional views of fields, succeeded by residential areas and the ocean in the distance. Development at Ho'opili (and the proposed elevated rail transit) will hence affect only part of the view plane from the highway. Project plans call for a landscape buffer along the H-1 Freeway right-of-way.

The visual impact of the project will be greater along Farrington Highway. Currently, there is little development along that roadway between Kapolei Golf Course and Fort Weaver Road. This will change with the development of the UHWO campus. Development of Ho'opili, along with the City-planned widening of Farrington Highway (and the proposed elevated rail transit), will extend the transformation of open space to urban areas. Also, Ho'opili will include destinations – notably commercial areas at the intersections of the highway with the North-South Road and Fort Weaver Road – encouraging travel along this roadway.

Urbanization will add to traffic on Fort Weaver Road and Farrington Highway through the project area.[4] On the other hand, development of the North-South Road and the H-1 Freeway access associated with the new roadway will help to limit congestion throughout the regional road system. New roads within the project will provide additional connectivity between Fort Weaver Road and the North-South Road and between the DHHL lands to the south of Ho'opili and Ho'opili itself.

Before Ho'opili is built, the new H-1 Freeway interchange will serve the North-South Road and Farrington Highway. This will be important for trucks to and from the Grace Pacific quarry and plant: they will travel to the new interchange, rather than along Farrington Highway past a major portion of the Ho'opili site. Accordingly, urbanization along Farrington Highway east of the new interchange will have little or no impact on this truck traffic.

Agricultural tenants and industrial managers expect that growth of residential areas will bring complaints about dust, litter, noise, and other irritants. As the

[4] For a detailed quantitative analysis of the project's impact on transportation and traffic congestion, see the Traffic Impact Analysis Report (Wilbur Smith Associates 2007). Traffic congestion is a social issue insofar as it affects the quality of life. As such, it is discussed in this report.

area urbanizes, they will need to be increasingly sure that they do not intrude on residents' enjoyment of the area.

Eventually, rail transit could be built along North-South Road and Farrington Highway. Plans for Ho'opili have been drawn up with transit in mind, even though the exact route and placement of stations is still undecided. With transit, the project can further minimize dependence on automobiles by its residents.

The Ho'opili site fronts Old Fort Weaver Road. Properties on that road include older homes and a mental health facility. These have already been affected by development in the region, inasmuch as the daily afternoon rush hour commute fills this roadway as well as the major roads. With development of Ho'opili, the existing properties will be more visible to new neighbors. Development of commercial areas – both fronting Old Fort Weaver Road and along Farrington Highway just east of the northern end of Old Fort Weaver Road – will make commercial facilities more accessible to this neighborhood. However, project plans call for open space along much of Old Fort Weaver Road, limiting visual impacts.

A new road (referred to as the "proposed East-West Connector") will link Old Fort Weaver Road to the new North-South Road, through the Ho'opili project. While the project will add to traffic along the existing road, it will also provide an additional route that residents of Old Fort Weaver Road and the Fort Weaver Road corridor can use to travel from their homes to the west towards the city of Kapolei.

Ho'opili has been planned with the reduction of traffic impacts in mind. First, it includes transit-oriented development. Bus lines have been identified to encourage residents throughout the project to use rapid transit or to use buses or bicycles within the project area. Street sizes and connectivity will encourage pedestrian and bicycle movement. To the extent that automobile use declines (or Ho'opili attracts new residents who are less committed to automobile use than others), residents can expect to have more exercise, and be healthier than people in other subdivisions of Leeward O'ahu.

Schools in the project will serve residents of Ho'opili and nearby subdivisions. A high school will certainly attract residents from nearby areas – West Loch, UHWO, and the future DHHL areas, and possibly Royal Kunia. As a result, students from those areas may come to see Ho'opili as a focus for community life. If, as planned, a private school is built within the project, this will increase local families' educational choices, and possibly reduce one of the destinations for commuting outside of the region.

A proposed medical office park will complement the nearby hospital, making it easier for residents of the region to get access to health providers.

The project includes a canyon area below the elevation of most of Ho'opili. This can be developed as a passive park space easily accessible to residents of the Fort Weaver Road communities and available to anyone in the region.

Additional park spaces within Ho'opili will serve residents by providing play space and open areas near the homes. The regional demand for play areas will be met in part at the new Kroc Center on North-South Road and a proposed County District Park site along Fort Weaver Road. Eventually, additional fields may be developed (as initially proposed by the City and County of Honolulu) within Kalaeloa to the south.

4.4 COMMUNITY DEVELOPMENT ON THE 'EWA PLAIN

Development of a "second city" on O'ahu has long been a policy of the State and City and County. The process began with planning for Kapolei and the growth of the James Campbell Industrial Park as the island's major industrial area. It continued with commercial and office development in Kapolei and several residential subdivisions in the Kapolei area and along Fort Weaver Road. With the rapid growth of those subdivisions, policy makers became concerned that 'Ewa would serve many of its residents as a bedroom suburb of Honolulu.

The second city is increasing understood as covering much of the 'Ewa Plain, with discrete land uses serving a regional community and with a system of roadways connecting different community areas and land uses. The new Kroc Center and UHWO campus, for example, will serve the region. They will be reached by routes now being built – the North-South Road and Kapolei Parkway – and new or widened roadways through Ho'opili, as well as bus and rail transit.

Mixed uses are increasingly being planned and built as well. Mehana in the City of Kapolei includes a mix of residential densities. Its first phase emphasizes live-work townhomes. Plans for the Kalaeloa Redevelopment District emphasize density, a new spine road, and mixed use development.

Ho'opili will contribute to the growth of urban community life in 'Ewa by providing new job locations, recreational areas, and schools as well as housing. Its transportation planning will work to address the region's serious traffic congestion problems. It will help to link existing and new communities, serving its neighbors as well as its residents.

Finally, further urbanization on the 'Ewa Plain could well have implications for community and political life on O'ahu. The region's political stance has been characterized in recent years by a sense of isolation. Local representatives have argued that their area receives O'ahu's unwanted land uses such as landfills and electrical plants, but little infrastructure that would improve quality of life for residents of the region. Support for this view can be found in studies that show county spending to be concentrated in older urban areas (Decision Analysts Hawaii, Inc. 1994). The obvious inference is that, with increasing population, areas of the island can expect to receive a larger share of government funding. As the 'Ewa Plain becomes urbanized, it will come to gain its fair share of funding for infrastructure and other services.

4.5 MITIGATION OF ADVERSE IMPACTS

The Ho'opili planning process has been characterized by extensive involvement with lessees and the surrounding community. That process has allowed for early identification of community concerns, leading to steps to mitigate or avoid anticipated impacts. As noted above, consultation with agricultural tenants is intended to lead to orderly consolidation of cultivated fields and to minimize the chance of conflict between agricultural operations and residents.

The developer plans to continue communications with local stakeholders such as the Neighborhood Boards, helping to alert the wider community to future opportunities for public input. After the current planning phase, it will be helpful to share information about upcoming construction activity and to invite regional participation in onsite events.

During construction, state and county regulations will limit noise and dust from construction activities. The project's builders will conform to those regulations and work with government agencies to co-ordinate work on or next to major roads, limiting the time in which drivers will be slowed down by construction zones.

Traffic impacts will be mitigated through several measures. First, the project's mixed use design is aimed to minimize traffic on the local roadways. The project is planned to be bicycle- and pedestrian-friendly, and transit-oriented. Next, Ho'opili will contribute to the 'Ewa Transportation Impact Fee program, supporting development of local roadways and easing impacts on the already-crowded arterials. Furthermore, the developer will implement the improvements identified in the Traffic Impact Analysis Report as needed to mitigate the impacts of the project on local roadways. Finally, the developer is investigating ways in which Transportation Demand Management activities can help to lower congestion during peak hours.

CHAPTER FIVE
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APPENDIX J
Market Assessment

MIKIKO CORPORATION

MARKET ASSESSMENT FOR HO`OPILI

ISLAND OF OAHU

Prepared for:
D.R. Horton – Schuler Homes, LLC
dba D.R. Horton - Schuler Division

FINAL REPORT

March 2007

Market Assessment for Ho`opili

Table of Contents

MARKET ASSESSMENT FOR HO'OPILI

Report Text

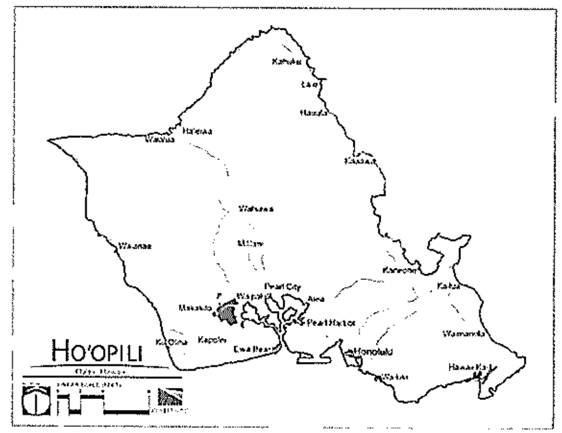
1 – Introduction and Executive Summary

Project Background (Exhibits 1-1 and 1-2)

D.R. Horton – Schuler Homes, LLC dba D.R. Horton – Schuler Division (DRH) owns approximately 1,555 acres in the Ewa District of Oahu. DRH proposes to develop these lands as an integrated, live-work community to be known as Ho`opili.

Ho`opili (the Project) occupies a prime development site due to its location within the Ewa Development Plan Area (DPA), which has long planned by the City and County of Honolulu (County) and the State of Hawaii (State) to accommodate the majority of future population growth for the island of Oahu. Within this district, Ho`opili is one of the most strategic urban expansion areas on the island:

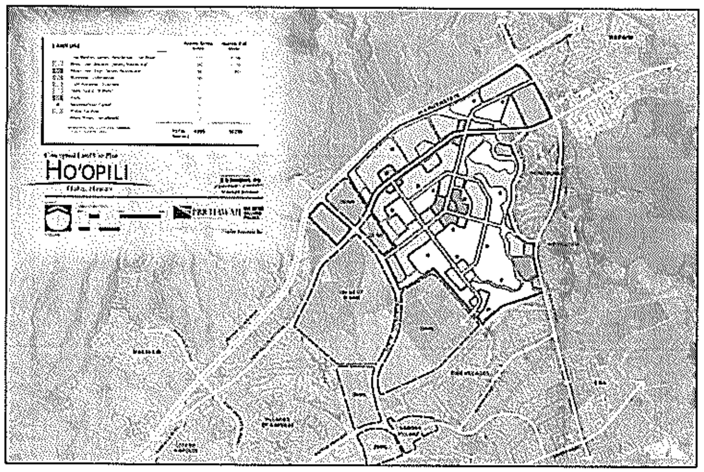
- It stands at the "gateway" between the Ewa and the Central Oahu districts, fronting both H-1 and Fort Weaver Road.
- It is at approximately the center of population for the island.
- It is next to the planned University of Hawaii at West O'ahu (UHWO) campus and community, several residential and commercial areas planned by the State Department of Hawaiian Home Lands (DHHL), and the existing communities of Ewa Villages and West Loch.
- It encompasses current alignments for the County's proposed mass transit system.



Source: PBR Hawaii & Associates, Inc.

As envisioned, Ho`opili would encompass:

- **11,750 residential units**. Many of these would be developed in mixed-use structures combining retail and/or office uses. Up to 30% are expected to be developed as "affordable" units, in accordance with County guidelines.
- **2.96 million square feet of commercial retail or office spaces**, some within six Business/Commercial designated areas,[1] and some dispersed in residential mixed-use areas.
- **50 gross acres of business park or light industrial** uses, located between H-1 and Farrington Highway.
- Regional and neighborhood **parks, open spaces and a trail system.**
- Up to six sites for **schools or other public uses.**



Sources: PBR Hawaii, DRH, Van Meter Williams Pollack, Charlier Associates, Inc., 2006. See Exhibit 1-1 for copy at larger scale.

[1] One Business-Commercial site is located across the developing North-South Road from the rest of the community, separated by lands held by DLNR.

DRH estimates that the first real estate products at Ho`opili could be marketed as early as 2012. Further information on the resident, commercial and business park uses, which are the subject of this market study, are presented in Exhibit 1-2.

Study Background

DRH has initiated a planning and entitlement process for Ho`opili, including an Environmental Impact Statement (EIS) that will be used in the State Land Use and County zoning processes. PBR Hawaii & Associates, Inc. (PBR Hawaii) is assisting DRH in this process and asked Mikiko Corporation (MC) to prepare market, economic and fiscal impact assessments for the Project, addressing the residential, commercial retail/office and industrial land uses noted above.

This report covers the market assessment. The economic and fiscal impacts of the Project are described in a separate report.

Mikiko Corporation Study Objective

MC's objective in this study was to describe the market support for development of the residential and commercial uses proposed at Ho`opili, in terms of:

a) Evidence of the demand for and competitive supply for the residential, commercial and light industrial/business park development elements, and

b) Assessment of likely market segments, supportable market shares and market absorption at Ho`opili; also, for residential units, assessment of supportable unit pricing.

These evaluations are based in part on information and planning parameters provided by PBR Hawaii and/or DRH.

The remaining sections of this chapter summarize the market conclusions. The rationale behind these conclusions, as well as documentation of the study methodology and supportive data, may be found in the subsequent chapters.

General Community Outlook

Structural Changes

The projections developed herein largely judge that during Ho`opili's marketing timeframe (about 2012 to 2030), the Ewa DPA in general and Kapolei and East Kapolei in particular will approach their desired roles in a "Second City" for the State of Hawaii. An analogous though more advanced example of the roles played by the various areas of this urbanizing area may be drawn from Hawaii's "First City":

- **The City of Kapolei** would be the Ewa DPA's Central Business District (CBD),
- **East Kapolei** would be a nearby, and one day possibly adjacent, supplementary business district with lower densities and more residential uses, analogous to the Kapiolani or Kaka`ako districts, and
- **Ewa DPA** would be the entire area that is directly driven by the economic and civic leadership of the CBD and its supplementary business areas, analogous to the broader "City of Honolulu."

Approaching this desired outcome will require structural changes in the economy and culture of the area and will have far-reaching effects on the markets for housing, retail, office, business park and other land uses. This general outlook for Ewa assumes that some significant regional milestones are met during Ho`opili's marketing. These include establishment of:

- New centers of "primary jobs," those with sufficient income to sustain a household;
- Public policy support for new economies relevant to the area;
- More, high-quality elementary, middle and/or high schools;
- More options for entertainment, cultural, civic and spiritual endeavors;
- More high quality housing targeting a wide range of income and age groups;
- Neighborhoods of move-up housing; and
- More efficient transportation linkages within the area and to the rest of Oahu.

All of these precursors to change are in progress, and all are also reinforced by Ho`opili itself. Those already underway include:

- Plans for the new UHWO campus, with expanded programs and a surrounding town;
- The new State judiciary complex in Kapolei, with 650 direct and indirect jobs;
- Plans for other office buildings in Kapolei;
- Significant inventory of new business park areas under development in Kapolei;

- Growth of the private Island Pacific Academy college preparatory PK-12 school;
- Second home and golf-front developments recently entitled at Kapolei West;
- Development planning for the first regional shopping centers in Ewa;
- The promotion of knowledge- and innovation-based economies Statewide;
- Discussion of high technology or defense-related developments at Kalaeloa;
- Planned transit service linking Kapolei to Honolulu, and going through Ho`opili;
- Development of the North-South Road and Kapolei Parkway; and
- Improvements to Fort Barrette and Fort Weaver Roads.

New Urbanism

Considering the magnitude of demand for new housing and commercial facilities, yet with respect for Hawaii's precious island land, it is fortunate that Hawaii residents, like other people worldwide, are showing interest in more dense "urban village" living styles. Given the environmental burdens of population growth, this "New Urbanism" or "Smart Growth" movement not only reflects taste changes but a more sound approach to the use of natural resources. Chapter 3 offers a more complete discussion of these trends.

Ho`opili is in the path of urbanization, along a proposed transit route, and adjacent to existing and new centers of employment such as UHWO. These characteristics enhance "New Urbanist" planning, and support the mixed-use, higher-density developments proposed at Ho`opili.

Summary of Market Conclusions

The table below summarizes the projected market support for the land uses evaluated. These conclusions are explained in the sections and chapters that follow.

Projected Market Absorption at Ho`opili

	2012-2015	2016-2030	Total
Residential units	2,600	9,150	11,750
Commercial (square feet)	600,000	2,360,000	2,960,000
Business Park (net acres)	40	0	40

Source: Mikiko Corporation, 2007.

Residential Market Assessment

Market Environment

Oahu has an acute shortage of housing suitable for primary residents, with an estimated pent-up demand for some 17,000 units as of the end of 2006. Additionally, based on growth projections in a study prepared for the State and county housing agencies, Oahu will need to house some 81,000 more households by 2030.[2]

About 55,100 potential future housing units are currently entitled at the State Land Use Commission (LUC) level.[3] Even assuming substantially accelerated housing development in the short-term, without further Urbanization of lands for residential use, Oahu's housing shortfall could gradually be pared down to some 10,000 units by about 2015, but it could then spiral to about 46,000 units by 2030.[4]

This conclusion is summarized as follows:

Supply and Demand for New Resident Housing Units on Oahu 2007 to 2030

Future Demand	Pent-up demand, end 2006	17,000
	Future need, 2007-2030	81,000
	Total need	98,000
Future Supply	Planned and entitled (55,000 less 5% vacancy)	52,000
Shortage	**As of 2030**	**46,000**

Source: Mikiko Corporation, 2007. Future supply estimate assumes full buildout of all lands currently designated Urban by the LUC, and proposed for residential development. See Exhibit 3-8 for further information.

[2] SMS, Inc., "Housing Policy Study, 2006: Hawaii Housing Model 2006," February 2007.

[3] In this report, "State-entitled" or "LUC-entitled" means lands carrying LUC "Urban" designation or those that are proposed for development but may be exempt from State regulatory control. Some of these would still require County zoning or other entitlement in order to proceed.

[4] Besides Ho'opili, other major developments for which State entitlement are sought include Koa Ridge and Waiawa by Castle & Cooke (up to 5,000 units) and Gentry Waiawa Phase 2 (up to 7,000 units.) Even if all three of these projects were entitled and developed to their full potential by 2030, Oahu could still be 22,250 housing units "short" (46,000 – 11,750 – 5,000 – 7,000).

Ho`opili Residential Market Assessment

Ho`opili's housing units are an important component of the Ewa regional plan as well as a solution for up to 25% of the island's currently unentitled housing needs through 2030.

- **Product mix** – The majority of Ho`opili's 11,750 residential units would be for-sale multifamily homes. The Project would also include single-family units for-sale and multifamily rental units. The exact mix of units by type will be determined during build-out, as market conditions and preferences materialize.

- **Development densities** – Ho`opili's single-family units would be developed at about 5 to 8 units per net acre while its multifamily units could range from low-rise townhouse units at 10 to 14 units per net acre, to mid-rise development at 30 to 50 units per net acre.

- **Target markets** – Up to 30% or 3,525 units is expected to be developed as affordable housing, in accordance with the County's affordable housing guidelines.

  Among the market for-sale units, the majority is expected to be purchased for use by owner-occupants. Some may be purchased as investments and rented out, again resulting in units for primary resident use.

- **Pricing (2006 dollars):**

  - **Market units:** Multifamily units are expected to find market support in the $350,000 to $650,000 range, while single-family units might be priced from about $500,000 to $750,000.

  - **Affordable units:** Pricing will be based on then-prevailing County rules and market conditions. For illustrative purposes, the County's 2006 price guidelines included:

    - For-sale units: $232,000 to $392,000 for families of four earning 80% to 120% of the County median income.

    - Rental units: $998 to $2,481 per month, for studio to 4-bedroom units and households earning 80% to 100% of the median County income.

- **Market share** – By the time of Ho`opili's marketing, there could be few other large residential developments with inventory. Hypothetically, if there were no further LUC entitlement of Oahu residential lands other than Ho`opili, the Project's fair market share in the 2016 to 2030 timetable would represent about 39% of developable inventory. However, three large residential projects in Central Oahu are preparing to petition the LUC at this time. Even if these projects were also entitled and marketed in a competitive time frame, Ho`opili's fair market share could still represent about 28% of Oahu's future market, as shown below.

Hypothetical Ho`opili Fair Market Share Under Two Entitlement Scenarios, 2016 to 2030

	Scenario 1: Add Ho`opili	Scenario 2: Add Ho`opili, Gentry-Waiawa, Waiawa-C&C & Koa Ridge	Notes
Entitled additional units, 2015 – 2030*	18,700	18,700	See Exhibit 3-7.
Ho`opili*	11,750	11,750	Maximum proposed.
Castle & Cooke-Waiawa and Koa Ridge plus Gentry Waiawa Ph 2*	0	12,000	Expected maximum residential entitlements to be sought.
Total potential inventory	**30,450**	**42,450**	Net of currently entitled but unplanned future developments.
Hypothetical Ho`opili Fair Market Share	**39%**	**28%**	**Percent of future Oahu market**

* Remaining developable inventory could vary, depending on amount of sales realized by 2015.
Source: Mikiko Corporation, 2007.

The above benchmarks are considered hypothetical since other development plans will inevitably emerge over the next decades. However, they are worthwhile benchmarks since Oahu is running out of large, developable tracts of land for new development.

In recent years, Oahu has absorbed around 2,000 developer units per year, with supply constraints. To begin to address pent-up and future demand, the island would have to produce around 3,900 units per year[5]. This assessment concludes that Ho`opili could achieve a 15% to 20% market share of the future island market, assuming there is sufficient other Oahu supply to approach the 3,900 units per year goal.

[5] 81,000 future + 17,000 pent-up demand satisfied over 25 years would require an average production of 3,920 units per year (98,000/25).

If future development represents only 2,000 units per year, closer to Oahu's historical levels and likely resulting in an increasing housing crisis, the Project's achieved market share could be expected to represent 30% to 35% of Oahu sales.

Projected Annual Residential Unit Sales Absorption at Ho`opili

	Scenario 1: At recent historical levels of Oahu production	Scenario 2: At demand-satisfying levels of Oahu production	Conclusion for Ho`opili
Assumed total Oahu developer sales	2,000	3,900	
Ho`opili market share	30% - 35%	15% - 20%	
Ho`opili average annual sales	**600 - 700**	**585 - 780**	**650**

Source: Mikiko Corporation, 2007.

Absorption – The above capture rates support the study conclusion that Ho`opili could sell about 650 units per year on a long-term average basis. Year-to-year sales would vary depending on production, unit mix, market and other factors.

The average sales could represent about 450 market units and 200 affordable units in any given year. The for-sale affordable housing is assumed to be absorbed more gradually because it would generally need to be developed as infrastructure and community facilities are supported by market unit sales.

This sales pace would lead to complete absorption of Ho`opili's residential inventory within 19 years, or by 2030.

This analysis assumes all units are built as for-sale housing. However, some may be developed as rentals, which would be expected to accelerate absorption.

Illustrative Mix of Potential Residential Sales Absorption at Ho`opili

	Market units	Affordable for-sale units	Total for-sale housing
Potential total inventory	8,250	3,500	11,750
Average annual sales	**450**	**200**	**650**
Years on market	19	18	19
Start date	2012	2012	2012
End date	**By 2030**	**By 2029**	**By 2030**

Source: Mikiko Corporation, 2007.

Commercial Market Assessment

The commercial market assessment encompasses retail- and office-based developments, in recognition of the mixed-uses planned at Ho`opili as well as the typical crossover of office spaces within shopping centers and retail uses in office complexes. Specific types of commercial uses within each area of the Project will be determined in accordance with future market conditions and area-specific needs as each area is planned.

Retail Market Environment

Oahu's retail environment is considered undersupplied, with a year-end 2006 vacancy of 2.18%, the lowest in 15 years, according to Colliers Monroe Friedlander, Inc. (CMF.) Considering a Project Trade Area consisting of the Ewa, Central Oahu and Waianae DPAs, there were about 3.9 million retail square feet of gross leasable area (GLA) with an average vacancy of 2.5% in December 2006.

Another 3.9 million square feet of retail-based areas are planned and entitled within the Trade Area, mostly in Kapolei and East Kapolei. While these increases would be dramatic, given the large population increases anticipated in the region, its transition away from a bedroom community, and its under-retailed status today, the Trade Area could still be undersupplied throughout the projection period.

Office Market Environment

The Ewa DPA includes some 436,000 square feet of rentable building area (RBA) office space, mostly in Kapolei.[6] Central Oahu offers 194,000 square feet. The fact that Ewa's inventory is already twice Central Oahu's despite a population of about half of Central Oahu's demonstrates the widespread confidence in the area's potential as a future urban center.

Year-end 2006 office vacancies in "Leeward Oahu," which includes Ewa, Central Oahu and Waianae, were estimated at 6.4%, compared to 7.0% for the island as a whole, according to CMF. The Oahu rate was the lowest it has been since 1991, due to strong recent absorption.

Based on current plans, Ewa and Central Oahu's office-based areas could increase to 1.6 million square feet by 2015, and to 2.4 million by 2030. However, about a third of this potential future inventory is in Kalaeloa, where development plans are in considerable flux.

Ho`opili Commercial Market Assessment

- **Product overview** - Ho`opili is proposed for up to 2.96 million square feet of commercial uses on six Business/Commercial-designated and other mixed-use sites. Commercial areas would be developed for retail or office purposes, or in flexible capacities such as "live-work" units where portions of a unit could be used for residential or office purposes.

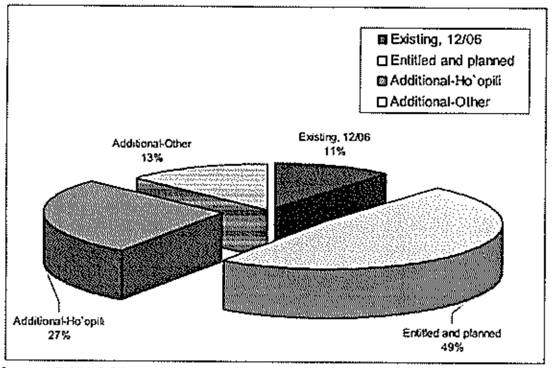
- **Sources of demand** – Ho`opili's primary retail Trade Area is considered to include the Ewa, Central Oahu and Waianae DPAs, while its office areas could draw from a larger community, including businesses that attract employees from throughout Oahu.

- **Market share** - If developed to the full proposed capacity, Ho`opili's commercial spaces could represent about 27% of the Ewa DPA's total 2030 inventory. It could also represent a venue for about two-thirds of the currently unplanned but future supportable commercial space in the DPA.

[6] The office market survey excludes government office buildings and office spaces that are ancillary to shopping centers. The Kapolei inventory noted above excludes the 215,000 square foot State Office Building, 96,000 square foot Kapolei Hale and 50,689 square foot Police headquarters.

These market shares are considered achievable in light of the prime locations enjoyed by the site and the diverse commercial development types that are proposed for Ho`opili. Given that potential commercial developments on other entitled lands throughout Kapolei, East Kapolei, Ocean Pointe and Ewa Beach have already been accounted for, Ho`opili appears to be one of the only remaining areas within the DPA on which substantial commercial development could occur.

Ho`opili Commercial Development in Relation to Ewa DPA Marketplace, at Maximum Build-Out



Source: Exhibit 7-2 for sources and further information.

- **Absorption** - While some early commercial development will likely be a priority to anchor and serve the first increments of development at Ho`opili by 2015, the majority of the Project's commercial areas could be expected to be developed between 2016 and 2030.

Business Park/Industrial Market Assessment

Market Environment

Ewa offered some 1,560 acres of business park or industrial areas in 2006, all in Kapolei. Central Oahu included only about 320 acres. In terms of industrial building space, Ewa is considered undersupplied, with a 2.6% vacancy as of December 2006, according to CMF.

Kapolei's share of Oahu industrial building space inventory has ranged from 12% to 14%, but the area accounts for the vast majority of new space absorption on Oahu, some 70% to 90% since 2003. This reflects the strong market potential of the Kapolei region and the island's growing dependence on this area to serve its industrial and business park-related needs.

There are some 280 net acres entitled and planned for business park/industrial use in Ewa. However, the analysis concludes that about 280 more acres could be needed in the DPA by 2015, or 850 by 2030, over and above the planned inventory.[7] Not included in the planned count is the Kapolei Harborside Center, which is proposed for 345 acres (240 net saleable) and currently involved in hearings before the LUC. If Harborside is entitled, the region would still be expected to demand another 40 acres by 2015 (280 - 240) or 610 by 2030 (850 – 240).

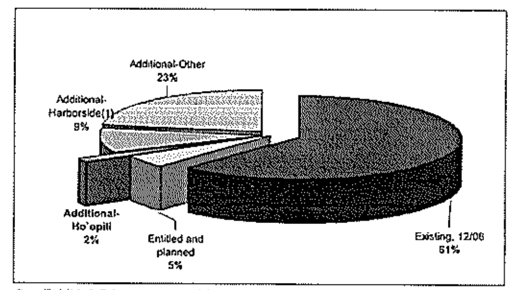
Ho`opili Business Park Market Assessment

- **Product overview** - Ho`opili would offer one prime business park site of 50 acres (40 net acres). Due to its location within a mixed-use residential community, the park is expected to cater to "clean" industries such as office headquarters campuses, research & development facilities, or service-retail uses.

- **Sources of demand** – As for other industrial/business park users in Kapolei, the trade area for businesses at this site would be expected to be super-regional, island-wide, Statewide or even out-of State. The analysis was prepared on the basis of Oahu-wide demand generators, with consideration for inter-regional movements of tenants.

- **Market share** – The 40-net acre site would represent only 2% of the future supportable areas in the region. Even if the Kapolei Harborside project receives LUC and other approvals to permit its development, there could remain substantial unmet demand for business park or industrial lands in the area, particularly in the 2015 to 2030 period.

Potential Ewa DPA Business Park/Industrial Inventory, 2030 (Ho`opili site as currently planned)



See Exhibit 8-7 for sources and further information.

[7] About 144 acres of the 280-net acre planned inventory are located in Kalaeloa, where the ultimate use and development timing is very uncertain as of this writing.

- **Absorption** – Based on the Ewa net demand and the other developments proposed at Ho`opili, this site could be expected to find market support by 2015. However, its sale or lease could also be delayed in order to find the optimal user(s) for this key, high visibility position within Ho`opili.

- **Further development potential** - Given the strong regional market outlook, the outstanding location, access and visibility of Ho`opili, and the planned integration of a business park site into a mixed-use community with a range of housing opportunities, it is concluded that there could be market support for two or more times the current land allocation of 40 net acres at the Project. The additional areas would be expected to find market support between 2015 and 2030.

  Even at an expanded 80 net acres, business park development at Ho`opili would represent only 4% of future regional inventory in 2030, or 10% of net unplanned-for demand in the DPA.

- **Potential development concepts** – A business park at Ho`opili could be an iconographic source of high quality employment for the community. Example development types that might be considered include:

  - **Science and technology park** – This could be a complex catering to innovation- and knowledge-based enterprises. Its market could relate to the site's proximity to the proposed UHWO as well as its location on a future transit route and the modern infrastructure and planning of Ho`opili.

  - **Lifestyle/wellness campus** – Baby Boomers and younger generations have demonstrated significant expenditures at enterprises that cater to enhancing quality of life and appearance, and in prolonging one's healthy and productive years.

  - **General business park** – The site could also be developed as a more generic business park, offering land sales or space sales/leases to a variety of enterprises, including those related to the above concepts.

Report Conditions

This assessment is based on information provided by government agencies, developers, brokers, landowners, and other third party sources. While every attempt has been made to verify information via multiple sources, it is not always possible to do so. MC has noted any data that appears inconsistent, but cannot guarantee the accuracy of all information upon which its assessments are based.

MC has no responsibility to update this report or any of the underlying data for events and circumstances occurring after February 1, 2007, the date of substantial completion of primary data collection.

This report is for the planning purposes of DRH, PBR Hawaii and their consultants, as well as for public disclosure of the nature of the Project pursuant to seeking State and County land entitlements. It is not to be used for solicitation of investment or other third party purposes without prior written consent of the author.

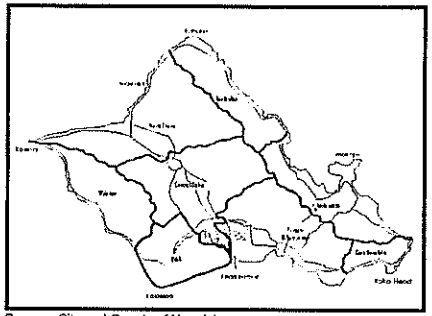
This report does not offer an appraisal of the Subject, nor should it be construed as an opinion of value for the Project.

2. Economic and Demographic Trends

Geographic Areas of Analysis

City and County DPAs

Oahu Development Plan Areas



Source: City and County of Honolulu.

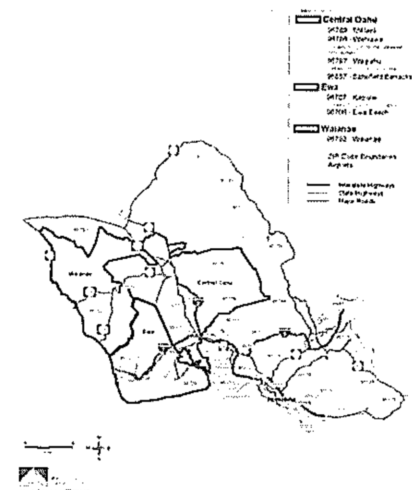
Much of the economic and demographic data presented herein is organized by the City's DPAs. Ho`opili falls within the Ewa DPA, which extends from Iroquois Point on the western side of Pearl Harbor, up Fort Weaver Road and circles back to the Waianae coastline between Waimanalo Gulch and Nanakuli.

Special attention is also given herein to the adjacent Central Oahu and Waianae DPAs because they represent supplementary markets for Ho`opili's commercial and community amenities.

- **The Ewa DPA** encompasses the Subject as well as Makakilo, Kapolei (including the Villages of Kapolei, Kapolei City and East Kapolei), Ko Olina Resort, Ewa Villages, Ewa by Gentry, Ewa Beach, Iroquois Point, and several proposed or developing communities including Mehana, Maka'iwa Hills, and UH West Oahu.
- **The Central Oahu DPA** includes the communities of Waipahu, Village Park, Waipio, Wheeler Air Force Base, Schofield Barracks, Wahiawa, Kunia, Mililani and Mililani Mauka, Waikele, Waipio Acres and Waiawa. It stops short of Pearl City and Waimalu.
- **The Waianae DPA** includes the towns of Nanakuli, Ma`ili, Wai`anae and Makaha, as well as the Lualualei Military Reservation. It extends out to Ka`ena Point.

DPAs Approximated by Zip Code (Exhibit 2-1)

DPAs as Approximated by Zip Code



Source: Claritas 2006, see Exhibit 2-1 for copy at larger scale.

The City's DPAs often follow natural features that are not recognized as census divisions, so it is difficult to collect economic and demographic information within the DPAs per se. Thus, this report uses zip code areas as a proxy for the City's DPAs, and data presented as representative of a DPA may be drawn from the corresponding area approximated by zip code. By zip code, these areas differ from the "real" DPAs as follows:

- Ewa includes more land at its northern tip, but this area includes few homes.
- Central Oahu includes an extension to its northwest, between Routes 803 and 99. This area includes the military housing areas of Whitmore Village and Helemano.
- Waianae includes additional lands that wrap around and behind Schofield Barracks and mauka of Mokule`ia, but these appear to include little or no housing.

Overview of Demographic Trends

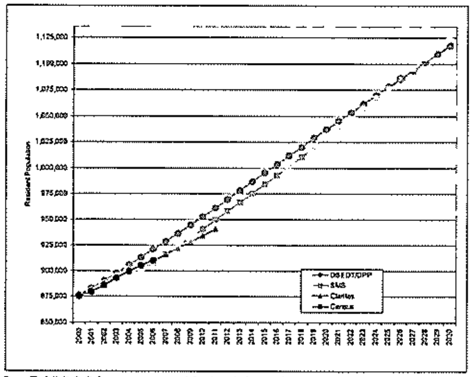
Projected Oahu Population (Exhibit 2-2)

Oahu recorded 876,156 residents at the U.S. Census in 2000. Four sources are considered in estimating how population has grown since then, and how it is likely to grow over the next two decades.

In March 2007, the U.S. Census estimated Oahu's 2006 resident population at 909,863, or 0.5% higher than the 905,266 estimated for 2005.

Claritas[1] provided this study with 2006 population estimates and a 5-year projection to 940,689 by 2011. Claritas' figures were prepared on the basis of the Census' 2005 estimate.

Resident Population – Island of Oahu



See Exhibit 2-2 for sources and further information.

SMS[2] recently prepared a long-term outlook, with 1,125,688 residents projected for 2030 based on the "official parameter" growth rate of 0.9%. While SMS's shorter-term projections (for 2005 through 2011) are higher than those made by the Census and Claritas with the benefit of updated information, in the medium-term, they are lower than those prepared by DBEDT and DPP (see next bullet).

The State of Hawaii, Department of Business, Economic Development and Tourism (DBEDT) also offers a long-term projection; the latest was prepared in August 2004. The City's Department of Planning and Permitting (DPP) has adopted DBEDT's projections. This series is higher than SMS's until 2025, after which the latter surpasses it. DBEDT/DPP's series anticipates 1,117,300 residents on Oahu by 2030.

[1] Claritas is a leading provider of geodemographic market research information to government and industry throughout the U.S. Claritas derives its information from the U.S. Bureau of the Census, State and local governmental planning and forecasting entities, its proprietary Business-Facts ® database and other sources.

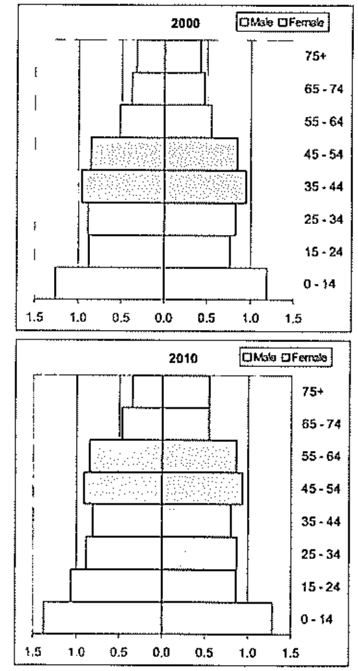
[2] SMS, Inc., "Housing Policy Study, 2006: Hawaii Housing Model 2006," February 2007. The study was prepared for a consortium including the Housing Officers and other Administrators of the City and County of Honolulu (as well as the other three Hawaii counties), and the State of Hawaii, Hawaii Housing Finance and Development Corporation, the Office of Hawaiian Affairs, and the Department of Hawaiian Home Lands.

Aging of the Population (Exhibit 2-3)

The changing age-composition of the population will have an enormous impact on home-buying and other consumer spending patterns in Hawaii as elsewhere in the nation. While long-term projected age-cohort data is not available by county or sub-areas, the U.S. Census does prepare decennial projections by state.

Viewed in an age pyramid, a most notable feature is the aging of the Baby Boomers, whose members were between the ages of 41 and 60 in 2006, will range from about 45 to 64 years old by 2010, 55 to 74 by 2020, and 65 to 84 by 2030.

Age Pyramids – State of Hawaii: 2000 and 2010



See Exhibit 2-3 for sources and further information.

2000 to 2010 - As the dominant consumers in the overall marketplace today and for years to come, Baby Boomers are fueling a move-up home-buying market consistent with their middle-aged, peak earnings-power status.

Age groups showing the most population gains in the 2000 to 2010 period in Hawaii are all over 45:

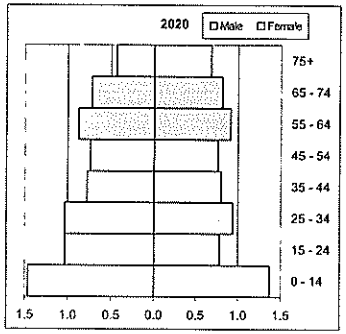
- 45 to 54: +14,000 persons
- 55 to 64: +64,000 persons
- 65 to 74: +16,000 persons
- 75+: +15,000 persons

2010 to 2020 – In the subsequent decade, Baby Boomers will continue to exert strong influence in the housing market. This is expected to be reflected in rapidly growing demand for downsized, retirement and/or other specialized housing types reflecting their empty nester and retiree stages of life. Also notable in this decade will be strong growth in the entry and early-housing market, represented by persons aged 25 to 34.

Thus, age groups projected to show the most gains in this later period include both early and older homebuyers:

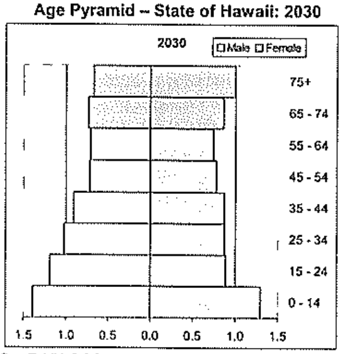
- ❑ 25 to 34: +22,000 persons
- ❑ 55 to 64: +8,000 persons
- ❑ 65 to 74: +52,000 persons
- ❑ 75+: +21,000 persons

Age Pyramid – State of Hawaii: 2020



See Exhibit 2-3 for sources and further information.

Age Pyramid – State of Hawaii: 2030



See Exhibit 2-3 for sources and further information.

2020 to 2030 – The last decade evaluated will be characterized by rapid growth of the elderly population, necessitating specialized and age-catering housing solutions.

The second most rapidly growing potential housing market during this period will consist of those aged 15 to 24, an age that usually encompasses household formation, often in rental housing.

The third rapidly growing group would be those aged 35 to 44, typically a home-buying or early trade-up housing market.

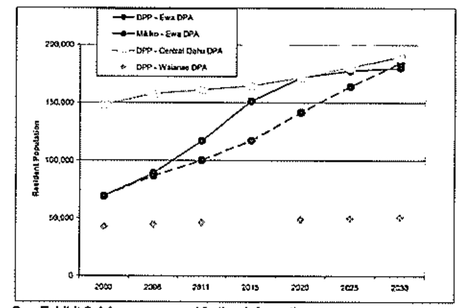
Cohorts expected to gain population statewide in this decade include:

- ❑ 15 to 24: + 27,000 persons
- ❑ 35 to 44: + 19,000 persons
- ❑ 65 to 74: + 6,000 persons
- ❑ 75+: +56,000 persons

Demographic Trends by Development Plan Area

Population by Area
(Exhibit 2-4)

Resident Population - Ewa, Central Oahu & Waianae



See Exhibit 2-4 for sources and further information.

DPP uses the State's projections to forecast population within its DPAs. DPP's most recent such forecast was prepared in 2006 and extends to 2030. These allocations of island population to DPAs are based in part on the City's development policies and plans. DPP anticipates relatively high rates of growth in Ewa over the projection period, as it becomes a "Second City." Ewa is eventually seen to house 17% of the island's population, more than doubling from some 86,000 persons in 2006 to 184,600 by 2030. The Ewa DPA is projected to approach Central Oahu in population by the end of the period.

MC reviewed DPP's Ewa projection in light of the existing inventory of unbuilt but State-entitled housing and found that even with dramatically smaller household sizes for new as compared to existing households and phased development of new projects, Ewa area population could grow more rapidly than projected by DPP initially, but could be constrained after 2025 by a lack of further developable housing inventory. In MC's analysis, population in the Ewa DPA is projected to grow 3.0% per annum over the next 24 years, finishing 2030 at about 180,200 persons. At 2025, this figure is closer than

DBEDT/DPP's to those estimated by Campbell Estate and Decision Analysts[3] for the area. MC's projections may be conservative because:

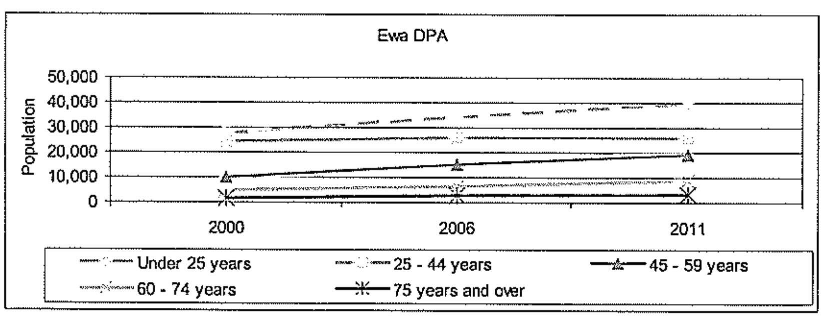
- We assume the new homes to be added will house fewer persons each than do existing homes, and
- We do not consider any impact from proposed developments that are not yet LUC-entitled, such as Ho`opili itself.

The conclusion of the entitled housing-based methodology is close to DPP's overall projection for the County in the long-run.

Population by Age Group (Exhibit 2-5)

The largest age groups in all three DPAs were those under 25, followed by the 25 to 44 and 45 to 59 age groups. Over the next five years, the greatest increases are anticipated within the under 25 and the 45 to 59 age groups, followed by the 60 to 74 age group. This reflects the Baby Boom generation moving into its 50s and 60s. In contrast, in this short-term view, Claritas projects that the 25 to 44 age group may decline in Central Oahu, and be static in Ewa and Waianae.

Population by Age Group – Ewa DPA



See Exhibit 2-5 for sources and further information.

[3] Decision Analysts Hawaii, Inc., projected Ewa regional population at 175,360 for 2025. "Ewa Development, 2006 to 2025: Economic, Population and Fiscal Impacts," September 2005.

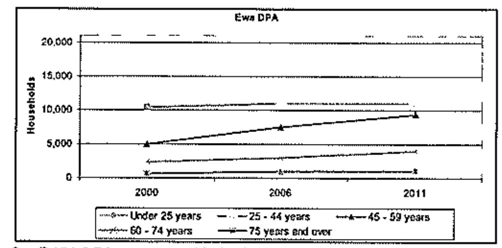
Ewa was estimated to have a median resident age of 32 in 2006, younger than the island-wide 37.7. This is attributed to Ewa's more numerous entry-level housing options. Central Oahu was also relatively young, at an estimated 2006 median age of 33.1, while Waianae was estimated at 29.3.

Number and Age of Households (Exhibits 2-6 and 2-7)

In 2006, Claritas estimated Oahu had about 300,900 households. Within this total, some 8% or 25,300 lived in Ewa[4], 16% or 48,000 lived in Central Oahu and 4% or 11,000 in Waianae. With the majority of entitled vacant lands on the island, Ewa's households are expected to gain against the County's over the next 5 years, to about 11% by 2011. This would represent 34,300 households at an average size of 3.4. This would represent new households at an average of 3.1 persons and already existing households at the 3.6 persons estimated by Claritas. Claritas sees household size declining in Central Oahu, to 3.3 by 2011, while remaining static in Waianae at 4.0.

Household heads are older than the population as a whole. The biggest group island-wide is currently householders ranging from 25 to 44.

Households by Age of Head – Ewa DPA



See Exhibit 2-7 for sources and further information.

However, the number of households headed by those aged 45 to 59 is increasing most rapidly. This group's size is anticipated to approach the 25 to 44 age group by 2011 in all three DPAs. The combination of population growth, aging and a trend towards smaller households could lead to 1,900 more households headed by persons aged 45 to 59, and 1,000 more by those aged 60 to 74 in Ewa over the next five years. Also over this period, the number of households headed by those aged 25 to 44 is expected to be static.

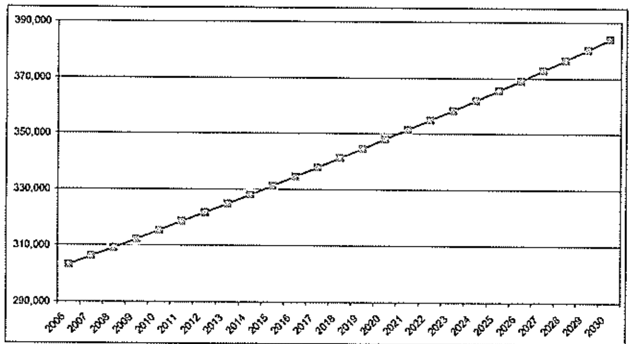
The 45 to 59 age group is considered a prime move-up housing market, while the 25 to 44 age group includes many first-time buyers.

[4] 2006 and 2011 Claritas figures for Ewa adjusted to be consistent with the area population projection presented previously.

Long-term Projection of Households

SMS projected Oahu households to 2030, utilizing the projected population figures shown previously and assuming a gradual continuation of the trend towards smaller households. The series shows 303,149 households on Oahu in 2006, (at 2.99 persons per household) and 384,005 in 2030 (at 2.93 per household).

Projected Oahu Households



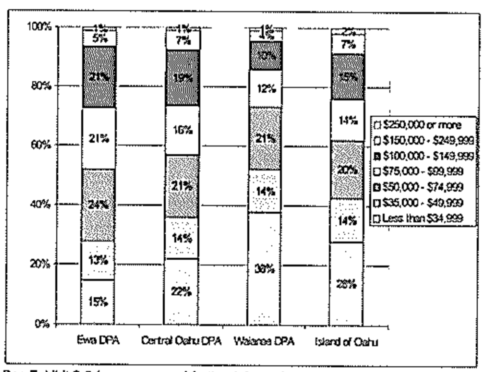
Source: SMS, Inc., February 2007.

Households by Income
(Exhibit 2-8)

Ewa and Central Oahu show a higher household income profile than the island as a whole, while Waianae shows a lower one. Claritas estimates the median 2006 household income is approximately $73,000 in Ewa, $66,700 in Central Oahu and $47,900 in Waianae, compared to $59,600 for the island of Oahu.

The Ewa DPA also shows relatively fewer households with incomes below $74,999

Households by Household Income, 2006



See Exhibit 2-8 for sources and further information.

(52%), and a greater share with incomes between $75,000 and $149,999 (42%) than the other regions evaluated. In comparison, an estimated 62% of Oahu's households earned less than $75,000 and only 29% $75,000 to $149,999 in 2006. Other areas of Oahu may have relatively more households in the highest income brackets; however, these represent a small number of households in absolute terms.

Further evidence of relatively high incomes in the Trade Area is found in an analysis of median household income by the state's top 30 zip codes in 2006[5], which found that:

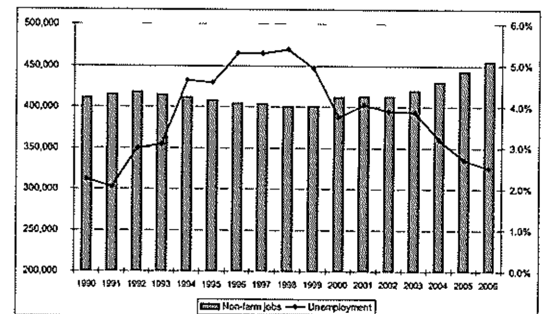
- **Mililani** (96789) showed the state's third highest median income, at $81,340;
- **Kapolei, Makakilo and Kalaeloa** (96707) had the sixth highest, at $77,902;
- **Ewa Beach** (96706) was seventh, at $74,396;
- **Waipahu** (96797) was ranked tenth, at $72,053.

For comparison, 96816 (Kahala, Waialae and Kaimuki) showed an estimated median household income of only $66,806. This made it only the thirteenth highest earning zip code area in the state in 2006, up from the fourteenth in 2005.

Employment Trends
(Exhibit 2-9)

The State of Hawaii, Department of Labor and Industrial Relations (DLIR) reports Oahu unemployment averaging 2.5% in 2006, down from 2.7% in 2005[6]. This is also down from the island averages of 3.2% in 2004 and 3.8% to 4.1% between 2000 and 2003, and significantly down from the 4.3% to 4.9% range exhibited from 1995 to

Oahu Labor Force Trends



See Exhibit 2-9 for sources and further information.

[5] Pacific Business News, December 22, 2006, 2007 Book of Lists: "Wealthiest Zip Codes, Ranked by 2006 Median Household Income." Data provided to Pacific Business News by ESRI.

[6] Not seasonally adjusted, for civilian labor force. Figures dated 12/4/2006.

1999. Oahu's unemployment rates have been among the lowest in the nation in recent years.

Oahu has supported annual increases in the number of employed persons since 2002. In 2006, some 446,200 persons were employed out of a total civilian labor force of 457,700, according to the DLIR.

3. Residential Market Environment

Historical Supply Conditions

2005 Inventory

- **Oahu** had some 329,300 housing units in 2005, of which 300,557 or 91% were estimated to be occupied, according to the U.S. Census, American Community Survey (ACS)[1]. This estimate is within 1% of the Claritas estimate for Honolulu for 2005, which was at 333,000 total housing units.

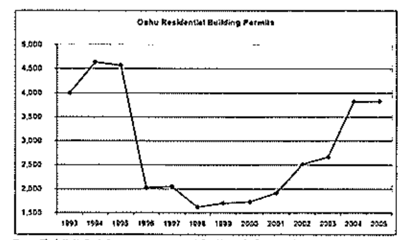
  Among occupied units, 57% were owner-occupied and 43% renter-occupied, according to the ACS. Among the 9% of units estimated to be vacant, the majority reflect non-resident housing uses, since the homeowner vacancy rate was estimated at less than 1% and the rental vacancy rate at 4%.

- **Ewa and Central Oahu** - While the ACS does not break out housing supply by area, according to Claritas, about 15% and 7% of the island's 2005 housing units were located in the Central Oahu and Ewa DPAs, respectively, representing about 50,900 in Central Oahu and 24,600 in Ewa.

  Both of these DPAs have substantially higher ownership rates than the County as a whole. In Central Oahu, some 61% of occupied units were estimated to be owner-occupied, while in Ewa some 72% were.

Residential Building Permits (Exhibit 3- 1)

Oahu residential permitting plunged from 1995 to 1996, as the effects of the collapsing real estate "bubble" of the late 1980s and early 1990s were finally realized. Permitting did not rise again materially until 2002.



See Exhibit 3-1 for sources and further information.

[1] Average figure for year, also referred to by State DBEDT as July 1 estimate. U.S. Census, "2005 American Community Survey," released October 2006. The ACS does not survey population living in institutions, college dormitories or other group quarters.

In 2005, 3,821 new residential building permits were obtained on Oahu, according to the City and County. This compares to more than 4,500 per year in 1994 and 1995.

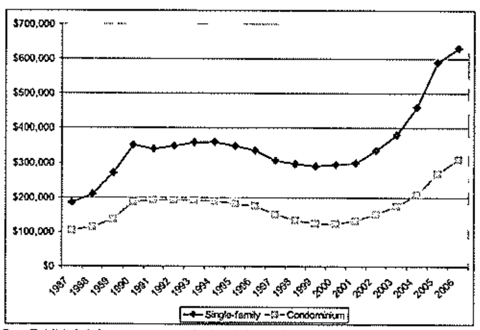
Data from the first three quarters of 2006 show a 30% decline in permitting activity from the same period in 2005. This represents the first decline in permitting activity since 1998, and reflects a lack of entitled land inventory held by developers, production difficulties related to labor and regulatory controls and a slowing business cycle.

Market Trends

Oahu Home Resales (Exhibit 3-2)

Rapidly rising home prices in recent years reflect the relatively limited production of new housing, combined with strong labor market conditions and favorable financing conditions in recent years.

Oahu Resales – Median Prices



See Exhibit 3-2 for sources and further information.

Sales recordations of existing homes during 2006 showed a median single-family price of $630,000 and a median condominium price of $310,000, according to the Honolulu Board of Realtors (HBOR).[2] These medians are 7% and 15% higher, respectively, than those recorded in 2005.

In the first two months of 2007, prices are flattening or rising more slowly, while residential sales velocity has slowed since 2005. During 2005, 4,617 existing single-family homes were resold on Oahu, as were 7,990 condominium homes. These represent 1.8% fewer single-family and 1.3% more condominium sales than recorded in 2004. At 4,041 and 6,380 sales, respectively, 2006 showed a 14% decline in single-family and 20% decline in condominium sales compared

[2] Honolulu Board of Realtors, "December 2006 Monthly Statistical Report," January 2007. The HBOR defines condominiums as duplexes, townhomes and other multifamily units having common areas.

to 2005. Previously, the number of homes resold on Oahu had shown nearly consistent annual increases since 1995.

Months inventory remaining, while still far below historical levels in the early- to mid-1990s, has been on an upswing since mid-2005, further defining a "landing" to the boom that endured over the prior six years. As of February 2007, the HBOR estimated there were 6.5 months worth of single-family inventory remaining on the island market, and 5.5 months of condominium inventory.

The short-term outlook is for slowing sales and stabilized or somewhat declining prices as the market makes adjustments to reflect the overly rapid rises of past years. However, longer-term, ongoing population growth, household formation and the still significant overhang of unhoused persons will continue to fuel demand for new housing.

Subject Area Resales (Exhibit 3-3)

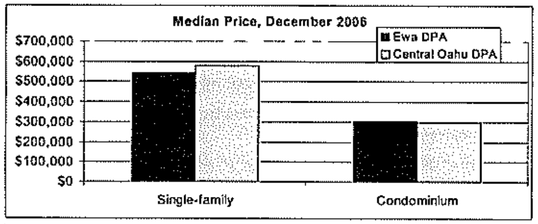
Like the island as a whole, Central Oahu and Ewa neighborhood markets are recording fewer sales, while prices have continued to appreciate. During 2006 (with comparisons to 2005):

- Within the Ewa DPA:
  - Sales slowed 10% on the Ewa Plain[3], but increased 7% in Makakilo. Overall, the Ewa DPA declined 7%.
  - Prices have continued to rise. The Ewa Plain showed price increases averaging 8% for single-family and 18% for condominium products, for median prices of $528,000 single-family and $302,000 condominium.
  - In Makakilo, median prices increased 9% and 16% for single-family and condominium sales, respectively, reaching $600,000 for single-family homes and $320,000 for condominiums.
- Within Central Oahu:
  - Wahiawa, Mililani and Waipahu all generally showed fewer sales, averaging 9% fewer than in 2005. The only exception is Wahiawa condominiums, which show 5% more sales than the prior year.

[3] As defined by the HBOR, the Ewa Plain includes Kapolei, Ewa Beach and Ewa by Gentry.

- Median prices rose across the board in these Central Oahu communities, ranging from 8% to 10% increases for single-family products and 14% to 39% increases for condominium products.

- Median single-family prices were highest in Mililani at $610,000, and lowest in Wahiawa at $462,000. Among condominium sales, the median price ranged from $188,000 in Wahiawa to $315,000 in Mililani. Wahiawa tends to have older housing stock than either Mililani or Waipahu.



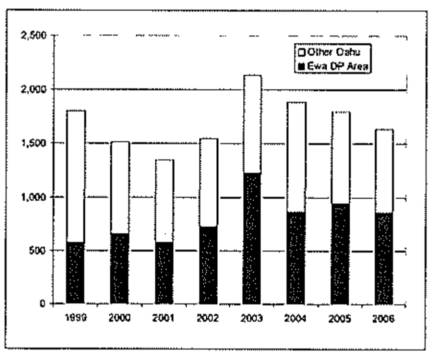
See Exhibit 3-2 for sources and further information.

Developer Unit Sales by Area (Exhibit 3-4)

Developer-built homes have also shown rising prices but absorption has been limited by production factors such as labor, permitting and the availability of entitled sites.

Oahu recorded an estimated 1,800 new home sales in 2005, but only 1,640 in 2006, according to The Harris Company. This is down from the peak production and absorption of 2,136 in 2003.[4] Of the total closings, 46% to 58% of units have been located in the Ewa DP area[5] over the past 5 years.

Oahu Developer Sales by Location



See Exhibit 3-4 for sources and further information.

[4] Note that developer unit sales are fewer than residential permits granted in any given year (Exhibit 3-1). The difference is due to permitted units not getting built, or being built as rental or other unit types not covered by the residential developer unit surveys.

Notably, there has been no long-term increase in new home production over the past eight years, despite population increases and very strong market activity. Production has generally stayed in the 1,500 to 2,000-unit level, subject to business cycles and other factors.

Also in recent years, single-family units have been losing market share to townhouse and high-rise home sales.

Ewa Developer Unit Sales by Type (Exhibit 3-4)

Considering only the Ewa area, developer sales have hovered between about 850 and 950 units per year in recent years, down from their peak of 1,230 units closed in 2003.

Historically, Ewa has provided an opportunity for smaller-unit, single-family living at relatively modest cost, given the trade-off of a longer commute to town. However, as Hawaii home prices have risen across the board, townhomes are assuming an increasing share of even Ewa area sales. In 2006 townhomes represented some 21% of area new sales, compared to an average 18% over the entire period. Additionally, the density of many single-family homes has increased to within the historical range of townhomes and a growing segment includes condominiumized elements such as driveways, courtyards, structural walls and the like. Thus the "single-family" homes being developed are increasingly likely to have characteristics previously associated with multifamily or townhome developments.

Housing Supply Outlook

Planned Communities in Ewa and Central Oahu (Exhibits 3-5 and 3-6)

MC reviewed planned residential development projects within the Ewa and Central Oahu DP areas. This survey targeted projects of 100 units or more for which LUC Urban designation was in place, and/or for which the landowner was be exempt from LUC governance.

- **Ewa** - Some 31,000 units of State-entitled future development were identified at 20 sites in Ewa. Of this total, about 65% could be fully absorbed by 2015.

  These figures do not include Ho`opili.

[5] Includes the Ewa, Kapolei and West Oahu (Ko Olina) areas, as defined by the Harris Company.

- **Central Oahu** has only about 8,200 potential future units entitled currently, all of which could be developed and absorbed by 2020, and 90% by 2015.

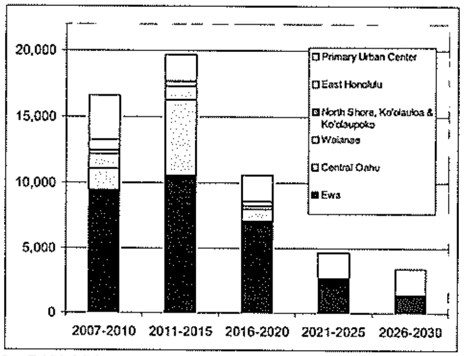
  Three planned Central Oahu developments, Castle & Cooke's Koa Ridge and Waiawa, and Gentry's Waiawa Phase 2 could conceivably add up to another 12,000 units. However, all three of these projects require LUC approval.

These potential inventories are considered generous since they consider current zoning or plan maximums and projected development schedules. Often projects get developed at less than their permitted or planned densities, and/or experience delays that push inventory further into the future.

Projected Oahu Housing Development (Exhibit 3-7)

Combining the data on Ewa and Central Oahu resident housing projects with information gathered on planned developments elsewhere on the island shows some 55,100 resident housing units with LUC approval at this time. This number is based on an estimated 31,000 units in Ewa, 8,200 in Central Oahu, 2,470 in Waianae, 1,230 in the North Shore, Ko'olauloa and Ko'olaupoko areas, 740 in East Honolulu and 9,370 in the Primary Urban Center (PUC.) The PUC figure includes an allowance of 2,000 units per 5-year period after 2010 for unforeseen redevelopment projects.

LUC-Entitled and Planned New Housing Unit Development on Oahu



See Exhibit 3-7 for sources and further information.

Considering information provided by developers and landowners and on historical absorption rates of similar products in the area, buildout of these entitled units could occur as shown above.

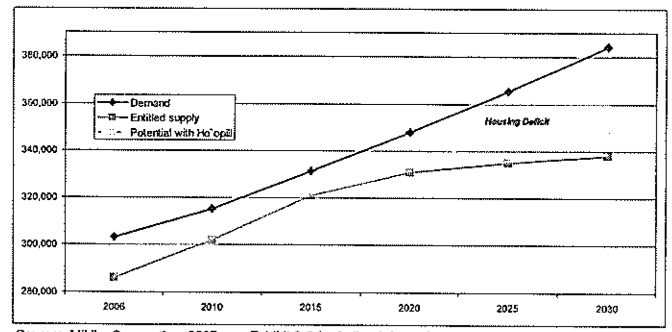
Summary of Island Demand and Supply Factors (Exhibit 3-8)

- **Current and Future Demand** - The SMS study previously cited projected that Oahu households will increase from about 303,149 in 2006, to 384,005 in 2030. These considerations suggest a need to provide housing for 81,000 new households over the next 24 years, or by 2030. In addition, existing pent-up demand as of the end of 2006 is estimated at 17,000 units.

- **Current Supply** – The current supply of housing is estimated using the ACS survey finding of 300,557 occupied housing units in 2005, less a 6% allowance for units held for nonresident use such as visitor or part-time resident use. This results in an estimated 283,000 occupied resident housing units (RHU) in mid-year 2005. Added to this figure are recorded new unit closings from July 2005 through December 2006. This results in an estimated 286,000 net available RHU by the end of 2006.

- **Future Supply** – Future supply estimates are based on the schedule of LUC-entitled potential future developments islandwide, representing some 55,100 units by 2030, as shown previously in Exhibit 3-7. From this figure a 5% vacancy allowance is deducted, resulting in some 52,000 units available for resident housing use. Note that these estimates are considered generous, as explained previously.

Oahu Resident Housing Unit Supply and Demand After Development of Currently LUC-Urban Lands

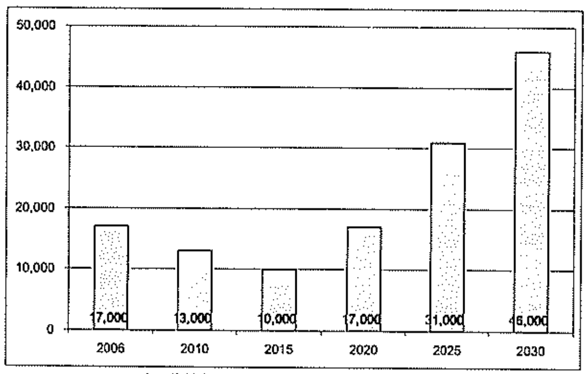


Source: Mikiko Corporation, 2007; see Exhibit 3-8 for further information.

Taken together, the outlooks for demand and entitled supply projections indicate a substantial shortfall in currently permitted housing opportunities. In addition to the need to house up to 81,000 new households by 2030, there is a pre-existing estimated pent-up demand for about 17,000 housing units, yet only 52,000 net units LUC-enabled.[6]

Thus, it appears that aggressive housing production efforts in the near term could pare Oahu's shortage of primary resident housing units down to about 10,000 units by about 2015. However, without further State entitlement of major housing developments, the unmet need for housing could thereafter be expected to spiral up to some 46,000 homes by the year 2030.

Oahu Resident Housing Unit Deficit
After Development of Currently LUC Urban Lands



See Exhibit 3-7 for sources and further information.

[6] Based on 55,000 LUC-entitled units total, less a 5% vacancy allowance on those units.

4 – Ho`opili Residential Market Assessment

Future Housing Market Setting

Housing Demand (reference Exhibits 2-2 and 3-8)

DRH anticipates Ho`opili's first housing units could be available for occupancy in 2012. At that time, the housing market is expected to still be in deficit mode, with about 10,000 to 13,000 fewer units available for resident use than desired.

From 2012 to 2030, potential new household formation could be expected to generate demand for another 65,800 or so units.[1] This new demand is expected to be distributed between:

- **Downsizers** – Hawaii's 55 to 74 year-olds are expected to increase by about 60,000 between 2010 and 2020. This is the Baby Boom generation, and a larger share will be entering their mid-60s than their mid-50s by 2020, as shown previously in Exhibit 2-2.

  Many members of this generation can be expected to downsize their housing and to seek to live closer to community amenities as their children move out, they enter retirement and/or as they no longer care to maintain large properties. The leading end of this trend is already seen nationwide; in Hawaii, those trading single-family homes for multifamily living in a more urban setting are evidenced in Kaka'ako's new high rises.

  After 2020, the 55 to 64 age cohort could decline as more move into their 70s (see "senior markets," below.)

- **Entry level markets** – Hawaii's next most rapidly growing cohort between 2010 and 2020 is likely to be persons aged 25 to 34, the "Echo Boom" generation. This phase often includes household formation, and one's first rental or home purchase. Since affordability is key to this market and many do not yet have spouses or children, this market also tends to seek smaller units. This cohort is anticipated to increase by 22,000 persons statewide between 2010 and 2020.

[1] See Exhibit 3-8; represents 12,800 demanded 2012-2015 (3,200/year) plus 17,000 from 2016 to 2020, 18,000 from 2021 to 2025, and 18,000 from 2026 to 2030.

- **First move-ups** – A strong move-up market could emerge after 2020, as the Echo Boom cohort ages into its mid 30s and early 40s. This age group is projected to increase by about 19,000 persons statewide between 2020 and 2030.

- **Retirement/senior markets** – The retiree/senior market will also show significant gains, with an additional 21,000 persons aged 75 or more anticipated statewide in 2020 compared to 2010, and another 56,000 between 2020 and 2030. Typically one or two persons per household, this market is also amenable to smaller units.

Altogether, satisfying the potential demand from Oahu's growing population after 2006, plus existing pent-up demand is projected to require that some 98,000 (81,000 + 17,000) more housing units be supplied over the next 24 years.

Within the island, the Ewa Plain has long been the preferred location for such future large-scale development, and a number of factors support this:

- **Land and infrastructure** – The Ewa DPA contains the majority of the island's remaining extensive, flat and less developed lands. State, County and private entities have already invested heavily in primary infrastructure for the area, including highways, major roads, harbor improvements and water and sewer systems.

- **Transit** – The County's proposed mass transit project, targeted to be operational by 2012, would link Kapolei to downtown Honolulu and eventually Waikiki and the University of Hawaii (UH) Manoa campus. The currently preferred route runs through Ho'opili, along Farrington Highway.

- **Jobs** – In addition to transportation solutions that enhance commuting out of the district, Kapolei is rapidly developing its own jobs base, which will reduce the need to out-commute. While historically the area has generated mostly secondary jobs, significant new primary job[2] creation is occurring, such as at:

  - **Judiciary** – The new State Court complex is projected to relocate 650 direct and indirect jobs to Kapolei.

  - **Island Pacific Academy** – This private school, opened in Kapolei in 2004 as a lower school, expanded enrollment and added middle and high school levels in 2006.

  - **UH West Oahu** – This major expansion is projected to generate 1,200 jobs at the new campus and support facilities.

[2] Meaning those jobs capable of providing the major financial support for a household.

  - **Business and industrial parks within the region** – Build-out of Kapolei Business Park and development of new parks such as the 54-acre Phase 2 of Kapolei Business Park, a 22-acre movie studio, and the 66-acre former Hawaii Raceway Park, as well as Kapolei Harborside Center (345 gross acres, now petitioning the LUC for a land use boundary amendment).

In summary, developments underway in Kapolei are projected to add 40,000 more jobs in the region by 2025, according to an earlier study[3].

Housing Supply (reference Exhibits 3-7 and 3-8)

Currently entitled projects are estimated to yield up to 52,000[4] of the required 98,000 housing units by 2030, if they are developed within the time frame and at currently planned or entitled use levels.

Despite these substantial developments and a greater than historical rate of new home production initially, the island could still anticipate a 46,000-unit shortage by 2030, the end of the projection period:

Supply and Demand for New Resident Housing Units on Oahu 2007 to 2030

Future Demand	Pent-up demand, end 2006 Future need, 2007-2030 Total need	17,000 81,000 98,000
Future Supply	Planned and entitled (55,000 less 5% vacancy)	52,000
Shortage	**As of 2030**	**46,000**

Source: Mikiko Corporation, 2007. Future supply estimate assumes full buildout of all lands currently designated Urban by the LUC, and proposed for residential development. See Exhibit 3-8 for further information.

Moreover, more than 65% of the entitled new development could be built out over the next 8 years, or by 2015. By 2020, within 8 years of Ho'opili's projected first marketing, all but 15% of the island's entitled inventory could have already been developed and absorbed.

[3] Decision Analysts Hawaii, Inc., "Ewa Development, 2006 to 2025: Economic, Population and Fiscal Impacts," 2005.

[4] This would represent up to 55,100 units delivered, less a 5% vacancy allowance.

In conclusion, a stepped-up rate of housing production that appears possible over the next several years could help to pare down the current housing deficit through about 2015. However, thereafter, currently entitled projects would be unable to keep up with demand. Without further entitlement of significant lands for residential development, another, an even more drastic housing crisis than today's is anticipated to emerge between 2016 and 2030.

Supply Solutions/Currently Entitled Projects

During the majority of Ho`opili's marketing, most of the currently entitled projects are expected to be sold out. By 2016, only a few projects are anticipated to have significant remaining inventory. Even so, most of these could be fully absorbed by 2020:

- **In Ewa** -
  - Makaiwa Hills – Higher end, likely to substantially sell-out by 2020.
  - East Kapolei II and III – DHHL projects, to be restricted to persons of Native Hawaiian ancestry; expected to be completed by 2020.
  - UH West Oahu – Core is oriented to campus needs; surrounding potential developments projected to sell out before 2020.
  - Kalaeloa – Development types and schedules to be determined; much depends on U.S. Navy decisions yet to be made and emerging State policy.
- **In Central Oahu** - Waiawa Gentry Phase 1 could be nearing sell-out in the 2016 to 2020 period.

Outside of Ewa and Central Oahu, there is likely to be redevelopment within existing neighborhoods but there are limited lands available for new development and no major primary residential communities known to be in the planning phase.

This contrasts with today's market, where more than 12 developments of 500 or more remaining units are underway or in planning. By the time of Ho`opili's marketing, without further land use entitlement, there could be only the five projects noted above, and by 2020, only one or two. This is the source of the drastic housing shortage that could materialize after 2015, in the event that significant further inventory is not entitled.[5]

[5] In addition to Ho`opili, other large proposed developments that may seek LUC Urban reclassification include Castle & Cooke's Koa Ridge and Waiawa, and Gentry's Waiawa Phase 2. Together, these Central Oahu projects could offer up to 12,000 residential units, as currently configured.

New Urbanism

The development concept for Ho`opili is one that has been widely tested and refined as the principles of "New Urbanism" or "Smart Growth" are adopted in communities worldwide.[6] In contrast to the former suburban/commuter model of development, typical guidelines for New Urbanism include:

- Mixed land uses (residential, commercial, community);
- Compact building designs and higher densities;
- Walkable neighborhoods;
- A variety of transportation choices;
- Housing opportunities and choices for a range of household types and incomes; and
- A greater balance of jobs and housing within each community.

According to The Congress for New Urbanism (CNU), a leading promoter of such development, even if overall demand for new housing were to slow, cultural changes are resulting in a preference for living in dense, walkable neighborhoods, and thus the demand for homes in New Urbanist communities is expected to increase rapidly. This is being driven by several trends:

- Rapid increase in the number of households that are middle-aged or older, even though these same persons likely grew up in and raised their children in suburban, car-centered communities;
- Receptivity of the young adult "Echo Boomers" to urban lifestyles and New Urbanist values, as well as their general inability to afford living in the suburbs;
- Deteriorating driving experience on most US highways and roadways; and
- Workforce changes related to technology and outsourcing that encourage more people to work from home.

In Hawaii, recent high-rise development in the Kaka'ako area illustrates the acceptability of these concepts in our island setting. Over the past five years, Oahu residents have demonstrated strong interest in high density housing in Kaka'ako that is proximate to

[6] Although often dated to the late 1990s, the New Urbanism or Smart Growth movement is rooted in the ideas of Jane Jacobs, whose The Death and Life of Great American Cities was published in 1961.

jobs (Waikiki, downtown and the corridor in between), entertainment, shopping, culture, multi-modal transportation and myriad recreational and natural resources.

Mehana, another DRH project, will be the first to directly implement these principles on the Ewa Plain. Mehana is expected to commence sales in mid-2007, and will offer 1,150 homes, most of which will be in mixed-use settings. Approximately 80% is planned as multifamily or attached housing. All of Mehana is within walking distance of the City of Kapolei and the site is traversed by the County's proposed transit route. To date, community reaction to Mehana has been very positive.

Also on the Ewa Plain, UHWO's college town area is planned to offer higher density developments dominated by multifamily housing, much of it in mixed-use settings.

Ho`opili's Proposal

Development Concept

Ho`opili is planned to respond to the trends and future community needs discussed above. It will serve a "graying" Kapolei and will make available opportunities for urban village living at more modest cost than now possible in Kaka'ako.

- It offers significant primary resident housing in an area that has long been planned for such expansion. Ho`opili's 11,750 units could represent a solution for up to about 25% of the island's currently unentitled housing needs through 2030.
- It offers a wide variety of housing types, not dominated by the high-end.
- It offers a highly accessible lifestyle that is not car-driven. This is enabled by its access to future transit service, its planned higher densities and mixed uses, and its planned trails and "walkable" streets. These transportation options further enhance the affordability of the community, as studies have shown that automobile costs represent up to 15% or more of the typical US household budget (and much more for lower income households.)
- It offers housing in conjunction with significant jobs, schools, parks and other community amenities. This in turn enhances Ho`opili's affordability as it reduces the need for a second or third automobile per household and also may represent significant timesavings.

Ho`opili Product Mix

The majority of Ho`opili's units are expected to be for-sale multifamily units. The development would also include single-family units for-sale and it may include multifamily rental units. The exact mix of units by type will be determined during the years of build-out, as market conditions and preferences materialize.

In terms of market orientation, up to 30% of Ho`opili's units are expected to be developed as affordable housing, in accordance with the County's affordable housing guidelines.

General densities, tied to the areas shown in the Land Use Map, are envisioned as follows:

- **Low- to medium-density** – 5,100 units total, including single-family homes at 5 to 8 units per acre and multifamily at 10 to 14 units per acre. Some multifamily development may be in residential-only buildings. Others would be located above lower or ground floor commercial uses and/or designed as "live-work" units that offer both a residence and a potential commercial area.
- **Medium-density** – 5,200 units total, all multifamily at 15 to 29 units per acre. These areas are planned as mixed-use, "live-work" units within low- to mid-rise buildings with neighborhood-serving commercial. They may include a senior housing or lifestyle component as well.
- **High-density** – 1,450 units total, developed in buildings at 30 to 50 units per acre, typically with neighborhood-serving commercial on the ground floor.

Affordable housing opportunities are planned within the medium and high-density areas.

Market Evaluation and Conclusions for Ho`opili

Anticipated Buyer Markets (Exhibit 4-1)

The proposed products respond to the market opportunities identified above as follows:

- **Entry-level markets** – Up to 30% units, those designated as affordable units, as well as many of the other higher density for-sale multifamily units are conceived to appeal to entry-level markets, typified by the rapidly increasing 25- to 34-year-old Echo Boom cohort in the 2010 to 2020 period.
- **Move-up markets** – Ho`opili's "traditional" or lower-density single-family housing, as well as some of its more amenitized multifamily offerings could appeal to move-up

markets and growing families. The first level move-up market, typified by persons aged 35 to 44, is projected to grow particularly rapidly in the 2020 to 2030 period as the Echo Boomers mature.

- **Downsizers** – Ho`opili's higher density single-family units and all of its mixed-use multifamily units are seen to appeal to the Baby Boomer cohort that is looking to simplify its lifestyle, lessen homeowner commitments and enhance access to urban amenities.

- **Retirement/senior markets** – The medium density areas are seen to possibly include one or more senior housing developments, catering to the 75+ population, a rapidly increasing age classification. Some of the senior housing may also be part of the affordable housing inventory.

The great majority of Ho`opili homebuyers are anticipated to be purchasing for use as an owner-occupant. Based on surveys of 365 persons who signed sales contracts at eight DRH projects in 2004 and 2005, 95% expected to be an owner-occupant, while only 5% were purchasing primarily for an investment or for second home use.

Ho`opili's live-work units might encourage a higher share of investor buyers than seen in the marketplace recently. However, most of these buyers would be expected to put the units back into long-term rental, meaning it would still be in the primary residential market.

Ho`opili Residential Prices (Exhibits 4-2 and 4-3)

Pricing at other DRH projects frames the market orientation and production capabilities that the company could bring to Ho`opili. DRH's current projects in the region include build-out at various sites in Makakilo and of its masterplanned Sea Country community in Ma'ili. In addition, the company has been selling the last of its townhouse inventory in Hawaii Kai and single-family condominiums in Kahala. 2006 price indicators at these locations are presented in Exhibit 4-2 and summarized on the following page.

Market Unit Price Indicators and Conclusion
2006, except Mehana

	Multifamily units	Single-family units	Comparison to Ho`opili
Makakilo	$316,000 - $583,000 (12-14 u/ac)	$543,000 - $913,000 (5-6 u/ac)	Some have superior location and views
Sea Country, Ma'ili	None offered	$327,000 - $550,000 (5-8 u/ac)	Less desirable location
Hawaii Kai & Kahala	$557,000 - $725,000 (15 u/ac)	$650,000 - $1,400,000	Locations command premiums
Mehana (estimated, mid-2007)	$350,000 - $550,000 (17 u/ac)	No product priced yet	Most comparable plans and location
Ho`opili assessment (market units)	**$350,000 - $650,000 (10+ u/ac)**	**$500,000 - $750,000 (5-8 u/ac)**	**May be additional premiums**

Sources: DRH and Mikiko Corporation. See Exhibits 4-2 and 4-3 for further information.

In conclusion, Ho`opili's market units are expected to support prices ranging from (in 2006 dollars):

- $350,000 to $650,000 for its various multifamily products, to

- $500,000 to $750,000 for its single-family products.

Additional premiums may be realized in the future due to New Urbanist features of Ho`opili and it's many community amenities.

Affordable for-sale multifamily units would be priced in accordance with then-applicable County rules and guidelines. In 2006, such units would have been priced from $232,000 to $392,000 for a family of four earning 80% to 120% of the Honolulu median income.

Rental rates, assuming some affordable housing units are developed as rentals, would also be based on County rules then in effect. Currently, these would be expected to be targeted at persons earning below 80% and up to 100% of Honolulu's median income, or in some circumstances, to lower income groups. In 2006, conforming rents for this target market ranged from $998 to $2,481 for studio to 4-bedroom units, according to the County.

Residential Production Capacity

Over the past two years, DRH closed approximately 400 new units on Oahu each year, the majority in Makakilo. These deliveries have been constrained within each community by labor and supply factors, while the island-wide sales have been capped by the company's lack of other large sites ready for development. DRH's capacity has also been hampered because, without a large single project, it has had to disperse its Oahu production activities among three or more disparate locations (including Makakilo, Ma'ili, Kahala and Hawaii Kai.)

DRH's 2005 and 2006 sales were produced under a relatively high competition setting, and represent 21% to 22% of the island-wide market for new home sales in each of the years. Schuler's past market records demonstrate the company's ability to sustain much higher levels of production and sales, even before its capacity-increasing association with DRH in 2002. From 1992 to 1995, Schuler closed some 600 to 1,100 units annually on Oahu, with sales peaking in 1994 at 1,143 homes.

Ho`opili Absorption Conclusions

Given the highly limited supply of community development opportunities on Oahu in the 2012+ time frame, and even assuming entitlement of the large properties currently considering petitioning for development entitlements in Central Oahu, DRH's market share could be substantially higher than during the last two years. Since Ho`opili is the only large community in planning by DRH on Oahu (other than Mehana, which likely will be substantially sold out), this enlarged market share would largely accrue to Ho`opili. Ho`opili's anticipated market share also considers:

- It is a highly desirable location, far more proximate to future job and school centers than Makakilo or Ma'ili.
- As shown in the analyses in Chapter 1, without further entitlement of other residential developments, Ho`opili's hypothetical fair share in the 2016 to 2030 period could be about 39% of the island market. If Koa Ridge, and both of the Waiawa projects were also entitled and developed in the time frame, their additional 10,500 units could reduce the Project's fair market share to about 29% after 2015.
- The Project will offer a wide range of products, targeting many household types of a broad range of income levels. In comparison, the ridge developments at Makakilo

(historically) and at Koa Ridge and Waiawa Phase 2 (if they are entitled in the future) will likely need to offer lower density and higher priced product.

As demonstrated previously in Exhibit 3-8, Oahu needs an annual average production of about 3,400 units through 2030 in order to meet future demand from household formation. In order to also pare down pent-up-demand, Oahu needs more than this.

The table on the next page shows two potential future housing scenarios with Ho`opili on the market. In both cases, the Project's assumed market share is substantially less than what its hypothetical fair share could be.

- **In the first case**, Oahu housing production would be near to recent historical levels, at an assumed 2,000 units per year. (In this scenario, the marketplace would likely continue to slide towards a greater housing crisis than is now being experienced.) This scenario could result from an inadequate supply of entitled and serviced lands, or other nonmarket barriers to production. Given the limited competitive product, Ho`opili's market share is expected to be substantially higher than has DRH's in recent years (21% to 22%), when there was a great deal of competition and the DRH's product was in less prime locations. This scenario suggests Ho`opili sales achieving a 30% to 35% market share, and averaging 600 to 700 closings per year.
- **The second scenario** assumes a more adequate supply of new housing on Oahu, though still not enough to also eliminate the backlog of pent-up demand. In this case, a hypothetical Oahu absorption of 3,900 units per year is assumed.

  This environment would be more competitive for DRH than Scenario 1, but still less than under current conditions. In this case the Project's market share is conservatively assumed to be 15% to 20% of the Oahu new home market, below the range of DRH's recent historical achievements, and less than its hypothetical fair share of about 30% in a similar situation. This would result in average annual Project sales of some 585 to 780 units as shown on the following page.

Oahu and Ho`opili Annual Residential Unit Sales Absorption, 2012+

	Scenario 1: At recent historical levels of island production	Scenario 2: At demand-satisfying levels of island production	Conclusion for Ho`opili
Assumed total Oahu developer sales	2,000	3,900	
Ho`opili market share[7]	30% - 35%	15% - 20%	
Ho`opili average annual sales	**600 - 700**	**585 - 780**	**650**

Source: Mikiko Corporation, 2007.

Projected Ho`opili Residential Absorption

Considering the two scenarios, it is concluded that Ho`opili should be able to sell 650 units per year on a long-term average basis. Actual sales from year to year could span the range of outcomes projected (585 to 780 units per year), or show even greater fluctuation depending on market conditions and the types of units under development at any given time.

The 650 unit sales could represent 450 market units and 200 affordable units in an average year. The affordable housing sales absorption is assumed to occur more gradually because it would generally need to be developed as infrastructure and community facilities are supported by market housing unit sales.

[7] Compared to the Project's potential fair market share of 40% and 30%, respectively, under two similar scenarios (see Chapter 1.)

These rates would lead to complete absorption of the Project within 19 years, or by 2030.

Illustrative Mix of Potential Residential Sales Absorption at Ho`opili

	Market units	Affordable for-sale units	Total for-sale housing
Potential total inventory	8,250	3,500	11,750
Average annual sales	**450**	**200**	**650**
Years on market	19	18	19
Start date	2012	2012	2012
End date	**By 2030**	**By 2029**	**By 2030**

Source: Mikiko Corporation, 2007.

Alternatively, if some of the units were developed as rental products, the community could be expected to become fully occupied even earlier, given the historically high demand for and limited supply of quality rental products on Oahu.

5 Retail Market Environment

Methodology

This chapter presents the estimated market support for additional commercial space in Ewa as derived from retail-based market indicators. While many retail shopping centers include substantial office space, and office buildings often include retail, office market conditions are considered more specifically in the next chapter[1].

The market assessment for retail areas compares retail supply to consumer demand, which consists of resident and daytime populations. Nationally, there was an average of 20.3 square feet of shopping center space per person in the U.S. in 2004, and 63% of all retail space was within shopping centers.[2] This is equivalent to 32 square feet total retail area per person.

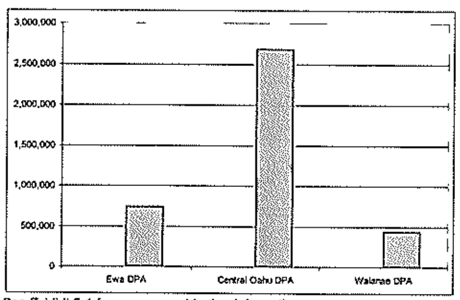
This is a useful benchmark, but Hawaii's retail market is unique in many respects. Thus, retail supply and population are also evaluated for the Ewa, Central Oahu and Waianae DPAs, which are considered the primary Trade Area, as well as for Hawaii Kai, which is considered a benchmark market.

Retail-Based Supply

Trade Area, 2006 (Exhibit 5-1)

The Trade Area had some 3.86 million square feet of retail space in December 2006. About 70% or 2.68 million square feet of this was located in Central Oahu. The Ewa DPA accounted for 19% of the region or some 737,000 square feet in place, while Waianae held the remaining 11%, with 439,000.

Existing Retail Gross Leasable Area
(square feet)



See Exhibit 5-1 for sources and further information.

[1] For purposes of this analysis, these relatively limited office areas within retail shopping centers are considered part of the "retail" market.

[2] National Research Bureau, Inc., "2004 NRB Shopping Center Census," 2005; Niemira, Michael P., "The U.S. Retail Space Market," Research Review, V.12, No. 2, 2005. Mr. Niemira is Vice President, Chief Economist and Director of Research for the International Council of Shopping Centers.

As of now, Ewa has no regional centers, but a 600,000 square foot center, the Kapolei Commons, is being planned.

Overall, Oahu's retail market is considered undersupplied, with a December 2006 vacancy rate of 2.2%, the lowest in 15 years, according to CMF. This is despite three strong years of net absorption, totaling about 650,000 square feet.[3] These trends are mirrored in West Oahu, which had an average 2.5% vacancy in December 2006. Central Oahu and Hawaii Kai's vacancies were even lower, at 0.6% each. Waianae showed the island's highest vacancy rate, at 14.5%.

Benchmark Area, 2006 (Exhibit 5-1)

As a planned community nearing buildout, with retail centers operating at or near capacity and a growing jobs base, Hawaii Kai is considered an indicator for the relationship of balanced retail supply to population levels in a suburban community.[4] Hawaii Kai has about 857,000 square feet of gross leasable areas (GLA), of which 247,000 are in the regional Hawaii Kai Towne Center, about 322,000 in Koko Marina Shopping Center, and 133,600 in Hawaii Kai Shopping Center.

Planned Development in the Trade Area (Exhibit 5-2)

Within Ewa, Kapolei is the focus of current commercial development interest. There are an estimated 3.3 million square feet of potential retail spaces underway or proposed on lands that are entitled[5] and planned for commercial development throughout the DPA. Of this, 75% or 2.5 million square feet are in Kapolei, including the East Kapolei area. Nearly 1.7 million square feet, more than twice Ewa's existing stock, could be added by 2011.

In contrast, the Central Oahu DPA has only about 540,00 square feet of identifiable and State-entitled retail projects in planning. The majority of this is at Gentry/A&B's Waiawa Phase 1, which has been designated Urban, but much of which still requires zoning. However, Waiawa could produce more retail development than the 400,000 square feet estimated here for planning purposes. Over 100 acres of lands within this project were previously designated for commercial or industrial use and presumably will be developed in accordance with market demands.[6]

[3] Colliers Monroe Friedlander, Inc., "Retail Market Report: Oahu Year-End 2006," January 2007.

[4] Because Hawaii Kai is a suburban community, whereas Ewa is planned to be mostly urban, Hawaii Kai's ratios are considered possibly low indicators for Ewa.

[5] As for residential developments, this analysis considers only those proposals on lands designated Urban by the LUC.

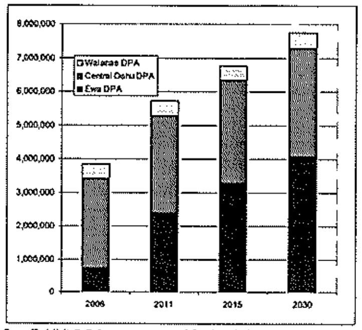
[6] The other potential major retail project in Central Oahu would be at Castle & Cooke's proposed Koa Ridge development. These plans are still under review, but the project could designate significant lands to retail use if market conditions warrant. Koa Ridge is not included in the "entitled/planned" inventory because it still requires LUC redesignation, as well as County zoning, in order to proceed.

Specific projects and land areas from which these estimates were derived are presented in Appendix 4.

Future Trade Area Inventory (Exhibit 5-3)

Considering the planned and entitled projects identified, retail areas in the Trade Area could nearly double by 2030, to approximately 7.7 million square feet. Most of this new inventory would be added in Ewa, in alignment with the area's projected residential and population growth.

Potential Future Retail Gross Leasable Area in Trade Area (square feet)



See Exhibit 5-3 for sources and further information.

Retail-Based Demand

Area Resident Profiles (Exhibit 5-4)

With about 88,800 residents, the Ewa DPA has a little more than half the population of the Central Oahu DPA, and Waianae has about half of Ewa's. In total, the Trade Area is home to about 290,950 persons or 32% of the island's population in 2006. Relationships within the Trade Area will change significantly over the next five years, as Ewa population is projected to grow an average of 5.6% per year to 2011, compared to 0.4% in Central Oahu and 0.7% in Waianae.

The benchmark market Hawaii Kai housed about 29,000 persons in 2006 and could grow 0.9% per annum in coming years.

Incomes in the Ewa DPA compare favorably to Central Oahu and the island of Oahu as a whole, with a median $73,025 per household in 2006, or some $22,900 per person. This compares to medians of $66,667 in Central Oahu, $47,923 in Waianae, and $75,432 for the island as a whole.

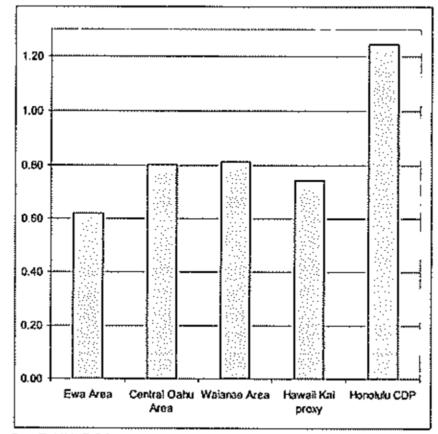
Hawaii Kai shows a higher median household income than the Trade Area, at an estimated $97,091.

Daytime Population Ratios (Exhibit 5-5)

Daytime populations within the Trade Area and benchmark market are estimated based on 2000 ratios prepared by the US Census within Census Designated Places (CDPs)[7]. The Ewa DPA includes three CDPs, while Central Oahu has seven and Waianae has three. The ratios derived from this source are considered baseline figures for the current analysis, as explained below.

Hawaii Kai is not a "Place" designated by the Census. Therefore, Kailua Town's population ratio was used as a proxy for Hawaii Kai's, since both are long-established bedroom communities to Honolulu, located about 30 minutes away, and both have shown recent increases in retail- and service-related employment.

Ratio of Daytime Population to Residents



See Exhibit 5-5 for sources and further information.

On average, the Ewa CDPs show a daytime population of 62% of their resident population, suggesting significant out-commuting during the day.

Central Oahu reflects less out-commuting, as evidenced by a daytime ratio averaging 80% among its CDPs.

Waianae's CDPs also show a relatively high daytime population ratio, at 81%. However, this may be influenced by the relatively high unemployment rates in the district as much as by out-commuting.

Out-commuting for the Trade Area as a whole would be substantially lower than these figures reflect, because (1) there are persons who live and work in different Census Places but still within the Trade Area, and (2) the data are based on 2000 employment and residence patterns and, particularly in Ewa, significant job creation has occurred since then.

As a proxy for Hawaii Kai, Kailua CDP showed a 74% daytime to resident population ratio. Figures for the Honolulu CDP are also presented as an example of an urban area with net daytime in-commuting, and the ratio achievable within a much larger area.[8] The Honolulu

[7] US Census Bureau, Census 2000, PHC-T-40, "Estimated Daytime Population and Employment-Residence Ratios: 2000" Journey to Work and Migration Statistics Branch, 2005.

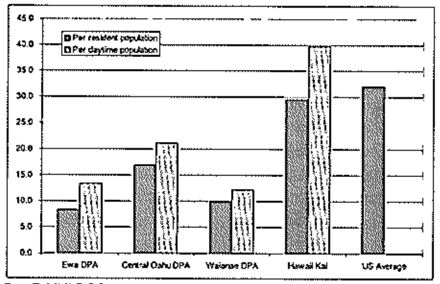
[8] The Census Bureau defines the Honolulu CDP to include Waikiki, the Primary Urban Center and East Honolulu. These data are not skewed by visitors, as they are not inventoried in the Census methodology.

CDP is estimated to provide 54% more jobs than could be filled by its resident workers, and shows a daytime population ratio of 1.25.

Retail Supply in Relation to Population
(Exhibit 5-6)

Comparing retail GLA to resident population, the Ewa and Waianae DPAs appear significantly under-retailed currently, at only 8 to 10 square feet per resident. Central Oahu's resident ratio is more than twice Ewa's, at 17 square feet, while Hawaii Kai is considered a relatively balanced suburban market, at 30 square feet per resident. The latter is more consistent with the U.S. average of about 32 square feet per resident, as discussed previously.

Gross Leasable Square Feet Per Person



See Exhibit 5-6 for sources and further information.

In comparison to estimated daytime population, Ewa and Waianae again stand out as under-retailed, with a ratio just over one-third that shown as supportable in Hawaii Kai. Hawaii Kai is able to support these significantly higher space ratios despite virtually no vacancies.

Supportable Retail-Based Area in Ewa

Methodology (Exhibits 5-7 and 5-8)

Future support for additional retail-based areas in Ewa is expected to come primarily from the resident and daytime populations of the Trade Area. Within the Trade Area, the rapidly increasing resident populations of the Ewa DPA itself would anchor demand for new retail in the DPA. Additionally, the populations of the nearby Waianae and Central Oahu DPAs are expected to contribute an increasing share of their retail expenditures in Ewa, as Ewa becomes a regional hub for jobs, services, entertainment and shopping.

Therefore, the anticipated market support for additional retail space in Ewa is considered from these two perspectives:

- **Immediate market (Ewa DPA)** – Demand is projected by correlating the existing and planned/entitled retail areas in the Ewa DPA with its projected resident and daytime populations. These populations are estimated to support 30 square feet GLA per resident, and 36 square feet per daytime population. Both of these ratios apply to expenditures within the Ewa DPA and are benchmarked to within-community ratios derived from Hawaii Kai.

- **Nearby markets (Waianae and Central Oahu DPAs)** – Demand is projected by estimating expenditures these resident and daytime populations make within a regional market, and within this, Ewa capture rates are estimated. For these purposes, retail potential is estimated at 32 square feet GLA per resident population, and 40 square feet per daytime population. These ratios are marginally higher than those applied to Ewa, since they refer to potential expenditures throughout the Trade Area region, not just Ewa.

Key Assumptions (Exhibits 5-7 and 5-8)

Key assumptions to the projection methodology include the retail to population ratios, daytime to resident population ratios and Ewa's capture rate of retail expenditures made by those who live or work outside the DPA.

- **Retail to population ratios** (as presented above) -

  - **Central Oahu** today is a relatively large, diverse area with significant and diverse retail and service industries that provide a job base. However, it is not a major job center and still experiences significant out-commuting. Thus its resident and daytime retail to population ratios of 17 and 21 square feet, respectively, are very low indicators for the Trade Area, particularly in the future. Also, its vacancy rate of approximately 0.6% suggests it is under-retailed for its existing populations.

  - **Hawaii Kai** is smaller in terms of population, but is a nearly mature bedroom community, with a wide variety of retail, dining and service choices. It also offers facilities that serve a broader regional market. Thus, its ratios of 30 and 40 square feet per resident and daytime population are considered more representative of what the Trade Area could achieve in the future. However, given Hawaii Kai's bedroom community status and its low vacancy rates (0.6% in December 2006), it could also be a low benchmark for Ewa in the future. Additionally, since these figures are derived from space supported within Hawaii Kai only, they could under-represent the total market support if a larger area were considered.

  - The estimated **U.S. average** of 32 square feet per resident population helps to further establish the reasonableness of a resident ratio slightly higher than Hawaii Kai's 30.

- **Regional capture rate** - Ewa's share of expenditures made by nearby residents is expected to increase over time, from a nominal amount currently, to up to 15% (daytime population) or 20% (resident population) by 2030, as Kapolei and East Kapolei grow as centers of employment, shopping, entertainment and dining. It is particularly logical that Ho`opili capture a significant share of Central Oahu resident and daytime population expenditures, due to its location on the Central Oahu border. Residents are expected to be more flexible as to where they make their expenditures than are employees, who are an additional component of daytime population.

- **Daytime population ratios** - This assessment assumes daytime to resident population ratios approaching 0.95 throughout the Trade Area, compared to the average 0.75 within CDP ratios observed in 2000. This approximately 25% increase in the daytime population ratio over the 30 year period (from observations in 2000 to the end of the projection period in 2030) is considered possibly conservative due to:
  - The regional ratio is likely already substantially higher than the 0.75 figure assumed for 2006, since it reflects only those persons remaining within the Trade Area.
  - Some of this change is likely to have occurred already, since the ratios to which these increases are applied were based on 2000 data.
  - The Kapolei region is poised to move from a primarily bedroom community to one that is increasingly a "Second City," in accordance with public and community visions for the area.
  - The assessment would position the Trade Area of the future above the Hawaii Kai proxy of 0.74 and the 2000 Central Oahu figure of 0.80. Both of these areas are somewhat mature but are still bedroom communities.
  - At 0.88, the Trade Area would still be well below the Honolulu CDP figure of 1.25, which reflects a more representative land area, but one anchored by the State's major urban and jobs center.

Conclusions for Ewa

In comparing the two approaches, the daytime population methodology is considered more appropriate because it better reflects Ewa's expected emergence as a regional hub for employees, students, commuters and others who will represent primary support for its commercial markets. Compared to the resident population method, the daytime population method shows a more gradual build-up of additional supportable GLA, but a slightly higher level overall by the end of the projection period in 2030. The implications of the two methods as well as the conclusion for additional supportable retail-based areas in Ewa are summarized in the table on the following page.

Projected Supportable Additional Retail-Based Commercial Space in the Ewa DPA (square feet)

	2015	2030
Method 1: Resident population	1,900,000	2,800,000
Method 2: Daytime population	1,500,000	3,000,000
Conclusion (daytime method)	**1,500,000**	**3,000,000**

Note: Figures represent net additional development potential, beyond that for currently existing and proposed/State-entitled developments.

Source: Mikiko Corporation; see Exhibits 5-7 and 5-8 for further information.

6 - Office Market Environment

Methodology

This chapter presents the estimated market support for additional commercial space in Ewa, as derived from office-based market indicators. Although office spaces are often included in retail shopping centers, this chapter focuses on the market for other office-based facilities: those developed as stand-alone office complexes (that may include some retail) as well as those that may be part of mixed-use developments.

Government office buildings are not considered, since their development and placement is more often a matter of policy and budget processes than market trends. Long-term demand for civilian office facilities is related to civilian job creation.

Waianae residents are as likely as Ewa or Central Oahu residents to find employment within office buildings in the Ewa DPA. However, at this time Waianae has very limited office facilities, so the area is not used as a supply or demand comparison. Rather, the analysis focuses on the Ewa and Central Oahu DPAs, with urban Honolulu and the island as a whole used as benchmarks to portray the types of structural changes that could take place in Ewa over time.

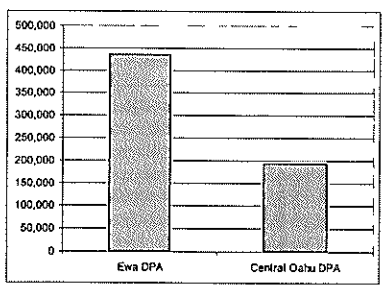
Office supply and demand is evaluated in terms of rentable building area (RBA), expressed in square feet.

Office-Based Supply

Area Inventory (Exhibit 6-1)

Ewa already has more RBA in office buildings than does the more populous Central Oahu DPA, reflecting the urban intent for Kapolei. As of December 2006, the Ewa DPA showed 436,00 square feet of private office space, compared to 194,000 in Central Oahu. The vast majority of Ewa's inventory is now in Kapolei.[1]

Existing Office RBA (square feet)



See Exhibit 6-1 for sources and further information.

[1] Not included in this Kapolei inventory because they are government facilities are 215,000 square feet at the State Office Building, 96,000 at the City's Kapolei Hale and 50,689 at its Police headquarters.

Although occupancy figures are not available for Ewa and Central Oahu separately, "Leeward Oahu," which includes both these areas as well as Waianae, showed a 6.4% office vacancy as of December 2006, according to CMF.

Benchmark Areas (Exhibit 6-1)

The island of Oahu had a total of 15.3 million RBA, of which 11.4 million or 74% was in urban Honolulu. For these purposes, urban Honolulu is defined as the Central Business District (CBD), Kapiolani and King Streets, and the Kaka'ako District, with the components as defined by CMF. Urban Honolulu would show considerably more office space if its government offices were included. Waikiki is not included in this definition of urban Honolulu.

The island's average vacancy rate was 7.0% in December 2006, while the CBD showed 6.7% and Kaka'ako, Kapiolani and King averaged 6.4%.

Planned and Entitled Development (Exhibit 6-2)

Ewa is poised for a nearly five-fold increase in office space, with about 2.2 million square feet of RBA planned and entitled as of December 2006. However, 725,000 square feet of this potential future inventory is located in Kalaeloa, where plans are in considerable flux as of this writing.

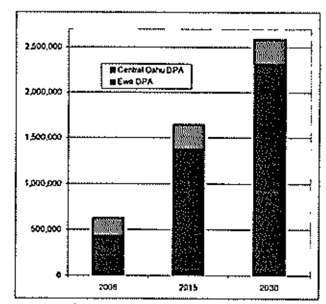
Central Oahu shows about 80,000 square feet in potential future office-based complexes, all within Gentry's Waiawa Phase 1, which is designated LUC Urban.

Specific projects and land areas from which these estimates were derived are presented in Appendix 5.

Future Area Inventory
(Exhibit 6-3)

Considering the planned and entitled projects identified, plus those already operating, Ewa and Central Oahu could have some 2.6 million RBA by 2030, if all projects are developed as currently planned and on the timetables projected. As for the planned retail inventories discussed in the last chapter, most of this new inventory would be added in Ewa, in alignment with the area's projected residential and employment growth.

Potential Future Office RBA in Ewa and Central Oahu (square feet)



See Exhibit 6-3 for sources and further information.

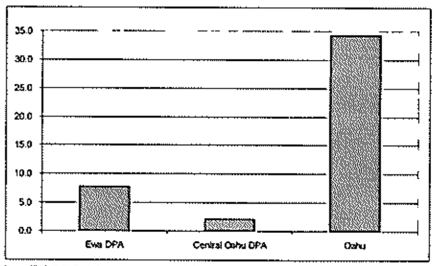
Office-Based Demand

Employment Ratios (Exhibit 6-4)

The civilian labor force in the Ewa DPA currently represents 63% of its resident population. In Central Oahu, the ratio is 57% and in urban Honolulu as for the island as a whole, the ratio is 49%. Ewa's higher ratio reflects its relatively younger population, a higher share of whom are of labor force age. With the job and career opportunities envisioned in Ewa, it is likely to continue to attract a substantial workforce population, but its age profile will also "gray" as will the rest of Oahu's.

RBA Ratios (Exhibit 6-4)

RBA Ratios Per Civilian Employed Persons



See Exhibit 6-4 for sources and further information.

Comparing existing office RBA to the number of civilian employees, the Ewa DPA shows more development than Central Oahu, but significantly less than Oahu as a whole and certainly than urban Honolulu. In 2006, Ewa's private office inventory was estimated at 8 square feet per person in the civilian labor force, compared to 2 in Central Oahu, 34 for the island, and 628 in urban Honolulu.

The very high ratio in urban Honolulu (not depicted in the chart) is evidence of an office worker base that comes from throughout the island. It is anticipated that as it becomes a "Second City," Ewa will also be a magnet for office-based employment on the island, and that it will particularly provide opportunities for those who live in the West Oahu region, including Ewa.

Supportable Office-Based Area in Ewa

Key Assumptions (Exhibit 6-5)

Unlike for shopping, people are accustomed to commuting to their offices. Thus, while the population of the Ewa DPA itself will be a geographically immediate source of demand for future office development, the adjacent and more populous Central Oahu DPA is just as likely to be a source of office employees in Ewa. Central Oahu also appears to be under-supplied with respect to office space at the current time.

Considering just the Ewa and Central Oahu DPAs as demand generators, by 2030, Ewa could require up to 1.37 million square feet of office RBA beyond the potential future supplies that are already entitled and planned. This assessment is based on the following assumptions:

- **Sources of demand** - Only Ewa and Central Oahu employees are considered as a metric for future demand in Ewa. This is conservative since some future enterprises of the DPA could draw employees from throughout the island.

- **Share of population in civilian workforce** – While Ewa now shows 63% and Central Oahu 57%, the civilian employee ratios of both areas are expected to migrate towards the Honolulu and Oahu 2006 averages of 49% as their populations age. However, with the large amount of workforce housing planned in the region, Ewa is expected to continue to show a greater than island-average rate of civilian labor force participation.

- **Supportable RBA per civilian employee** – As the real estate and economic developments planned for the Ewa region take root, the area can expect to see structural changes in the nature of business and employment. Specifically, the Ewa DPA of the future is seen to have more professional and technical opportunities than today. These sectors tend to generate more office-based employment than others.

  Accordingly, the supportable RBA in the Ewa and Central Oahu DPAs is projected to increase to 10, 15 and then 25 square feet per civilian employed residents. This would be a significant change from the 2006 profiles of the areas, but is still a conservative assessment when compared to the 34-square foot average for the island as a whole or the 628 square feet per resident supported in urban Honolulu in 2006.

- **Ewa capture of regional market** – Ewa is projected to capture up to 55% of the combined DPA areas' office market opportunities. This reflects its fair market share (estimated at 50% based on 2030 residents) as well as Ewa's more urban nature relative to Central Oahu's.

Conclusions for Ewa (Exhibit 6-5)

Based on the analyses shown, the Ewa DPA is expected to support some 480,000 square feet of additional office-related building area by 2015, or up to 1.37 million additional RBA (including the 480,000) by 2030. These anticipated supportable areas are in addition to existing office buildings in the DPA, as well as office-based uses that are entitled and proposed for development in the interim.

7 – Ho`opili Commercial Market Assessment

Overview

Ho`opili Proposal

DRH proposes to offer up to 2.96 million square feet of commercial area at Hoòpili, including both retail- and office-based uses. The majority would be located on six BusinessCommercial-designated sites. The balance would be distributed in mixed-use settings andór live-work units near to the village core. As for residential development, the first finished commercial building products are assumed to be available for use in about 2012.

Methodology

The commercial market assessment encompasses both retail- and office-based uses, in recognition of the mixed uses planned at Hoòpili as well as the typical crossover of office spaces within shopping centers and retail uses in office complexes. Thus, the types of commercial uses at the Project will likely be determined as each area is developed.

This chapter summaries the projected supportable additional commercial space for the Ewa DPA as derived from the retail-based and the office-based analyses of the two prior chapters. It also provides the market assessment for commercial uses at Hoòpili.

Ewa DPA Commercial Market

Projected Supportable Area (Exhibit 7-1)

Considering the analyses of retail- and office-based markets presented previously, the Ewa DPA could be expected to support 1.98 million square feet of commercial space in addition to that already in place and entitled and planned for development, by 2015. Over the ensuing 15 years, the DPA is expected to support another 2.39 million square feet of new development, for a cumulative total of about 4.37 million square feet over and above those areas already existing or proposed and entitled for development.

Projected Supportable Additional Commercial Areas in Ewa DPA (square feet)

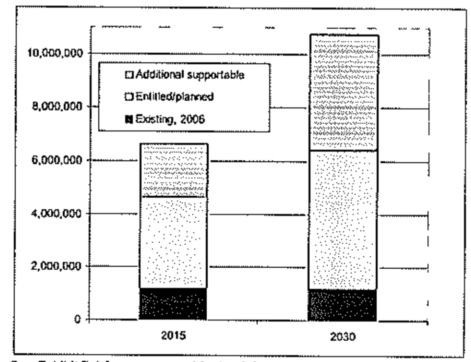
	2015	2030
Retail-based demand	1,500,000	3,000,000
Office-based demand	480,000	1,370,000
Total	1,980,000	4,370,000

Note: Represents net additional supportable development potential, beyond that for currently existing and proposed/State-entitled developments.

See Exhibits 5-8 and 6-5 for further information.

If added to the existing and proposedéntitled the retail and office areas, the net additional markets represent a potential total Ewa DPA commercial marketplace of up to 10.8 million square feet by 2030. This could include neighborhood, community and regional shopping centers, office buildings, "flex units" that could accommodate a proprietor's office as well as home, and retail spaces mixed into residential andór office structures.

Projected Supportable Commercial Areas in Ewa (square feet)



See Exhibit 7-1 for sources and further information.

Supportive Conditions are in Place

The strong commercial outlook for Ewa is based on an assumption that significant economic, workforce, and spending pattern changes take place within the DPA and its neighboring districts prior to or during Hoòpili's mark eting. Of great significance to commercial markets, these changes are expected to be accompanied by a decrease in out-commuting from Ewa, and its surrounding DPAs. These necessary precursors are consistent with the "Second City" vision for the area and include:

- **New centers of "primary jobs,"** meaning jobs with sufficient income to be the primary support for households living in the area;
- **Public policy support for new economic enterprises** relevant to the area, including knowledge- and innovation-based initiatives;
- **More, high quality elementary, middle and high schools,** offering a wide variety of options, including quality public, charter or magnet, private/religious affiliated, and private/non-affiliated schools;
- **More options for entertainment, cultural and civic and spiritual endeavors,** such as performing arts centers, theaters, museums, shopping, social/business clubs, places of worship and libraries;
- **Renewed development** of high quality housing targeting a wide range of income and age groups;
- **Neighborhoods of move-up housing,** to which area households with rising income and home equity would be proud to relocate;and
- **More efficient transportation systems**, both within and to the region.

All of these precursors are in progress in Kapolei and/or East Kapolei, and all are being pursued within Hoòpili itself. Regional developments already underway that are advancing the Ewa DPA towards these desired outcomes include:

- The significant planned expansion of the UHWO campus and programs, and plans to develop a surrounding college town;
- The new State judiciary complex in Kapolei, with 650 direct and indirect jobs;
- Plans for other office buildings in Kapolei;
- Significant inventory of new business park areas under development in Kapolei;
- The State Administration's various "Innovation Initiatives," directed at transforming Hawaii's economy and preparing its citizens for jobs in the new sectors;
- Discussion of high technology or defense-related developments at Kalaeloa;
- The private Island Pacific Academy college preparatory PK-12 school in Kapolei, which opened in 2004 and is now expanding its middle- and high-school programs;
- Second home and golf-front developments recently entitled at Kapolei West;

- Development planning for the first regional shopping centers in Ewa, the Kapolei Commons and DHHL's project;
- Planned transit service linking Kapolei to Honolulu, and going through Hoòpili;
- Development of the North-South Road and Kapolei Parkway;and
- Improvements to Fort Barrette and Fort Weaver Roads.

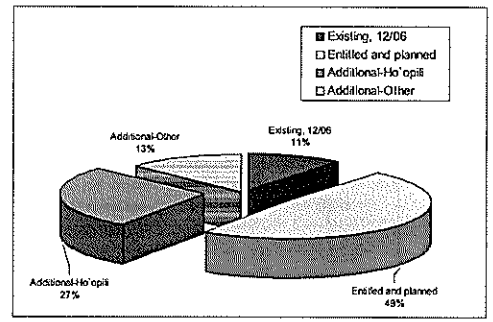
Assessment for Ho`opili

(Exhibit 7-2)

Hoòpili is proposed for up to 2.96 million square feet of commercial uses, including retail and office spaces.

If developed to the full proposed capacity, Hoòpili's commercial spaces could represent about 27% of the Ewa DPA's total future inventory. It could also represent a venue for about two-thirds of the currently unplanned but future supportable commercial space in the DPA.

Potential Ewa DPA Commercial Space Inventory: 2030



See Exhibit 7-2 for sources and further information.

These market shares are considered achievable in light of the prime locations enjoyed by the site and the diversity of commercial development types that are proposed for Hoòpili. Given that potential commercial developments on other entitled lands throughout Kapolei, East Kapolei, Ocean Pointe and Ewa Beach have already been accounted for, Hoòpili appears to be one of the only remaining areas within the DPA on which such development could occur.

8 – Business Park Market Environment and Ho`opili Assessment

Overview

Ho`opili Proposal

As currently laid out, Ho`opili would offer 50 acres for a light industrial research or business park development. After allowing for circulation and infrastructure, a net of 40 acres of the site could be saleable. As discussed at the end of the chapter, however, this analysis concludes that up to two or more times this area could be supported at Ho`opili by future market demand.

Due to its location within a mixed use residential community, Ho`opili's business park is expected to cater to "clean" industries such as office headquarter campuses, research & development facilities, or service-retail uses. As such, the park is expected to have a relatively high floor area ratio (FAR). Ho`opili's site is preliminarily envisioned to show an FAR of 0.50 compared to a typical 0.40 at other built-up light industrial lands on Oahu and about 0.13 as observed for built properties in industrial parks in the Ewa region as a whole.

Methodology

Industrial areas can support business parks, manufacturing, research & development, wholesale, office and retail uses as well as light or heavy industry. They typically serve a super-regional or island-wide market. This analysis profiles current market trends within Ewa and Central Oahu, but the assessment for future demand is based on island-wide trends. This is appropriate because, as eastern Oahu and the island's urban core are redeveloped with higher density and higher value uses, more land-extensive industrial and business park facilities are increasingly being pushed to the western areas of the island.

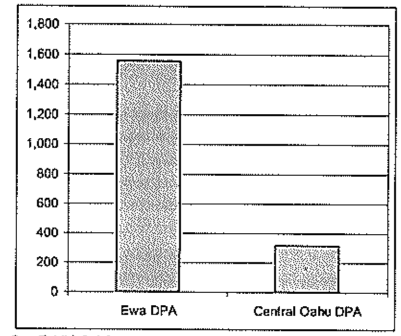
Like office demand, long-term market demand for business park/industrial land is related to trends in civilian job creation. This analysis does not consider public facilities with industrial-related uses or industrial-designated lands such as at military bases, harbors, universities and airports.

This analysis is prepared in terms of acres of land, although much of the available market data is for square feet within buildings developed on such lands.

Industrial and Business Park Supply

Area Inventory (Exhibit 8-1)

Existing Industrial Lands (in acres)

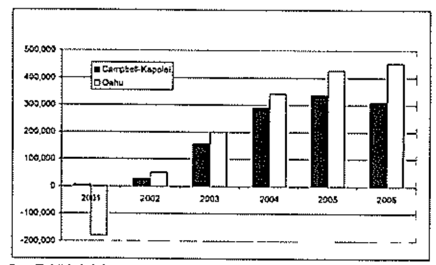


See Exhibit 8-1 for sources and further information.

Ewa's entire business park/industrial inventory is currently in the Kapolei area, where some 1,560 acres were sold or in use as of December 2006. In comparison, Central Oahu includes about 320 acres, which are dispersed in a number of locations.

Ewa showed a 2.6% vacancy as of December 2006, according to CMF, only slightly higher than Oahu's rate. This is a below-optimum level, one that inhibits the growth of businesses and increases their occupancy costs. As further evidence of the current inadequate supply of available properties, CMF reports that net asking rents for developed space have increased about 140% since 2002/03 in Kapolei,[1] and 23% for the island. Likewise, CMF estimates land appreciation since 2004 at 150% in Kapolei and 83% for Oahu as a whole.

Industrial Space Absorption (square feet)



See Exhibit 8-2 for sources and further information.

Market Trends for Industrial Space (Exhibit 8-2)

Oahu's current under-supplied market is in spite of four years of very strong industrial space absorption, particularly in Kapolei. Based on CMF's surveys of leaseable space in industrial buildings, Kapolei has been absorbing around 300,000 square feet in each of the past three years, peaking in 2005 at 335,500 square feet absorbed. Since at least 2001,

[1] CMF describes this area as "Campbell-Kapolei."

Oahu has shown consistent increases in absorption.

The Kapolei area now includes about 5.4 million square feet of leasable industrial building space, representing 14% of the island's built inventory of some 39 million square feet. While Kapolei's share of Oahu inventory has ranged from 12% to 14%, the area accounts for the vast majority of new space absorption, some 70% to 90% since 2003. This reflects the strong future market potential of the Kapolei region and Oahu's growing dependence on this area to serve its industrial- and business-related needs.

Although land area data is not available for the rest of Oahu, with its generally lower-costs and hence lower-density uses, the Kapolei region would represent an even greater share of both current inventory and abosrption if evaluated in terms of land acres rather than built square feet.

Planned Development and Future Inventory (Exhibit 8-3)

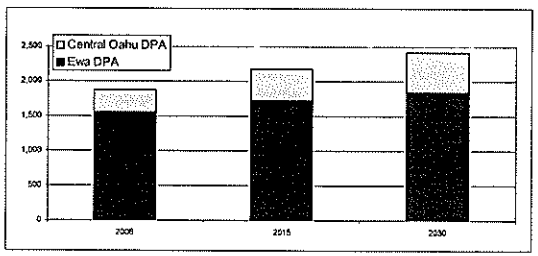
There are some 280 net acres of land entitled and planned for business park/industrial use in the Ewa DPA as of December 2006. However, some 144 acres of this potential future inventory are located in Kalaeloa (Navy plus HCDA-administered lands), and the ultimate use and development timing for these lands are very uncertain. Not included the 280-acre count is the Kapolei Harborside Center, which is proposed for 345 gross acres (240 net). Landowner Kapolei Property Development is now petitioning the LUC to entitle this project.

Another 260 net acres could be provided by 2030 in the Central Oahu DPA. These are largely within future phases of Mililani Tech Park and in Gentry's Waiawa Phase 1.

Specific projects from which these estimates were derived are presented in Appendix 6.

Considering these planned developments, plus areas already in use, Ewa and Central Oahu could have some 2,400 acres of private business or industrial park lands available by 2030, if all projects are developed as currently planned and on the timetables projected. The majority of this inventory would remain in the Ewa DPA.

Potential Future Industrial Land Inventory in Ewa and Central Oahu (acres)



See Exhibit 8-3 for sources and further information.

Industrial and Business Park Demand

Demand for future business park/industrial lands in Ewa can be expected to come from two sources:

1. **Employment-driven demand** - This is estimated based on projections of civilian employment and is driven by the future needs of businesses island-wide.

2. **Transition-driven demand** - Within Oahu, some existing industrial tenants and landowners can be expected to move to Ewa, as they are displaced from areas nearer to the urban core of Honolulu. Transition demand will also be driven by an increasing "pull" from Ewa with its critical mass of services, facilities and consumers, as well as its potentially lower costs and more modern infrastructure.

Employment-Driven Demand (Exhibit 8-4)

Oahu offered 88 square feet of industrial building area per civilian employed person in 2006. Considering the supply-constrained current marketplace, however, a more desirable ratio would be 90 square feet per employee, which would support an average 5% building vacancy compared to the current 2.3%. The ratio of building area to employees has been increasing, reflecting the strong State economy in recent years. Its rise also reflects as an evolving mix of industries on Oahu, particularly growth outside of tourism in areas such as research, high technology, film and media production and the like. As public policy and private efforts continue to encourage such economic transitions, one can expect to see the ratio of industrial space demand to employment continue to increase.

Compared to eight U.S. market areas reported on by Robert Charles Lesser & Co., LLC (RCL),[2] Honolulu's industrial space to employment ratio was the lowest. Comparison locales surveyed in 2004 include:

- Metro Las Vegas – 95 (with 7.6% vacancy);
- Metro Seattle – 111 (with 9.5% vacancy);
- San Diego County – 125 (with 7.6% vacancy);
- San Francisco Bay Area – 131 (with 0.0% vacancy);
- Metro Phoenix, Metro Denver and Los Angeles County – 143 to 236.

Based on just a 0.3% per annum increase in Oahu's ratio, to 97 square feet per employee by 2030, the island could be expected to demand up to 53.3 million square feet of industrial building area by 2030. This compares to the 39.1 million square feet existing as of December 2006, and implies need for another 14.2 million square feet over the next 24 years. The future inventory would represent only about a 1.2% per annum increase over the period, compared to a 0.9% projected annual increase in employed civilians.

[2] Robert Charles Lesser & Co., LLC, "Industrial Market Feasibility: 345-Acre Kapolei Harborside Center," Exhibit II-7, January 31, 2006, (prepared for Aina Nui Corporation). RCL cites Grubb and Ellis and Colliers as its sources.

Assuming a FAR of 0.20 for the new areas[3], the projected demand for new building space implies need for another 1,627 net acres of land by 2030. This includes some 113 acres of estimated pent-up demand in 2006. The ratio used in this projection would position the Oahu of 2030 between Metro Las Vegas and Metro Seattle of 2004.

Given the 540 net acres identified as planned in Ewa and Central Oahu, plus another 115 documented at three other sites on Oahu, the island could require another 972 net acres of business park/industrial lands by 2030, beyond those already entitled and planned (1,627-540-115). This is the need component that can be associated with increases in the island's employment base.

Transition-Driven Demand (Exhibit 8-5)

In addition to demand related to a growing employment base, the Ewa district in particular will need to support business park/industrial land users moving from other areas of Oahu. Sources of this transition-based demand are two-fold:

- **Displacement** – Two large areas of current business park/industrial use near to Honolulu's urban core are already displacing tenants and can be expected to continue to do so. These include the Kaka'ako District, estimated by CMF to house some 2.88 million square feet of business park/industrial tenants (2.78 million estimated to be occupied), and the former Kapalama Military Reservation on Sand Island, with an estimated 1.25 million square feet. KMR's transition is expected to take about 5 years, while Kaka'ako's could persist over the next 15 years.

  Together, these two areas represent about 4.0 million square feet of space that will need to relocate within the island. By 2012, the projected start date for Ho'opili, some 100 acres worth of tenant space might have already relocated, including all of KMR and a portion of Kaka'ako. Tenants requiring up to another 73 acres (23 + 50) might still need to be relocated by 2021.[4]

- **Lease turnover** – Based on a common five-year space lease, in any given year approximately 20% of existing leases would come up for renewal and some 5% of those could be expected to relocate. Considering Oahu's current business park/industrial space inventory (outside of Kaka'ako and KMR), this would represent about 342,000 square feet of business park/industrial space seeking to relocate in any given year. While this source of demand will grow as the island inventory of space increases, for these purposes, only the 342,000 square foot figure is used.

[3] This compares to the 0.13 currently observed in business park/industrial areas in West Oahu, according to survey data provided by CMF.

[4] Expiring ground leases, area redevelopment and other factors will also displace tenants at other locations, including the Airport and Mapunapuna areas. These situations are not added to the demand calculations here because of the lack of complete information. The assessment of demand in Ewa would be higher if more such situations could be documented.

Within the study horizon, lease turnover could generate about 8.2 million square feet of relocations (3.1 million + 5.1 million), which could represent about 340 acres of land.

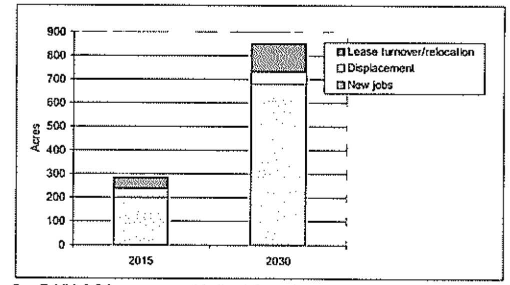
Business Park/Industrial Land Assessment

Ewa DPA (Exhibit 8-6)

The market potential for the Ewa DPA will be determined by its capture rates of the employment-driven and the transition-driven sectors of demand.

- **Employment-driven demand** – This demand originates primarily from new or expanding businesses that require new or more space. Because much of this demand could be attributable to new enterprises, it is considered more likely to be able to locate away from Oahu's existing centers of business and tourism near Honolulu and more likely to be attracted to the more modern infrastructure of the Kapolei region.

Potential Future Business Park/Industrial Land Requirements in the Ewa DPA by Demand Source



See Exhibit 8-6 for sources and further information.

A 70% capture rate is employed for this source, roughly equivalent to the Ewa DPA's fair share of anticipated new business park/industrial development on the island. Seventy percent is also within the Campbell-Kapolei area's share of new island industrial space absorption over the past four years, as presented in Exhibit 8-2.

This would result in about 199 more acres supportable in the DPA by 2015, or 680 cumulatively by 2030.

- **Transition-driven demand** – Transition-driven demand is the relocation of existing tenancies rather than a net increase in island-wide demand. The Ewa DPA is likely to be an attractive area for many transitioning tenants, with its lower occupancy costs that permit more land-extensive operations, and its greater supply availability.

  On the other hand, the majority of the existing lease turnover tenancies and all of those examined for displacement (Kaka'ako and KMR) are already established near to the urban core, and likely have business and client relations there. Thus only 30% to 35% of the identified transitioning sources of demand are assumed to relocate to the Ewa DPA.

  Transition-driven demand could be expected to support some 82 new acres of business park/industrial or business park tenancy in Ewa by 2015, or 171 cumulatively by 2030.

- **Total demand** – In total, supportable new industrial/business park land in the Ewa DPA, beyond that already entitled and planned, could amount to some 280 acres by 2015, or 850 cumulatively by 2030.

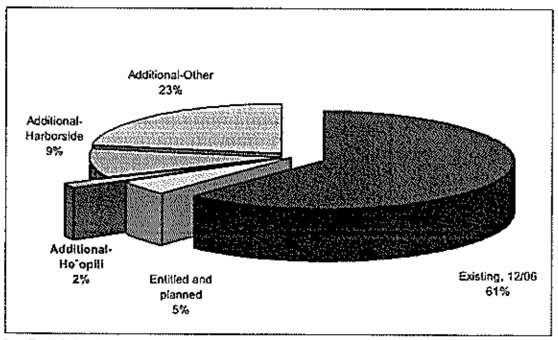
  Kapolei Harborside Center, a 240 net acre (345 gross acre) proposed development, is currently petitioning the LUC for Urbanization. Even if Harborside Center is approved, the region could still be expected to support at least 40 more net acres by 2015, or 610 cumulative by 2030 (850-240).

Assessment for Ho`opili (Exhibit 8-7)

The land use plan for Ho`opili includes a 50-acre (40 net acre) site for business park development.

This site would represent a solution for only 2% of the net unprovided-for demand in the region. Even if the Kapolei Harborside project receives LUC and other approvals to permit its development, there could remain substantial unmet demand for business park or industrial lands in the area, particularly in the 2015 to 2030 period.

Potential Supportable Ewa DPA Business Park/Industrial Inventory in 2030
(Hoopili land allocation as currently planned)



See Exhibit 8-7 for sources and further information.

Given the strong regional market conditions as well as Ho`opili's outstanding location, access and visibility, and the integration of its business park site into a mixed-use community with a range of housing opportunities, it is expected that the net 40-acre site proposed could be fully absorbed by 2015. In addition, it appears there could be market support for two or more times the current land allocation, with the additional area supportable between 2015 and 2030. At 80 net acres, the greater land allocation would still represent only 4% of 2030 regional supply or 10% of future demand currently not provided for by State entitlements and private development plans.

While even a 80 net acre site at Ho`opili would represent a small addition to the region's future inventory in 2030, it could enable an iconographic source of high quality employment for the community. Example development types that a Ho`opili business park could support include:

- **Science and Technology Park** – This opportunity could relate to the site's proximity to the proposed UH West Oahu as well as its location on a transit route and the modern infrastructure and planning of Ho`opili. Example enterprises or activities in such parks could include:

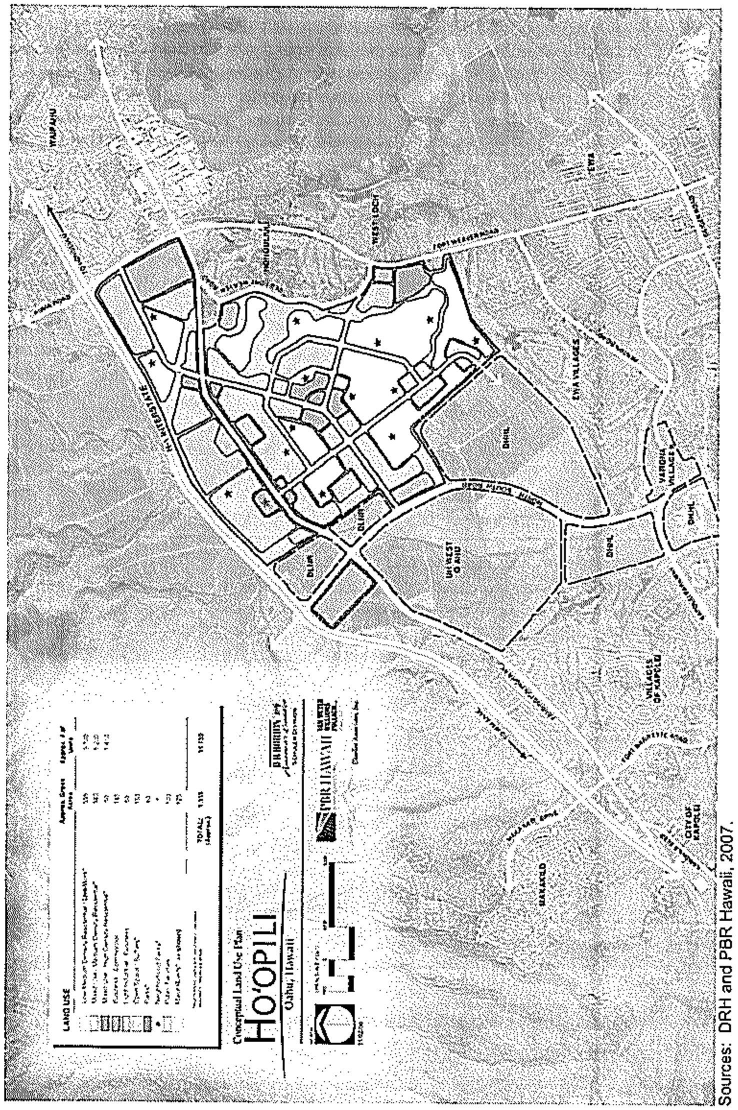
  - Wet lab-based research & development or production;
  - Social science or public health research;
  - Software or distance learning production;
  - Media/film/music school or production facility; and
  - Natural resource research and/or management.

- **Lifestyle/Wellness Center** – As Baby Boomers move into their 50s, 60s and beyond, there is amble evidence of interest in enterprises that cater to enhancing their quality of life or appearance, and in prolonging their healthy and productive years. Baby Boomers as well as younger generations have also demonstrated a willingness to expend significant funds on such endeavors. Example facilities within a lifestyle/wellness center include:

  - Health and wellness campus;
  - Fitness and rehabilitation institute;
  - Medical park;
  - Senior lifestyle and care facilities; and
  - Post-surgical retreat and recovery center.

- **General Business Park** – The site could also be developed as a more generic business park, offering land sales or space sales/leases to a variety of enterprises.

Exhibit 1-1
Ho`opili Conceptual Land Use Plan



Sources: DRH and PBR Hawaii, 2007.

Exhibit 1-2
Overview of Ho`opili Development Plan

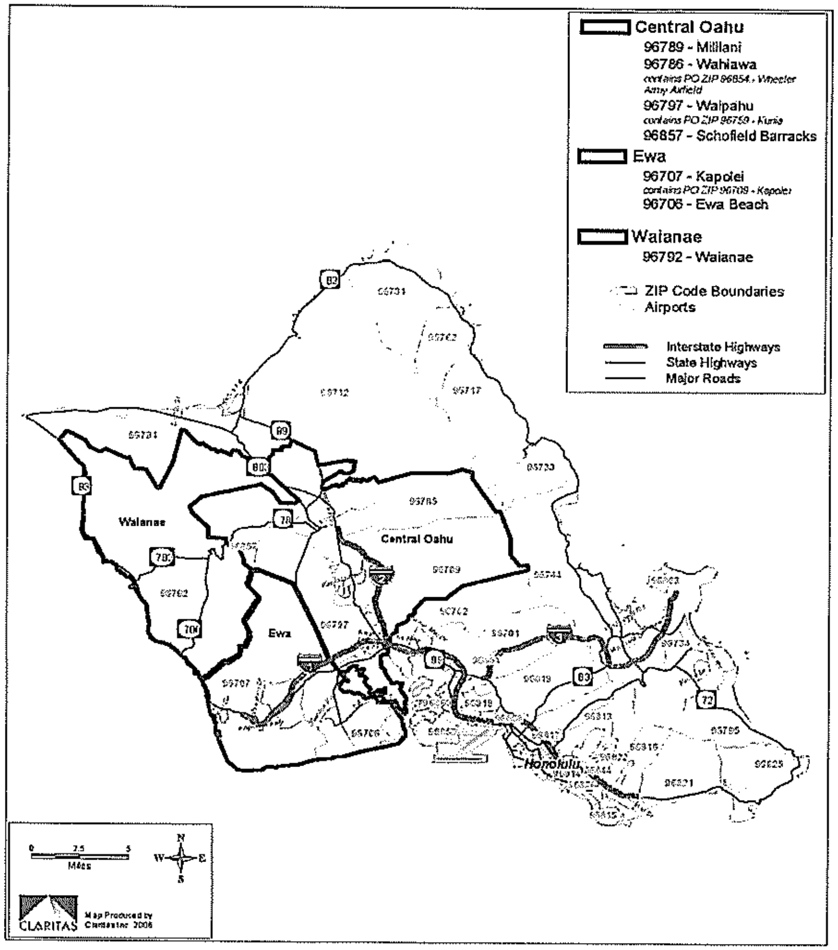
	Gross acres	Net acres[1]	Density range	Total	Comment
Residential:			*Units/net acre*	*Units*	
Low-Medium Density	535	400 - 475	5 -14	5,100	Single-family and mixed use (multifamily); includes office spaces within mixed-use areas.
Mixed Use/Medium Density	340	250 - 300	15 - 29	5,200	Mixed-use, including retail and office spaces (neighborhood-serving).
Mixed Use/High Density	50	40	30 - 50	1,450	Mixed-use, typically residential-over-retail, including retail and office spaces (neighborhood-serving).
Total	925	690 - 815		11,750	
			Floor area ratio	*Square feet*	
Commercial retail/office	145	130	.23 - .50	2,960,000	Figures include spaces within mixed-use residential areas; majority of retail space within two stand-alone sites serving regional markets.
Research and business park	50	40	0.50	800,000	Mauka of HECO sub-station, along Farrington.

Mixed use - combines residential with office and/or retail

[1] Excludes interior roadways and other non-saleable areas.

Sources: DRH and PBR Hawaii.

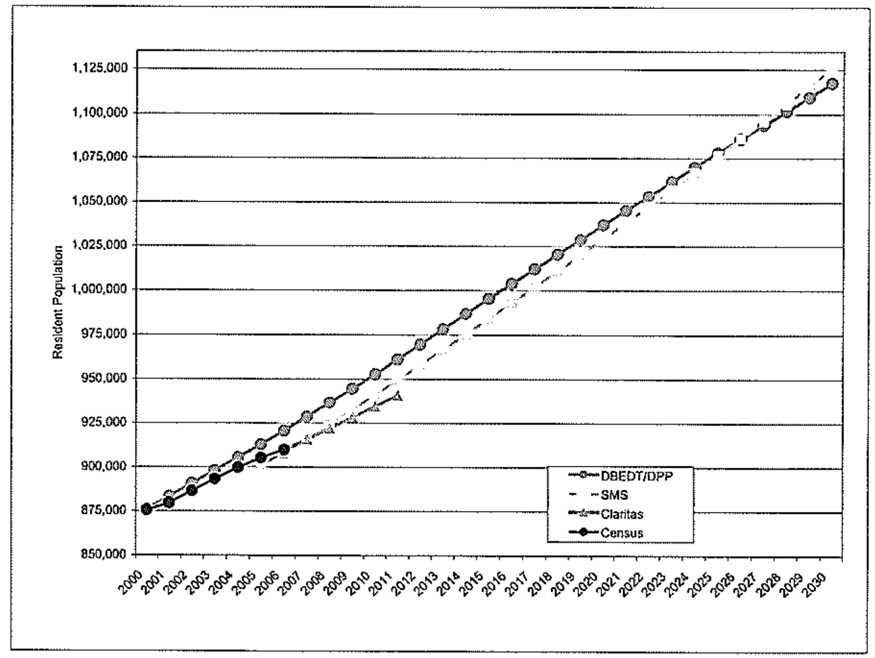
Exhibit 2-1
Trade Area Development Plan Areas as Approximated by Zip Code



Source: Claritas, Inc., 2006.

Exhibit 2-2
Resident Population - Island of Oahu
Comparison of Estimates and Projections
2000 to 2030

	Date prepared	2005	2006	2011	2015	2020	2025	2030
DBEDT/DPP[1]	2004	912,900	920,700	961,100	995,550	1,037,250	1,078,050	1,117,300
SMS[2]	2007	901,155	907,883	949,480	984,125	1,029,215	1,076,371	1,125,688
Claritas[3]	2006	--	909,408	940,689				
U.S. Census[4]	2006	905,266	909,863					



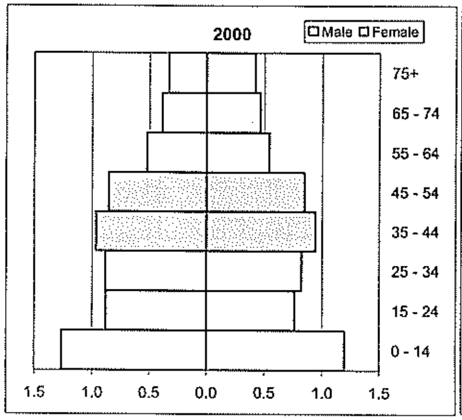
1 State of Hawaii, Department of Business, Economic Development and Tourism, Research and Economic Analysis Division, "Population and Economic Projections for the State of Hawaii to 2030," (DBEDT 2030 Series), August 2004. Projections for 2005 and 5-year increments thereafter to 2030; figures interpolated in-between. City and County of Honolulu, Department of Planning and Permitting uses DBEDT's projections.

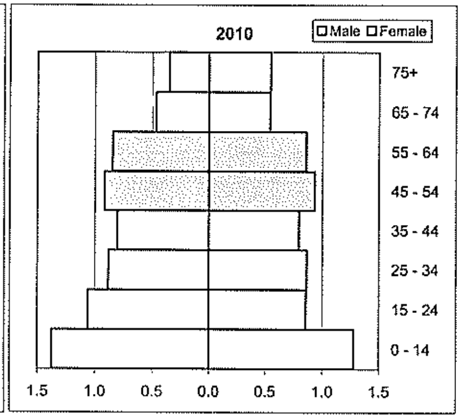
2 SMS, Inc., "Housing Policy Study, 2006: Hawaii Housing Model 2006," February 2007. Population growth set to "official parameters" for Honolulu County of 0.9%.

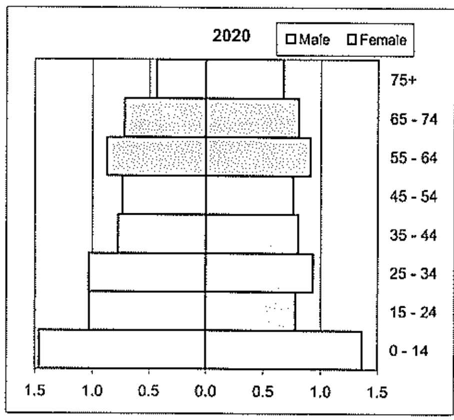
3 Claritas, Inc., October 23, 2006. Estimate for 2006; projection for 2011; figures interpolated in-between.

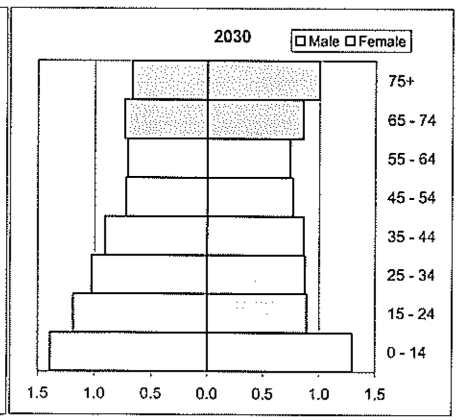
4 U.S. Census Bureau, Population Division, Table 1; Annual Estimates of the Population for Counties of Hawaii (3/16/06). As of July 1.

Exhibit 2-3
Projected Population by Age Group - State of Hawaii
2000 to 2030





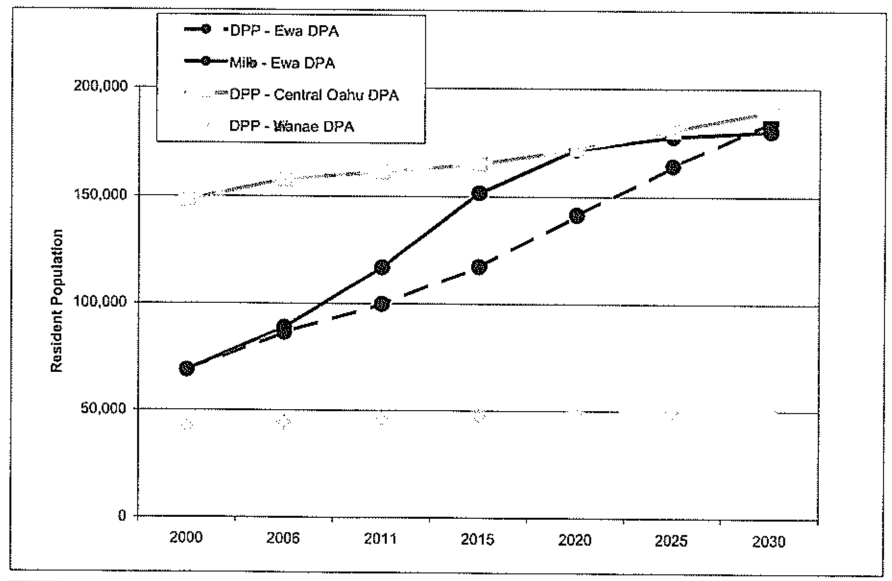




Notes: Each unit on axis represents 100,000 persons. Highlighted bars include Baby Boom cohort.
Source: U.S. Census Bureau, Population Division, Interim State Population Projections (released 4/21/05), http://www.census.gov/population/www/projections/statepyramid.html.

Exhibit 2-4
Resident Population - Ewa, Central Oahu and Waianae
2000 to 2030

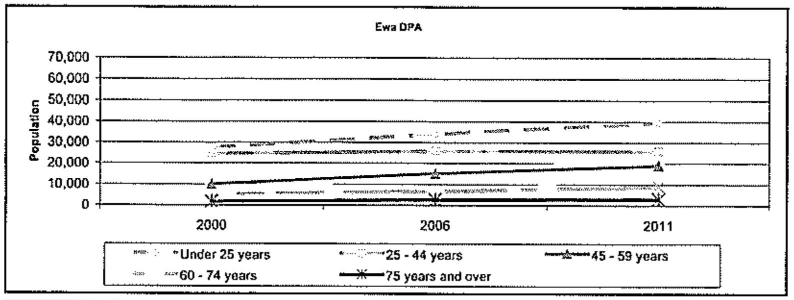
	2011	2015	2020	2025	2030	Average annual % increase, 2006-2030
DPP projections:						
Population:						
Ewa DPA	99,720	117,250	141,420	164,140	184,610	3.2%
Central Oahu DPA	161,250	164,950	172,100	180,690	189,600	0.8%
Waianae DPA	45,830	47,300	48,620	49,680	50,620	0.6%
Island of Oahu	961,080	995,550	1,037,250	1,078,050	1,117,300	0.8%
As a percentage of Oahu:						
Ewa DPA	10%	12%	14%	15%	17%	--
Central Oahu DPA	17%	17%	17%	17%	17%	--
Waianae DPA	5%	5%	5%	5%	5%	
Mikiko projection for Ewa DPA[1]:						
Population	116,800	151,600	171,900	177,800	180,200	3.0%
Percent of Oahu	12%	15%	17%	16%	16%	--

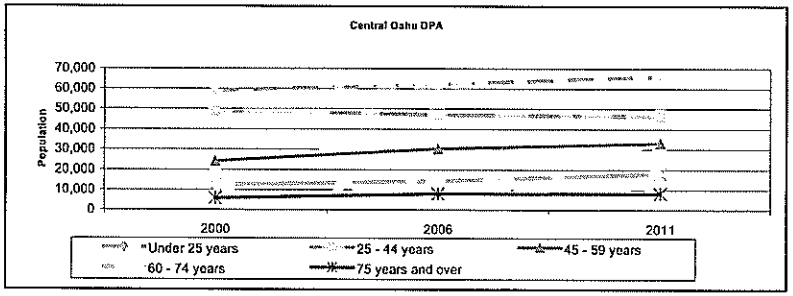


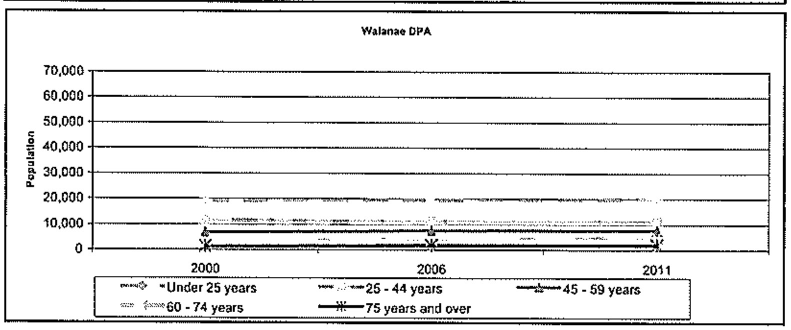
1 Mikiko Corporation projections are based on DPP's estimates for 2000 and 2005, with population thereafter based on anticipated development of UC-entitled housing in Ewa as shown in Exhibit 3-7 (adjusted 5% for vacancy) and an average household size of 3.1 (vs. historical area estimate of 3.5) in new housing units. Figures do not reflect impact of Hoopili or other unentitled, proposed developments. Other DPA projections not reviewed by Mikiko.

Source: City and County of Honolulu, Department of Planning and Permitting, February 16, 2006; Mikiko Corporation, 2007.

Exhibit 2-5
Population by Age Group - Ewa, Central Oahu and Waianae
2000 to 2011







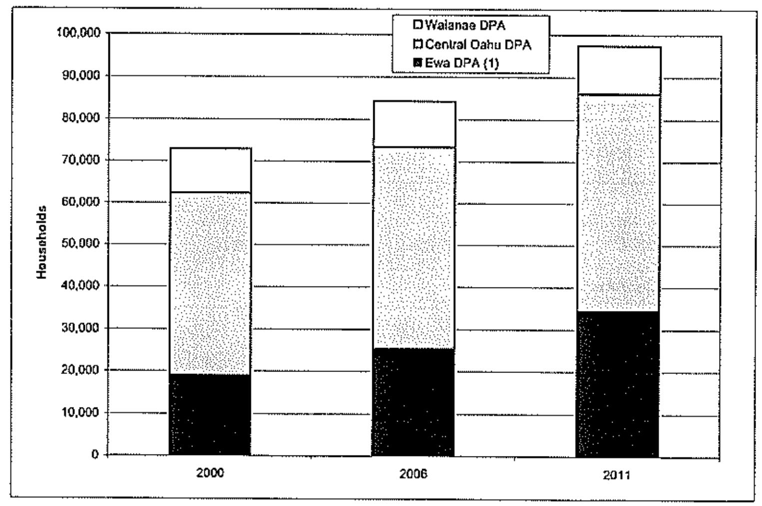
Median ages 2006: Ewa DPA - 32.0 Central Oahu - 33.1 Waianae DPA - 29.3 Oahu - 37.7

Note: DPAs (Development Plan Areas) are those defined by the City and County of Honolulu, but approximated for data generation purposes by zip code area. See Chapter 2 for further information.

Source: Claritas, Inc., October 23, 2006, October 24, 2006 and December 8, 2006.

Exhibit 2-6
Households - Ewa, Central Oahu and Waianae
2000 to 2011

	2000	2006	2011	Average annual % increase 2000 - 2006	2006 - 2011
Number of households:					
Ewa DPA[1]	18,942	25,371	34,344	5.0%	6.2%
Central Oahu DPA	43,384	47,981	51,811	1.7%	1.5%
Waianae DPA	10,535	10,960	11,365	0.7%	0.7%
Island of Oahu	286,450	300,924	313,409	1.0%	0.8%
Average household size:					
Ewa DPA[1]	3.6	3.5	3.4	-0.5%	-0.6%
Central Oahu DPA	3.5	3.4	3.3	-0.5%	-0.6%
Waianae DPA	4.0	4.0	4.0	0.0%	0.0%

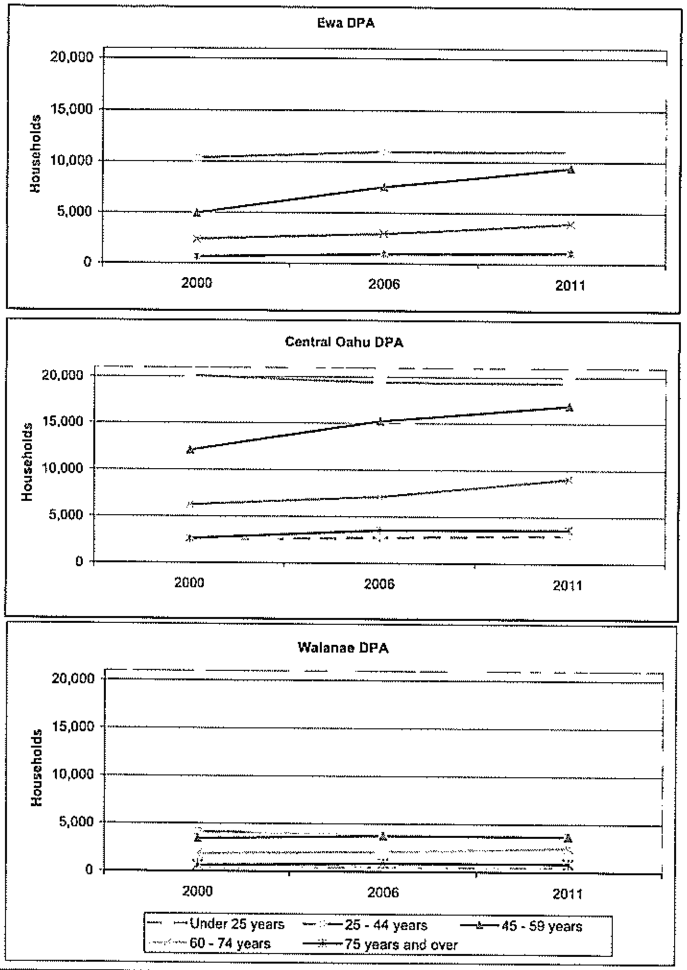


[1] Claritas figures for 2006 and 2011 adjusted by Mikiko Corporation to reflect anticipated population levels based on State LUC-entitled expected housing development, as shown in Exhibit 2-4. New households assumed to average 3.1 persons, while previously existing households assumed to average 3.5 in 2006.

Note: DPAs (Development Plan Areas) are those defined by the City and County of Honolulu, but approximated for data generation purposes by zip code area. See Chapter 2 for further information.

Source: Claritas, Inc., October 23, 2006, October 24, 2006 and December 8, 2006; Mikiko Corporation.

Exhibit 2-7
Households by Age of Head - Ewa, Central Oahu and Walanae
2000 to 2011

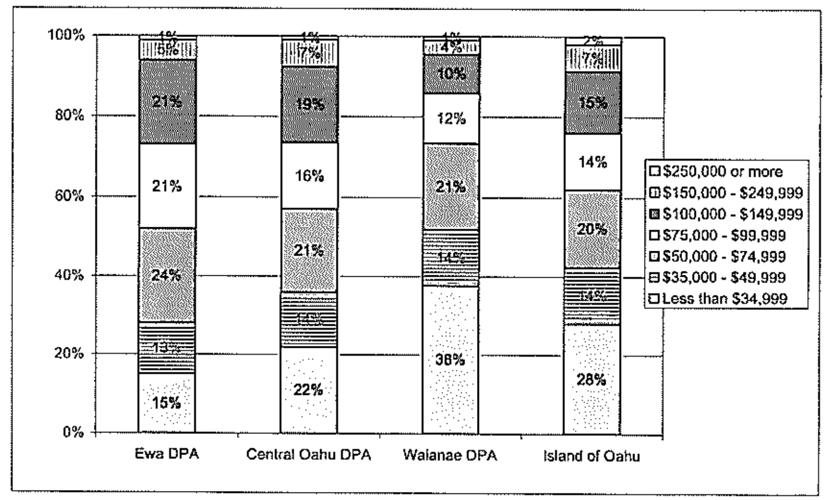


Note: DPAs (Development Plan Areas) are those defined by the City and County of Honolulu, but approximated for data generation purposes by zip code area. See Chapter 2 for further information.

Source: Claritas, Inc., October 23, 2006, October 24, 2006 and December 8, 2006.

Exhibit 2-8
Households by Household Income - Ewa, Central Oahu and Waianae
2006 Estimate

	Ewa DPA[1]	Central Oahu DPA	Waianae DPA	Island of Oahu
Median household income	$73,025	$66,667	$47,923	$59,606
Per capita income	$22,876	$23,493	$14,971	$25,565
Number of households, by income -				
Less than $34,999	3,806	10,563	4,127	84,338
$35,000 - $49,999	3,298	6,665	1,570	43,552
$50,000 - $74,999	6,089	10,143	2,353	58,744
$75,000 - $99,999	5,328	7,898	1,354	41,949
$100,000 - $149,999	5,328	9,060	1,068	46,369
$150,000 - $249,999	1,269	3,235	384	20,084
$250,000 or more	254	417	104	5,888
Total	25,371	47,981	10,960	300,924



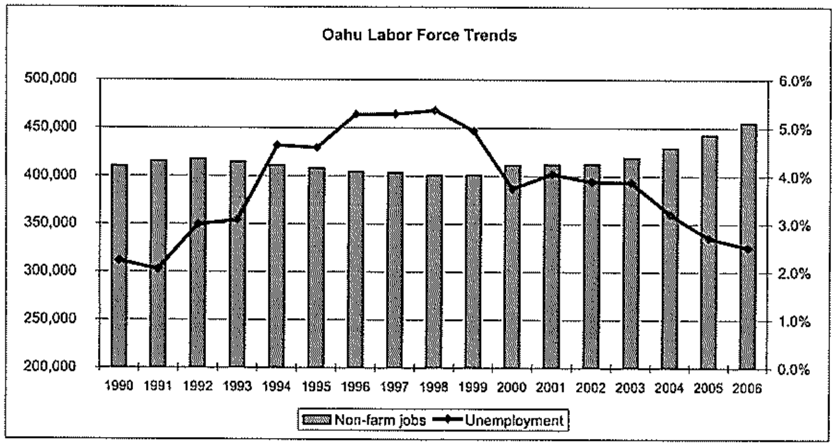
Note: DPAs (Development Plan Areas) are those defined by the City and County of Honolulu, but approximated for data generation purposes by zip code area. See Chapter 2 for further information.

1 Number of households in Ewa reflect Mikiko Corporation projections as shown in Exhibit 2-6, with distribution according to Claritas' projections.

Sources: Claritas, Inc., October 23, 2006, October 24, 2006 and December 8, 2006; Mikiko Corporation.

Exhibit 2-9
Labor Force Trends - Honolulu County
1990 to 2006

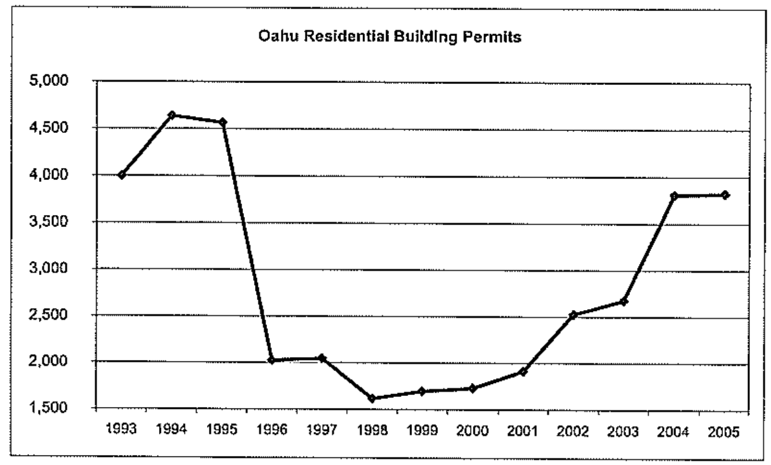
	Civilian labor force	Employed persons	Non-farm wage & salary jobs	Percent unemployment
1990	409,250	401,250	410,700	2.0%
1991	412,000	403,600	415,600	2.0%
1992	418,000	406,400	418,000	2.8%
1993	423,200	409,900	414,800	3.1%
1994	425,450	408,750	411,600	3.9%
1995	428,000	409,550	408,300	4.3%
1996	432,000	411,000	404,700	4.9%
1997	433,600	412,800	403,600	4.8%
1998	434,700	413,600	400,900	4.9%
1999	433,350	414,300	401,500	4.4%
2000	433,100	416,450	412,000	3.9%
2001	435,300	417,500	412,450	4.1%
2002	430,900	413,850	412,800	4.0%
2003	432,650	416,300	419,700	3.8%
2004	433,850	420,000	429,700	3.2%
2005	445,150	432,950	443,250	2.7%
2006	457,700	446,200	455,300	2.5%



Source: Hawaii State Department of Labor & Industrial Relations, 2007. Labor force estimates revised by DLIR with new methodology employed by U.S. Bureau of Labor Statistics, as of 2007. As referenced in: www.hiwi.org/admin/uploadedPublications/466_FHN.PD F. Non-farm wage and salary job estimates provided by DLIR as referenced in: http://www.hiwi.org/article.asp?ARTICLEID=615&PAGEID=94&SUBID=

Exhibit 3-1
Private Residential Building Permits - Island of Oahu
1993 to 2006

	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Annual
1993	554	992	1,545	908	3,999
1994	613	1,385	1,261	1,380	4,639
1995	1,581	923	1,580	482	4,566
1996	532	260	885	347	2,024
1997	195	980	532	337	2,044
1998	423	334	497	361	1,615
1999	468	479	334	415	1,696
2000	352	469	382	527	1,730
2001	466	595	497	353	1,911
2002	296	553	807	867	2,523
2003	682	785	576	630	2,673
2004	1,509	940	620	742	3,811
2005	520	954	965	1,382	3,821
2006[1]	453	473	782	INA	INA

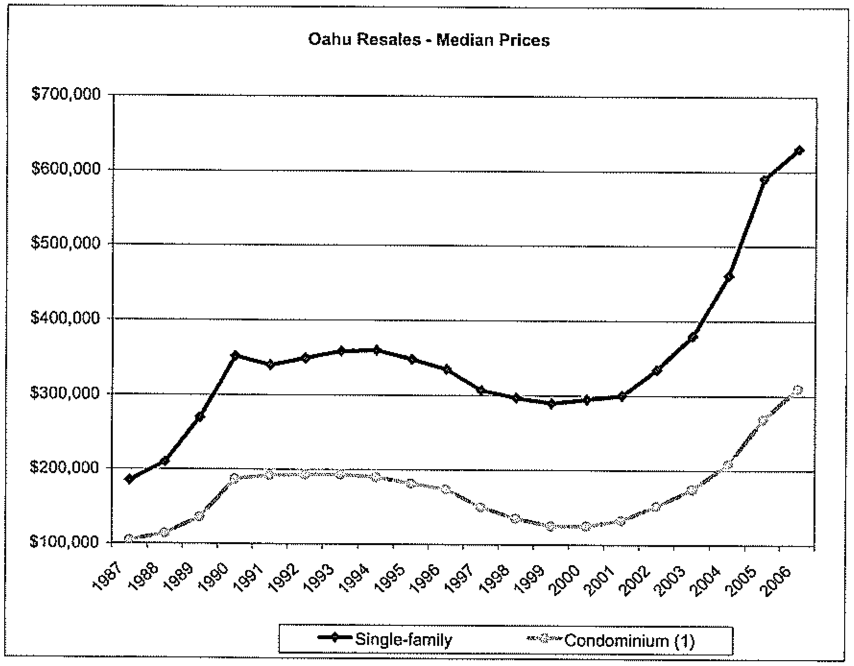


INA = Information not available.
[1] As of third qarter 2006.

Source: City & County of Honolulu Bilding Department, as referenced in http://www.hawaii.gov/dbedt/info/economic/data_reports/qer/select-county-tables.xls.

Exhibit 3-2
Median Home Sales Prices - Honolulu County
1987 to 2006

	Single-family	Condominium[1]
2000	$295,000	$125,000
2001	$299,900	$133,000
2002	$335,000	$152,000
2003	$380,000	$175,000
2004	$460,000	$208,500
2005	$590,000	$269,000
2006	$630,000	$310,000

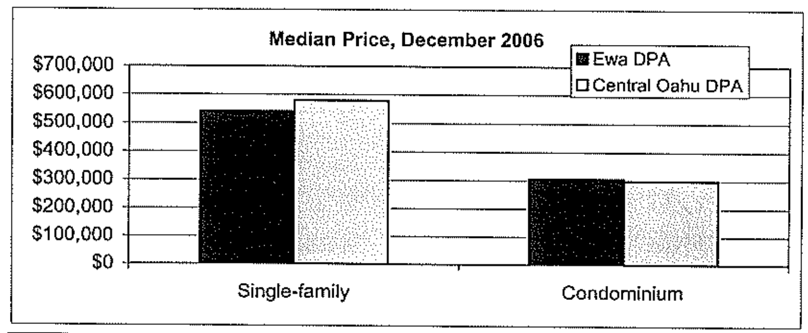


Note: Resales only; shows residential units that are entered in the Multiple Listing Service.
[1] Includes duplexes, townhomes and other multifamily units with common areas.

Source: Honolulu Board of Realtors, Residential Resale Activity on Oahu, monthly.

Exhibit 3-3
Residential Resales Indicators - Ewa and Central Oahu
As of December 2006

	Number of sales, Jan. - Dec. 2006			Median price, Dec. 2006	
	Single-family	Condominium	Total	Single-family	Condominium
Ewa DPA:					
Ewa Plain	692	500	1,192	$528,000	$302,000
Makakilo	179	191	370	$600,000	$320,000
Total	871	691	1,562	$543,000	$307,000
	Percent change since Jan. - Dec. 2005:			*Percent change since 12/05:*	
Ewa Plain	-9%	-12%	-10%	8%	18%
Makakilo	20%	-3%	7%	9%	16%
Total	-5%	-9%	-7%	9%	18%
Central Oahu DPA:					
Wahiawa	76	69	145	$462,000	$188,000
Mililani	348	524	872	$610,000	$315,000
Waipahu	355	410	765	$575,000	$298,000
Total	779	1,003	1,782	$580,000	$299,000
	Percent change since Jan. - Dec. 2005:			*Percent change since 12/05:*	
Wahiawa	-21%	5%	-10%	10%	39%
Mililani	0%	-19%	-12%	8%	17%
Waipahu	-3%	-7%	-5%	10%	14%
Total	-4%	-13%	-9%	9%	16%



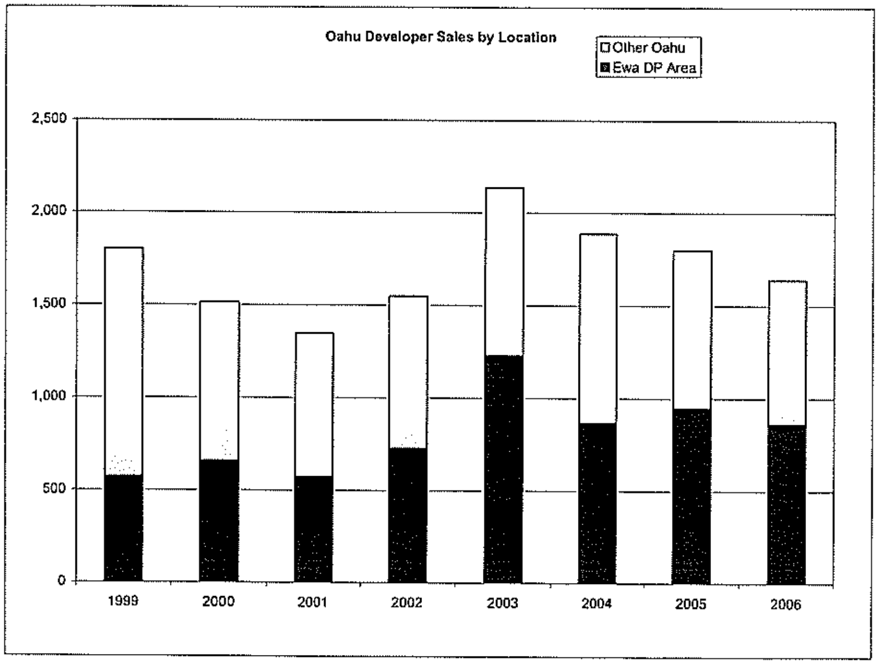
Source: Honolulu Board of Realtors, December 2006 Monthly Statistical Report, Residential Resale Activity on Oahu, January 2007.

Exhibit 3-4

Developer Unit Sales - Island of Oahu and Ewa DPA

1999 to 2006

	1999	2000	2001	2002	2003	2004	2005	2006	Average annual
Island of Oahu:									
Single-family units	912	1,115	1,025	1,155	1,744	1,315	1,086	955	1,163
Townhouse units	290	195	268	381	371	547	531	358	368
High-rise condominium units	601	204	55	13	21	26	183	327	179
	1,803	1,514	1,348	1,549	2,136	1,888	1,800	1,640	1,710
Ewa DP area[1]:									
Single-family units	466	599	508	526	1,031	731	752	691	663
Townhouse units	108	62	66	204	199	136	195	170	143
High-rise condominium units	0	0	0	0	0	0	0	0	0
Total	574	661	574	730	1,230	867	947	861	805
As % of Island	*32%*	*44%*	*43%*	*47%*	*58%*	*46%*	*53%*	*53%*	*47%*



[1] Approximated by the Ewa, Kapolei and West Oahu (Ko Olina) areas, as defined by The Harris Company.

Source: Te HAI6 Company, figures represent units reported by developers to have closed escrow and recorded.

Exhibit 3-5

Projected New Housing Supply - Ewa DPA

Planned Developments with State Land Use Entitlement or Exemption

as of December 2006

Project	Total planned units	2007 - 2010	2011 - 2015	2016 - 2020	2021 - 2025	2026 - 2030	Total, 2007-2030
Kapolei West	1,450	275	875	300	0	0	1,450
Makaiwa Hills I and II	4,100	650	1,625	1,625	200	0	4,100
City of Kapolei (Campbell)	1,000	650	350	0	0	0	1,000
Palailai Mauka (also "Kapolei Mauka")	750	225	525	0	0	0	750
Villages of Kapolei (remnants)	472	472	0	0	0	0	472
Wai Kalo'i ("Palehua East B")	300	300	0	0	0	0	300
Ewa Villages	57	0	57	0	0	0	57
Kahiwelo (por., Palehua East C & D)	475	285	190	0	0	0	475
Mehana (also "Kapolei Makai")	1,150	750	400	0	0	0	1,150
Ewa by Gentry and Gentry Ewa Makai	2,000	1,500	500	0	0	0	2,000
Ocean Pointe (prev. "Ewa Marina")	2,100	1,500	600	0	0	0	2,100
E A H	242	242	0	0	0	0	242
Ko Olina Resort & Marina	268	90	178	0	0	0	268
Franciscan Vistas Ewa	328	328	0	0	0	0	328
East Kapolei I	403	403	0	0	0	0	403
East Kapolei II & III	5,200	600	1,875	1,875	850	0	5,200
Kaupe'a (Villages of Kapolei, Village 8)	326	326	0	0	0	0	326
UH West Oahu project	4,041	400	1,875	1,766	0	0	4,041
Kalaeloa	6,290	400	1,500	1,500	1,500	1,390	6,290
Mokuola Vista	70	70	0	0	0	0	70
Total (rounded)	**31,000**	**9,500**	**10,600**	**7,100**	**2,600**	**1,400**	**31,000**
Percent of period		**31%**	**34%**	**23%**	**8%**	**5%**	**100%**

Source: Based on information presented in Appendix 2. Ko Olina units valued at 20% and Kapolei West units at 60% of respective total entitlements, to exclude nonresidential buyers.

Exhibit 3-6
Projected New Housing Supply - Central Oahu DPA

Planned Developments with State Land Use Entitlement or Exemption
as of December 2006

Project	Total planned units	2007-2010	2011 - 2015	2016 - 2020	2021 - 2025	2026 - 2030	Total, 2007-2030
Mililani Mauka	440	440	0	0	0	0	440
Waipio Point	66	66	0	0	0	0	66
Waiawa Gentry Phase 1	5,000	600	3,500	900	0	0	5,000
Kau'olu Properties	370	0	370	0	0	0	370
Royal Kunia II	2,000	200	1,800	0	0	0	2,000
Plantation Town Apartments	330	330	0	0	0	0	330
California Ave. Apartments	42	42	0	0	0	0	42
Total (rounded)	8,200	1,600	5,700	900	0	0	8,200
Percent of period		20%	70%	11%	0%	0%	100%

Source: Based on information presented in Appendix 2.

Exhibit 3-7
Projected New Housing Supply - Island of Oahu

Planned Developments with State Land Use Entitlement or Exemption
as of December 2006

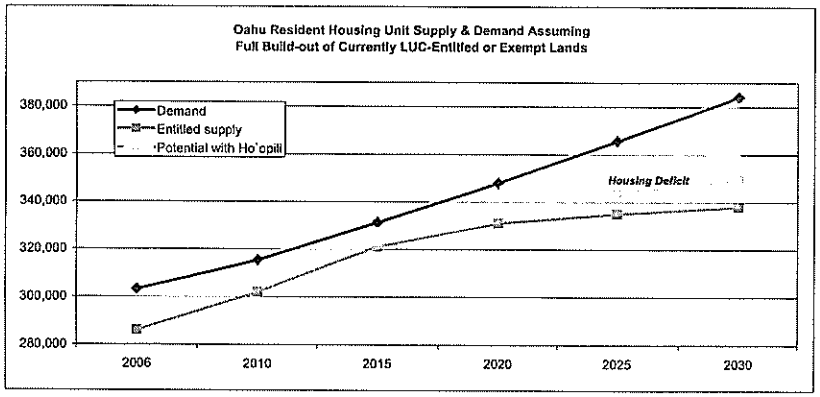
Development Plan Area	2007 - 2010	2011 - 2015	2016 - 2020	2021 - 2025	2026 - 2030	Total, 2007-2030	Comment
Ewa	9,500	10,600	7,100	2,600	1,400	31,000	Excludes Subject Hoopili. Includes off-ocean sites at Ko Olina, with resident use valued at 20% of development potential.
Central Oahu	1,600	5,700	900	0	0	8,200	Excludes Koa Ridge and Waiawa (Castle & Cooke, c. 5,000 units) and Gentry Waiawa Phase 2 (c. 7,000 units), all of which reqire LUC approvals.
Waianae	1,110	990	370	0	0	2,470	Includes units by DHHL;Village Pokai Bay;Sea Country;selfhelp;maximum affordable condition at Makaha Valley; others.
Nrth Shore, Ko'olauloa & Ko'olaupoko	310	430	370	120	0	1,230	Includes DHHL units in Waimanalo. Excludes resort units but includes maximum affordable condition at Turtle Bay Resort under existing Unilateral Agreement.
East Honolulu	740	0	0	0	0	740	Excludes buildout of custom lots and potential for some 200 units at Kamilonui (now designated Urban but under lease.)
Primary Urban Center	3,370	2,000	2,000	2,000	2,000	9,370	Majority high rise;inventories discounted for estimated share nonresident units (ranging from 0% on elderly/affordables, 20% in Kakaako and up to 60% at some Waikiki projects);also includes 400 military homes on Ford Island and on-going allowance of 2,000 units per 5-year period after 2011 for unforeseen future redevelopment projects.
Total (rounded)	16,600	19,700	10,700	4,700	3,400	55,100	
Percent of period	30%	36%	19%	9%	6%	100%	

Note: Targeting projects of 100 units or more. Excludes emergency shelters, dormitory beds and other group living qarters.

Sources: Interviews with developers, landowners and project principals;City and County of Honolulu, Department of Planning an d Permitting, "Annual Report on the Status of Land Use on Oahu: Fiscal Year 2004," July 2005; interviews with developers and landowners;Hawaii Kai Neighborhood Board Meeting Minutes, January 2006;Honolulu Advertiser, "60,000 new homes planned for O'ahu," September 19, 2006;Ibid, "Special Report on Homeless on the Waianae Coast," October 20, 2006;Exhibits 36 and 36.

Exhibit 3-8
Projected Supply and Demand for Housing - Island of Oahu
2006 to 2030

	Reference	2006	2010	2015	2020	2025	2030	Total/ average, 2006-2030[1]
Demand (households):								
Number	SMS[1]	303,149	315,333	331,254	347,979	365,549	384,005	
Change since prior date -								
Total (rounded)		--	12,000	16,000	17,000	18,000	18,000	81,000
Average annual		--	3,000	3,200	3,400	3,600	3,600	3,380
Supply (resident housing units):								
Estimated occupied RHUs in 2005[2]	U.S. Census[2]	283,000						
New homes delivered, 2005-06	Harris[3]	2,800						
Entitled new developments, 2006-2025:								
Development since prior date	Exhibit 3-7	--	16,600	19,700	10,700	4,700	3,400	55,100
Less vacancy allowance (applied to new units)	5%	--	-830	-985	-535	-235	-170	-2,755
Net available RHUs (rounded)		286,000	302,000	321,000	331,000	335,000	338,000	52,000
Change since prior date -								
Total		--	16,000	19,000	10,000	4,000	3,000	52,000
Average annual		--	4,000	3,800	2,000	800	600	2,170
Resident housing unit surplus (deficit):								
At prior date shown		INA	(17,000)	(13,000)	(10,000)	(17,000)	(31,000)	
Net surplus (deficit) in RHU production since prior date		INA	4,000	3,000	(7,000)	(14,000)	(15,000)	
By end of year, column date		(17,000)	(13,000)	(10,000)	(17,000)	(31,000)	(46,000)	



INA = Information not available.

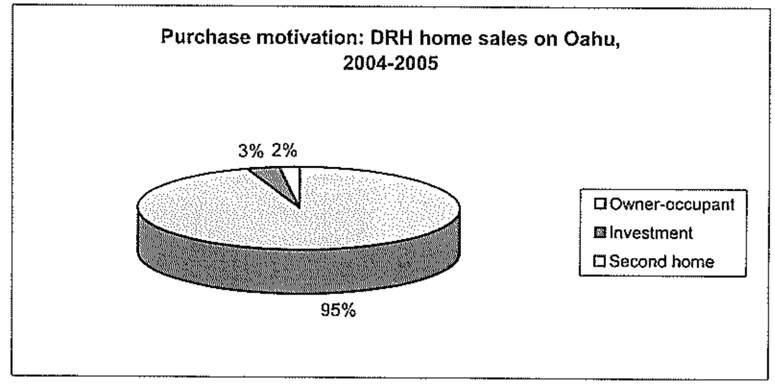
[1] SMS, Inc., "Housing Policy Study, 2006: Hawaii Housing Model 2006," February 2007. Population growth rate on interactive model set to "official parameters" for Honolulu County of 0.9% per annum.

[2] RHU = resident housing unit. Occupied housing units estimated by U.S. Census Bureau, 2005 American Community Survey (ACS, released October 2006) at 300,557. From this total, 6% are conservatively estimated to be used as second homes, vacation homes or for other nonresident uses. Note that a 2003 SMS study prepared for the State and Counties projected nonresident housing units on Oahu at 7.5% for 2006, while the ACS reflects the majority of the 9% of units found to be vacant were not RHUs..

[3] Developer ("new") unit sales since mid-2005 from The Harris Company, quarterly surveys of developer sales closings. Data is for 3Q05 through 4Q06 (six quarters), since the Census survey of supply refers to an "average" figure for 2005.

Exhibit 4-1
Comparison Project Buyer Motivations
Recent DRH Projects on Oahu
Sampled project sales through 2005

	Locations	Owner-occupant	Investment	Second home	Total
Townhomes	Hawaii Kai & Makakilo				
Distribution		92%	6%	2%	100%
Sample size		115	7	3	125
Single-family condos:	Makakilo & Ma'ili				
Distribution		98%	1%	1%	100%
Sample size		189	1	2	192
Traditional single-family:	Makakilo & Kapolei				
Distribution		85%	10%	4%	100%
Sample size		41	5	2	48
Total					
Distribution		95%	3%	2%	100%
Sample size		345	13	7	365



Notes: Based on samples of persons who executed purchase contracts at eight DRH residential projects on Oahu in 2004 and 2005. Purchasers did not necessarily close the sale.

Source: DRH, December 2006.

Exhibit 4-2
Comparison Project Pricing
Recent DRH Projects on Oahu

	Location	Unit Description	Units per acre	Market unit pricing (2006)	Comment
Townhomes:					
Moana Kai	Hawaii Kai	1,327 - 1,729 SF	15	$57,000 to $25,000	3-story buildings; behind Nanea
Kai Nani	Makakilo	1,010 - 1,766 SF	12 to 14	$30,000 to $83,000	
Ocean Ridge	Makakilo	1,424 - 1,529 SF	12	$16,000 to $79,000	Western end of Makakilo
Nanala	*Mehana, Kapolei*	*1,038 - 2,013 SF*	*17*	*$350,000 to $550,000*	*Preliminary pricing and plans; to be marketed 2007*
Pulewa		*1,182 - 1,562 (market units)*	*17*		
Single-family condos:					
Anuhea	Makakilo	1,291 - 1,808 SF	6	$43,000 to $20,000	Hillside
Holomoana	Maili (Sea Country)	1,119 - 1,270 SF	7	$27,000 to $26,000	3 to 4 units per courtyard
Kaimalino	Maili (Sea Country)	SFD and "duets"	8	$13,000 to $96,000	Duets share common walls at unit backs
Traditional single-family:					
Highpointe	Makakilo	1,359 - 2,757 SF	5	$99,000 to $13,000 (median $30,000)	Top of Makakilo; purchase lot & select home package
Wailana	Maili (Sea Country)	1,187 - 1,809 SF	5	$90,000 to $50,000	Ocean and valley views

Notes: SF - square feet; SFD - single-family detached
Source: DRH, January 2007.

Exhibit 4-3
Illustrative Potential Pricing of Residential Products at Ho`opili
In 2006 dollars

	Multifamily	Single-family	Comment
For-sale units (sales price):			
Market units	$50,000 - $50,000	$00,000 - $50,000	All single-family in Low-Medium Density areas; multifamily distributed throughout residential areas
"Affordable for-sale units"[1]	$32,000 - $92,000	Not offered	To be located in Medium- and High-Density mixed-use areas
"Affordable rental units" (monthly rent)[2]	$98 - $3,481	Not offered	For studio to 4-BR units targeted at 80% to 100% of median income households.

[1] Pricing and other terms to be determined in agreements to be made with the County. Figures shown provided by County DPP in February 2007, represent guidelines that were in effect as of March 2006, assuming a family of 4 earning 80% to 120% of median family income, putting 5% to 10% down. According to the U.S. Department of Housing &Urban Development, as of 2006, median family income in Honolulu was $1,300, meaning that the 80% to 120% of median income was approximately $7,000 to $6,000.

[2] As provided by the County DPP, guidelines in effect from February 2006 through February 2007.

Sources: City &County of Honolulu, Department of Housing and Community Development, "Adoption of Rules for the Terms of Unilateral Agreements Requiring Affordable Housing," 1994;Ibid, Department of Planning &Permitting, February 2007.

Exhibit 5-1
Existing Retail Gross Leasable Area in Trade Area and Benchmark Market
In square feet, as of December 2006

	Trade Area				
	Ewa DPA	Central Oahu DPA	Waianae DPA	Total	Benchmark - Hawaii Kai
Existing inventory:					
Kapolei	524,807			524,807	
Ewa Beach	212,457			212,457	
Waipahu		1,986,007		1,986,007	
Mililani		694,764		694,764	
Waianae			439,112	439,112	
Hawaii Kai				0	857,392
Total, rounded	737,000	2,681,000	439,000	3,857,000	857,000
Vacancy indicators (12/06)[1]	2.1% "West Oahu"	0.6% "Central Oahu"	14.5% "Waianae"	2.5% Weighted average	0.6%
Largest properties (gross leasable area)	Kapolei Shopping Center (134,400)	Waikele Center (786,302)	Waianae Mall (208,000)	Waikele Center (786,302)	Koko Marina Shopping Center (322,261)
	Big Kmart (122,848)	Pearl Highlands Center (410,325)	Makaha Marketplace (98,768)	Pearl Highlands Center (410,325)	Hawaii Kai Towne Center (247,000)

[1] Based on CMF reported vacancy for areas as defined by CMF. These vary somewhat from the DPAs but are the same for Hawaii Kai.

Sources: Colliers Monroe Friedlander, Inc. 2006 and 2007, custom reports;Ibid, "Oahu Retail Guide," in Hawaii Business January 2007;Ibid, "Retail Market Report: Oahu Year End 2006," released January 24, 2007;Pacific Business News, 2006, "Book of Lists: 2007";www.kapolei.com;other internet searches.

Exhibit 5-2
Planned and Entitled Retail Areas in Trade Area
Square feet of gross leasable area

Location	Estimated total[1]	Potential timing of deliveries 2007-2010	2011-2015	2016-2030
Ewa DPA:				
Kapolei, East Kapolei	2,494,155	1,391,155	720,000	383,000
Makaiwa	360,000	0	100,000	260,000
Ko Olina	20,000	0	20,000	0
Ewa Beach	255,000	255,000	0	0
Ocean Pointe	100,000	0	20,000	80,000
Kalaeloa	116,000	0	31,000	85,000
Subtotal, rounded	3,350,000	1,650,000	890,000	810,000
Central Oahu DPA:				
Mililani Mauka	85,000	85,000	0	0
Waiawa Phase 1	400,000	70,000	170,000	160,000
Waipio Gentry	25,189	25,189	0	0
Waipahu	34,000	34,000	0	0
Subtotal, rounded	540,000	210,000	170,000	160,000
Waianae DPA	10,000	6,000	4,000	-
Total, rounded	3,900,000	1,866,000	1,064,000	970,000

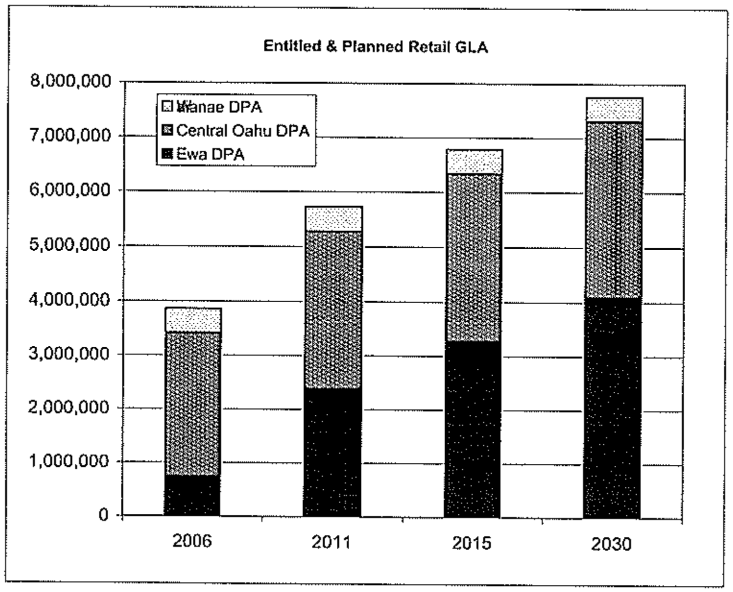
[1] See Appendix 4 for detailed listings. Based on State-entitled lands with development proposals in place; plans announced as of February 2007.

Note: Areas are net of those expected to primarily serve visitors, and of planned exclusive office or business parks uses (may include some office uses mixed with retail in shopping-center type settings.)

Sources: Interviews with developers, landowners and brokers;area site visits;Pacific Business News, Book of Lists 2007;Pacific Business News (weekly);Colliers Monroe Friedlander;developer websites; Honolulu Advertiser;Hawaii Community Development Authority;Internet searches.

Exhibit 5-3
Potential Future Retail Areas in Trade Area
Existing and PlannedEntitled Developments as of February 2007

	Existing, 2006	Potential future 2011	2015	2030
Ewa DPA	737,000	2,387,000	3,277,000	4,087,000
Central Oahu DPA	2,681,000	2,891,000	3,061,000	3,221,000
Waianae DPA	439,000	445,000	449,000	449,000
Total	3,857,000	5,723,000	6,787,000	7,757,000



Source: Mikb Corporation, based on Exhibits 5-1 and 5-2.

Exhibit 5-4
Area Resident Profiles
2006 estimates and 2011 projections

	Trade Area: Ewa DPA	Central Oahu DPA	Waianae DPA	Total	Benchmark - Hawaii Kai
Resident population[1]:					
2006 estimated	88,800	157,860	44,290	290,950	29,023
2011 projected	116,800	161,250	45,830	323,880	30,373
Compound annual % increase	5.6%	0.4%	0.7%	2.2%	0.9%
Income (2006):					
Median per household	$3,025	$6,667	$7,923	INA	$7,091
Est. per capita	$2,876	$3,493	$4,971	INA	$6,366

Note: DPAs (Development Plan Areas) are those defined by the City and County of Honolulu, but approximated for data generation purposes by ip code area. See Chapter 2 for further information. INA = Information not available.

[1] As shown in Exhibit 2-4;Ewa DPA population as adjusted by Mikb Corporation.

Sources: Exhibits 2-4 and 2-8;Claritas Inc.: October 20, 2005 for benchmarkmarkt, with population updated based on projected 2005-2010 growth rates. Hawaii ki 2006 median income supplied by ESRI.

Exhibit 5-5
Daytime Population and Employment Residence Ratios by Census Designated Places
2000

	Residents, 2000	Employment residence ratio[1]	Daytime population[2]	Daytime pop/ residents
Trade Area:				
Ewa area CDPs -				
Ewa Beach CDP	14,650	0.35	10,627	0.73
Ewa Gentry CDP	4,939	0.06	2,477	0.50
Makakilo City CDP	13,156	0.09	7,243	0.55
Total/weighted av.	32,745	0.20	20,347	0.62
Central Oahu area CDPs -				
Mililani Town CDP	28,608	0.27	17,394	0.61
Schofield Barracks CDP	14,228	1.68	19,703	1.38
Wahiawa CDP	16,151	0.80	14,872	0.92
Village Park CDP	9,625	0.16	5,484	0.57
Waipahu CDP	33,108	0.55	27,397	0.83
Waipio CDP	11,672	0.37	7,547	0.65
Waipio Acres CDP	5,298	0.08	2,981	0.56
Total/weighted av.	118,690	0.58	95,378	0.80
Waianae area CDPs -				
Waianae CDP	10,506	0.68	9,264	0.88
Nanakuli CDP	10,814	0.28	8,355	0.77
Makaha CDP	7,753	0.34	6,031	0.78
Total/weighted av.	29,073	0.44	23,650	0.81
Benchmark markets:				
Hawaii Kai proxy[3]	INA	0.49	INA	0.74
Honolulu CDP[4]	371,657	1.54	462,962	1.25

INA -Information not available.

Note: All ratios shown are within the respective CDP. Ratios would be higher if reported on a regional basis.

[1] Workers working in the CDP divided by workers living the CDP.

[2] Residents plus in-commuters less out-commuters.

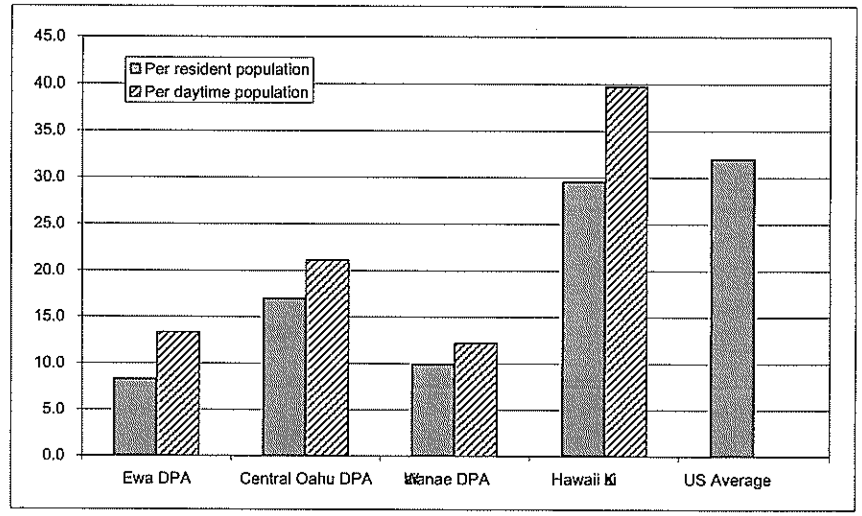
[3] The 2000 Census included Hawaii Kai within the Honolulu CDP, so Kailua CDP used as a proxy for Hawaii Kai ratios; actual population figures not relevant.

[4] Includes PUC and East Honolulu, encompassing Waikiki, Aina Haina, Hawaii Kai. The Census' daytime population calculations in this case do not consider visitors.

Source: US Census Bureau, Census 2000, PHC-T-40, "Estimated Daytime Population and Employment-Residence Ratios: 2000" durney to Work and Migration Statistics Branch, 2005.

Exhibit 5-6
Existing Retail Areas in Relation to Consumer Population
As of 2006, except where noted

	Trade Area				Benchmark markets	
	Ewa DPA	Central Oahu DPA	Waianae DPA	Total	Hawaii Kai	2004 US average[1]
Estimated consumers:						
Resident population[2]	88,800	157,860	44,290	290,950	29,023	INA
Daytime ratio[3]	*0.62*	*0.80*	*0.81*	*0.75*	*0.74*	INA
Daytime population	55,200	126,900	36,000	218,100	21,568	INA
Existing retail GLA[4]	737,000	2,681,000	439,000	3,857,000	857,000	INA
Existing GLA ratios:						
Per resident population	8	17	10	13	30	32
Per daytime population	13	21	12	18	40	INA



Note: DPAs (Development Plan Areas) are those defined by the City and County of Honolulu, but approximated for data generation purposes by ip code area. See Chapter 2 for further information.

INA - Information not available.

[1] Based on shopping center per resident ratio of 20.3, as reported by National Research Bureau;figure adjusted by the estimated 37% U.S. retail space not located in shopping centers, as reported by the same source.

[2] Trade Area populations as shown in Exhibit 2-4;Ewa DPA according to Milb projections shown there.

[3] 2000 ratios, as shown in Exhibit 5-4

[4] Hawaii information as shown in Exhibit 5-1.

Sources: Claritas Inc., October 20, 2005;Colliers International, "Retail Markt Report: Oahu Yar End 2006", 2007;State of Ha waii, Department of Business Economic Development and Tourism;National Research Bureau, Inc., "2004 NRB Shopping Center Census," 2005;Niemira, Michael P., "The U.S. Retail Space Markt," Research Review, V12, No. 2, 2005.

Exhibit 5-7

Projected Supportable Additional Retail-Based Commercial Areas in the Ewa DPA
Based on Resident Population Ratios

Gross leasable square feet, 2011 to 2030

	Basis/reference	2011	2015	2030	Av. annual change, 2011-2030
Immediate market (Ewa DPA)					
Resident population	Exhibit 2-4[1]	116,800	151,600	180,200	2.3%
Supportable GLA in Ewa	30 sf/person [2]	3,500,000	4,500,000	5,400,000	2.3%
Less existing & planned	Exhibit 5-3	2,400,000	3,300,000	4,100,000	2.9%
Subtotal, supportable additional GLA in Ewa		1,100,000	1,200,000	1,300,000	0.9%
Nearby markets (Central Oahu and Wai'anae DPAs)					
Resident population	Exhibit 2-4[1]	207,080	212,250	240,160	0.8%
Supportable GLA in Trade Area	32 sf/person [2]	6,600,000	6,800,000	7,700,000	0.8%
New shares of region captured in Ewa DPA	Share of other Trade Area	5%	10%	20%	7.6%
Subtotal, supportable additional GLA in Ewa		300,000	700,000	1,500,000	8.8%
Total additional market potential in Ewa DPA		1,400,000	1,900,000	2,800,000	

Note: DPAs (Development Plan Areas) as defined by the City and County of Honolulu. Differ slightly from those approximated by zip code area, as shown elsewhere in this report. See Chapter 2 for further information.

[1] Ewa DPA as assessed by Mikiko Corporation; others as projected by City & County of Honolulu, Department of Planning & Permittin g, 2006.

[2] Derived from within Hawaii and average U.S. ratios shown in Exhibit 5-6.

Exhibit 5-8

Projected Supportable Additional Retail-Based Commercial Areas in the Ewa DPA
Based on Daytime Population Ratios

Gross leasable square feet, 2011 to 2030

	Basis/reference	2011	2015	2030	Av. annual change, 2011-2030
Immediate market (Ewa DPA)					
Resident population	Exhibit 2-4[1]	116,800	151,600	180,200	2.3%
Daytime population -					
Ratio to resident pop	0.62 in 2000[2]	0.70	0.75	0.90	1.3%
Projected persons		81,760	113,700	162,180	3.7%
Supportable GLA in Ewa	36 sf/person [3]	2,900,000	4,100,000	5,800,000	3.7%
Less existing & planned	Exhibit 5-3	2,400,000	3,300,000	4,100,000	2.9%
Subtotal, supportable additional GLA in Ewa		500,000	800,000	1,700,000	6.7%
Nearby markets (Central Oahu and Wai'anae DPAs)					
Resident population	Exhibit 2-4[1]	207,080	212,250	240,160	0.8%
Daytime population -		161,250	164,950	180,690	0.6%
Ratio to resident pop	0.80 in 2000[2]	0.85	0.85	0.90	0.3%
Projected persons		176,018	180,413	216,144	1.1%
Supportable GLA throughout Trade Area	40 sf/person [3]	7,000,000	7,200,000	8,600,000	1.1%
New shares of region captured in Ewa DPA	Share of other Trade Area	5%	10%	15%	6.0%
Subtotal, supportable additional GLA in Ewa		400,000	700,000	1,300,000	6.4%
Total additional market potential in Ewa DPA		900,000	1,500,000	3,000,000	

Note: DPAs (Development Plan Areas) as defined by the City and County of Honolulu. Differ slightly from those approximated by zip code area, as shown elsewhere in this report. See Chapter 2 for further information.

[1] Ewa DPA as assessed by Mikiko Corporation; others as projected by City & County of Honolulu, Department of Planning & Permittin g, 2006.

[2] Based on figures for Census Defined Places, not regions, in 2000, as shown in Exhibit 5-6. Hence these benchmark are consider ed below daytime ratios that would be effective for the larger regions considered here.

[3] Reference Hawaii ratio shown in Exhibit 5-6.

Exhibit 6-1
Existing Office Space in Ewa, Central Oahu and Benchmarks
Rentable building area, in square feet, as of December 2006

	Ewa DPA	Central Oahu DPA	Total	Benchmark markets: Island of Oahu	Benchmark markets: Urban Honolulu[1]
Existing inventory:					
Kapolei	422,118		422,118		
Ewa Beach	14,126		14,126		
Waipahu		84,999	84,999		
Mililani		108,804	108,804		
Waianae			0		
Central Business District					7,931,698
Kaka'ako/Kapiolani/ King					3,433,414
Total Oahu			0	15,336,904	
Total, rounded	436,000	194,000	630,000	15,337,000	11,365,000
Vacancy indicators (12/06)	INA	INA	6.4% "Leeward Oahu"	7.0% Island of Oahu average	6.7% and 6.4% CBD and Kaka'ako/ Kapiolani/King
Largest properties/areas (rentable building area)	Bank of Hawaii Building (208,406)	Lee Towne Center (52,557)	Bank of Hawaii Building (208,406)	Central Business District (7.9 million)	58 buildings, including Chinatown & Capitol district
	Campbell Square (136,868)	Castle & Cooke Building (34,241)	Campbell Square (136,868)	Kaka'ako/ Kapiolani/King (3.4 million)	

Notes: Excludes government-owned buildings and exclusively owner-occupied buildings. INA - information not available.

[1] Includes the Central Business District, Kapiolani and King Streets and Kaka'ako District, as defined by CMF. Excludes Waikiki.

Sources: Colliers Monroe Friedlander, Inc. 2006, custom reports; Ibid. "Honolulu Year-End 2006 Office Report Brief," released January 24, 2007; Internet searches.

Exhibit 6-2
Planned and Entitled Office Developments in Ewa and Central Oahu
Square feet of rentable building area

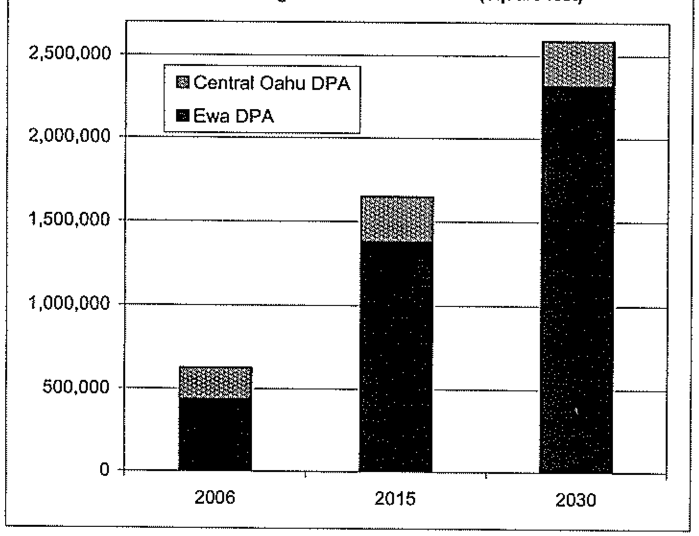
Location	Potential new development[1]: Total	2007-2015	2016-2030	Comments
Ewa DPA:				
Kapolei	1,285,000	785,000	500,000	Stand-alone and MUD buildings. Excludes Subject.
Makaiwa	90,000	0	90,000	Much in mixed-use development.
Kalaeloa	725,000	150,000	350,000	Long-term development, assumed to extend beyond 2030.
Subtotal, rounded	2,100,000	940,000	940,000	
Central Oahu DPA:				
Wahiawa	80,000	80,000	0	Zoning allows office, industrial or retail on many of these sites.
Subtotal, rounded	80,000	80,000	-	
Total, rounded	2,180,000	1,020,000	940,000	

[1] Excludes buildings proposed by government agencies. See Appendix 5 for detailed listings. Based on State LUC-entitled lands and plans known as of February 2007. Some proposed projects assumed to occur beyond the projection period, if at all.

Sources: Interviews with developers, landowners and brokers;area site visits;Pacific Business News, Book of Lists 2007; Pacific Business News (weekly);Colliers Monroe Friedlander Inc., 2006;developer websites;Honolulu Advertiser; Internet searches.

Exhibit 6-3
Potential Future Office Areas in Ewa and Central Oahu
Existing and PlannedEntitled Developments as of December 2006

	Existing, 2006	Potential future 2015	Potential future 2030
Ewa DPA	436,000	1,376,000	2,316,000
Central Oahu DPA	194,000	274,000	274,000
Total	630,000	1,650,000	2,590,000

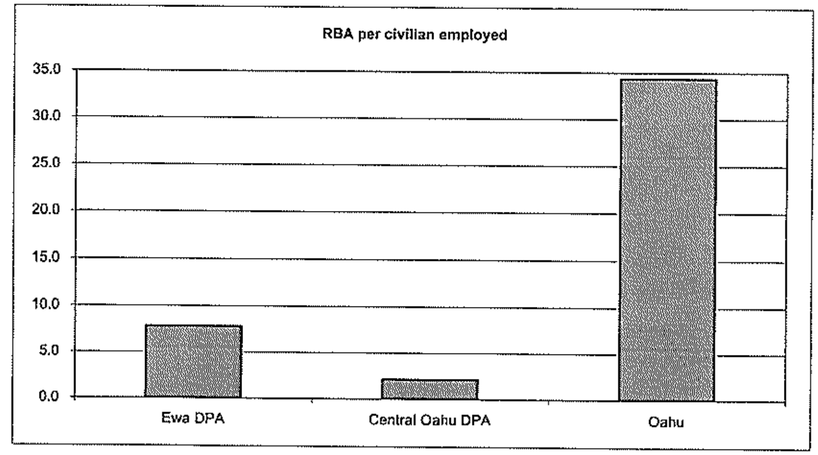


Note: Excludes government-owned buildings. RBA - rentable building area, in square feet.

Source: Mikiko Corporation, based on Exhibits 6-1 and 6-2.

Exhibit 6-4
Existing Office RBA in Relation to Employment
As of 2006, except where noted

	Ewa DPA	Central Oahu DPA	Total	Benchmark markets: Island of Oahu	Benchmark markets: Urban Honolulu[1]
Estimated consumers:					
Resident population[2]	88,800	157,860	246,660	909,408	37,100
% civilian employed[3]	63%	57%	59%	49%	49%
Civilian employed persons[4]	55,900	90,000	145,900	446,200	18,100
Existing office RBA[5]	436,000	194,000	630,000	15,337,000	11,365,000
Existing RBA ratio:					
Per civilian resident employee	8	2	4	34	628



Note: INA - Information not available; RBA - Rentable building area, in square feet.

[1] Includes the Central Business District, Kapiolani and King Streets and Kakaako District, as defined by CMF. Associated population based on 2000 U.S. data for zip codes 96813 and 96814. Population updated to 2006 based on island growth rate in interim. Civilian employed persons estimated based on number in labor force in 2000, adjusted for 2006 island unemployment and 2000 to 2006 island growth rates.

[2] Ewa and Central Oahu populations as shown in Exhibit 2-4;Oahu total population as estimated by Claritas, 2006. See footnote 1 re Honolulu.

[3] 2005 estimates for Ewa and Central Oahu provided by Claritas, Inc., 2006;Island figure derived from DLIR estimate of civilian employed persons, as shown in Exhibit 2-9. See footnote 1 re Honolulu.

[4] Indicates civilians resident in area who are employed, but not necessarily in the area. See footnote 1 re Honolulu.

[5] As shown in Exhibit 6-1.

Sources: Claritas Inc., 2005 and 2006;American Factfinder, 2007;prior exhibits as cited.

Exhibit 6-5
Projected Supportable Additional Office-Based Commercial Areas in the Ewa DPA
Private sector rentable building area, in square feet, 2011 to 2030

	Basis/reference	2011	2015	2030	Av. annual change, 2011-2030
Ewa and Central Oahu region:					
Resident population (Ewa and Central Oahu DPAs)	Exhibit 2-4[1]	278,050	316,550	369,800	1.5%
Number of civilian employees	55% of population	152,900	174,100	203,400	1.5%
Supportable RBA/employee[3]	In Ewa and Central Oahu	10	15	25	4.9%
Supportable RBA	In Ewa and Central Oahu	1,529,000	2,611,500	5,085,000	6.5%
Less existing & planned in Ewa and Central Oahu	Exhibit 6-3	1,220,000	1,650,000	2,590,000	4.0%
Supportable additional RBA in region[4]		309,000	961,500	2,495,000	11.6%
Ewa DPA conclusion:					
Share captured in Ewa DPA	Share of region	45%	50%	55%	1.1%
Total additional market potential in Ewa DPA		**140,000**	**480,000**	**1,370,000**	**12.8%**

Notes: Does not consider needs of government agencies, nor demand that could originate from employment provided to residents beyond the two DPAs evaluated.

[1] Ewa DPA as assessed by Mikiko Corporation; others as projected by City & County of Honolulu, Department of Planning & Permitting, 2006.

[2] As shown in Exhibit 6-1.

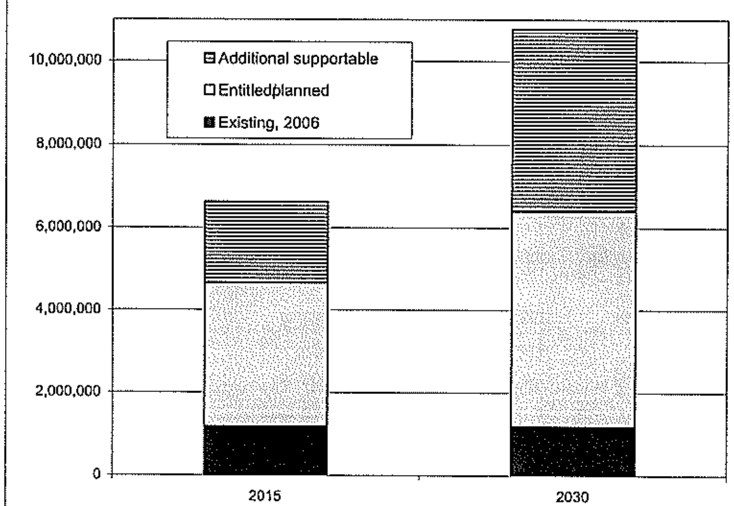
[3] Expected to approach Oahu ratio shown in Exhibit 6-4.

[4] As supported by Ewa and Central Oahu populations; other areas could also contribute to demand.

Exhibit 7-1
Ewa DPA Commercial Market Summary
Retail and office uses, in square feet, 2015 and 2030

	Basis/reference	2015	2030
Completed as of December 2006:			
Retail	*Exhibit 5-1*	737,000	737,000
Office	*Exhibit 6-1*	436,000	436,000
Subtotal		1,173,000	1,173,000
Entitled and planned:			
Retail	*Exhibit 5-2*	2,540,000	3,350,000
Office	*Exhibit 6-2*	940,000	1,880,000
Subtotal		3,480,000	5,230,000
Net additional supportable	*Exhibits 5-8 & 6-5*	**1,980,000**	**4,370,000**
Total		**6,600,000**	**10,800,000**

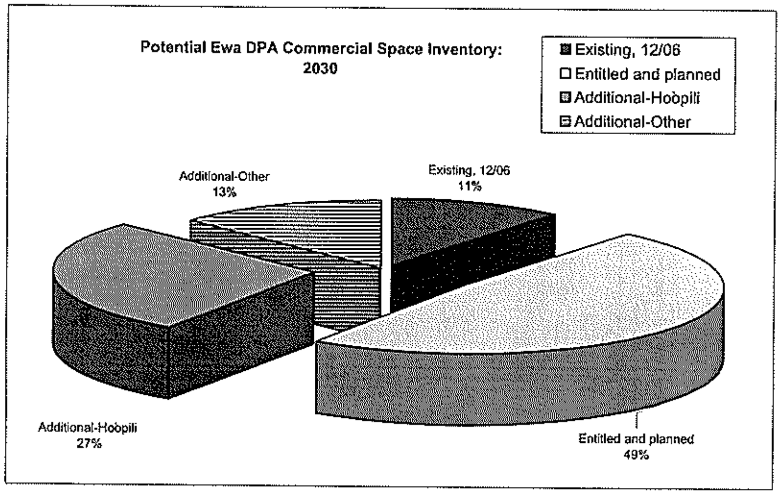
Projected Supportable Commercial Areas in Ewa (square feet)



Source: Mikiko Corporation, 2007

Exhibit 7-2
Commercial Market Assessment for Ho`opili
Retail and office uses, in square feet, 2015 and 2030

	Basis/reference	2015	2030
Ho`opili commercial market:			
Potential development phasing	*2,960,000 total proposed*	**600,000**	**2,960,000**
Share of total future Ewa DPA		**9%**	**27%**
Share of net additional Ewa DPA		**30%**	**68%**
Projected supportable in Ewa DPA:	*Exhibit 7-1*		
Existing, 12/06		1,173,000	1,173,000
Entitled and planned for 2007-2030		3,480,000	5,230,000
Net additional supportable		1,980,000	4,370,000
Total		6,600,000	10,800,000



Source: Mikiko Corporation, 2007

Exhibit 8-1
Developed Business Park/Industrial Lands in Ewa, Central Oahu and Benchmarks
Acres, as of December 2006

	Ewa DPA	Central Oahu DPA	Island of Oahu
Existing inventory:			
Kapolei	1,563		
Waipahu		121	
Mililani		71	
Waipio		122	
Wahiawa		4	
Total, rounded	1,560	320	INA[1]
Vacancy indicators (12/06)[2]	2.6% Kapolei Business Park, Campbell Industrial Park, Kina Industrial Park	3.6% Waipahu, Mill Town Business Center	2.3% Island of Oahu average
		0.2% Gentry Business Park	Below 3% for last 5 years
Weighted average net asking rent psf (developed space, per month)[2]	$.03 - Campbell Industrial, Kapolei Business Park	$.19 - Waipahu/ Milltown; $.67 - Gentry	$.12
% increase since 2002/2003	140%	INA	23%
Land appreciation (since 2004)	150% - Kapolei	INA	83%

Notes: INA - Information not available. Net of government-owned and operated facilities such as military bases, harbors, airports and universities.

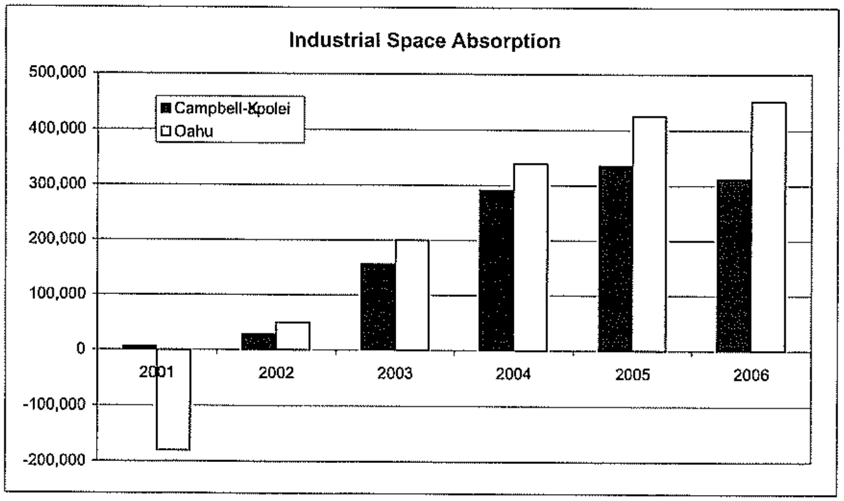
[1] Data not available in land acres.

[2] Based on spaces in I-1 and I-2 zoned lands. Excludes IMX zoned lands, which can also permit retail development, as well as Mapunapuna and Kaka`ako, where vacancies are estimated to be higher than this average.

Sources: Colliers Monroe Friedlander, Inc. 2006, custom reports; Ibid, "Industrial Market Report: Honolulu Year-End 2006," January 24, 2007; Ibid, "Kapolei's Expanding Industrial Marketplace," December 2006 presentation.

Exhibit 8-2
Business Park/Industrial Space Market Trends: Campbell-Kapolei and Oahu
Square feet in leasable buildings

	2001	2002	2003	2004	2005	2006
Campbell-Kapolei						
Vacancy	5.2%	5.2%	1.3%	0.3%	1.6%	4.6%
Absorption	6,400	28,900	156,300	290,900	335,500	312,200
Inventory	4,321,000	4,321,000	4,321,000	4,598,000	4,973,000	5,453,000
Island of Oahu						
Vacancy	4.4%	4.0%	2.7%	1.7%	1.8%	2.3%
Absorption	-180,800	50,300	199,400	339,700	425,300	452,000
Inventory	33,345,000	35,939,000	36,512,000	37,070,000	37,787,000	39,125,000
Campbell/Kapolei market share						
Absorption	NA	57%	78%	86%	79%	69%
Inventory	13%	12%	12%	12%	13%	14%

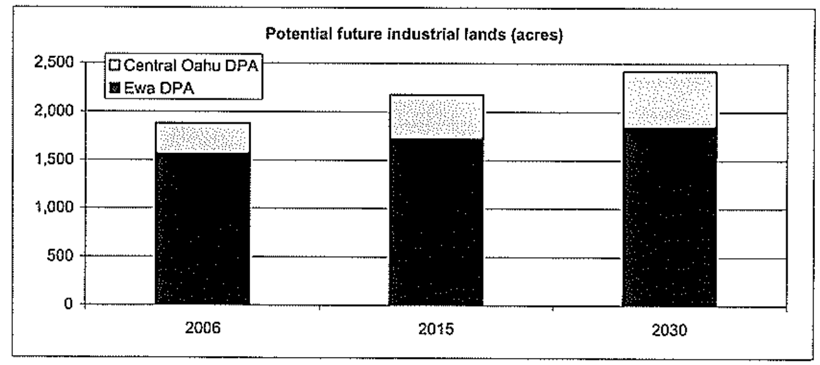


Notes: Net of owner-occupied or government-owned and operated facilities such as military bases, harbors and airports.

Sources: Colliers Monroe Friedlander, Inc. 2006, custom reports;ibid, "Industrial Market Report: Honolulu Year-End 2006," January 24, 2007. Published CMF data adjusted to include CMF estimate of an additional 2.88 million square feet of inventory in Kalaeloa. Vacancy rates shown do not reflect relatively higher rates reported in Kalaeloa.

Exhibit 8-3
Planned and Entitled Business Park/Industrial Lands in Ewa and Central Oahu DPAs
Net acres; plans known as of December 2006

Location	Existing, 2006	Potential new development[1] 2015	2030	Total	Areas
Entitled potential supply (net acres since prior date):					
Ewa DPA		160	120	280	Kapolei, Kalaeloa, Kunia, Ewa Beach
Central Oahu DPA		140	120	260	Mililani, Waiawa
Total, rounded		300	240	540	
Potential future supply (existing and planned, cumulative):					
Ewa DPA	1,560	1,720	1,840		
Central Oahu DPA	320	460	580		
Total, rounded	1,880	2,180	2,420		



Note: Net acres represent salable or leasable areas, after allowance for major roads and other infrastructure. Planned inventory excludes government-owned and operated facilities such as military bases, harbors, airports and universities.

[1] See Appendix 6 for detailed listings. Based on plans known as of December 2006. Some proposed projects assumed to occur beyond the projection period, if at all. Future use of the Kalaeloa lands, representing some 200 acres of the proposed Ewa DPA inventory, is considered very preliminary but are included within the projection period to be conservative.

Sources: Interviews with project landowners, their consultants, planners, land managers, and brokers; Pacific Business News; company web sites; Enterprise Honolulu; Hawaii Community Development Authority, "Draft Kalaeloa Master Plan," 2005; Colliers Monroe Friedlander Inc., 2006.

Exhibit 8-4
Projected Business Park/Industrial Land Requirements - Employment-Based Demand
Cumulative, Island of Oahu: 2015 and 2030

	Basis/notes	Benchmark - 2006	Projected 2015	Projected 2030	Average annual change, 2006-20230
Sources of demand:					
Resident population[1]	Exhibit 2-4	909,408	995,500	1,117,300	0.9%
Civilian employed persons[2]	49% of residents	446,200	488,400	548,200	0.9%
2006 market characteristics:[3]					
Building area (sq. ft.), 2006	Year-end, 2006	39,124,741			
Occupied building area, 2006	2.4% vacancy	38,196,000			
Net additional demand:					
Required building area for balanced market	5.0% vacancy	40,110,000	45,220,000	53,300,000	1.2%
Ratio for balanced market [4]	Bldg. sq. ft. per employee	90	93	97	0.3%
Additional sq. ft. required to achieve balance	Cumulative, vs. 2006	985,259	6,095,259	14,175,259	11.8%
Associated land area (cumulative net acres)	0.20 Floor Area Ratio (FAR)[5]	113 [6]	700	1,627	
Planned and entitled supply (cumulative net acres):					Percent mix, 2030
Ewa & Central Oahu	Exhibit 8-3		300	540	82%
Other - Hawaiian Cement	CMF, RCL		29	29	4%
Other - Manana Lands	CMF, RCL		15	15	2%
Other - Tesoro	CMF, RCL		71	71	11%
Total, cumulative			415	655	100%
Net additional requirements (cumulative acres)			285	972	

Notes: Net of government-owned and operated facilities such as military bases, harbors, airports and universities. FAR - Floor area ratio.

[1] 2006 figure from Claritas' estimate based on U.S. Census updates;2015 and 2025 figures based on State and County long-term pro jections as cited in Exhibit 2-2.

[2] 2006 ratio is based on DLIR's civilian labor force estimate, as shown in Exhibit 2-9. Projections assume ratio remains stable.

[3] CMF estimates Oahu space inventory at 36,244,741 square feet at 2.3% vacancy as of year-end 2006. However, per CMF, February 2007, these figures exclude approximately 2.88 million square feet in Kaka'ako. Kaka'ako areas estimated at 3.5% vacancy based on CMF in R CL.

[4] RCL reports 2004 ratios (not adjusted for vacancy) at 80 in Honolulu, 95 Metro Las Vegas, 111 Seattle, and 125 San Diego County . Oahu's industrial building area required ratio is expected to increase as the economy transitions.

[5] According to data provided by CMF, 2006 industrial inventory in West Oahu, including Pearl City, Ewa, and Central Oahu, average s 0.13 FAR over 1,980 acres (11.4 million sf). Industrial uses in more urban areas would show higher FARs.

[6] Estimate of pent-up demand in 2006.

Sources: Colliers Monroe Friedlander, Inc. 2006, custom reports;Ibid, "Industrial Market Report: Honolulu Year-End 2006," January 24, 2007;Robert Charles Lesser & Co., LLC, "Industrial Market Feasibility: 345-Acre Kapolei Harborside Center," January 31, 2006;Claritas, 2007;State of Hawaii, Department of Labor & Industrial Relations, 2007.

Exhibit 8-5
Projected Business Park/Industrial Land Requirements - Transitioning Demand
Within Oahu: 2015 and 2030

	Occupied sq. ft.	Impacted area (sq. ft.)[1]	Loss over # years	Average annual replacement need (sq. ft.)	Duration Start	Duration End
Areas of displacement:						
Kapalama Military Reservation	1,250,000	1,250,000	5	250,000	2007	2011
Kaka'ako	2,780,000	2,780,000	15	185,000	2007	2021
Subtotal, in square feet	4,030,000	4,030,000		435,000		
Lease turnover:						
Oahu inventory (net of above), in square feet	34,160,000	342,000	On-going	342,000	On-going	

Total, replacement requirements (rounded):	Estimated total area impacted: Square feet	Acres[2]	Annual: Square feet	Acres[2]
Due to displacement -				
2007-2011	2,360,000	100	435,000	18
2012-2015	555,000	23	185,000	8
2016-2021	1,110,000	50	185,000	8
Due to turnover -				
2007-2015	3,078,000	130	342,000	14
2016-2030	5,130,000	210	342,000	14

Notes: Net of government-owned and operated facilities such as at military bases, harbors, airports and universities.

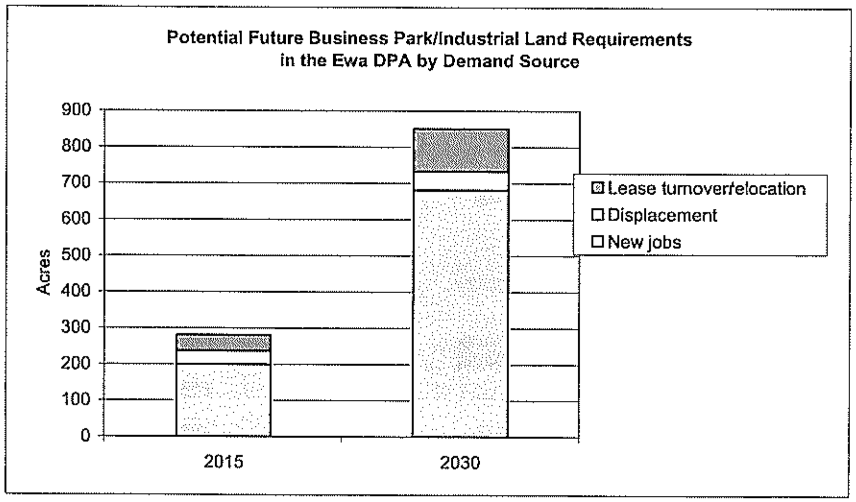
[1] Kapalama and Kaka'ako impacted areas based on occupied square feet. Oahu lease turnover assumes 5-year terms and 5% of those expiring seeking to move. Turnover estimate is conservative in that it does not account for an increasing Oahu inventory.

[2] Based on an average FAR of 0.55 which considers the higher than average existing densities of the areas to be relocated.

Sources: Colliers Monroe Friedlander, Inc. 2006, custom reports and subsequent discussions; Ibid, "Industrial Market Report: Honolulu Year-End 2006," January 24, 2007; Robert Charles Lesser & Co., LLC, "Industrial Market Feasibility: 345-Acre Kapolei Harborside Center," January 31, 2006; internet research.

Exhibit 8-6
Business Park/Industrial Market Assessment for the Ewa DPA
Required additional land, cumulative acres, 2015 and 2030

	Basis/ reference	Potential Island-wide 2015	Potential Island-wide 2030	Capture rate	Ewa DPA 2015	Ewa DPA 2030
Employment-driven demand	Exhibit 8-4	285	972	70%	199	680
Transition-driven demand:	Exhibit 8-5					
Due to displacement[1]	2007-2021	123	173	30%	37	52
Due to lease turnover[2]	2007-2030	130	340	35%	46	119
Subtotal		253	513		82	171
Total demand, rounded[3]		540	1,490		280	850



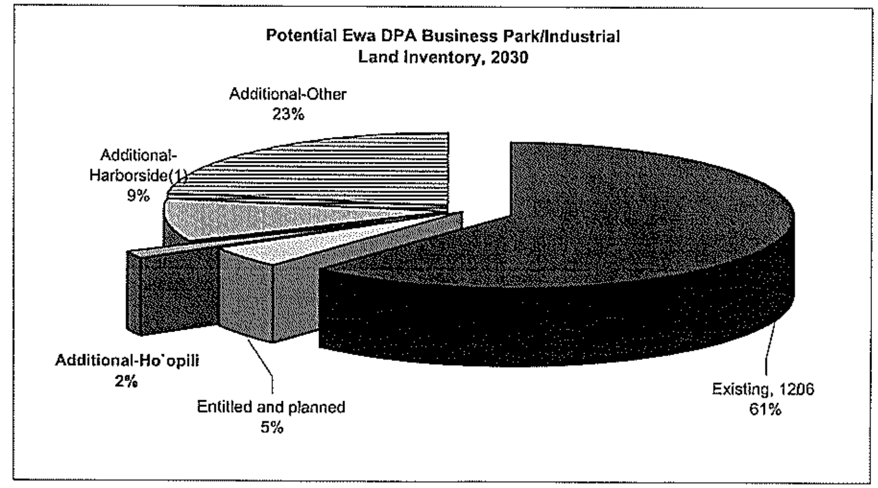
[1] Cumulative demand by 2015 based on 2007 to 2011 and 2012 and 2021 impacted areas;demand by 2030, based on 2015 total plus 2016 to 2021 impacted areas, as shown in Exhibit 8-5.

[2] Cumulative demand by 2015 based on 2007 to 2015 impacted areas;demand by 2030, based on 2015 total plus 2016 to 2030 impacted areas, as shown in Exhibit 8-5. Turnover estimate considered conservative in that it does not account for an increasing Oahu inventory.

[3] Beyond those already entitled. If entitled and zoned, Kapolei Harborside Center could satisfy about 240 acres (net) of this demand after 2009.

Exhibit 8-7
Business Park/Industrial Market Assessment for Ho`opili
(Ho`opili Land Allocation as Currently Planned)
Cumulative net acres, by 2015 or 2025

	Basis/reference	2015	2030
Projected supportable in Ewa DPA:			
Existing, December 2006	Exhibit 8-1	1,560	1,560
Entitled and planned for 2007-2030	Exhibit 8-3	160	120
Net additional supportable in Ewa	Exhibit 8-6	280	850
Total, rounded		2,000	2,530
Ho`opili market:			
Proposed net acres		40	40
Share of total future Ewa DPA		2%	2%
Share of net additional Ewa RBA		14%	5%



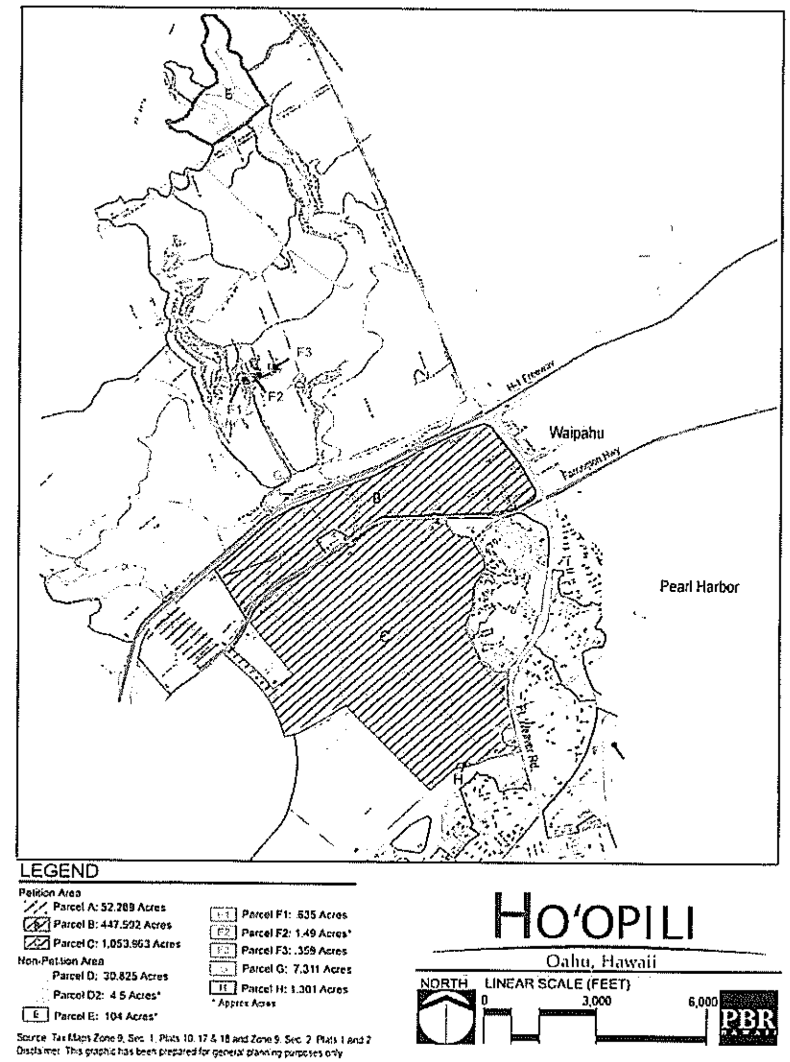
[1] Kapolei Harborside Center, petitioning the State LUC for Urban designation as of March 2007. This market share would revert to "Additional-Other" if KHC were not to receive necessary entitlements.

Source: Mikiko Corporation, 2007.

MARKET ASSESSMENT FOR HO`OPILI

Report Appendices

Appendix 1: Ho`opili Petition Area



Source: PBR Hawaii, 2007.

Appendix 2: Planned Residential Development Projects in the Ewa Development Plan Area, Con't.

Projects with State Land Use Entitlement or Exemption, as of February 2007

Project	Developer or Owner	Number of units: Total	Built as of 1/07	Potential remaining	Estimated project timing/buildout	Residential product mix	Entitlement status	Comment
E A H	Hui Kauhale, Inc. (E A H)	242	0	242	2007 - 2010	192 apartment rentals 50 SF for-sale	Entitled	Ewa Villages Area "H", 123 acres. Rentals are tax credits targeted at <70% of MFY.
Ko Olina Resort & Marina	Ko Olina Development LLC (various entities) and Sekiguchi	2,500	1,164	1,340	2008 +	Condo: tower & low-rise	Entitled	A-1 and A-2 zoned sites only; excluding sites 44 and 47, being considered for nonresidential uses. Likely 70-80% out-of-state markets.
Franciscan Vistas Ewa	St. Francis Development Corp.	328	0	328	Available for sale/rent 2008	207 senior rentals 121 for-sale SF & TH	Entitled	Behind Ewa Villages Manager's home; 23 acres. Rentals are tax credits.
East Kapolei I	State of Hawaii (DHHL)	403	0	403	Grading start 2006; occupancy 2009+	All SF	SLUC Urban; not zoned but DHHL exempt	Average 5,000 s.f. lots, 97 acres. Contingent on DOT completion of N-S Road. Adjacent UHWO.
East Kapolei II & III	State of Hawaii (DHHL, HHFDC, DLNR)	5,200	0	5,200	Ground break 2008+; home completions 2009+	1,000 SF 1,200 MF	INA but DHHL exempt	Financing an issue to completion, as DHHL State funding expires in 2012. Includes 600 rental units to be developed by HHFDC.
Kaupe'a (Villages of Kapolei, Village 8)	State of Hawaii (DHHL)	325	0	326	Under construction 2006; occupancy 2007 - 2010	All SF homes	Entitled	Last of Villages of Kapolei, 53.3 acre site; minimum 5,000 s.f. lots.
UH West Oahu project	UH/West Oahu Campus Development LLP (Hunt ELP Ltd.)	4,041	0	4,041	2009 to 2020+	761 - student & faculty homes 355 - workforce /affordable units 2,560 - MF 365 - SF	500-acre site was Urbanized by HCDCH	MF includes 925 high density, 1,050 medium density and 585 in mixed use. About 300 of 500 acres are for college town, 100 for campus. Campus requires further State funding.
Kalaeloa	Various (State HCDA is master planner)	6,350	60	6,290	60-unit Onelau'ena reopened 2006; most rest 2015-2030	Med-high density TH and apartments	SLUC Urban; HCDA must zone & establish rules	3700 acre masterplanned area. More than half on Navy-brokered lands.
Mokuola Vista	INA	70	0	70	2007			Waipahu
	Total, rounded	41,500	9,400	32,100				

Note - Excludes Subject and c. 150 potential units at Palehua D-2, not yet Urban. Shows remaining units to be developed at each masterplanned project, targeting those of 100+ units each. Figures shown based on stated owner or developer plans within entitlement restrictions, wherever information is available.

INA - Information not available; DP - on City Development Plan Map; SF - Single-family; MF - Multifamily; TH - Townhouse (multifamily); SLUC - State Land Use Commission; DHHL - Department of Hawaiian Home Lands; DLNR - Department of Land & Natural Resources; HHFDC - Hawaii Housing Finance & Development Corporation; HCDA - Hawaii Community Development Authority; MFY - median family income for City and County of Honolulu; DEIS - Draft Environmental Impact Statement.

Sources: Interviews with project principals, developers, planners and brokers, and City and State officials; Honolulu Advertiser; Honolulu Star Bulletin; Pacific Business News; project websites.

Appendix 2: Planned Residential Development Projects in the Ewa Development Plan Area

Projects with State Land Use Entitlement or Exemption, as of February 2007

Project	Developer or Owner	Number of units: Total	Built as of 1/07	Potential remaining	Estimated project timing/buildout	Residential product mix	Entitlement status	Comment
Kapolei West	Aina Nui Corporation (Campbell Estate)	1,450	0	1,450	2009 - 2020	SF & TH	SLUC Urban as of 2006; not zoned	Entitled for 2,370 units but 38% estimated to be targeted at non-resident/second home buyers.
Makaiwa Hills I and II	Makaiwa Hills LLC (Campbell & Monarch Group)	4,100	0	4,100	2009 - 2025	Emphasis on SF; Affordable to luxury	SLUC Urban; not zoned	Includes limited neighborhood commercial. EIS in 2006. Across highway from Kapolei West.
City of Kapolei (Campbell)	Aina Nui Corporation (Campbell Estate)	1,000	0	1,000	2008 - 2015	Some age restricted	SLUC Urban; not zoned	Mauka of Mehana site by D.R. Horton/Schuler; count includes Leihano for-sale housing (Brookfield/Kisco).
Palailai Mauka (also "Kapolei Mauka")	Aina Nui Corporation (Campbell Estate)	750	0	750	2009-2015	THs for affordable to middle markets	SLUC Urban; not zoned	May address some of affordable requirements for Kapolei West.
Villages of Kapolei (remnants)	Castle & Cooke Homes Hawaii, Inc.	472	0	472	Estimated completions 2008 - 2010	228 for sale MF, 244 rental	Entitled	Tax credit (<60% MFY) & gap rentals (120-140% MFY); for-sale. Por. Villages 2, 5, 6 & 8.
Wai Kalo'i ("Palehua East B")	Castle & Cooke Homes Hawaii, Inc.	300	0	300	Estimated buildout 2008	SF detached, min. 5,000 s.f. lots	Entitled	At end of Makakilo Drive. Also "Makakilo Extension."
Ewa Villages	City and County of Honolulu	57	0	57	Indefinite	Vacant lots	Entitled	Held at Managing Director's Office; disposition uncertain.
Kahiwelo (por., Palehua East C & D)	D.R. Horton/Schuler Homes	475	0	475	2008 - 2012	SF homes	Entitled	Includes C-1, C-2, D-1 and portion of C-3 (the latter not part of Palehua East).
Mehana (also "Kapolei Makai")	D.R. Horton/Schuler Homes	1,150	0	1,150	2008 - 2015	SF, duplex, TH, condo	Entitled	30% affordable to households at 80% to 120% of median. Also "City of Kapolei - Schuler," and "Kapolei Parkway Residential"
Ewa by Gentry and Gentry Ewa Makai	Gentry Homes	8,350	6,350	2,000	Makai started 2005; buildout estimated by 2011-2014	SF condo, SF detached, MF	Entitled	Zoning on Makai obtained 4/2004.
Ocean Pointe (prev. "Ewa Marina")	HASEKO (Ewa), Inc.	3,900	1,800	2,100	On-going, started 1998	SF detached & TH	Entitled	Includes potential vacation units but excludes 950-unit hotel. 4,850 maximum units per Unilateral.

Appendix 4: Entitled and Planned Retail Developments in the Ewa and Central Oahu Development Plan Areas

Projects with State LUC entitlement and plans, as of February 2007

Project Identification	Location	Developer	Site area (ac)	Estimated retail GLA (SF)	Potential new project delivery (square feet) 2007-2010	2011-2015	2016-2030	Comment
Ewa:								
Boat Parcel	Kapolei	Low Archibald (Newport Beach, CA)	14	88,000	88,000	0	0	To market 2-14 acre lots; not planned as shopping center; across Hawaiian Waters.
Kapolei Commons	Kapolei	MacNaughton /Kobayashi Groups	41	550,000	250,000	300,000	0	Initial 21 acres leased; 23-acre site at Kapolei West for 2nd phase under negotiation.
Costco	Kapolei	INA	13	160,000	160,000	0	0	Across from Home Depot.
Wal-Mart	Kapolei	Wal-Mart	25	148,000	148,000	0	0	Off of H-1 Makakilo Drive exit.
Leihano Senior Village	Kapolei	KISCO Senior Living/Brookfield Homes	INA	40,000	40,000	0	0	MUD in senior village.
Kapolei BMX Site	Kapolei	Brookfield Homes Hawaii	4	40,000	20,000	20,000	0	Currently being marketed for sale; part of Brookfield Transit Village MUD development.
Kapolei Center	Kapolei	MW Group	10	147,000	147,000	0	0	Former 12-acre site between K Mart & Home Depot; MW retaining 2 acres for self-storage.
Kapolei Promenade	Kapolei	INA	14	88,155	88,155	0	0	Balance of 335,155 GLA proposed as auto dealership.
City of Kapolei - other	Kapolei	Campbell	INA	333,000	50,000	100,000	183,000	Est. balance of zoned lands; includes Village Walk
Kapolei West	Kapolei	Aina Nui	21	125,000	0	70,000	55,000	15-acre transit site planned for MUD; 2 acre neighborhood retail site further west.
UH West Oahu Campus Village	East Kapolei	To be selected	46	175,000	50,000	80,000	45,000	Neighborhood; MUD
DHHL[1]	East Kapolei	De Bartolo Development	67	600,000	350,000	150,000	100,000	Regional/other

Appendix 3: Planned Residential Development Projects in the Central Oahu Development Plan Area

Projects with State Land Use Entitlement or Exemption, as of February 2007

Project	Developer or Owner	Number of units: Total	Built as of 1/07	Potential remaining	Estimated project timing/buildout	Residential product mix	Entitlement status	Comment
Mililani Mauka	Castle & Cooke Homes Hawaii, Inc.	6,480	6,040	440	Projected sell-out by 2008	70% SF historically; c. 55% future	Entitled	All product levels, including affordables.
Waipio Point	Castle & Cooke Homes Hawaii, Inc.	66	0	66	Projected sell-out by 2007	All SF	Entitled	Near Waipahu High School; all released units reserved as of 2/24/06.
Waiawa Gentry Phase 1	Gentry Investments	5,000	0	5,000	Ground break 2006/07; unit sales estimated 2010-2020	Est. 40% attached; 60% detached	Entitled	4,500 to 6,000 units possible depending on density. Planned for multiple homebuilders. Phase 2 (c. 5,000 units) has DP recognition but is not Urban.
Kau'olu Properties	GSF (from State - HCDCH)	370	0	370	>2010	For-sale condos	SLUC Urban, seeking up-zoning	Waipahu. Targeted at households earning 140% or less of County median income. Now zoned R-5; preparing EA.
Royal Kunia II	Horita (161 acres); Robinson Trusts (50 acres)	2,000	0	2,000	Indefinite	SF and MF 600 affordable	SLUC - all; Zoning - Horita lands only	2,000 max based on off-site infra-structure, not entitlements. Horita repurchased at bankruptcy auction, 8/06.
Plantation Town Apartments	Plantation Town Apartments LLC	330	0	330	2008	2, 12-story towers, units, $139-298K	Needs height variance	Within HHFDC's Kau'olu community, Waipahu. Affordable housing.
California Ave. Apartments	INA	42	0	42	2007	Elderly rentals		Wahiawa
	Total, rounded	14,300	6,000	8,200				

Note - Excludes Koa Ridge and Waiawa by Castle & Cooke (up to 5,500 units) and Gentry Waiawa Phase 2 (up to 5,000 units), both planned developments requiring SLUC approval. Exhibit shows net remaining units to be developed at each masterplanned project, targeting those of 100+ units each. Figures shown based on stated owner or developer plans within entitlement restrictions, wherever information is available.

INA - Information not available; DP - on City Development Plan Map; SF - Single-family; MF - Multifamily; TH - Townhouse (multifamily); SLUC - State Land Use Commission; HCDCH - Housing & Community Development Corporation of Hawaii; DHHL - Department of Hawaiian Home Lands; DLNR - Department of Land & Natural Resources; HHFDC - Hawaii Housing Finance & Development Corporation; HCDA - Hawaii Community Development Authority; MFY - median family income for City and County of Honolulu; DEIS - Draft Environmental Impact Statement.

Sources: Interviews with project principals, developers, planners and brokers, and City and State officials; Honolulu Advertiser; Honolulu Star Bulletin; Pacific Business News; project websites.

Appendix 5: Planned and Entitled Office Developments in the Ewa and Central Oahu Development Plan Areas

As of February 2007

Project identification	Location	Developer/ Owner	RBA or building size (SF)	Potential new delivery (SF) 2007-2015	Potential new delivery (SF) 2016-2030	Project timing	Comments
Ewa:							
Kapolei Pacific Center	Kapolei	Avalon Development	335,000	335,000	0	2009	11-stories; includes up to 50,000 sq. ft. ground floor retail; across from library and regional park.
Kapolei City Center Office Complex	Kapolei	Kahl & Goveia	200,000	200,000	0	2009	Includes both medical and general office space
Goodwill Site	Kapolei	INA	200,000	200,000	0	2009	Planned for office development. Goodwill seeking proposals for ground lease.
City of Kapolei - other	Kapolei	Campbell	550,000	50,000	500,000	2008-2025	Estimated balance of City of Kapolei commercial-zoned lands, net of those committed to State or County.
Makaiwa Hills	Makaiwa	Aina Nui Corporation	90,000	0	90,000	2011+	Possibly additional office areas as future conditions warrant.
Kalaeloa	Kalaeloa	State/private partner(s)	725,000	150,000	350,000	2010 to 2030+	Includes about 56,000 RBA on Navy-brokered lands.
Central Oahu:							
Gentry Waiawa Phase 1	Waiawa	Gentry	80,000	80000	0	2010+	Not committed yet - could be interchanged with commercial, industrial uses.
Totals of available information, rounded:							
	Ewa		2,100,000	940,000	940,000		
	Central Oahu		80,000	80,000	-		
	Total Trade Area		2,180,000	1,020,000	940,000		

SF - square feet

Sources: Interviews with project developers, landowners, planners and brokers; area site visits; Pacific Business News, 2006, "Book of Lists 2007"; Pacific Business News (weekly); Colliers Monroe Friedlander; www.kapolei.com and other internet sites; Honolulu Advertiser; Hawaii Community Development Authority; Hawaii State Department of Business Economic Development & Tourism, Research and Economic Analysis Division, "Economic Impacts of the Proposed Kalaeloa Project," January 2007.

Appendix 4: Entitled and Planned Retail Developments in the Ewa and Central Oahu Development Plan Areas

Projects with State LUC entitlement and plans, as of February 2007

Project identification	Location	Developer	Site area (ac)	Estimated retail GLA (SF)	Potential new project delivery (square feet) 2007-2010	2011-2015	2016-2030	Comment
Makaiwa Hills	Makaiwa	Campbell	INA	360,000	0	100,000	260,000	Community center or MUD; balance of 450,000 assumed to be office
Ko Olina Junction	Ko Olina	Honu Group	INA	20,000	0	20,000	0	Balance of c. 60,000 expected to be primarily resort-oriented
Laulani Shopping Center	Ewa Beach	Bristol Group/Hamico (Art Howard)	20	255,000	255,000	0	0	Potential Target or other big box; on Ft. Weaver Rd.
Ocean Pointe	Ocean Pointe	Haseko	INA	100,000	0	20,000	80,000	Balance of 500,000 may include spa, other hotel-support
Kalaeloa	Kalaeloa	State/private partner(s)	INA	116,000	0	31,000	85,000	All commercial retail development on Navy brokered lands within Kalaeloa.
Central Oahu:								
Mililani Mauka Commercial B	Mililani Mauka	Castle & Cooke		85,000	85,000	0	0	INA
Gentry Waiawa	Waiawa	Gentry	18	100,000	30,000	70,000	0	Neighborhood, community, non-shopping center
Gentry Waiawa	Waiawa	Gentry	85	300,000	40,000	100,000	160,000	Commercial or industrial; unzoned
Laniakea Plaza	Waipio Gentry	INA	INA	25,189	25,189	0	0	
Plaza at Mill Town	Waipahu	Avalon	INA	34,000	34,000	0	0	2 acres of 15.3 acre site; balance zoned for industrial
Totals/average of available information, rounded:								
	Ewa			3,350,000	1,650,000	890,000	810,000	
	Central Oahu			540,000	210,000	170,000	160,000	
	Total			3,890,000	1,860,000	1,060,000	970,000	

INA = Information not available U/C = Under construction MUD = Mixed-use development, including residential and retail SC = Shopping center

[1] Assumes phasing of regional mall.

Sources: Interviews with project developers, landowners, planners and brokers; area site visits; Pacific Business News, 2006, "Book of Lists: 2007"; Pacific Business News (weekly); Colliers Monroe Friedlander, Inc.; developer websites; Honolulu Advertiser; Hawaii Community Development Authority; Hawaii State Department of Business Economic Development & Tourism, Research and Economic Analysis Division, "Economic Impacts of the Proposed Kalaeloa Project," January 2007.

Appendix 6: Existing and Planned Business and Industrial Parks in Ewa and Central Oahu DPAs

As of February 2007

Project	Location	Year opened/ projected	Land area (gross acres): Total	Land area (gross acres): In use or sold	Land area (gross acres): Future supply[1]	Future net acres[2]	Potential new delivery (net acres): 2007-2015	Potential new delivery (net acres): 2016-2030	Zoning	Comment
Central Oahu:										
Mililani Technology Park	Mililani	1989	101	71	30	23	20	3	Ph I - IMX-1	Ph I - 101 acres; Ph II - 135 acres but excluded because still Ag. Ph 1D infrastructure not complete.
Mill Town Business Center	Waipahu	1998	48	35	13	10	10	0	I-1	Includes Avalon's Sugar Mill Center (15-acres = 2 acres ground floor retail and 2 acres industrial, to market 2007).
Waipahu	Waipahu	INA	86	86	0	0	0	0	Most I-2; some B-2	Throughout town; c. 2.2 mil s.f. buildings.
Gentry Business Park	Waipio	1980	122	122	0	0	0	0	IMX-1, I-2	c. 1,523,000 s.f.
Wahiawa Industrial Center	Wahiawa	1990	4	4	0	0	0	0	I-2	Intensive industrial.
Gentry Waiawa Phase 1	Waiawa	2009+	175	0	175	131	90	41	B-2, IMX-1 & unzoned	Lands designated Commercial/Industrial on master plan - most could be developed as either.
Royal Kunia	Kunia	2012+	123	0	123	92	20	72	A-1	Requires zoning.
Subtotal, rounded			660	320	340	260	140	120		
Total, rounded			2,590	1,880	710	540	300	240		

[1] Estimated lands with State entitlement or exemption, and planned but not yet committed. Aina Nui's Kapolei Harborside Center (345 acres gross, 240 saleable) not included as it is currently before the LUC. Aina Nui projects 2009 to 2017 marketing period if entitled.

[2] Net acres estimated at 75% of gross acres, to allow for roads, infrastructure, etc.

INA - Information not available s.f. - square feet. FAR - Floor Area Ratio

Sources: Interviews with project landowners, their consultants, planners, land managers, and brokers; Pacific Business News; company web sites; Enterprise Honolulu; Hawaii Community Development Authority, "Draft Kalaeloa Master Plan," 2005; Colliers Monroe Friedlander Inc., 2006.

Appendix 6: Existing and Planned Business and Industrial Parks in Ewa and Central Oahu DPAs

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Ewa:										
Hawaii Raceway Park	Kapolei	2010	54	0	54	41	41	0	INA	To sell developed lots. Owner Irongate also developing Trump Towers in Waikiki.
James Campbell Industrial Park	Kapolei	1959	1,367	1,367	0	0	0	0	I-2	Heavy industry; vertical developments sold to HRPT.
Kapolei Business Park	Kapolei	1993	189	136	53	40	40	0	I-2, restricted	Phase 1 and 2 sold to Jupiter; 53 acres (19 lots) in phase 2, includes Kapolei Spectrum (condos) and Kapolei Industrial Court (also built.)
Kenai Industrial Park	Kapolei	1990	60	60	0	0	0	0	I-3	Sold out.
West Kalaeloa	Kapolei	2008+	100	0	100	75	75	0	I-2	Makai of Honolulu Advertiser site, adjacent to studio site. SHM Partners expect 2 mil s.f.
Kapolei Studios	Kapolei	2008+	23	0	23	17	17	6	I-2	Movie/production studios. SHM Partners; planning on State tax credits (Act 88).
Kalaeloa - Navy brokered & State administered properties	Kalaeloa	2010+	192	0	192	144	30	114	INA	Industrial, Light Industrial and Eco-Industrial lands, 10% in Navy-brokered lands; acreage estimated by CMF based on assumed FAR.
Subtotal, rounded			1,930	1,560	370	280	160	120		

Appendix K
Economic & Fiscal Impact

MIKIKO CORPORATION

ECONOMIC AND FISCAL IMPACT ASSESSMENT FOR HO`OPILI

ISLAND OF OAHU

Prepared for:
D.R. Horton – Schuler Homes, LLC
dba D.R. Horton – Schuler Division

FINAL REPORT

August 2007

Economic and Fiscal Impact Assessment for Ho`opili

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ECONOMIC AND FISCAL IMPACT ASSESSMENT FOR HO'OPILI

Report Text

1 – Introduction and Executive Summary

This chapter relates the study background, objectives, approach and principal conclusions of an economic and fiscal impact assessment prepared for the proposed Ho'opili development on Oahu. The following chapters offer a more detailed explanation of the findings and analyses on which these conclusions are based.

Project and Study Background

D.R. Horton – Schuler Homes, LLC dba D.R. Horton – Schuler Division (DRH), has initiated a planning and entitlement process to develop Ho'opili (also "the Project"). The mixed-use, master-planned community encompasses approximately 1,555 acres in the City and County of Honolulu's Ewa Development Plan Area (DPA). As proposed, Ho'opili would include up to 11,750 homes, a 50-acre (40 net acres) business park, and several areas of retail and/or office commercial development, totaling up to 2.96 million square feet of gross leasable area at buildout. It would also include one or more County-operated transit stations, up to six sites for schools or other public uses, regional and neighborhood parks, and other open spaces.

The Project is described further below, and in Mikiko Corporation (MC)'s prior report, "Market Assessment for Ho'opili," which is dated March 2007.

The planning firm PBR Hawaii & Associates, Inc. (PBR Hawaii) is preparing materials to support DRH's entitlement efforts for these lands.

Mikiko Corporation Study Objectives

PBR Hawaii engaged MC to prepare two reports:

1) **Market assessment** – An assessment of the market support for the residential, commercial and business park uses proposed at Ho'opili, including:

   - ☐ Evidence of demand and competitive supply
   - ☐ Assessment of appropriate markets, pricing, and supportable absorption

2) **Economic and fiscal impact assessment** – An assessment of the economic and fiscal impacts of the Project in terms of population, employment, personal income and State and County government operating expenditures.

The market report is the separate document cited above. This report uses the findings of the market report as input assumptions.

Economic and Fiscal Impact Approach

This economic and fiscal impact assessment is intended to assess the Project's effects within the State of Hawaii (State) and the City and County of Honolulu (County). Impacts that were evaluated include:

☒ Economic impacts:

- ☐ Part-time resident expenditures in Hawaii
- ☐ Development-related employment
- ☐ Operations-related employment
- ☐ Personal income deriving from development and operations

☒ Population impacts:

- ☐ Residential utilization patterns
- ☐ In-migrant population

☒ Fiscal impacts:

- ☐ Property tax and other County government revenues
- ☐ General excise tax, income and other State government revenues
- ☐ County and State government operating expenditures
- ☐ County and State net fiscal operating impacts

State and County revenues and expenses estimated herein are generally based on the structure of tax collections and services reported as of the fiscal year ending June 30, 2006[1]. The impacts estimated would differ if governmental taxing and spending policies were to be materially altered.

All dollar amounts in this report are stated in 2007 dollars, and year references are to calendar years, unless otherwise stated.

[1] Real property tax rates, however, have been updated to FY 2008 rates, since the County enacted significant changes to its tax structure in summer 2007.

Executive Summary

Development Proposal

Over three decades ago, city planners set out to create a "second" city in West Oahu that would provide island residents an alternative to living and working in downtown Honolulu's existing urban core. This is documented in the County's Ewa Development Plan, which was adopted by the City Council in August 1997 and is periodically updated. The plan presents a vision for Ewa's future development and provides conceptual land use plans that serve as a policy guide for more detailed planning and for public and private sector investment decisions.

In the near future, Ewa should also become a major economic engine for the state. For the 2006 to 2025 period, planned development in the DPA is projected to generate some $620 million in annual payroll, and 40,000 new jobs in the area. Projections also forsee over 38,000 new workers employed in the area by 2025.[2]

This is the context in which Ho`opili was conceived. The new community is designed as one of the last pieces of the larger master plan for the area, delivering needed homes and jobs in this fast-growing region. Ho`opili is proposed as mixed-use project developed in a New Urbanist[3] style, a community where residences, employment opportunities and amenities are closely integrated and may be reached by foot, bike or transit, as well as by car. Like other New Urbanist developments, Ho`opili is intended as a community where one can "live, work and play."

Ho`opili will offer traditional single- and multifamily homes, as well as multifamily residences developed in mixed-use settings. These may be units developed on second or third floors above ground floor retail, as well as "live-work" units, which include spaces designed and permitted for commercial business operations. In general, housing at Ho`opili will be developed at higher average densities than Hawaii's planned communities have been historically. This should serve to enhance the affordability of its housing, to encourage non-automobile-based modes of travel, and to support the Project's commercial facilities.

In accordance with County policies, about 30% of Ho`opili's residential units would be priced to County standards for affordable housing. The table on the next page summarizes the key Project components that drive the economic and fiscal impact assessment presented herein.

[2] Decision Analysts Hawaii, Inc., September 2005, "Ewa Development, 2006 to 2025: Economic, Population and Fiscal Impacts."

[3] See market study, Chapter 4 for discussion on New Urbanism.

Ho`opili would also offer up to 2.96 million square feet of commercial areas, including retail and office uses. Some of this space would be located within six business/ commercial designated areas, and some dispersed in residential mixed-use areas. With its advantageous location at the "gateway" to Ewa, including the intersection of H-1 freeway and Fort Weaver Road, Ho`opili's commercial areas could serve broad regional markets as well as its own community needs.

Finally, the Project's 50-acre (40 net acres) business park is envisioned to seek establishments that serve national and international markets. This could include a science and technology center, a health-and-wellness-related facility or other professional or technical-focused enterprises.

This report does not consider the impacts of developing and operating the County's proposed transit station(s) at Ho`opili.

Overview of Proposed Developments at Ho`opili
2007 dollars

	Comment	By 2015	By 2030	Total
Homes:	*Overall mix:*			
Market units	*70%*	1,800	6,450	8,250
Affordable units[1]	*30%*	300	3,200	3,500
Total		**2,100**	**9,650**	**11,750**
Average home sales price:				
Market units		$480,000	$480,000	$480,000
Affordable units		$295,000	$295,000	$295,000
Weighted average		**$425,000**	**$425,000**	**$425,000**
Other developments:				
Business park	*Net acres*	20	20	40
Business park	*Same areas, but in building sq. ft.*	120,000	680,000	800,000
Commercial centers	*Gross leasable sq. ft.*	600,000	2,360,000	2,960,000
Total development costs	*Hard and soft costs (mils)*	**$1,076.6**	**$3,531.7**	**$4,608.3**

Note: Project also includes school and park sites, public facility sites, a bike path and open spaces.

1 Assumes 1:1 credit per County guidelines currently in effect. Actual credit could vary, changing the affordable unit count. See City & County of Honolulu, "Adoption of Rules for the Terms and Unilateral Agreements Requiring Affordable Housing," October 20, 1994.

Sources: Exhibits 1 and 5; DRH, 2007; Mikiko Corporation, "Market Assessment for Ho`opili," March 2007.

As shown in the preceding table, development costs are estimated to total some $4.6 billion, including on- and off-site infrastructure, vertical construction, landscaping and soft costs such as professional services, administration of operating subsidiaries, marketing and the like.

Projected Impacts[4]

The Project would generate significant, on-going economic and fiscal benefits for residents of the islands, as well as for the County and State governments. Development of facilities would generate employment and consequent income and taxes. In addition, by attracting new part-time residents or retirees to Oahu and generating additional real estate sales activity, the Project is expected to support long-term impacts, including additional consumer expenditures, employment opportunities, personal income and government revenue enhancement.

Highlights of the Project impacts are summarized in the table on the next page.

- **Development employment** - Throughout its development, Ho'opili could support some 2,300 to 3,300 full-time equivalent (FTE) development-related jobs through its direct, indirect and induced impacts. These jobs are expected to be associated with annual personal earnings[5] of some $131 to $178 million per year, or $53,000 to $56,000 per job.

- **Operational employment** - By its completion in about 2030, the Project could also be expected to have generated about 7,000 permanent, ongoing FTE jobs, through its direct, indirect and induced impacts. About 1,550 of these jobs could be new to the County and State. They could be expected to include professional, technical and managerial positions at the proposed business park, sales and marketing positions supported by resales and releasing of property at the Project after its initial occupancy, and myriad other positions generated throughout the economy, as supported by the activity generated by such new expenditures. Altogether, these net new operations-related positions could be expected to generate personal earnings for Hawaii residents of about $109 million per year.

[4] See following chapter for study methodology and definitions of key terminology, such as "direct," "indirect" and "induced" impacts.

[5] Earnings are defined as wage, salary and proprietary income, plus director's fees and employer contributions to health insurance, less employee contributions to social insurance. "Earnings" are typically less than salaries.

Summary of Projected Economic and Fiscal Impacts

2007 dollars, in millions

	Comment	By 2015	By 2030
FTE employment[1]:	*Direct, indirect and induced*		
Development-related	*Average annual in preceding period*	2,340	3,340
Operations-related	*Annual, on-going*		
Total generated by Project	*On-site and directly supported*	1,836	7,043
Net new jobs	*New to County or State*	740	1,550
Total personal earnings[2]:	*Direct, indirect and induced*		
Development-related	*Average annual in preceding period*	$130.7	$178.3
Operations-related	*Annual, on-going, on net new jobs only*	$65.2	$109.2
Average earnings per FTE job[2]	*Direct, indirect and induced*		
Development-related	*Average annual in preceding period*	$56,000	$53,000
Operations-related	*On net new jobs only*	$88,000	$70,000
In-migrant resident population:	*Average daily employees, dependents, and part-time residents*		
To the County		550	2,170
To the State	*Subset of County in-migrants*	260	1,020
Net additional government operating revenues[3]:	*Operating revenues less operating expenditures*		
For the County		$7.8	$27.5
For the State		$14.4	$19.9
Revenue/expenditure ratio[3]:	*For government operations*		
For the County		9.8	8.5
For the State		9.4	3.8

1. FTE = Full-time equivalent, defined as 40 hours per week or 2,080 hours per year.
2. Earnings defined to include wage, salary and proprietary incomes, plus directors' fees and employer contributions to health insurance, less employee contributions to social insurance.
3. Does not consider impact and permit fees paid to County and State governments. These are projected to amount to approximately $194 million and $25 million, respectively, over the life of the Project, in 2007 dollars. They include sewer, water, transportation, schools, and other fees and permits. Figures also exclude impacts of transit facilities.

Sources: DRH, 2007; Mikiko Corporation, "Market Assessment for Ho'opili," March 2007.

- **Population movements** - It can be assumed that the jobs created by Ho'opili, particularly its professional, technical and managerial career opportunities, will create incentives for some neighbor islanders or former Hawaii residents to move to Oahu. These and other indirect factors can be expected to result in up to 2,170 persons living on Oahu who might not otherwise have lived on the island (in-migration to the County.) Within this total, some 1,020 persons could be those who had previously lived out-of-State.

- **Net County fiscal impacts** - The Project could be expected to contribute some $27.5 million in net additional County revenues at its completion. By 2030 and beyond, new County government revenues are estimated to represent 8.5 times the new County government operating expenditures required to support the additional population expected to be attracted to Oahu by the Project.

- **Net State fiscal impacts** - For the State, net additional operating revenues derived from the Project are estimated at $19.9 million per year by 2030 and beyond. This represents a revenue/expenditure ratio of 3.8.

These public sector contributions do not consider the value of the school sites, public parks or various off-site infrastructural improvements to be contributed by DRH, nor do they consider the estimated $219 million in various impact and permit fees expected to be paid to the County and State governments during the development of the Project. These additional contributions would greatly increase the net public benefits of Ho'opili.

Report Organization

The rest of the report is organized in three parts, as follows:

1) **Remainder of Report Text** - Explanation of the study analyses and conclusions, including:

   - Study Approach
   - Economic Impacts
   - In-Migrant Population
   - Fiscal Impacts

2) **Exhibits**- Detailed bases and findings on which the conclusions are based.

3) **Appendices** – Report conditions and further documentation of input assumptions.

2. Study Approach

Special Considerations

Special considerations for some of Ho'opili's facilities guide the analyses presented herein. These and other aspects of this study's analytical framework are set forth below:

- **Time frame** – This analysis extends from 2009 to 2030, a 22-year period that would encompass from preconstruction planning through Project build-out. Ground-breaking may be anticipated in 2010. All residential units, as well as commercial and industrial space are projected to be sold and/or occupied during this period, in accordance with findings of the market study.

- **Use and classification of residential units** – Although not considered a major market segment, Ho'opili's unique development style and mixed-uses could attract some buyers that would be seeking a part-time residence in the community. This group is distinguished from primary resident buyers or renters because their economic and fiscal impacts are distinct.

  - Homes occupied by full-time residents are referred to herein as "primary resident homes" and are assumed to be occupied by persons who would be living elsewhere on Oahu even if the Project were not developed.

  - Homes occupied by part-time residents may be referred to herein as "non-resident homes" and/or "non-resident/second homes," and are assumed to be occupied by persons who will stay at the unit for significant portions of the year, but whose primary place of residence is or was formerly somewhere other than Oahu. This latter group also includes persons who retire to Ho'opili from somewhere off-island, even if their Ho'opili home becomes their principal place of residence.

- **Commercial facilities** - The proposed commercial facilities are expected to attract spending from:

  - Unit buyers at Ho'opili who reside on-site full- or part-time,
  - Oahu residents not living at Ho'opili, and
  - Oahu visitors not staying at Ho'opili.

  It is likely that Oahu residents and visitors not staying at Ho'opili would have spent an equivalent amount on dining out and/or personal services whether or not the Project's commercial facilities were developed. Thus, given the competitive retail market on Oahu, the planned complexes could lead to a geographic reallocation of spending within the region, but would not in themselves be expected to increase expenditures made in the County or State.

On the other hand, commercial facilities would contribute to the Project's ability to attract residential buyers to Ho`opili.

In other words, Ho`opili's commercial facilities will employ workers, pay taxes and generate other economic and fiscal benefits. These are considered directly generated impacts and most of these jobs would be located on-site. However, the net benefits of the Project's commercial facilities are best measured in terms of the part-time residents Ho`opili attracts, and the spending, taxes and other benefits these persons will generate throughout the County and State.

- **Other uses/considerations not modeled** – Other than development costs for the parks and infrastructure affiliated with the school site, this assessment does not consider the economic and fiscal impacts of development that would be of a public or civic nature. Thus, building or other facilities on the school sites or parks, the proposed transit station(s) and other public facilities are not considered. Neither is the value of the lands to be contributed to governmental agencies considered.

  With respect to the proposed transit station(s), it is assumed that they might be developed elsewhere in the Ewa district, if at all, whether or not Ho`opili proceeds. Thus the development costs and many other impacts of introducing mass transit in the region, although likely profound, are not considered to be a function of the development of Ho`opili per se.

- **Entitlement spending not considered** – DRH's currently on-going entitlement process for Ho`opili is already generating economic and fiscal benefits by employing professionals and supporting various vendors around the State. However, since such benefits are not dependent on the outcome of the entitlement process, they are not enumerated in this analysis.

- **Other** –This study does not compare the proposed developments to prior master plan(s) for the property nor to other developments that could be hypothesized given the lands' existing entitlements.

Definition of Terminology

Within this report, the following definitions apply:

- **Direct impacts** - Those economic, population or other impacts attributable to persons or activities that are a direct result of the proposed development. For instance, direct employment impacts might include those involved in building the proposed facilities, such as construction workers, and those who would later work at them in their operations.

Many, but not all of direct impacts can be expected to occur on-site. For instance, a portion of the construction budget is for architects and engineers. While such persons' employment might be temporarily dependent on the contracts generated by Ho`opili, they may do the majority of their work from offices in Honolulu or elsewhere. Likewise, administrative and managerial staff located off-site would support construction professionals working on-site.

- **Indirect impacts** - Indirect impacts occur when the businesses or persons who are directly affected make expenditures for additional supplies or services. For instance, some of the additional retail spending by those newly attracted to Hawaii by Ho`opili could be spent on eating out. These elevated dining out expenditures could indirectly increase demand for produce, seafood and meats from Hawaii farms, fishermen and/or ranching enterprises. Ho`opili would thus have indirectly supported new business opportunities for area providers of such goods and services.

- **Induced impacts** - Induced impacts occur throughout the community when those persons or companies that have benefited from the direct or indirect impacts of the Project spend their associated earnings on consumer goods and services. For instance, a construction worker may spend her earned wages to buy a new pair of shoes, or to pay for her child's day care. The farmer who sells produce to a restaurant at Ho`opili may use some of his profit to take his family out to the movies. The businesses and individuals impacted by such re-spending are said to enjoy induced economic impacts from the Project.

- **Total impacts** - Total impacts are defined as the sum of direct, indirect and induced impacts for any given variable.

- **Resident population** - Resident population refers to all those persons who habitually reside in a given area, whether or not they may have temporarily traveled away.

- **Full-time equivalent** - Although some direct, indirect and induced employment opportunities generated by Ho`opili can be expected to be part-time, this study measures employment opportunities in full-time equivalent (FTE) units. For purposes of this study, one full-time equivalent position is defined as 2,080 hours of employment (including paid vacation and sick leave) per year. This is equivalent to 40 hours per week, and may also be referred to as a "person-year" of employment. Two half-time jobs would be considered to together represent one FTE job.

  Residents may also be referred to as FTE. In this case, one FTE resident would represent 365 days of presence in the community. As an illustration, this could also represent four part-time residents each staying three months.

Project Parameters

Assumptions regarding the scale, nature and timing of the Project are made in order to assess its impacts. This assessment is based on findings of the market study, and on timelines and development programs provided by DRH, PBR and others as noted.

Development Program (Exhibit 2-1)

Ho'opili is proposed to be developed with up to 11,750 residential units, 2.96 million square feet of commercial (retail and office) space, and 40 net acres (50 gross acres) of business park. The business park lands could be expected to accommodate up to 800,000 square feet of rentable building areas at completion.

Among the residential units, about 30% or some 3,500 would be developed as affordable housing, in accordance with County guidelines. If these units were developed for sale (as opposed to rentals), they could expect to be marketed for about $295,000 on average, based on County guidelines in effect in February 2007. Affordable units might be produced at a rate of about 200 per year, on average.

The average market-priced unit could be expected to be sold at $480,000, with an average of 450 units selling each year. These assumptions are explained in the market study.

Including the above land uses plus school and park sites, roads, pathways and other open spaces planned, the Project encompasses some 1,555 acres. The school and/or "public facilities" sites and several of the park sites are intended for contribution to State and County governments.

Assuming entitlements are obtained on a timely basis, the landowner believes construction of infrastructure could begin in 2010, and the first units could be available for occupancy in 2012. The Project as a whole is anticipated to be fully sold out and/or leased by 2030. As noted previously, however, this analysis begins in 2009, in order to capture the impacts of pre-construction but post-discretionary permit planning, design and related professional services.

Utilization Patterns (Exhibit 3-2)

County guidelines are expected to restrict the use of affordable housing units to primary residents. Market units are also likely to be mostly used as primary residences. Many would be purchased by households intending to live in them themselves, while some others may be purchased by investors who would subsequently rent them out. This would again result in a unit available for primary resident use.

Based on historical estimates for Oahu, about 7% of homes could be expected to be purchased by persons who customarily live or previously lived off-island, on a neighbor

island or out-of-State. These would include those who intend to live in their new unit on a part-time basis, as well as those who intend to move to Oahu to reside in the unit full-time, such as a retiree who relocates from off-island.

Primary resident market units at Ho'opili are assumed to be occupied 95% of the time, at 3.2 persons per household for market units, and 3.4 per household for the affordable units. These are based on the estimated 3.5 persons per household now resident in the Ewa DPA, and the projected 3.4 per household by 2011[6]. The current estimate and near-term projection are discounted further during the projection period to reflect ongoing anticipated declines in average household size.

The nonresident/second home units are assumed to be occupied an average of 50% of the year, by an average of 2.3 persons per unit, based on surveys of brokers and residents in other second home communities on Oahu. These assumptions support an average daily Project population of some 35,290 persons, assuming its full build-out and sales absorption by 2030.

[6] Claritas, Inc., 2006.

3. Economic Impacts

Ho`opili may be expected to impact the State and County economies by (a) attracting part-time residents who would make new expenditures,[7] (b) generating development activity, which supports expenditures for goods and services, and (c) creating and supporting jobs and business enterprises in its ongoing operations. The new jobs would in turn generate additional personal earnings in the County and throughout the State.

Part-Time Resident Expenditures (Exhibit 3-1)

Expenditures by part-time residents attracted to Oahu by the Project will contribute to Ho`opili's economic benefits. Direct expenditures made in Hawaii by the part-time residents themselves are projected to amount to about $2.4 million by 2015, or $11.1 million per year by the Project's stabilization in 2030. Including the indirect and induced impacts of these direct expenditures, the total contribution to the State economy by Ho`opili's part-time residents is expected to amount to about $4.1 million per year by 2015 and $19.0 million per year by 2030 and thereafter.

Project Costs

Coefficients and Multipliers (Exhibit 3-2)

The State of Hawaii, Department of Business Economic Development and Tourism (DBEDT) periodically evaluates the economic interdependencies of the various industries within the State, and their rates of job and personal earnings creation. The latest such study is dated June 2006 and entitled, "The 2002 State Input-Output Study for Hawaii." Exhibit 4 shows the information extracted from this report for use in the analysis of Ho`opili's development activity.

- **Final demand industry coefficients** show the relationship between input, or spending within any given industry category, and its resulting creation of jobs and earnings in other sectors of the State economy[8]. Such coefficients are used to estimate the direct effects of the construction and development activities planned for Ho`opili.

- **Industry multipliers** show the relationship between direct jobs or earnings and the indirect and induced jobs or earnings that they can be expected to subsequently support.

[7] Although not planned as a second home community, nearly all areas of Hawaii attract some part-time resident ownership. Ho`opili's relatively smaller, mixed-use units could additionally appeal to neighbor islanders who frequently do business in or travel to Oahu.

[8] Personal earnings are defined in the DBEDT study as wage and salary income plus proprietors' income, plus director's fees, plus employer contributions to health insurance, less personal contributions to social insurance (i.e., social security taxes). See pp. 23 to 24.

Development Costs (Exhibits 3-3 and 3-4)

Based on estimates provided by DRH and other sources as cited in the exhibits, Ho`opili's development costs will amount to some $4.6 billion in total, spent over the 22 years between 2009 and 2030. This budget is in 2007 dollars and includes:

- **Professional services** – planning, architectural, engineering, landscape design, development management, legal, and similar services. Note that those services related to the effort to entitle Ho`opili's lands are not included in this estimate, since they are not contingent on the entitlement.

- **Construction** – including on- and off-site infrastructure, land subdivision and site preparation, all facility development (except for public facilities), and retail, office and business park tenant improvements.

- **Other** – including administrative overhead, subsidiary operations, marketing, public relations, off-site community contributions and other "soft" costs incurred during the Project's development.

Because the latest DBEDT coefficients are calibrated to 2002 dollars, the development budgets are also re-estimated in 2002 dollars, as also shown in Exhibit 3-3.

Exhibit 3-4 restates the 2007 figures but on an average annual basis within each period considered, rather than as a total for each period. Over the projection period, the Project could be expected to average $209.5 million per year in development expenditures in Hawaii. The rate of expenditures could be higher than this average between 2016 and 2030.

Employment and Earnings

Development Employment (Exhibit 3-5)

Over the life of its buildout, Ho`opili could directly generate some 27,400 person-years of development-related work. The majority of this work would occur on-site. However, some, such as the professional services and administrative positions, are likely to be located off-site, likely elsewhere on Oahu. This estimate includes wage, salaried and proprietary employment opportunities supported by Ho`opili's development.

Considering also the indirect and induced employment opportunities that these direct impacts are likely to support, the total impacts of the Project's development could represent 66,600 FTE jobs by 2030.

The impacts are also considered on an average annual basis, in order to suggest the numbers of persons that could be employed in Ho'opili's development in an average year. Over the entire development period from 2006 to 2030, the Project is anticipated to support an average 1,240 direct FTE development-related jobs within the State. Total employment impacts, including direct, indirect and induced FTE jobs, could represent about 3,020 FTE positions in an average year. Average annual demand for development-related employees could be higher between 2016 and 2030.

Personal Earnings from Development (Exhibits 3-6 and 3-7)

Direct personal earnings associated with Hawaii-based positions could amount to some $1.84 billion over the Project's initial development. Considering the indirect and induced earnings, Hawaii workers could expect to enjoy some $3.59 billion in additional earnings over the Project's development.

On an annual basis, these total earnings represent an average of $163.1 million per year from 2009 to 2030, or up to $178.3 million per year between 2016 and 2030. The indirect and induced benefits could be expected to be supported throughout the State, with concentration on Oahu.

Comparing projected earnings to the employment figures shown previously, the FTE-wages, salaries, proprietary income and other earnings generated by the Project's overall development are estimated to average about $67,000 per direct FTE position, or $54,000 considering its total, more dispersed impacts.

Since most families include more than one jobholder, and many employees themselves hold more than one job, these position-specific salaries can be expected to be associated with higher average family incomes.[9] Thus, on average, those employed in positions directly supported by Ho'opili's development could be expected to have family incomes averaging $121,000, while those associated with all jobs created through the Project's direct, indirect or induced effects could be expected to have family incomes averaging $97,000. These would represent 165% and 132% of the median family income for Honolulu County, which was estimated at $73,500 in 2007.[10]

[9] Ratio derived from average annual wage in Honolulu County, as reported by the State Department of Labor & Industrial Relations and the median family income as reported for Honolulu MSA by the U.S. Department of Housing & Urban Development. See Exhibit 3-7 for further information.

[10] U.S. Department of Housing & Urban Development, HUD USER, July 2007.

Operational Employment (Exhibits 3-8 and 3-9)

In addition to its development-related positions, Ho'opili would create numerous long-term permanent jobs in its operations. Operational employment may be considered in two ways:

- **Employment directly generated** (Exhibit 3-8) – Ho'opili is expected to be directly associated with over 7,000 permanent positions in its operations. Most of these jobs would be on-site, such as employees of Ho'opili's business park, and its retail and office facilities, including those working at their own live-work units. Additionally, second home residents of Ho'opili will likely require assistance with property management, landscaping, cleaning and the like. Also, the development and marketing of Ho'opili will generate opportunities in real estate brokerage, management, sales and marketing. Some of these latter opportunities may be based at offices off-site. These estimates do not include employees of public facilities that may be developed on-site, such as at schools, parks or the like.

- **Net additional employment** (Exhibit 3-9) - It is likely that existing and future Oahu residents would spend an equivalent amount on dining out and/or personal services whether or not the Project's commercial facilities were developed. One impact of the Project's development may be a geographic reallocation of spending and hence jobs within the region. However, from a broader standpoint, many of the jobs to located at Ho'opili would not be net new jobs for Hawaii.

  On the other hand, to the extent that Ho'opili attracts new residents to the islands, those persons' spending can be considered new monies in the State economy, and that new spending will generate new employment opportunities that may be dispersed State-wide.

  In conclusion, Ho'opili's impacts on employment opportunities State-wide are estimated:

  - Via employment multipliers applied to estimated spending by new residents attracted by the Project;
  - Via employment multipliers applied to the projected volume of sales and leasing costs and commissions; and
  - As an estimated percent of the jobs at the business park that would be supported at businesses serving markets outside of Hawaii.

  Altogether, some 680 of the direct operational jobs to be generated by Ho'opili are considered likely to be net new jobs to the State. Indirect and induced effects could add another 870 permanent positions in Hawaii, for a total of some 1,550 net new permanent positions by the Project's stabilization in 2030.

Personal Earnings from Operations (Exhibits 3-10 and 3-11)

Personal earnings are estimated for the net new operational jobs supported by Ho`opili. Direct wages and salaries paid to those employed in the Project's operations, plus proprietary earnings, director's fees and the like earned as a direct result of the Project's resident spending are expected to reach $40.9 million per year by Project stabilization in 2030. Including personal earnings associated with the indirect and induced positions, the Project could generate some $109.2 million per year in ongoing payroll within the State.

These figures do not include gratuities, bonuses or some of the employee benefits that would also be realized by many of the employees and proprietors benefiting from this economic growth.

Based on the multipliers derived from DBEDT's Input-Output Study, the direct employment and proprietary opportunities generated by Ho`opili could be expected to support average FTE earnings of about $70,000 at stabilization. This relatively high average reflects the caliber of earnings expected to be associated with the business park and with real estate brokerage.

As for development employment, these operational earnings per job would be associated with higher average family incomes. Using the same methodology explained previously, the families that include a person employed through direct, indirect or induced employment impacts of Ho`opili can be expected to have average incomes of about $126,000. This would put these Ho`opili-associated families in the 171st percentile with respect to the 2007 Oahu median family income

4. In-Migrant Population

Ho`opili is expected to lead to in-migration to the State and County as discussed below.

Ho`opili Residents (Exhibit 4-1)

Part-time/second home or retirement home buyers coming from off-island would have a direct impact on population. The majority of such in-migrants are anticipated to come from out-of State, but some could be newcomers to Oahu only, having moved from a neighbor island. Those moving could be attracted by a variety of factors, including the community lifestyle offered at Ho`opili, its job opportunities or those at the nearby UHWO.

By 2030, part-time/second home buyers or off-island retirees living at Ho`opili are estimated at 660 FTE persons. Some 430 of these persons are estimated to be in-migrants to the State, having moved from the US mainland or internationally. These persons, together with perhaps 230 FTE others that could have moved to Oahu from another island comprise the estimated total of 660 in-migrants to the County.

Employees and Dependents (Exhibit 4-1)

Some of those taking advantage of the construction and operational employment generated by the Project might move from other counties or states because of a job opportunity at Ho`opili. These might include young householders who grew up in Hawaii but had been working on the U.S. mainland due to the lack of attractive career and living environments in Hawaii, or neighbor islanders who seek employment and lifestyle opportunities such as envisioned at Ho`opili. Other household members might also accompany such in-migrating workers.

- **Development employees** - Hawaii's labor market is considered to have sufficient supply and the required skills to satisfy most of the Project's development labor needs. A nominal 3% of FTE specialty staffing needs is assumed to come from or be employed on the U.S. mainland. This could represent 30 or so of the development employees required in any given year. Such persons might be temporarily resident in the islands during periods of the Project's development.

  Those moving or commuting between islands during the Project's development could fill another 2%. Together with those from out-of-State, this would represent 5% of development employees being temporary in-migrants to the County, for a total of 50 of the FTE development positions per year.

- **Operational employees** – Some 93% of the Project's operational employee needs are anticipated to be satisfied from within the State's and 85% from within Oahu's labor pool. Conversely, this could mean that nearly 500 operational employees are ultimately attracted to Hawaii because of Ho`opili's operational employment opportunities, and another 500 or so are attracted from the neighbor islands. Together this would mean that total migration to Oahu from off-island (from out-of-State and within the State) would represent about 1,000 FTE persons.

- **Dependents** - In-migrant dependents are estimated at an average of 0.2 per FTE in-migrant construction worker, since the position on which the "move" is based would be temporary, and 1.0 per FTE in-migrant operational employee. Dependents are estimated at about 500 moving to the State plus another 500 moving to Oahu from within the State.

Total In-Migrant Impacts (Exhibit 4-1)

In total, by 2030, Ho`opili's employment creation is projected to have been associated with about 2,170 in-migrants to the County, of whom about 1,020 were also new to the State.

5. Fiscal Impacts

Ho`opili's fiscal impacts are estimated by comparing its anticipated impacts on government revenues to the government service costs associated with the additional population the Project could attract to the State and County.

Operating Revenues

Real Property Taxes (Exhibit 5-1)

For the County, the Project's most significant fiscal impact would be the higher real property taxes it would generate compared to those currently paid. Net new real property taxes are based on the County's Fiscal Year 2007-2008 (FY08) rates for land and building uses of the relevant land use classifications, as approved by the City Council in summer 2007.

Future assessed values will be based on the County assessors' estimates at a future time, and County standards of practice for establishing such values. For projection purposes, the following proxies are used:

- **Assessed values of the residential areas as improved** are based on the estimated average home sales price of $425,000, together with the total number of units projected to have been sold as of the two benchmark years of 2015 and 2030.

- **Assessed values of the unimproved residential areas** are based on comparison to FY07 tax assessed values per acre at other Urban-designated and Unimproved Residential use lands held by DRH at Mehana and Kahiwelo, and a pro-rata share of the Project's residential lands assumed to remain undeveloped at any given time.

- **Assessed values of the business park and commercial improvements** are estimated based on the estimated "hard" construction costs for the buildings, plus their tenant improvement costs, as presented previously.

- **Assessed values of the business park and commercial lands** are based on currently assessed values for an undeveloped industrial property held by DRH in East Kapolei and an unimproved commercial site held by DRH in Mehana, both in the Ewa DPA.

Based on these proxies, the Project is estimated to have a tax assessed value of $1.39 billion in 2015, and $6.29 billion by 2030, when it is assumed to be fully built-out.

County Real Property Tax Revenues (Exhibit 5-1)

Considering the estimated assessments and the current County real property taxation structure, Ho`opili could support potential new real property taxes of up to $8.3 million by 2015 or $32.4 million per year by 2030 and thereafter.

Deductions from these figures include real property taxes currently paid for the subject lands, and an allowance for homeowners' exemptions.

On balance, Ho`opili is projected to supply the County with about $7.7 million in net additional real property tax revenues in 2015, or $29.1 million on an on-going annual basis after its completion in 2030.

Total County Government Operating Revenues (Exhibit 5-2)

In addition to real property taxes, the County obtains liquid fuel, utility franchise, motor vehicle weight, and other license and permit fees from residents and businesses. Based on Honolulu County revenues reported by City and County of Honolulu for FY06, these minor County taxes and fees amount to about $204 per resident, in 2007 dollars. Applying this revenue rate to the number of persons expected to move to the County because of Ho`opili yields an estimated $0.6 million in new County revenues by 2030.

Honolulu County also receives a 0.5% "surcharge" on all Gross Excise Tax (GET) collected by the State. Considering the development and operational activities of the Project that would be subject to GET, at completion Ho`opili could generate another approximately $1.5 million per year in new tax revenues for the County from this revenue source.

Added to the real property taxes discussed above, net new taxes earned by the County as a result of the Project's development and operations are estimated at $8.7 million in 2015 or $31.1 million per year by 2030 and thereafter.

These figures do not include some $194 million in impact and permit fees anticipated to be paid to the County during the development of the Project, nor the value of lands to be dedicated to County agencies such as for police, fire and transportation uses.

State Government Operating Revenues (Exhibits 5-3 and 5-4)

Additional operating revenues accruing to the State government are expected to derive principally from:

- GET applied to Ho`opili's development expenditures, brokers' commissions, the in-State spending by its part-time or retiree residents and employees who came from out of State, as well as
- Individual income taxes paid by the Project's employees, including both its development- and operations-related employees.

- Conveyance taxes on the initial developer sales of homes and developed commercial properties.
- Other sources evaluated include income taxes on new personal earnings generated by Ho`opili, and specific excise, licenses, fees, fines and other payments to the State made by those who move to Hawaii because of the Project.

Assumptions on which the above sources are estimated are shown in Exhibit 5-3.

Exhibit 5-4 applies these assumptions and shows net new operating revenues for the State at some $16.1 million in 2015, or $27.0 million per year by 2030 and thereafter.

These projected State tax revenues may be conservative in that they do not include:

- Potential income taxes from certain business operating incomes, including those that may be paid by the operating entity for Ho`opili,
- Personal income tax on gratuities, bonuses or other earnings by Project employees not accounted for herein,
- GET on any portion of Homeowners' Association fees that may be non-exempt,
- Conveyance taxes on commercial and business park space leasing,
- Conveyance taxes on the ongoing resales of residential and commercial or business park properties within the Project, and
- State surcharges on motor and tour vehicles that could be rented by the Project's residents.

The figures cited above also exclude some $25 million in school fees and a share of transportation fees that are expected to be paid to the State on behalf of Ho`opili over the years of its development. Neither do they include the value of lands to be dedicated to the State such as to the departments of Education and Transportation.

Operating Expenses

Per Capita Government Operating Expenditures (Exhibits 5-5 and 5-6)

Both State and County governments can be expected to incur additional operating expenses in supporting the in-migrants that are attracted by the Project. An analysis of the County's FY06 operating expenditures, net of Federal and State grants, suggests that the County spends some $1,291 per FTE resident per year, in 2007 dollars. These expenditures support functions ranging from public safety and highways to recreation, as well as County debt service and benefits for its employees.

A similar analysis of State government operating expenditures, also based on data provided for FY06, suggests that the State spends about $4,912 per year to support government operations on behalf of each FTE resident.

Additional County Government Operating Expenditures (Exhibit 5-7)

The per capita budgets derived above are applied to the counts of those anticipated to in-migrate to the County because of employment or housing opportunities at the Project. This results in an estimated $0.9 million in additional County government operating expenditures in 2015, and $3.7 million per year by the time of project stabilization in 2030 and thereafter.

Additional State Government Operating Expenditures (Exhibit 5-8)

Employing an analogous methodology, the State could be expected to require up to $7.1 million more per year to support the net additional residents the Project could eventually attract, by 2030.

Net Fiscal Benefits (Exhibit 5-9)

Comparing the net new government operating revenues and expenditures discussed above yields the projected net fiscal benefits for the County and State governments.

- **County government** operating revenues attributable to Ho'opili are anticipated to exceed the additional operating expenses in both of the benchmark years evaluated. By Project stabilization, net additional operating revenues could represent some $27.5 million per year, for a revenue/expenditure ratio of 8.5.
- **The State government's** operating revenues are also anticipated to exceed the additional operating expenses throughout the Project's development and operating periods. The State's net additional revenues are projected to amount to $19.9 million per year by Project stabilization in 2030. New revenues to the State government could then represent some 3.8 times new State government operating expenditures.

Economic and Fiscal Impact Assessment for Ho`opili

Exhibits

Exhibit 2-1
Project Concept and Potential Development Timing
2009 to 2030

	Unit	Notes		2009-15	2016-30	Total
Highlights of period:				■ 2009-2011 infra-structure planning and develop-ment ■ First deliveries 2012	■ Ho`opili buildout and sales completion	
Development in period:						
Residential unit completions/sales -		*Av. price:*	*Av. sales/year*			
Market units (single & multifamily)	*Sold homes*	*$480,000*	*450*	1,800	6,450	8,250
Affordable units (multifamily)[1]	*Sold homes*	*$295,000*	*200*	300	3,200	3,500
Subtotal, residential units/weighted average price		*$425,000*	*650*	2,100	9,650	11,750
Business Park-developed land	*Net acres*	*Exhibit 8-7, Market study*		20	20	40
Business Park-buildings	*Built square feet*	*Assumes lag from land delivery*		120,000	680,000	800,000
Commercial Centers	*Gross leasable square feet*	*Exhibit 7-2, Market study*		600,000	2,360,000	2,960,000
Cumulative development by end of period:						
Residential unit completions/sales -						
Market units (single & multifamily)	*Sold homes*			1,800	8,250	
Affordable units (multifamily)	*Sold homes*			300	3,500	
Subtotal				2,100	11,750	
Business Park	*Net acres*			20	40	
Commercial Centers	*Gross leasable square feet*			600,000	2,960,000	

[1] Assumes 1:1 credit per County guidelines currently in effect. Actual credits could vary, changing the affordable unit count. See City & County of Honolulu, "Adoption of Rules for the Terms of Unilateral Agreements Requiring Affordable Housing," October 20, 1994, page 2-2.

Sources: DRH, 2007; Mikiko Corporation, "Market Assessment for Ho`opili," March 2007.

Exhibit 2-2
Residential Utilization Patterns
2015 and 2030

	Basis/reference	2015	2030
Usage assumptions:			
Market units-primary residences	*93% of sold market units*	1,674	7,673
Market units-2nd home/off-island buyer	*7% of sold market units*	126	578
Affordable units (all primary homes)[1]	*100% of sold affordable units*	300	3,500
Total		2,100	11,750
Unit occupancy assumptions:			
Market units-primary residences	*Allowance for vacancy/transitions*	95%	95%
Market units-2nd home/off-island buyer	*Share of time spent on-island*	50%	50%
Affordable units (all primary homes)	*Allowance for vacancy/transitions*	95%	95%
Utilization pattern:			
Average daily occupied units -	*Exhibit 2-1 + usage assumption*		
Market units-primary residences		1,590	7,289
Market units-2nd home/off-island buyer		63	289
Affordable units (all primary homes)		285	3,325
Subtotal		1,938	10,903
Average daily persons in residence[2] -			
Market units-primary residences	*3.2 persons per occupied unit*	5,089	23,324
Market units-2nd home/off-island	*2.3 persons per occupied unit*	145	664
Affordable units	*3.4 persons per occupied unit*	969	11,305
Subtotal, rounded		6,200	35,290

[1] Assumes 1:1 credit per County guidelines currently in effect. Actual credits could vary, changing the affordable unit count. See City & County of Honolulu, "Adoption of Rules for the Terms of Unilateral Agreements Requiring Affordable Housing," October 20, 1994, page 2-2.

[2] Primary resident occupancy based on Claritas, Inc., 2006 estimate of average 3.5 persons per household in Ewa District and projected 3.4 by 2011. Discounted further to reflect declining household sizes in future. Non-resident/second home estimate based on interviews with area realtors and property operators.

Exhibit 3-1
Part-Time Resident Expenditures in Hawaii, Average Annual
2015 and 2030 (2007 dollars, in millions, except as noted)

	Basis/reference (not in millions)		2015	2030
Bases for direct expenditures:				
Average household income	*Part-time residents, pre-tax*	*$175,000*		
Percent of income spent on island[1]	*US Bureau of Labor Statistics*	*22%*		
Persons per household	*(See Exhibit 2-2):*	*2.3*		
Projections:				
Direct expenditures	*Expenditure per FTE person:*	*$16,700*	$2.4	$11.1
Indirect & induced	*0.71 multiplier*[2]		$1.7	$7.9
Total			$4.1	$19.0

Note: Assumes new expenditures are attributable to part-time residents of residential units and their associated guests only, i.e., no additional retail spending on-island hypothesized for kama'ainas or other island visitors because they are assumed to spend elsewhere on the island even if the Project were not developed.

1 Based on spending patterns for consumer units averaging $115,629 income as shown in US Bureau of Labor Statistics, Table 2, "Income before taxes: Average annual expenditures and characteristics, Consumer Expenditure Survey, 2002." Excludes expenditures for mortgage interest and charges, rented dwellings, other lodging, natural gas, cash contributions, health & other insurance and pensions. Figures adjusted further to account for percent of time spent on island (see Exhibit 2-2, occupancy assumptions.)

2 Based on estimates by Dr. Xijun Tian, DBEDT (personal communication, 4/18/1999). Considers weighted average visitors to Hawaii and their expenditures as allocated to 118 industry categories as available in 1992 State Input-Output model by DBEDT.

Exhibit 3-2
Industry Coefficients and Multipliers for Development Activities

FINAL DEMAND INDUSTRY COEFFICIENTS[1]

	DBEDT industrial categories applied	Final demand coefficient per $1 million (2002$) project cost: Jobs[2]	FTE factor[3]	$ Earnings[4]
Professional services	*#45-Architectural and engineering services*	10.31	0.85	0.63
Construction:				
Residential units	*#13-SF housing construction*	7.37	0.94	0.34
Business park	*#14-Construction of other buildings*	8.41	0.94	0.44
Commercial facilities	*#14-Construction of other buildings*	8.41	0.94	0.44
Tenant improvements	*#14-Construction of other buildings*	8.41	0.94	0.44
Infrastructure	*#15-Heavy & civil engineering construction*	11.61	0.94	0.86
Other costs	*#42-Real estate, #44-Legal services, #40-Other finance and insurance*	8.55	0.85	0.52

DIRECT-EFFECT INDUSTRY MULTIPLIERS[5]

	DBEDT industrial categories applied	Indirect & induced multiplier per direct: FTE job	$ Earnings[4]
Professional services	*Same as above*	1.03	0.63
Construction:			
Residential units	*Same as above*	1.52	1.22
Business park	*Same as above*	1.42	1.05
Commercial facilities	*Same as above*	1.42	1.05
Tenant improvements	*Same as above*	1.42	1.05
Infrastructure	*Same as above*	1.40	0.67
Other	*Same as above*	0.97	1.17

1 For direct impacts of development expenditures. Type I total jobs and earnings direct impact coefficients, from Hawaii State Department of Business, Economic Development & Tourism, "The 2002 State Input-Output Study for Hawaii," June 2006 (revised from May 2006), Detailed Tables. Jobs coefficients are for 2012; earnings coefficients not provided for future years.

2 Input-Output Study estimates total wage, salaried and proprietary jobs, both full- and part-time (not full-time equivalent).

3 Adjustment factor applied in addition to the jobs coefficient to estimate full-time equivalent jobs at 40 hours per week. Factor derived from the 37.5 average weekly hours reported worked in the natural resources, mining and construction industries and 34.0 in financial activities industries for Honolulu MSA for 2006, as reported by Hawaii Department of Labor and Industrial Relations, at www.hawaii.gov/labor/rs, "Average Hourly Earnings," as accessed May 2007.

4 Earnings defined to include wage, salary and proprietary incomes, plus directors' fees and employer contributions to health insurance, less employee contributions to social insurance.

5 For indirect and induced impacts of respective direct impacts. Indirect and induced factors derived from Type II Direct-Effect total job/total job and earnings/earnings multipliers as shown in DBEDT, ibid, "Job multipliers for 2012-2012" and "2002 Detailed Output, Earnings and Tax Multipliers for Hawaii."

Exhibit 3-3
Estimated Current Development Costs: Total for Each Period
2009 to 2030 (2007 and 2002 dollars, in millions unless stated)

	Basis/reference (not in mils unless stated)	2009 2015	2016 2030	Total
In 2007 dollars[1]**:**				
Professional services	*$34 mil. total, of which 39% assumed expended by 2015*	$13.1	$20.4	$33.5
Construction -	*Net of contingencies; vertical and infrastructure*			
Residential units	*Average cost/unit: $161,000*	$338.1	$1,553.7	$1,891.8
Business park	*800,000 sq. ft at psf cost: $150*	$18.0	$102.0	$120.0
Commercial facilities	*2,960,000 sq. ft at psf cost: $200*	$120.0	$472.0	$592.0
Tenant Improvements[2]	*$200 psf leased*	$144.0	$608.0	$752.0
Infrastructure[3]	*$1,072 mil. total, of which 37% assumed expended by 2015*	$396.6	$675.4	$1,072.0
Subtotal		$1,016.7	$3,411.0	$4,427.8
Other	*$147 mil., distributed pro rata by number of years in period*	$46.8	$100.2	$147.0
Total, rounded		$1,076.6	$3,531.7	$4,608.3
In 2002 dollars:	*0.73 of 2007 values*[4]			
Professional services		$9.5	$14.8	$24.3
Construction -				
Residential units		$245.7	$1,128.8	$1,374.5
Business park		$13.1	$74.1	$87.2
Commercial facilities		$87.2	$342.9	$430.1
Tenant improvements		$104.6	$441.8	$546.4
Infrastructure		$288.2	$490.7	$778.9
Other		$34.0	$72.8	$106.8
Total, rounded		$782.2	$2,566.0	$3,348.2

Note. Figures exclude impacts of development of transit facilities.

1 Provided by DRH , May 2007.

2 Includes developer- and tenant-provided construction budgets. Recent Kapolei area examples for first generation buildouts include office space at $150-170 per square foot, retail at $150-$250 per square foot, industrial with 10% office $125, as provided by Colliers Monroe Friedlander, May 2007; high tech/laboratory spaces at $350-$1,000 per square foot; restaurants minimum $300 per square foot per SL Sofos & Co., Ltd.

3 Covers site preparation for residential and commercial pads, including sewer, water, electrical and drainage; also off-site utilities, roads, signalization, drainage; bicycle network; and preparation of school, public facility (fire/police stations) and parks site. Excludes vertical construction costs for schools, fire station and police station; park equipment to be donated; and contingencies representing 5-10% of each budget item.

4 First Hawaiian Bank, Research Department, records; Hawaii State Department of Business, Economic Development and Tourism (DBEDT), Research & Economic Analysis Division, Quarterly Statistical and Economic Reports, as reported by DBEDT for 2002 to 2006; UHERO, Honolulu construction cost index forecast for 2006 to 2007.

Exhibit 3-4
Estimated Current Development Costs: Average Annual
2009 to 2030 (2007 dollars, in millions)

	Basis/reference	2009 2015	2016 2030	Overall average
Costs by type:	*Exhibit 3-3, annualized*			
Professional services		$1.9	$1.4	$1.5
Construction -				
Residential units		$48.3	$103.6	$86.0
Business park		$2.6	$6.8	$5.5
Commercial facilities		$17.1	$31.5	$26.9
FF&E/Tenant Improvements[1]		$20.6	$40.5	$34.2
Infrastructure[2]		$56.7	$45.0	$48.7
Other		$6.7	$6.7	$6.7
Total, rounded		$153.8	$235.4	$209.5

Note: Figures exclude impacts of transit facilities.

1 Includes developer- and tenant-provided construction budgets.

2 Covers site preparation for residential and commercial pads, including sewer, water, electrical and drainage; also off-site utilities, roads, signalization, drainage; bicycle network; and preparation of school, public facility (fire/police stations) and parks site. Excludes vertical construction costs for schools, fire station and police station; park equipment to be donated; and contingencies representing 5-10% of each budget item.

Exhibit 3-5
Development Employment, FTE Jobs[1]
2009 to 2030 (Total in each period)

	Basis/reference	2009 2015	2016 2030	Total/ average
Total:				
Direct jobs -	*Exhibits 3-2 and 3-3*			
Professional services		83	130	213
Construction -				
Residential units		1,697	7,800	9,497
Business park		103	584	687
Commercial facilities		687	2,704	3,391
FF&E/Tenant improvements[2]		825	3,483	4,308
Infrastructure[3]		3,137	5,341	8,478
Other		247	529	776
Subtotal direct jobs (rounded)		6,800	20,600	27,400
Indirect and induced jobs[4]	*Exhibit 3-2*	9,591	29,597	39,188
Subtotal jobs (rounded)		16,400	50,200	66,600
Average annual:				
Direct jobs -				
Professional services		12	9	10
Construction[2,3]		921	1,327	1,198
Other		35	35	35
Subtotal direct jobs (rounded)		970	1,370	1,240
Indirect and induced jobs[4]		1,370	1,973	1,781
Subtotal jobs (rounded)		2,340	3,340	3,020

Note: Figures exclude impacts of transit facilities.

1 FTE = Full time equivalent, defined as 40 hours per week or 2,080 hours per year.

2 Includes employees supported by developer- and tenant-provided construction activities.

3 Covers site preparation for residential and commercial pads, including sewer, water, electrical and drainage; also off-site utilities, roads, signalization, drainage; bicycle network; and preparation of school, public facility (fire/police stations) and parks site. Excludes employment associated with vertical construction activities for schools, fire station and police station; park equipment; and contingencies.

4 Based on weighted average of Direct-Effect jobs multipliers for each job category, as shown on Exhibit 3-2.

Exhibit 3-6
Personal Earnings from Development - Total in Period
2009 to 2030 (2007 dollars, in millions)

	Basis/reference	2009 2015	2016 2030	Total
Direct earnings[1]:	*Exhibits 3-2 & 3-3*			
Professional services		$6.0	$9.4	$15.4
Construction -				
Residential units		$92.3	$424.2	$516.5
Business park		$6.4	$36.0	$42.4
Commercial facilities		$42.4	$166.8	$209.2
FF&E/Tenant improvements[2]		$50.9	$214.8	$265.7
Infrastructure[3]		$273.9	$466.4	$740.3
Other		$17.7	$37.9	$55.6
Subtotal, direct		$489.5	$1,355.4	$1,844.9
Indirect and induced earnings[4]		$425.3	$1,318.8	$1,744.1
Total earnings		$914.8	$2,674.2	$3,589.1

Note: Earnings defined to include wage, salary and proprietary incomes, plus directors' fees and employer contributions to health insurance, less employee contributions to social insurance. *Figures exclude impacts of transit facilities.*

1 Based on industry coefficients and FTE factors as shown in Exhibit 3-2 and estimated construction costs in 2002 dollars, as shown in Exhibit 3-3. Figures inflated forward to estimated 2007 dollars based on Honolulu CPI-U index from 2002 (first half) to second half 2006 dollars, at: 17.58% based on U.S. Department of Labor, Bureau of Labor Statistics, May 2007, at http://data.bls.gov.

2 Includes earnings supported by developer- and tenant-provided construction activities.

3 Covers site preparation for residential and commercial pads, including sewer, water, electrical and drainage; also off-site utilities, roads, signalization, drainage; bicycle network; and preparation of school, public facility (fire/police stations) and parks site. Excludes vertical construction costs for schools, fire station and police station; park equipment to be donated; and contingencies representing 5-10% of each budget item.

4 Weighted average of estimated direct earnings by industry as shown above, and Direct-Effect industry multipliers shown in Exhibit 3-2.

Exhibit 3-7
Personal Earnings from Development - Average Annual
2009 to 2030 (2007 dollars, in millions except average earnings)

	Basis/reference	2009 2015	2016 2030	Average
Average annual in period:	*Exhibit 3-6, refers to all jobs*			
Direct earnings		$69.9	$90.4	$83.9
Indirect & induced earnings		$60.8	$87.9	$79.3
Total earnings		$130.7	$178.3	$163.1
Average per new FTE job:	*Exhibits 3-5 and 3-6, rounded*			
Direct jobs		$72,000	$68,000	$67,000
Indirect and induced jobs		$44,000	$45,000	$45,000
Average per job		$56,000	$53,000	$54,000
Estimated average family income[1]:	*1.8 times average wage*			
For direct job-holders		$130,000	$119,000	$121,000
For indirect and induced job-holders		$79,000	$81,000	$81,000
All Ho`opili-related job-holders		$101,000	$95,000	$97,000
Percent of median income[2]:	*$73,500 median family income, 2007*			
For direct job-holders		177%	162%	165%
For indirect and induced job-holders		107%	110%	110%
All Ho`opili-related job-holders		137%	129%	132%

Note: Earnings defined to include wage, salary and proprietary incomes, plus directors' fees and employer contributions to health insurance, less employee contributions to social insurance. Figures exclude impacts of transit facilities.

1 Ratio estimated from 2005 average annual wage in Honolulu County ($37,656), as provided by State of Hawaii, Department of Labor & Industrial Relations, and FY 2005 median family income in Honolulu MSA ($67,750), as provided by U.S. Department of Housing & Urban Development, HUD USER. Reflects multiple job-holders within each family as well as multiple job-holding by individuals.

2 U.S. Department of Housing & Urban Development, HUD USER, July 2007.

Exhibit 3-8
Direct Operational Employment Generated by the Project
FTE Jobs
2015 and 2030

	Basis/reference	2015	2030
On-site:			
Residential units -			
Second home properties	*7% of sold market units see Exhibit 2-2*	126	578
Supported jobs	*5 jobs per 100*	6	29
Commercial facilities -			
Business park	*550 square feet RBA per FTE job*	218	1,236
Commercial retail/office	*425 square feet GLA per FTE job*	1,412	5,553
Subtotal, on-site jobs, rounded		1,640	6,820
Other associated jobs:			
Residential and commercial brokerage	See Exhibit 3-9	196	223
Subtotal, other jobs, rounded		196	223
Total direct jobs associated with Project		1,836	7,043

Note: Figures exclude impacts of transit facilities. FTE = Full time equivalent, defined as 40 hours per week or 2,080 hours per year.

Exhibit 3-9
Net Additional Operational Employment, FTE Jobs[1]
2015 and 2030 (2007 dollars, in millions)

	Basis/reference	2015	2030
Bases for projection:			
Av. annual spending by PT residents -	*Direct, indirect & induced, in state: Exhibit 3-1*	*$4.1*	*$19.0*
Av. annual residential selling costs -	*See Exhibit 3-1*		
Sell-out of developer inventory	*4.5% of gross sales, preceding years*	*$10.0*	*$12.3*
Resales after 2015	*2.3% Turnover per year[2]* *6.0% of gross sales, same av. price*	*$0.0*	*$0.5*
Av. annual commercial & industrial leasing expenses -			
Initial lease-up	*$25.9 mil total, listing & outside agents*	*$1.2*	*$1.4*
Releasing after 2015	*5.0% Turnover per year*	*$0.0*	*$0.1*
Av. annual commercial & industrial selling costs -	*3.5% of gross sales, preceding years*		
Sell-out of developer inventory	*9% Cap, sales of stabilized centers*	*$2.7*	*$1.4*
Resales after 2015	*10% Resold between 2016 and 2030*	*$0.0*	*$0.3*
Projected net additional jobs:			
Direct -			
Attributable to part-time residents[3]	*23.0 I$mil, net margin: 35%*	33	152
Real estate leasing & sales	*14.0 I$mil selling costs, new and resales*	196	223
Business park	*25% assumed new jobs to island; Exhibit 3-8*	55	309
Subtotal, direct jobs, rounded		280	680
Indirect and Induced -	*Multiplier and industry category applied[4]:*		
Attributable to part-time residents	*1.07 Average of select industries*	36	163
Real estate leasing & sales	*1.91 Real estate & rentals industries*	374	426
Business park	*0.91 Average of select industries*	50	282
Subtotal, indirect & induced jobs, rounded		460	870
Total net additional jobs		740	1,550

Note: Figures exclude impacts of transit facilities.

1 FTE = Full time equivalent, defined as 40 hours per week or 2,080 hours per year.

2 From 2016 on, resales activity assumed at 2.3% of completed and sold residential inventory shown in Exhibit 2-1. Resales factor based on 2004 Oahu sales activity of approximately 7,000 units per year vs. estimated 300,000 housing units (2.3%) and 2006 ratio of 10,421 resales among approximately 340,000 total units (3.0%), : Honolulu Board of Realtors and American Community Survey. Commissions and other selling costs estimated at rate shown and average prices shown in Exhibit 2-1.

3 Category includes shopping center and office operational employment, since net additional employment is largely considered a function of induced new spending on-island, not leasable area to be developed at the Project. Also spending by existing island residents, such as at the commercial centers to be developed, is assumed to have occurred elsewhere on-island even if the Project were not developed.

Retail spending subject to reduction by 35% assumed retail trade margin prior to application of weighted average Type II jobs multiplier shown in Appendix 2. This results in conservative estimates since DBEDT multipliers for many applicable industry categories such as services, agriculture, food processing & etc. are calculated assuming they will be applied to total expenditures rather than trade margin expenditures.

4 Based on Type II Direct-Effect Multipliers (less 1.0 each) as shown by industry groups in Appendix 2. Part-time residents based on all industries shown; business park multiplier based on information, health services, professional services, and business services industries.

Exhibit 3-10
Personal Earnings from Net New Operational Activity - Total Annual
2015 and 2030 (2007 dollars, in millions except where noted)

	Basis/reference (not in millions)	2015	2030
Direct earnings -	*Estimated average FTE salary or other basis[1]:*		
Attributable to part-time residents	*$41,434 Average Honolulu wage*	$1.4	$6.3
Av. annual commercial leasing -	Residential, commercial and industrial properties, Exhibit 3-9		
Initial lease-up		$1.2	$1.4
Releasing after 2015		$0.0	$0.1
Real estate sales & marketing -	Residential, commercial and industrial properties, Exhibit 3-9		
Sell out of developed inventory		$12.7	$13.7
On-going resales		$0.0	$0.8
Business park	*$60,200 average of select industries*	$3.3	$18.6
Subtotal, direct earnings		$18.6	$40.9
Indirect and induced earnings -	*Multiplier and industry category[2]:*		
Attributable to part-time residents	*1.01 Average of select industries*	$1.4	$6.4
Real estate leasing and sales	*3.07 Real estate & rentals industries*	$42.9	$49.0
Business park	*0.70 Average of select industries*	$2.3	$13.0
Subtotal, Indirect & Induced		$46.6	$68.3
Total earnings		$65.2	$109.2

Note: Exhibit portrays on those earnings on positions that would be new to the community; not on all employment associated with Ho'opili. Figures exclude impacts of transit facilities.

1 Exclusive of tips, bonuses, etc. Average Honolulu salary based on $37,656 reported for 2005 by Department of Labor and Industrial Relations, "2005 Employment and Payrolls in Hawai'i," with inflation to 2007 dollars based on Honolulu CPI-U. Considered conservative because it incorporates no adjustment to FTE work. Business park typical wage estimated as average for the following industrial classifications: information, professional & technical services, management of companies & enterprises, health care & social assistance.

2 Based on Type II Direct-Effect Multipliers (less 1.0 each) as shown by industry groups in Appendix 2. Part-time residents based on all industries shown; business park multiplier based on information, health services, professional services, and business services industries.

Exhibit 3-11
Personal Earnings from Net New Operational Activity - Average Per Job and Family
2015 and 2030 (2007 dollars)

	Basis/reference (not in millions)	2015	2030
Average earnings per new FTE job:	*Not in millions*		
Direct jobs		$67,000	$60,000
Indirect and induced jobs		$101,000	$79,000
Average per job		$88,000	$70,000
Estimated average family income[1]:	*1.8 times average wage*		
For direct job-holders		$121,000	$108,000
For indirect and induced job-holders		$182,000	$142,000
All Ho`opili-related job-holders		$158,000	$126,000
Percent of median income[2]:	*$73,500 median family income, 2007*		
For direct job-holders		165%	147%
For indirect and induced job-holders		248%	193%
All Ho`opili-related job-holders		215%	171%

Note: Exhibit portrays on those earnings on positions that would be new to the community; not on all employment associated with Ho`opili. Figures exclude impacts of transit facilities. Earnings defined to include wage, salary and proprietary incomes, plus directors' fees and employer contributions to health insurance, less employee contributions to social

1 Ratio estimated from 2005 average annual wage in Honolulu County ($37,656), as provided by State of Hawaii, Department of Labor & Industrial Relations, and FY 2005 median family income in Honolulu MSA ($67,750), as provided by U.S. Department of Housing & Urban Development, HUD USER. Reflects multiple job-holders within each family as well as multiple job-holding by individuals.

2 U.S. Department of Housing & Urban Development, HUD USER.

Exhibit 4-1
Average Daily In-Migrant Population
2015 and 2030

	Basis/reference	2015	2030
Ho`opili part-time residents:			
Average FTE persons in residence	*At 2nd home/off-island buyer units: Exhibit 2-2*	145	664
In-migrants to State (rounded)	*65% of FTE persons in residence*	90	430
In-migrants to Co. (rounded)[1]	*100% of FTE persons in residence*	140	660
Employees:			
In-migrants to the State[1] -	*(Subset of in-migrants to County)*		
Development employees	*3% of direct av. annual jobs (Ex. 3-5)*	0	29
Direct operational employees	*7% of jobs generated (Exhibit 3-8)*	129	493
Dependents[2]	*Ratio of in-migrant employees*	129	499
In-migrants to State (rounded)[3]		260	1,020
In-migrants to County[3] -	*(Includes in-migrants to State)*		
Development employees	*5% of direct av. annual jobs (Ex. 3-5)*	0	49
Operational employees	*15% of jobs generated (Exhibit 3-8)*	275	1,056
Dependents[2]	*Ratio of in-migrant employees*	275	1,066
In-migrants to County (rounded)[3]		550	2,170

Note: Figures exclude impacts of transit facilities.

1 Subset of County in-migrants. See footnote 3, below.

2 In-migrant dependents estimated to average 0.2 per in-migrant development employee, and 1.0 per in-migrant operational employee.

3 In-migrants to the County include all those moving to the State plus any that may move between islands due to job opportunities at the Project.

Exhibit 5-1
Real Property Taxes Generated by Development
2015 and 2030 (2007 dollars, in millions except as noted)

	Basis/reference (not in millions)	2015	2030
Total assessed values[1]:			
Improved residential	*Based on number sold by average price (Ex. 2-1)*	$892.5	$4,993.8
Unimproved residential	*Estimated assessed value per acre: $135,000*	$102.6	$0.0
Business park - land	*50 acres, @ per acre: $165,000*	$8.3	$8.3
Business park - improvements	*Vert. cost (Ex. 3-3) + share of TI @ 50%*	$90.0	$406.0
Commercial - land	*145 acres, @ per acre: $630,000*	$91.4	$91.4
Commercial - improvements	*Vert. cost (Ex. 3-3) + share of TI @ 50%*	$192.0	$776.0
Park & open space land[2]	*210 acres, @ per acre: $50,000*	$10.5	$10.5
Total assessed values		$1,387.2	$6,285.9
Real property tax revenues:			
Potential new revenues -	*FY08 rates per $1,000 net taxable value*		
Improved residential	*$3.29 Improved Residential*	$2.9	$16.4
Unimproved residential	*$5.70 Unimproved Residential*	$0.6	$0.0
Business park - land	*$12.40 Industrial*	$0.1	$0.1
Business park - improvements	*$12.40 Industrial*	$1.1	$5.0
Commercial - land	*$12.40 Commercial*	$1.1	$1.1
Commercial - improvements	*$12.40 Commercial*	$2.4	$9.6
Parks & open spaces	*$5.70 Preservation*	$0.1	$0.1
Subtotal, potential tax revenues		$8.3	$32.4
Less deductions -			
RPT payments prior to Project	*FY07 real property taxes, per DRH*	$0.1	$0.1
Homeowners' exemption[4]	*$88,000 /unit, primary residences (Ex. 2-2)*	$0.6	$3.2
Subtotal deductions		$0.6	$3.3
Estimated net additional RPT		$7.7	$29.1

Note: Figures exclude impacts of transit facilities; public facility lands such as schools and roads presumed not taxed and dedicated.

1 Tax assessed values for unimproved lands based on other lands of same classification held by DRH at East Kapolei (other than Ho`opili), Mehana and Kahiwelo (Palehua). Undeveloped residential areas estimated pro rata based on number of units sold and total of: 925.0 acres, for a total land value of: $124.88 million. These lands include 390 acres that would be designated mixed-use and could be taxed at higher rates.

2 Based on estimated raw land values only; excludes value of grading, irrigating & grassing these lands.

3 Assumes 20% of households at $120,000 exemption, and 80% at $80,000 exemption. Note methodology may overstate exemptions/understate tax revenues: Claritas projects that by 2011, approximately 11% of Ewa DPA households will be headed by persons 65 or older (Claritas, Inc., 2006.)

Exhibit 5-2
Total Annual Revenues to County Government Attributable to Development & In-Migrant Population
2015 and 2030 (2007 dollars, in millions, except as noted)

	Basis/reference	2015	2030
Bases for projection:			
FTE in-migrants to County -	*Exhibit 4-1*		
Ho`opili part-time residents		*140*	*660*
Employees and their dependents		*550*	*2,170*
GET County surcharges	*Spending as shown in Exhibit 5-3*		
Estimated tax and other revenues:			
Net new property tax revenues	*Exhibit 5-1*	$7.7	$29.1
Taxes and other revenue sources from in-migrant residents[1]	*Other than real property taxes* *$204 per person*	$0.1	$0.6
General excise taxes, on -	*County GET surcharges only*		
Development	*0.5% of professional service and construction costs*	$0.8	$1.2
Real estate sales and marketing	*0.5% of costs*	$0.1	$0.1
Spending by Project PT residents	*0.5% of spending*	$0.0	$0.1
Spending by in-migrants to State	*0.5% of employee & dependent spending*	$0.0	$0.1
Total new County revenues		$8.7	$31.1

Note: Does not consider impact and permit fees paid to County. These projected to amount to approximately $194 million over the life of the Project, in 2007 dollars, including sewer, water system, water meter and other fees and permits, as well as a share of transportation impact fees. Figures also exclude impacts of transit facilities.

1 Includes fuel and motor vehicle weight taxes, licenses and permits and charges for services. Excludes forfeitures, fines and penalties, public utility franchise tax, transient accommodation taxes, public service company tax, sewer charges, bus transportation revenues, solid waste & other revenues. As stated in City and County of Honolulu, "The Executive Program and Budget: Fiscal Year 2008 - Volume 1 - Operating Program and Budget," 2007 (summary of resources by source.)

Exhibit 5-3
Bases for Projecting State Government Revenues
2015 and 2030 (2007 dollars, in millions, except as noted)

	Basis/reference (in millions only where noted)		2015	2030
For GET calculations:				
Project development costs -	*Exhibit 3-4, average annual for preceding period*			
Professional services			$1.9	$1.4
Construction and other			$151.9	$234.1
Subtotal development cost			$153.8	$235.4
Real est. sales & marketing costs -	*Based on average activity in prior 5 years*			
Residential	*New and resold units, Exhibit 3-9*		$10.0	$12.8
Commercial & business park	*Leasing and selling costs, Exhibit 3-9*		$3.9	$3.2
Subtotal			$14.0	$15.9
Spending by part-time residents	*In-State spending: Exhibit 3-9*		$4.1	$19.0
In-migrant employees & dependents to State -				
Number persons	*Exhibit 4-1*		260	1,020
Estimated number households	*2.5 persons per household*		104	408
In-State spending[1]	*58% of hhd income, av. $79,000*		$4.8	$18.7
For individual income taxes:				
Net new personal income earned -	*Average annual in preceding period*			
Development employment	*Exhibit 3-7 (total personal earnings)*		$130.7	$178.3
Operational employment	*Exhibit 3-10 (total personal earnings)*		$65.2	$109.2
Av. personal earnings/FTE job -				
Development employment	*Exhibit 3-7 (total personal earnings)*	*Not in millions >>*	$56,000	$53,000
Operational employment	*Exhibit 3-10 (total personal earnings)*	*Not in millions >>*	$88,000	$70,000
For conveyance taxes[2]:				
On residential sales	*$480,000 av price (Ex. 2-1)*	*App. unit sales (Ex. 2-2)>>*	126	578
On commercial & industrial sales	*$1,315 mil total sales*	*% transacted (Ex. 2-1)>>*	19%	81%
For other State taxes:				
FTE in-migrants to State	*FTE part-time residents & primary residents: Exhibit 4-1*		350	1,450

Note: Does not consider impact fees paid to State. These projected to amount to approximately $25 million over the life of the Project, in 2007 dollars, including school fees and a share of transportation fees. Figures also exclude impacts of transit facilities.

1 U.S. Department of labor, Bureau of Labor Statistics, "Consumer Spending Patterns in Honolulu: 2001-02", released April 30, 2004 at www.bls.gov/ro9/cexhono.htm. Estimate uses study findings showing 77.6% of pre-tax income of household units was spent, of which 75.1% were on items likely subject to Hawaii Gross Excise Tax. Excludes spending on shelter (owned dwellings), cash contributions, personal insurance and pensions. Applied to estimated in-migrant households and average of personal earnings for 2015 and 2030 for operational employees, as shown. Excludes potential household income from other household members.

2 Conservative estimate in that conveyance taxes on commercial leasing are not considered nor conveyance taxes on resales. Conveyance taxes on residential sales applicable only to those that will not claim a homeowner's exemption.

Exhibit 5-4
Projected State Government Revenues
2015 and 2030 (2007 dollars, in millions, except as noted)

	Basis/reference (not in millions)	2015	2030
General excise taxes, on:	*County GET surcharges accounted for on prior exhibit*		
Development[1]		$4.0	$6.1
Real estate sales and marketing	*4.0% of costs*	$0.6	$0.6
Spending by Project PT residents	*4.0% of spending*	$0.2	$0.8
Spending by in-migrants to State	*4.0% of employee & dependent spending*	$0.2	$0.7
Individual income taxes[2]:			
Development employees	*5.01% effective tax rate on est. av. $53-$56K income*	$6.5	$8.9
Operational employees	*5.63% effective tax rate on est. av. $89K income (2015)* *5.34% effective tax rate on est. av. $70K income (2030)*	$3.7	$5.8
Conveyance taxes[3]:			
On residential sales	*0.15% of full consideration paid*	$0.1	$0.4
On commercial & industrial sales	*0.30% of full consideration paid*	$0.6	$3.2
Other taxes and revenues from in-migrants[4]	*$224 per person*	$0.1	$0.3
Total, additional revenues		$16.1	$27.0

Note: Does not consider impact fees paid to State. These projected to amount to approximately $25 million over the life of the Project, in 2007 dollars, including school fees, and a share of transportation fees. Figures also exclude impacts of transit facilities.

1 Based on 4% on 100% of professional services and 60% of construction costs, plus a wholesale construction materials tax of 0.5% against 40% of construction costs.

2 Based on 2006 Tax Table, Schedule II for married taxpayers filing joint returns and range of average personal earnings per job shown above. Adjusted Gross Incomes (AGI) assumed to be 15% less than total average earnings shown. Estimated tax impact likely to be conservative due to frequency of dual incomes and multiple job-holding among Hawaii households, which could push household incomes to higher tax brackets.

3 Conservative estimate in that conveyance taxes on commercial leasing are not considered nor conveyance taxes on resales. Conveyance taxes on residential sales applicable only to those that will not claim a homeowner's exemption.

4 Based on total FY 2006 State tax revenue receipts as reported by State of Hawaii, "Comprehensive Annual Financial Report for the Fiscal Year Ended June 30, 2006," statement of activities-general revenue taxes. Includes tobacco and liquor taxes, liquid fuel tax, and motor vehicle weight & registration tax. Excludes fines & forfeitures, licenses and other fees.

Exhibit 5-5
City and County of Honolulu Operating Expenditures by Function, Net of Federal and State Sources
Per Capita in Fiscal Year July 1, 2005 to June 30, 2006

		Expenditures ($thousands)	Service population[1]	Expenditures (not in thousands) per: Resident	Visitor
Executive:					
General Government		$137,333	992,800	$138	$138
Public Safety		$288,511	992,800	$291	$291
Highways and Streets		$21,838	992,800	$22	$22
Sanitation[2]		$176,175	992,800	$177	$177
Human Services		$59,348	907,100	$65	
Culture-Recreation		$67,949	992,800	$68	$68
Utilities or Other Enterprises (Mass Transit)		$158,525	992,800	$160	$160
Debt Service		$202,336	992,800	$204	$204
Retirement System Contributions		$61,268	907,100	$68	$0
FICA and Pension Costs		$19,538	907,100	$22	$0
Health Benefits Contributions		$71,201	907,100	$78	$0
Miscellaneous		$19,225	992,800	$19	$19
Subtotal		$1,283,247		$1,313	$1,080
Legislative (Council operations)		$10,920	907,100	$12	$0
Less non-County operating resources:					
Federal Grants		-$75,094	992,800	-$76	-$76
State Grants		-$7,294	992,800	-$7	-$7
Subtotal, other sources		-$82,388		-$83	-$83
Total, in 2006 dollars		$1,211,779		$1,242	$997
Total, in 2007 dollars, based on increase of[3]	4.0%			$1,291	$1,037

1 Resident population of 907,100 as estimated by the U.S. Census Bureau, Population Division, March 20, 2007 (January 1 population estimated based on compound rate of growth between July 1, 2005 to July 1, 2006 estimates); plus average daily visitor population of 85,700 as published by Hawaii State Department of Business, Economic Development and Tourism, Research & Economic Analysis Division, for 2006.

2 Debt service on bonds for new sewer facilities included in Sanitation line item. Other City interest payments accounted for on the Debt Service line.

3 Based on 2007 vs. 2006 Honolulu CPI-U, 2007 as forecast by Hawaii State Department of Business, Economic Development and Tourism, February 21, 2007.

Source: City and County of Honolulu, "The Executive Program and Budget: Fiscal Year 2008, Volume 1 - Operating Program and Budget", 2007, pages A-5 and A-6.

Exhibit 5-6
State of Hawaii Primary Government Activity Expenses
Per Capita in Fiscal Year July 1, 2005 to June 30, 2006

	Operating expenditures ($thousands)	Service population[1]	Expenditures (not in thousands) per: Resident	Visitor
Governmental activities:				
General government	$455,008	1,464,300	$311	$311
Public safety	$336,362	1,464,300	$230	$230
Highways	$646,336	1,464,300	$441	$441
Conservation of natural resources	$76,490	1,464,300	$52	$52
Health	$690,265	1,464,300	$471	$471
Welfare	$1,709,526	1,279,400	$1,336	$0
Lower education	$2,151,891	1,279,400	$1,682	$0
Higher education	$678,338	1,279,400	$530	$0
Other education	$19,183	1,279,400	$15	$0
Culture and recreation	$98,121	1,464,300	$67	$67
Urban redevelopment and housing	$87,789	1,279,400	$69	$0
Economic development and assistance	$215,578	1,279,400	$168	$0
Interest expense	$172,673	1,464,300	$118	$118
Business-type activities:				
Airports	$292,086	1,464,300	$199	$199
Harbors	$61,408	1,464,300	$42	$42
Unemployment compensation	$105,786	1,279,400	$83	$0
Nonmajor proprietary fund	$2,587	1,464,300	$2	$2
Subtotal	$7,799,427		$5,817	$1,934
Less: Intergovernmental revenues	($1,601,005)	1,464,300	($1,093)	($1,093)
Total, in 2006 dollars	$6,198,422		$4,723	$840
Total, in 2007 dollars, based on increase of[2]		4.0%	$4,912	$874

Note: General government includes legislative expenses; line items may also have debt service and employee benefit expenses within each. Excludes expenses of "Component Units" including the University of Hawaii, Housing and Community Development Corporation of Hawaii, Hawaii Health Systems Corporation and Hawaii Hurricane Relief Fund. The first three charge for services, and receive capital and operating grants and contributions.

1 Resident population of 1,279,400 as estimated by the U.S. Census Bureau, Population Division, March 20, 2007 (January 1 population estimated based on compound rate of growth between July 1, 2005 to July 1, 2006 estimates); plus average daily visitor population of 184,900 as published by Hawaii State Department of Business, Economic Development and Tourism, Research & Economic Analysis Division, for 2006.

2 Based on 2007 vs. 2006 Honolulu CPI-U, 2007 as forecast by Hawaii State Department of Business, Economic Development and Tourism, February 21, 2007.

Source: State of Hawaii, Department of Accounting and General Services, "State of Hawaii: Comprehensive Annual Financial Report For the Fiscal Year Ended June 30, 2006," 2007.

Exhibit 5-7
Annual County Government Expenditures
Attributable to Population In-Migrating
2015 and 2030 (2007 dollars, in millions, except where noted)

	Basis/reference (not in millions)	2015	2030
Bases for County projection -			
FTE in-migrants to County	*Part-time residents, employees and dependents (Ex. 4-1)*	*690*	*2,830*
Annual expenditures -			
FTE in-migrants to County	*$1,291 per person, ref: Exhibit 5-5*	$0.9	$3.7
Subtotal new County expenditures		$0.9	$3.7

Note: Does not consider impact and permit fees paid to County. These projected to amount to approximately $194 million over the life of the Project, in 2007 dollars, including sewer, water system, water meter and other fees and permits, as well as a share of transportation impact fees. Figures also exclude impacts of transit facilities.

Exhibit 5-8
Annual State Government Expenditures
Attributable to Population In-migrating
2015 and 2030 (2007 dollars, in millions, except where noted)

	Basis/reference	2015	2030
Bases for State projection -			
FTE in-migrants to State	*Part-time residents, employees and dependents (Ex. 4-1)*	*350*	*1,450*
Annual expenditures -			
FTE in-migrants to State	*$4,912 per FTE person, ref. Exhibit 5-6*	$1.7	$7.1
Subtotal new State expenditures		$1.7	$7.1

Note: Does not consider impact fees paid to State. These projected to amount to approximately $25 million over the life of the Project, in 2007 dollars, including school fees and a share of transportation fees. Figures also exclude impacts of transit facilities.

Exhibit 5-9
County & State Government Revenue and Expenditure Comparison
2015 and 2030 (2007 dollars, in millions, except where noted)

	Basis/reference	2015	2030
City and County of Honolulu:			
New revenues	*Exhibit 5-2*	$8.7	$31.1
New expenditures	*Exhibit 5-7*	$0.9	$3.7
Net additional revenues		$7.8	$27.5
Revenue ÷ expenditure ratio[1]		9.8	8.5
State of Hawaii:			
New revenues[2]	*Exhibit 5-4*	$16.1	$27.0
New expenditures	*Exhibit 5-8*	$1.7	$7.1
Net additional revenues		$14.4	$19.9
Revenue ÷ expenditure ratio[1]		9.4	3.8

Note: Does not consider impact and permit fees paid to County and State governments. These are projected to amount to approximately $194 million and $25 million, respectively, over the life of the Project, in 2007 dollars. They include sewer, water, transportation and other fees and permits. Figures also exclude impacts of transit facilities.

1 New revenues divided by new expenditures. Calculated where denominator (additional expenses) exceeds zero.

2 Excludes potential income taxes from any operating entities and GET on ground lease rents.

ECONOMIC AND FISCAL IMPACT ASSESSMENT FOR HO'OPILI

Appendices

Appendix 1: Report Conditions

This assessment incorporates information provided by government agencies, developers, brokers, landowners, DRH, PBR Hawaii, and other sources as cited in the exhibits. While attempts have been made to verify information via multiple sources, it is not always possible to do so. MC cannot guarantee the accuracy of all information upon which its assessments may be based.

MC has no responsibility to update this report or any of the underlying data for events and circumstances occurring after May 15, 2007, the date of substantial completion of primary data collection.

This report is for the planning purposes of DRH, PBR Hawaii and their consultants, as well as for public disclosure of the nature of the Project pursuant to seeking State and County land entitlements. It is not intended to be used for solicitation of investment.

This report does not offer an appraisal of the Subject, nor should it be construed as an opinion of value for the Project.

Appendix 2: Derivation of Multipliers for Part-Time Resident Spending

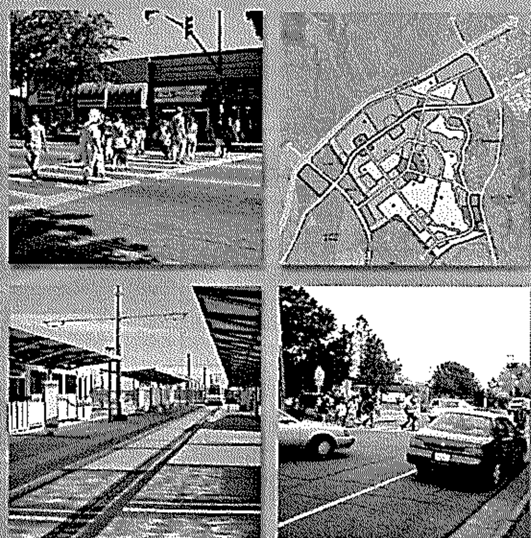
	Type II final demand multipliers		Type II direct effect multipliers (for Indirect & Induced Impacts)	
	Earnings	Job	Earnings	Job
Agriculture	0.66	36.6	1.77	1.44
Food processing	0.51	21.6	3.05	3.05
Other manufacturing	0.34	10.2	1.97	2.36
Transportation	0.57	17.7	2.26	2.55
Information	0.52	13.6	1.71	2.15
Utilities	0.33	8.2	2.38	4.17
Wholesale trade	0.55	17.1	1.76	1.96
Retail trade	0.57	24.4	1.69	1.51
Real estate & rentals	0.22	9.1	4.07	2.91
Professional services	0.81	23.3	1.69	1.97
Business services	0.83	30.9	1.69	1.62
Educational services	0.83	33.2	1.70	1.57
Health services	0.77	24.1	1.71	1.91
Arts & entertainment	0.77	37.4	1.59	1.38
Accommodations	0.63	20.0	1.90	2.06
Eating & drinking	0.60	30.5	1.99	1.54
Other services	0.69	30.7	1.80	1.54
Government	0.85	24.7	1.40	1.54
Average	0.61	23.0	2.01	2.07

Source: State of Hawaii, Department of Business, Economic Development and Tourism, "The 2002 State Input-Output Study for Hawaii," June 2006 (as revised from May 2006), Table 2.4.

APPENDIX L

Traffic Impact Analysis Report

Traffic Impact Analysis Report (TIAR)
Ho'opili
Oahu, Hawaii



prepared for
D.R. Horton Inc.
by Wilbur Smith Associates
February 2008

WilburSmith ASSOCIATES

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APPENDIX

EXECUTIVE SUMMARY

This document presents the results of the transportation impact analysis report (TIAR) prepared for the proposed Ho'opili Development (herein referred to as the "proposed Project"), a transit-oriented development in the 'Ewa District on the island of O'ahu, Hawaii. The purpose of this analysis is to identify the likely transportation impacts associated with the proposed development on the surrounding transportation system and to identify improvements to mitigate significant impacts. This TIAR solely reports on the impacts to intersections indentified herein, notably only those encompassed internally by the proposed project. As such, impacts found at intersections external to the project fall outside of the proposed project's jurisdiction and are not the responsibility of the project sponsor.

E.1 PROJECT DESCRIPTION

The proposed project involves development of a mixed-use community on approximately 1,555 acres in East Kapolei. The proposed plan for Ho'opili – which means "coming together" in Hawaiian – reflects the ideas, hopes and dreams of what the community wanted to see in this new development. The plan reflects the community's desire for vibrant and safe neighborhoods where people feel a sense of connection with one another, and with the rest of O'ahu.

The Conceptual Land Use Plan reflects the desire for a community that is "complete" with: affordable living options; employment centers; quality schools; shopping, gathering and recreational places; and parks and open space for residents. Implementation of the Plan will allow residents the ability to live, work, learn, play, and shop within Ho'opili without needing to use personal motor vehicles on regional roadways.

Ho'opili will be connected to the surrounding 'Ewa District (and neighboring Department of Hawaiian Home Lands (DHHL), the University of Hawaii at West Oahu (UHWO) and the Hawaii Community Development Authority (HCDA)) properties by a network of closely-spaced gridded streets and bicycle paths which allow a variety of circulation options for residents and visitors. Wider tree-lined boulevards will create a distinct axis running north-south and diagonally east-west across the site, but unlike a conventional subdivision of cul-de-sacs, there will many more streets, sized at a walking scale. Ho'opili is being designed to be transit-ready, and the land use plan, while subject to change, has been designed to accommodate a high-capacity transit corridor either along Farrington Highway or diagonally through the project site, with either one or two transit station locations. While the proposed residential unit count will not change, the land use plan will need to be adjusted depending on the final alignment of the high-capacity transit corridor, as the potential for noise impact from an elevated high-capacity transit alignment would likely require taller, higher density residential or industrial uses along the alignment. The final setting of the transit station location(s) will also provide transit-oriented development potentials, which will also cause the plan to be refined, as higher intensity development (and density) will be concentrated around the transit station(s).

The general land use allocation is described below:

Low-Medium Density Residential/Live-Work
Ranging from traditional single family detached homes on varying lot sizes to multifamily dwellings with a variety of live-work opportunities, there are approximately 535 gross acres (which includes secondary roads and mini-"neighborhood" parks) planned to accommodate approximately 5,100 residential units at densities of 5 to 14 units per acre. These areas would include mini-parks located as focal points and activity centers of the community.

Mixed-Use/Medium Density Residential
Planned to be oriented along future high-capacity transit and major roadway alignments, these medium density mixed use districts would include live-work residential units or residential uses over ground floor commercial and office uses. Within these districts that comprise approximately 340 acres (all of which will not be developed for housing because the acreage includes secondary roads, off-street parking and mini-"neighborhood" parks), there are approximately 5,200 dwelling units planned at densities of 15 to 29 units per acre along with retail and office use.

Mixed-Use/High Density Residential
Planned to be located near major transportation junctions, these higher density mixed use districts would include commercial, office space, and higher density live-work residential units or residential uses above ground floor businesses. Within these districts that comprise approximately 50 gross acres (which includes secondary roads, off-street parking and mini-"neighborhood" parks) would be approximately 40 net developable acres that would accommodate approximately 1,450 dwelling units planned at densities of 30 to 50 units per acre along with retail and office use.

Business / Commercial
To serve the neighborhoods and surrounding communities and to provide a variety of employment opportunities within Ho'opili, the business/commercial uses are located to be conveniently accessed from the major transportation corridors of the region. The approximately 145 gross acres illustrated (which includes secondary roads and off-street parking) are estimated to yield a net development area of approximately 130 acres that are projected to accommodate retail and office use. These areas would be significant employment generators for Ho'opili and the region.

Light Industrial / Business Mixed-Use
To meet regional demands and to provide for an additional employment center for Ho'opili, approximately 50 gross acres (which includes secondary roads and off-street parking) are planned to provide an area for larger light industrial type users and businesses. It is estimated that there would be a net development area of approximately 40 acres industrial mixed-use.

Open Spaces / Buffers
Integral to the connectivity of Hoÿopili to the surrounding neighborhoods, a variety of open space buffers and drainage detention areas are planned. Some of the key open space buffers include along the H-1 Freeway, Honouliuli Gulch and along Old Fort Weaver Road.

Parks
Some of the key parks being planned include a district park along Fort Weaver Road and a "downtown" civic square to serve as the community gathering area.

Mini-Parks
Integral to the establishment and identity of neighborhoods, a variety of smaller parks of approximately one to two acres in size are planned. Properly planned and located, most residents will be within walking distance of one of these mini-parks.

Public Facilities
The proposed project could include as many as five or more public school sites. The Conceptual Land Use Plan shows the possible locations for five State Department of Education (DOE) school sites planned to be as accessible to the neighborhoods of Ho'opili as the community is developed; one high school, one middle school and three elementary schools. The plan can also accommodate a private school(s) as the need is determined. In addition, area is set aside along the western end of Farrington Highway fronting the Petition Area for either a fire station or a police substation. In total, approximately 100 acres are allocated to meet public facility needs.

There are several major transportation projects that have been long-planned for East Kapolei. The Ho'opili project has been planned assuming that the appropriate government agencies will secure the required rights-of-way from the landowner, these include the lands under: a portion of North-South Road between Farrington Highway and Kapolei Parkway; a portion of the North-South Road and a new H-1 Freeway interchange; a portion of the intersection of North-South Road and Farrington Highway; the long-planned widening of Farrington Highway fronting Ho'opili; the proposed East-West Connector Road through the Petition Area; and the segment of the proposed Honolulu High-Capacity Transit Corridor project through the Project Area.

The proposed project has been designed to reduce future residents' reliance on private motorized vehicles through the following measures:

- The project is the first new project designed to embrace high-capacity transit (elevated, fixed-guideway) corridor and station(s);
- The project is large enough to be designed and offer a full range of mixed land uses, including a wide range of places of live, work, shop, recreate and learn and will aspire to achieve a job-housing balance;
- The project is designed to maximize connectivity (transit, pedestrian, bicycle and vehicular) with surrounding streets and communities (including DHHL and UHWO),while minimizing cul-de-sacs and dead-end streets;
- The project will be designed to take advantage of the relatively flatness of the site and proximity to UHWO by designing streets and grade-separated multi-modal pathways for walking and bicycling; and
- The project will seek to implement other transportation management and transportation demand management strategies.

E.2 SCOPE OF ANALYSIS

The analysis for the Proposed Ho'opili Project focused on conditions with the City's proposed transit corridor project. However, an in depth analysis of conditions without the transit corridor was also conducted to identify additional traffic impact and improvement actions in the event that the proposed transit corridor does not extend to Ho'opili in 2030.

E.2.1 YEARS AND SCENARIOS

The transportation analysis was prepared according to the scope of work approved by the City and County of Honolulu, and the Hawaii Department of Transportation. For the analysis of the proposed Project, the following transportation scenarios were examined:

- Existing Conditions (2006)
- 2030 Baseline Conditions
- 2030 Baseline plus Project Conditions "With Transit Corridor"
- 2030 Baseline plus Project Conditions "Without Transit Corridor"

E.2.2 ANALYSIS LOCATIONS

The following intersections in the vicinity of the Proposed Project were analyzed for intersection Level of Service (LOS) during morning peak hour (one hour between 6:00 AM and 8:00 PM) and the evening peak hour (one hour between 3:00 PM and 5:00 PM):

- Kunia Rd / Kunia Loop
- Kunia Rd / H-1 WB On-Ramp
- Kunia Rd / H-1 EB Ramps
- Farrington Hwy / Fort Weaver Rd. SB Ramps
- Farrington Hwy/ Fort Weaver Rd. NB Ramps
- Farrington Hwy / Leokū St
- Fort Weaver Rd / Laulauni St
- Fort Weaver Rd / Old Fort Weaver Rd
- Fort Weaver Rd / Renton Rd
- Farrington Hwy / East Old Fort Weaver Rd
- Farrington Hwy / West Old Fort Weaver Rd
- Farrington Hwy / Fort Barrette Rd

As part of the future network, the following key intersections were also analyzed for this project:

- North South Road/ H-1 Westbound Ramps
- North South Road/ H-1 Eastbound Ramps
- North South Road/ Farrington Highway
- North South Road/ North University of Hawai'i Connector
- North South Road/ South University of Hawai'i Connector
- North South Road/ Kapolei Parkway

- East-West Road/ Old Fort Weaver Road
- B Street/ 1st Avenue
- Farrington Highway/ B Street
- B Street/ 4th Avenue
- Parkway/ B Street
- B Street/5th Avenue
- East-West Road/ A Street
- 1st Avenue/ 2nd Avenue
- Farrington Highway/ Parkway/ 2nd Avenue
- Parkway/ 4th Avenue
- Parkway/ C Street
- C Street/ 5th Avenue
- 2nd Street/ D Street
- Kunia Road/ 2nd Avenue
- Kunia Road/ 3rd Avenue
- East-West Road/ B Street

Additionally, traffic impacts on freeways serving the vicinity of the development were also analyzed, these included:

- H-1 EB South of Makakilo Dr.
- H-1 EB West of Kunia Rd
- H-1 EB West of Paiwa St
- H-1 EB East of Kamehameha Hwy
- H-2 NB At Ka Uka Blvd.
- H-1 WB South of Makakilo Dr.
- H-1 WB West of Kunia Rd
- H-1 WB West of Paiwa St
- H-1 WB East of Kamehameha Hwy.
- H-2 SB At Ka Uka Blvd.

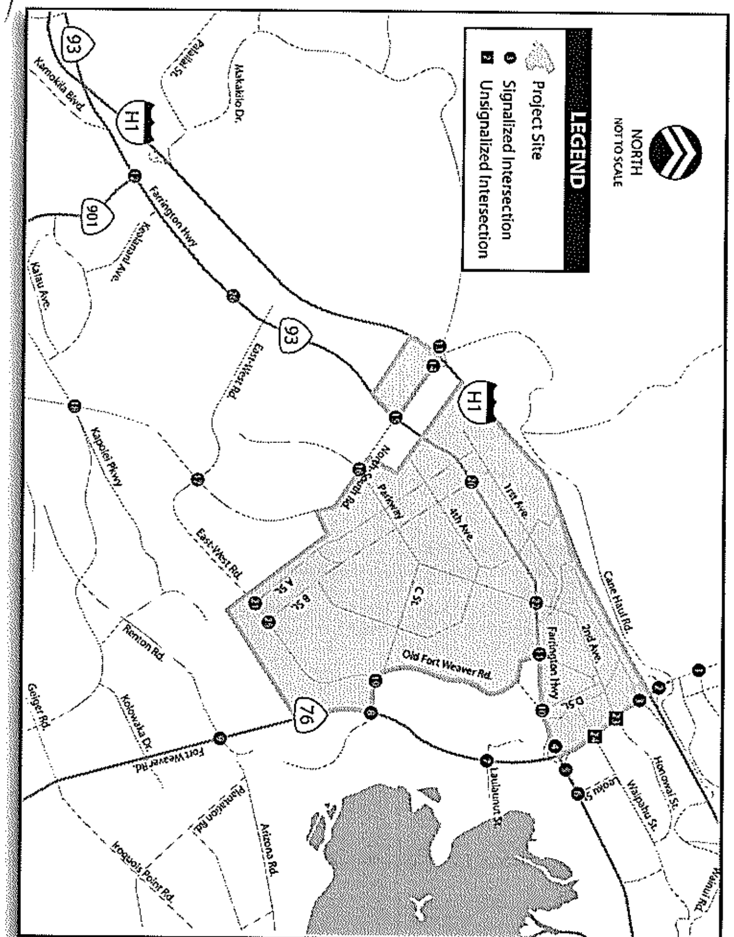


Figure E.2
STUDY INTERSECTIONS
100061/Draft October - 10/17/07

E.2.3 THRESHOLDS OF SIGNIFICANCE

Neither the City and County of Honolulu nor the State of Hawai'i have guidelines for identifying the transportation impacts caused by a project. As such, WSA followed the guidelines provided in *Sections 5.1.1, 5.1.2, and 5.1.3* to identify the transportation impacts at the intersections, freeway segments, and ramp-freeway junctions.

E.2.3.1 Intersections

The thresholds of significance for the study intersections are as follows:

1. A project would cause a transportation impact at an intersection if it degrades the LOS of the intersection to LOS E or worse.
2. A project would cause a transportation impact at an intersection operating at LOS E or F if it degrades the volume-to-capacity ratio of the intersection by more than 10 percent.

E.2.3.2 Freeway Segments

The thresholds of significance for the freeway segments are as follows:

1. A project would cause a transportation impact at a freeway segment if it degrades the LOS of the freeway segment to LOS E or worse.

E.2.2.3 Ramp-Freeway Junctions

The thresholds of significance for the ramp-freeway junctions are as follows:

1. A project would cause a transportation impact at a ramp-freeway junction if it degrades the LOS of the ramp-freeway to LOS E or worse.

E.3 TRAVEL DEMAND FORECASTS

The process used to identify the demand and forecast the total number of trips that would be generated by the proposed Project, included a three step process:

1. Trip generation
2. Trip distribution
3. Trip assignment

In the first step, the amount of traffic entering and exiting the Project land uses is estimated on a daily and peak hour basis. In the second step, the directions that vehicles use to approach and depart the project site are estimated. In the final step, the trips are assigned to specific street segments and intersection turning movements.

As mentioned above, the methodologies used in the estimation of the project traffic included a multiple step process involving the following:

4. Categorizing project land uses into appropriate Institute of Transportation Engineers (ITE) Trip Generation Categories
5. Identifying trip generation rates and/or trip generation equations
6. Applying trip generation reductions
7. Calculating the Final Trip Generation

Under "With Transit Corridor Conditions" the proposed Project is estimated to generate 140,920 daily trips of which 7,069 would be morning peak hour trips and 12,077 would be evening peak hour trips.

Under "Without Transit Corridor Conditions", the proposed Project is estimated to generate 158,669 daily trips of which 9,172 would be morning peak hour trips and 13,776 would be evening peak hour trips.

E.4 PROPOSED IMPACTS AND ACTIONS WITH TRANSIT CORRIDOR

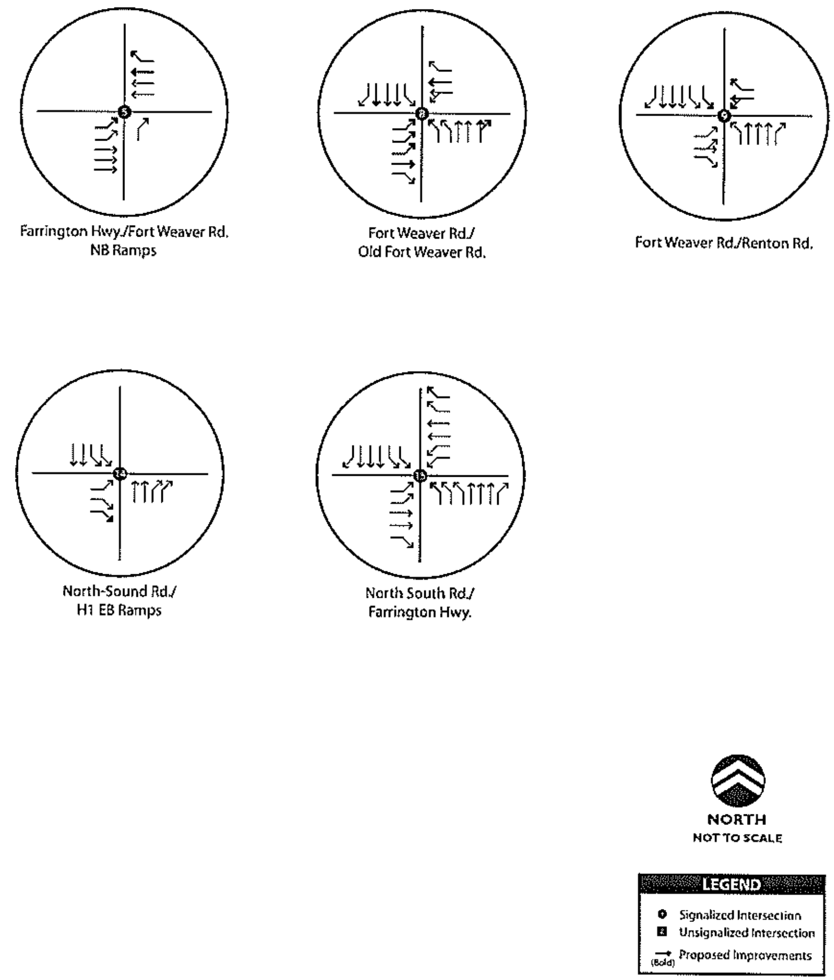
In general, under "With Transit Corridor" conditions, impacts would occur on the following roadways: Farrington Highway, Fort Weaver, North-South Road, and East-West Road, as well as at the following external intersections:
- Farrington Highway/ Fort Weaver Rd. Northbound Ramps
- Farrington Highway /Leokū Street
- Fort Weaver Road/ Old Fort Weaver Road
- Fort Weaver Road/ East-West Road
- Fort Weaver Road/ Renton Road
- Farrington Highway/Fort Barrette Road
- North-South Road/ H-1 Eastbound Ramps
- North-South Road/ Farrington Highway
- North-South Road/ Kapolei Parkway

Note that impacts at these locations are identified under Year 2030 conditions, and represent increases in cumulative traffic within the entire study area. Therefore, the contribution of traffic from the proposed Project to cumulative traffic increases must be recognized, and the assignment of traffic impacts must be proportionally allocated. One such method would be the implementation of a recurrent monitoring program to periodically measure traffic at specific locations. This would include the measurement of traffic associated both with the proposed Project (e.g., at key project access points/driveways), as well as along key transportation facilities.

The following locations are proposed for improvement under Scenario A: With Transit Corridor Conditions:
- Farrington Highway/Fort Weaver Road Northbound Ramps

- Fort Weaver Road/Leokū Street
- Fort Weaver Road/Old Fort Weaver Road
- Fort Weaver Road/ Renton Road
- Farrington Highway/Fort Barrette Road
- North-South Road/H-1 Eastbound Ramps
- North-South Road/Farrington Highway
- North-South Road/Kapolei Parkway

Figure E.4 presents the proposed improvements at the above locations.



Wilbur Smith Associates

Figure E.4
PROPOSED MITIGATION MEASURES
SCENARIO A: WITH TRANSIT CORRIDOR SCENARIO
100061/DEC 2007-12/10/07

Proposed Intersection Improvements

Farrington Highway/Fort Weaver Road Northbound Ramps

1. Eastbound Approach: Construct one additional exclusive left-turn lane to provide dual left-turn lanes.
2. Westbound Approach: Convert existing shared through-right lane to through lane and construct a separate free right-turn lane.
3. Signal Optimization: Optimization of intersection splits and cycle lengths along with the intersection offsets.

Fort Weaver Road/Leokū Street

The majority of the project-related traffic volumes would be added to the westbound through movements along Farrington Highway. Note that this section on Farrington Highway is planned to be widened to a six-lane roadway by Year 2030. To mitigate this impact, additional lanes would need to be constructed to accommodate through traffic, requiring acquisition of a new right-of-way. As such, it would not be feasible to add additional through lanes along Farrington Highway due to right-of-way constraints. However, implementation of the Transportation Demand Management (TDM) strategies discussed in *Section 6.3* could reduce the peak hour traffic volumes and Project impacts at this intersection.

Fort Weaver Road / Old Fort Weaver Road

1. Northbound Approach: Construct one additional exclusive left-turn lane to provide dual left turn lanes. Convert one of the existing through lanes to a shared through-right lane.
2. Eastbound Approach: Convert existing shared through-left turn lane to a through lane and construct 3 exclusive left turn lanes to allow a triple left-turn movement from Old Fort Weaver Road. Right-of-way acquisition may be required for the eastbound approach.
3. Signal Timing: For the eastbound and westbound directions, convert the signal timing from permitted to split phasing. In addition, provide free right-turns for eastbound and westbound movements.

Fort Weaver Road / Renton Road

1. Westbound Approach: Convert existing shared left-through-right lane to shared through-left lane and construct one exclusive right-turn lane.

Farrington Highway/Fort Barrette Road

1. Signal Timing: Change the cycle length from 210 seconds to 120 seconds. Also, convert the southeast and northwest right-turn phases from permitted to permitted plus overlap phases.
2. Signal Optimization: Optimization of intersection splits and cycle lengths along with the intersection offsets.

North-South Road / H-1 Eastbound Ramps

1. Eastbound Approach: Construct one additional right-turn lane to provide dual right-turn lanes.

North-South Road / Farrington Highway

Two options were identified as part of the traffic analysis for this intersection. Option 1 is proposed as part of the Ho'opili TIAR while Option 2 is incorporated from the University of Hawai'i West O'ahu Traffic Study Report.

Option 1: Proposed as part of the Ho'opili TIAR
1. Southeast-bound Approach: Convert the shared through-right lane to an exclusive right-turn lane
2. Southwest-bound Approach: Construct one additional exclusive right-turn lane to provide dual right-turn lanes.
3. Northwest-bound Approach: Construct an additional left-turn lane to provide three exclusive left-turn lanes. This would also require widening Farrington Highway west of the intersection to provide three westbound departure lanes to receive the triple left-turn lane movement.

Option 2: Incorporated from the University of Hawai'i West O'ahu Traffic Study Report

As an alternative to the above mitigation measure, the mitigation measure proposed as part of the University of Hawai'i West O'ahu (UHWO) could also be implemented as a mitigation measure at this intersection. The UHWO Traffic Study Report suggests a potential configuration for grade separation to conduct the Farrington Highway through movement over the intersection. North-South Road would remain as an at-grade facility and all turning movements would occur at-grade at the intersection. By removing the Farrington Highway through movement from the intersection, more green time could be allocated to the other movements, to accommodate the projected traffic volumes.

North-South Road / Kapolei Parkway

1. Southbound Approach: Convert shared through-right lane to exclusive right-turn lane to provide three through lanes and one right-turn lane.
2. Northbound Approach: Convert shared through-right lane to exclusive right-turn lane to provide three through lanes and one right-turn lane.

The proposed improvements identified for the above intersections could be implemented in a number of ways, including 1) by programming an alternate signal timing plans that would be in operation during specified peak commute periods, or 2) restricting pedestrian crossings on one or more intersection approach in order to allow for unconstrained vehicle movement.

Transportation Demand Management

Transportation Demand Management (TDM) strategies address traffic congestion by reducing the amount of vehicle miles traveled, thereby reducing overall travel demand. The aim of these strategies is focused on promoting travel alternatives such as increased transit usage, walking, and bicycling to help achieve this goal. The Leeward Oahu Transportation Management Association (LOTMA) currently provides TDM services in the vicinity of the proposed Project. It is anticipated that the proposed Project will continue to support the existing programs and services in place. It should be noted however that based on the proposed Project's trip generation during the AM and PM peak hours, the Project Sponsor may want to consider additional TDM strategies as a means of managing and improving travel demand. The following strategies are suggested for consideration:

- **Carsharing** – Project Sponsors could make carsharing available for residents of the Proposed development. Carsharing would provide residents access to a car on an "as needed" basis without incurring the fixed costs associated with owning and operating a personal automobile.
- **Carpool/Vanpool** – Developers and employers could promote carpool or vanpool programs for commuters who either live or work in the proposed Project and share the same schedule, through subsidizing the cost of vehicles and fuel costs.
- **Preferential HOV Parking** – Developers or employers could provide incentives for use of alternative modes of travel to the single occupancy vehicle by reserving close-in, secure, covered, or otherwise preferable parking spaces for high-occupancy vehicles.
- **Rent subsidies** – Developers of residential developments could offer tenants rent subsidies (reductions in rent) for the amount of money they would typically pay for a parking space included in the price of their rent.
- **Transit Subsidies** – Developers and employers could encourage the use of transit by offering a discounted monthly pass to its residents and employees.
- **Bicycle Parking and Shower Facilities** – Both businesses and developers can provide bicycle parking, storage, and shower facilities to promote and encourage the use of bicycles for work and home trips.
- **Staggered Class Schedules** – The University of Hawai'i and Department of Education (DOE) schools should consider following an alternative class schedules where courses begin at 9:00 AM so as to avoid the peak commute period (6:00AM to 8:00 AM).

E.5 PROPOSED IMPACTS AND ACTIONS WITHOUT TRANSIT CORRIDOR

The following presents a summary of the proposed impacts and actions that would occur as a result of the proposed Project in the event the City's transit corridor was not in place by Year 2030.

Under Scenario B: Without Transit Corridor, the following intersections would be impacted:

- Farrington Highway/ Fort Weaver Road Northbound Ramps
- Farrington Highway / Leokū Street
- Fort Weaver Road/ Laulaunui Street
- Fort Weaver Road/ Old Fort Weaver Road
- Fort Weaver Road/ Renton Road
- Farrington Highway/Fort Barrette Road
- North-South Road/ H-1 Eastbound Ramps
- North-South Road/ Farrington Highway
- North-South Road/ Kapolei Parkway

Of the 9 intersections identified above, 5 are found to be impacted under Scenario A: With Transit Corridor. While those impacts are discussed in detail under section E.4, the following three intersections are identified as having additional impacts under Scenario B and their corresponding improvement actions are also discussed:

- Farrington Highway/ North-South Road
- Fort Weaver Road/Laulaunui Street
- Farrington Highway/Fort Barrette Road

Note that impacts at these locations are identified under Year 2030 conditions, and represent increases in cumulative traffic within the entire study area. Therefore, the contribution of traffic from the proposed Project to cumulative traffic increases must be recognized, and the assignment of traffic impacts must be proportionally allocated. One such method would be the implementation of a recurrent monitoring program to periodically measure traffic at specific locations. This would include the measurement of traffic associated both with the proposed Project (e.g., at key project access points/driveways), as well as along key transportation facilities.

North-South Road/ Farrington Highway

Two options were identified as part of the traffic analysis for this intersection. Option 1 is proposed as part of the Ho'opili TIAR while Option 2 is incorporated from the University of Hawai'I West O'ahu Traffic Study Report.

Option 1: Proposed as part of the Ho'opili TIAR

1. Southwest-bound Approach: Construct one additional exclusive right-turn lane to provide dual right-turn lanes.
2. Southeast-bound Approach: Convert the existing permissive right-turn to a free right-turn.
3. Northeast-bound Approach: Convert the existing permissive right-turn to a dual free right-turn. Construct an additional right-turn lane.
4. Northwest-bound Approach: Construct an additional left-turn lane to provide triple left-turn lanes.

5. Signal Timing: Change the cycle length from 150 seconds to 140 seconds.

Even with the proposed mitigations, the impact at this intersection is identified as significant but avoidable during the PM peak hour. As such, additional improvement actions may be required.

Option 2: Incorporated from the University of Hawai'i West O'ahu Traffic Study Report

As an alternative to the above mitigation measure, the mitigation measure proposed as part of the University of Hawai'i West O'ahu (UHWO) could also be implemented as a mitigation measure at this intersection. The UHWO Traffic Study Report suggests a potential configuration for grade separation to conduct the Farrington Highway through movement over the intersection. North-South Road would remain as an at-grade facility and all turning movements would occur at-grade at the intersection. By removing the Farrington Highway through movement from the intersection, more green time could be allocated to the other movements, to accommodate the projected traffic volumes.

Fort Weaver Road/Laulaunui Street

1. Signal Optimization: Optimization of intersection splits and cycle lengths along with the intersection offsets.
2. Eastbound Approach: Construct an exclusive left-turn lane in addition to the shared through-left lane.

Farrington Highway/Fort Barrette Road

1. Signal Timing: Change the cycle length from 210 seconds to 120 seconds. Also, convert the southeast and northwest right-turn phases from permitted to permitted plus overlap phases.
2. Signal Optimization: Optimization of intersection splits and cycle lengths along with the intersection offsets.

The proposed improvements identified for the above intersections could be implemented in a number of ways, including 1) by programming an alternate signal timing plans that would be in operation during specified peak commute periods, 2) restricting pedestrian crossings on one or more intersection approach in order to allow for unconstrained vehicle movement, or 3) by reducing travel lane widths to accommodate the recommended lane additions within existing (or future) intersection right-of-way.

Chapter 1
INTRODUCTION

The following document is a Transportation Impact Analysis Report (TIAR) which presents the existing transportation conditions and assesses the transportation impacts associated with the proposed Ho'opili Development Project (herein referred to as the "proposed Project") in the 'Ewa District on the Island of Oahu, Hawaii. The following transportation impacts were analyzed in the study:

- Traffic conditions
- Transit operations
- Parking conditions
- Pedestrian circulation
- Bicycle circulation

1.1 PROJECT DESCRIPTION

The proposed project involves development of a mixed-use community on approximately 1,555 acres in East Kapolei. The proposed plan for Ho'opili – which means "coming together" in Hawaiian – reflects the ideas, hopes and dreams of what the community wanted to see in this new community. The plan reflects the community's desire for vibrant and safe neighborhoods where people feel a sense of connection with one another, and with the rest of O'ahu.

The Conceptual Land Use Plan reflects the desire for a community that is "complete" with: affordable living options; employment centers; quality schools; shopping, gathering and recreational places; and parks and open space for residents. Implementation of the Plan will allow residents the ability to live, work, learn, play, and shop within Ho'opili without needing to use personal motor vehicles on regional roadways.

Ho'opili will be connected to the surrounding 'Ewa District (and neighboring Department of Hawaiian Home Lands (DHHL), the University of Hawaii at West Oahu (UHWO) and the Hawaii Community Development Authority (HCDA) properties by a network of closely-spaced gridded streets and bicycle paths which allow a variety of circulation options for residents and visitors. Wider tree-lined boulevards will create a distinct axis running north-south and diagonally east-west across the site, but unlike a conventional subdivision of cul-de-sacs, there will many more streets, sized at a walking scale. Ho'opili is being designed to be transit-ready, and the land use plan, while subject to change, has been designed to accommodate a high-capacity transit corridor either along Farrington Highway or diagonally through the project site, with either one or two transit station locations. While the proposed residential unit count will not change, the land use plan will need to be adjusted depending on the final alignment of the high-capacity transit corridor, as the potential for noise impact from an elevated high-capacity transit alignment would likely require taller, higher density residential or industrial uses along the alignment. The final siting of the transit station location(s) will also provide transit-oriented development potentials, which will also cause the plan to be refined, as higher intensity development (and density) will be concentrated around the transit station(s).

The general land use allocation is described below:

Low-Medium Density Residential/Live-Work
Ranging from traditional single family detached homes on varying lot sizes to multifamily dwellings with a variety of live-work opportunities, there are approximately 535 gross acres (which includes secondary roads and mini-"neighborhood" parks) planned to accommodate approximately 5,100 residential units at densities of 5 to 14 units per acre. These areas would include mini-parks located as focal points and activity centers of the community.

Mixed-Use/Medium Density Residential
Planned to be oriented along future high-capacity transit and major roadway alignments, these medium density mixed use districts would include live-work residential units or residential uses over ground floor commercial and office uses. Within these districts that comprise approximately 340 acres (all of which will not be developed for housing because the acreage includes secondary roads, off-street parking and mini-"neighborhood" parks), there are approximately 5,200 dwelling units planned at densities of 15 to 29 units per acre along with retail and office use.

Mixed-Use/High Density Residential
Planned to be located near major transportation junctions, these higher density mixed use districts would include commercial, office space, and higher density live-work residential units or residential uses above ground floor businesses. Within these districts that comprise approximately 50 gross acres (which includes secondary roads, off-street parking and mini-"neighborhood" parks) would be approximately 40 net developable acres that would accommodate approximately 1,450 dwelling units planned at densities of 30 to 50 units per acre along with retail and office use.

Business / Commercial
To serve the neighborhoods and surrounding communities and to provide a variety of employment opportunities within Ho'opili, the business/commercial uses are located to be conveniently accessed from the major transportation corridors of the region. The approximately 145 gross acres illustrated (which includes secondary roads and off-street parking) are estimated to yield a net development area of approximately 130 acres that are projected to accommodate retail and office use. These areas would be significant employment generators for Ho'opili and the region.

Light Industrial / Business Mixed-Use
To meet regional demands and to provide for an additional employment center for Ho'opili, approximately 50 gross acres (which includes secondary roads and off-street parking) are planned to provide an area for larger light industrial type users and businesses. It is estimated that there would be a net development area of approximately 40 acres industrial mixed-use.

Open Spaces / Buffers
Integral to the connectivity of Ho'opili to the surrounding neighborhoods, a variety of open space buffers and drainage detention areas are planned. Some of the key open space buffers include along the H-1 Freeway, Honouliuli Gulch and along Old Fort Weaver Road.

Parks
Some of the key parks being planned include a district park along Fort Weaver Road and a "downtown" civic square to serve as the community gathering area.

Mini-Parks
Integral to the establishment and identity of neighborhoods, a variety of smaller parks of approximately one to two acres in size are planned. Properly planned and located, most residents will be within walking distance of one of these mini-parks.

Public Facilities
The proposed project could include as many as five or more public school sites. The Conceptual Land Use Plan shows the possible locations for five State Department of Education (DOE) school sites planned to be as accessible to the neighborhoods of Ho'opili as the community is developed; one high school, one middle school and three elementary schools. The plan can also accommodate a private school(s) as the need is determined. In addition, area is set aside along the western end of Farrington Highway fronting the Petition Area for either a fire station or a police substation. In total, approximately 100 acres are allocated to meet public facility needs.

Based on the above land use plan, the overall density is not anticipated to change. However, the distribution of density will change based upon the location of the proposed transit stations within Ho'opili. Additionally, internal traffic should be anticipated to change depending on the transit alignment and final station locations.

There are several major transportation projects that have been long-planned for East Kapolei. The Ho'opili project has been planned assuming that the appropriate government agencies will secure the required rights-of-way from the landowner, these include the lands under: a portion of North-South Road between Farrington Highway and Kapolei Parkway; a portion of the North-South Road and a new H-1 Freeway interchange; a portion of the intersection of North-South Road and Farrington Highway; the long-planned widening of Farrington Highway fronting Ho'opili; the proposed East-West Connector Road through the Petition Area; and the segment of the proposed Honolulu High-Capacity Transit Corridor project through the Project Area.

The proposed project has been designed to reduce future residents' reliance on private motorized vehicles through the following measures:

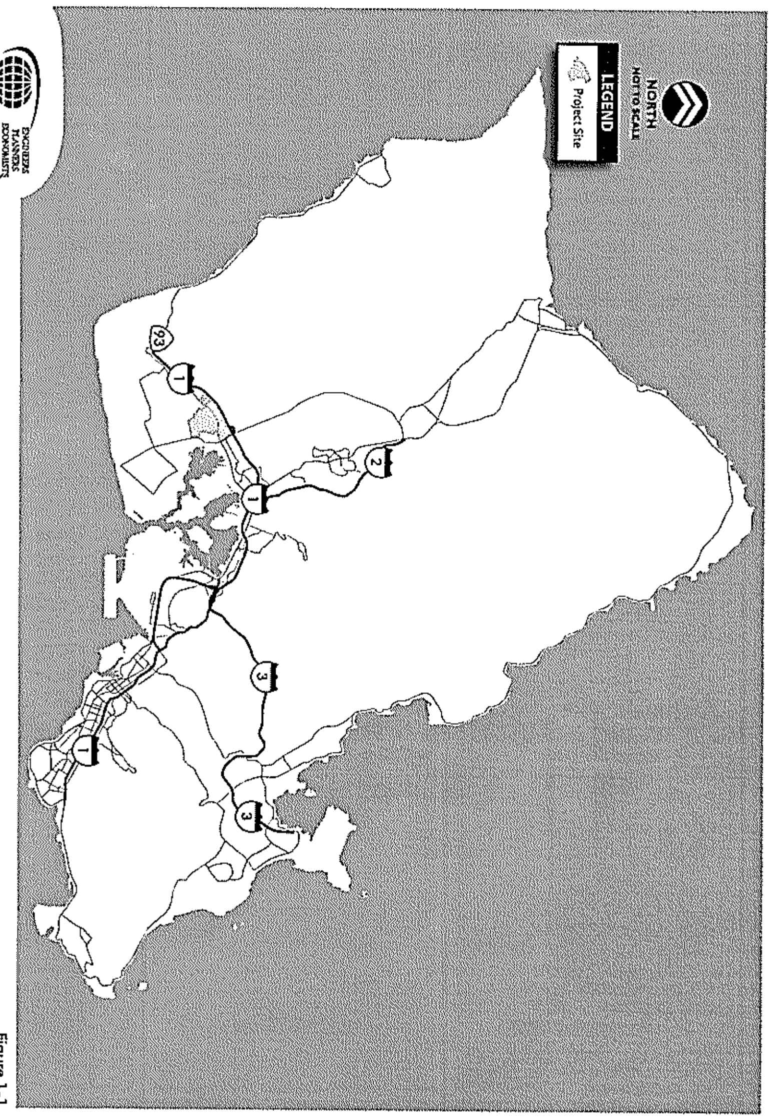
- the project is the first new project designed to embrace high-capacity transit (elevated, fixed-guideway) corridor and station(s);
- the project is large enough to be designed and offer a full range of mixed land uses, including a wide range of places of live, work, shop, recreate and learn and will aspire to achieve a job-housing balance;
- the project is designed to maximize connectivity (transit, pedestrian, bicycle and

vehicular) with surrounding streets and communities (including DHHL and UHWO), while minimizing cul-de-sacs and dead-end streets;
- the project will be designed to take advantage of the relatively flatness of the site and proximity to UHWO by designing streets and grade-separated multi-modal pathways for walking and bicycling; and
- the project will seek to implement other transportation management and transportation demand management strategies.

1.2 STUDY SCOPE AND APPROACH

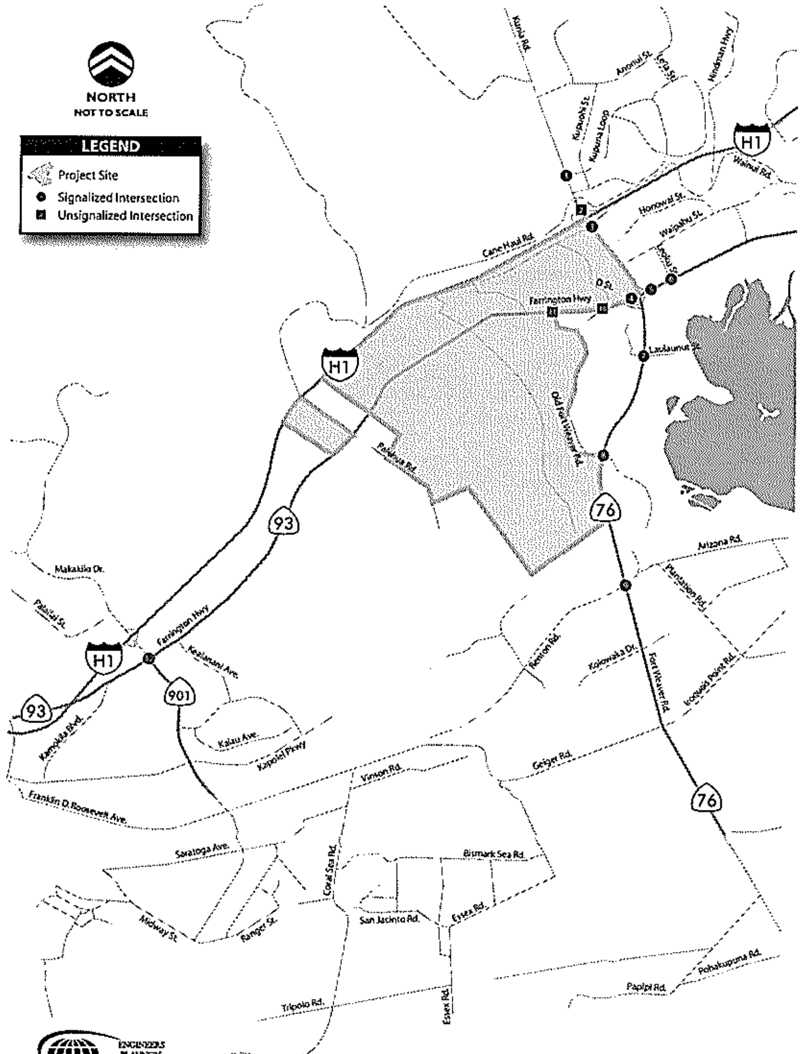
The transportation analysis was prepared according to the scope of work approved by the City and County of Honolulu, and the Hawaii Department of Transportation. For the analysis of the proposed Project, the following transportation scenarios were examined:

- Existing Conditions
- 2030 Baseline Conditions
- 2030 Baseline plus Project Conditions "With Transit Corridor"
- 2030 Baseline plus Project Conditions "Without Transit Corridor"



Wilbur Smith Associates ENGINEERS PLANNERS ECONOMISTS

Figure 1-1
PROJECT LOCATION
100061/BASE - 12/11/06



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ENGINEERS PLANNERS ECONOMISTS

Figure 1-2
PROJECT STUDY AREA
100061/BASE - 01/08/07

The purpose of this analysis is to identify the potential impacts of the proposed Project on the transportation system in the vicinity of the site that would be most directly impacted by the Project. As part of the existing traffic network, the following key intersections were analyzed for this project:

1. Kunia Road/ Kupuna Loop
2. H-1 Westbound Ramps/ Kunia Road
3. Fort Weaver Road/ H-1 Eastbound Ramps
4. Fort Weaver Road Southbound Ramps/ Farrington Freeway
5. Fort Weaver Northbound Ramps/ Farrington Freeway
6. Farrington Highway/ Leokū Street
7. Fort Weaver Road/ Laulaunui Street
8. Fort Weaver Road/ Old Fort Weaver Road
9. Fort Weaver Road/ Renton Road
10. Farrington Highway/ East Old Fort Weaver Road
11. Farrington Highway/ West Old Fort Weaver Road
12. Fort Barrette Road/ Farrington Highway

As part of the future traffic network, the following key intersections were also analyzed as part of this project:

13. North South Road/ H-1 Westbound Ramps
14. North South Road/ H-1 Eastbound Ramps
15. North South Road/ Farrington Highway
16. North South Road/ North University of Hawai'i Connector
17. North South Road/ South University of Hawai'i Connector
18. North South Road/ Kapolei Parkway
19. East-West Road/ Old Fort Weaver Road
20. B Street/ 1st Avenue
21. Farrington Highway/ B Street
22. B Street/ 4th Avenue
23. Parkway/ B Street
24. B Street/5th Avenue
25. East-West Road/ A Street
26. 1st Avenue/ 2nd Avenue
27. Farrington Highway/ Parkway/ 2nd Avenue
28. Parkway/ 4th Avenue
29. Parkway/ C Street
30. C Street/ 5th Avenue
31. 2nd Street/ D Street
32. Kunia Road/ 2nd Avenue
33. Kunia Road/ 3rd Avenue
34. East-West Road/ B Street

An evaluation of the traffic impacts on the freeways serving in the vicinity of the development area was also conducted. The following freeway mainline freeway segments were analyzed for this project:

- Section 1: H-1 Freeway (south of Makakilo Drive)
- Section 2: H-1 Freeway (west of Kunia Road)
- Section 3: H-1 Freeway (west of Pāiwa Street)
- Section 4: H-1 Freeway (east of Kamehameha Highway)
- Section 5: H-2 Freeway (at Ka Uka Boulevard)

Traffic impact evaluation was also conducted for the ramps connecting to the freeways serving in the vicinity of the proposed Project. This analysis was conducted for the existing ramp connections from Fort Weaver Road/Kunia Road to H-1 Freeway. Ramp analyses were also conducted for the future ramp configurations connecting from Fort Weaver Road/Kunia Road to H-1 Freeway as well as the ramps connecting from North South Road to H-1 Freeway.

Some of the mitigation measures in this TIAR proposed additional laneage at the intersections analyzed. Land acquisition for additional right of way where land is owned of controlled by the Project is readily accommodated. Land acquisition at project extremities and remote locations/intersections, if necessary, may require assistance from City and State as part of the overall master planned roadway network.

The operations of the key intersections and freeway segments were evaluated during the weekday morning (AM) and evening (PM) peak traffic periods for the following scenarios:

Scenario 1: Existing Conditions includes the analysis of existing traffic volumes obtained from traffic counts.

Scenario 2: 2030 Baseline Conditions includes future transportation improvements including freeway, intersection, transit, and bicycle/pedestrian improvements that will be in place without the project by the year 2030. The future traffic volumes have been obtained from the Year 2030 Oahu Metropolitan Planning Organization (OMPO) Transportation Model.

Scenario 3: 2030 Baseline plus Project Conditions "With Transit Corridor" (Scenario A: With High-Capacity Transit Corridor) includes project conditions volumes plus traffic associated with the proposed project under the assumption that the Honolulu High-Capacity Transit Corridor would pass through the project site. The transit corridor's alignment would be fixed and run diagonally through Ho'opili using the University of Hawai'i's Road B. It would further turn down North-South Road in the median and stop in front of the Kroc Center in the North-South median. Two stops are currently proposed within Ho'opili for which the exact stop locations are still being determined. The project sponsor will be responsible for integrating the transit stops into the surrounding environment. It should be noted that depending on their locations, the bus stops may experience higher densities and be able to capture increased ridership as a result. Additionally, it is likely that a transit maintenance facility be located within Ho'opili. The details of this arrangement are discussed in the EIS report.

Scenario 4: 2030 Baseline plus Project Conditions "Without Transit Corridor" (Scenario B: Without High Capacity Transit Corridor) includes project conditions volumes plus traffic

associated with the proposed project under the assumption that the Honolulu High-Capacity Transit Corridor would not pass through the project site.

The remainder of the report is divided into six chapters. Chapter 2 describes Existing Conditions with regards to roadway facilities, transit services, pedestrian and bicycle facilities, and analysis methodologies. Intersection and Freeway operations under Background Conditions with traffic from approved but not yet constructed developments are discussed in Chapter 3. Chapter 3 provides a baseline from which to identify Project impacts.

Chapter 4 describes the methodology used to estimate the project traffic and the project's impact on the transportation system. Chapter 5 describes the future (Year 2030) transportation conditions including freeway, and intersection operations that will be a result of the construction of the East Kapolei Project. The results of the Project condition analysis as compared to the results of the 2030 Baseline Conditions (Chapter 3) analysis are used to identify significant project impacts. In Chapter 6, these significant impacts are identified, recommended improvements are proposed, and a phasing plan for improvement implementation is described. Chapter 6 also includes an assessment of site access, on-site circulation, transit services & pedestrian facilities and a review of the proposed roadway cross-sections for internal roadways and roadways adjacent to the project site. The study conclusions are presented in Chapter 7.

Chapter 2
EXISTING CONDITIONS

This chapter provides a description of Existing Conditions in the vicinity of the proposed Project. Included in this chapter are descriptions of the existing roadway and transit networks, documentation of existing traffic, transit, pedestrian, and bicycle conditions.

2.1 EXISTING ROADWAY NETWORK

The project area includes several major roadways that serve regional trips within Central O'ahu, as well as provide access to the commercial and residential areas adjacent to the project area.

2.1.1 Regional Access

This section provides a discussion of the existing regional roadway network in the vicinity of the proposed Project site, including the location of the nearest access points.

H-1 Freeway (H-1) – H-1 extends east-west through Central Honolulu and the 'Ewa District to provide connections of the project area to areas outside of the 'Ewa District. East of the Waiawa interchange, it provides five travel lanes in each direction with one lane in each direction designated as a HOV lane for vehicles with two or more occupants, during the peak commute periods. Between the Waiawa and Kunia interchanges, the freeway provides four lanes in each direction. West of the Kunia interchange, the freeway has three travel lanes in each direction.

H-2 Freeway (H-2) – The H-2 Freeway extends north-south throughout Central O'ahu and connects at its interchange to the H-1 Freeway. The northern terminus is just south of Wahiawā at the junction with Kamehameha Highway and Wilikina Drive. It provides four lanes in each direction from the Waiawa interchange to Mililani, where it narrows to two lanes in each direction.

Farrington Highway – Farrington Highway extends east-west to accommodate traffic between its east terminus, at the interchange with Kamehameha Highway, and the Wai'anae coast of O'ahu. It is located generally parallel to and one-half to three quarters of a mile south of the H-1 Freeway within the study area. It provides four lanes in each direction from the Kamehameha interchange to Old Fort Weaver Road. It extends westward with one lane in each direction to the Villages of Kapolei where it widens to provide 2 lanes in each direction from Kapolei Golf Course Road into the City of Kapolei.

Kamehameha Highway (State Route 99) – Kamehameha Highway extends north-south to accommodate traffic between the north and south shores of O'ahu. It is located generally parallel to and one-half to one mile west of the H-2 Freeway within the study area. Kamehameha Highway has been widened to a four-lane highway, with separate left- and right-turn lanes at Waipahu Street, Lumiauau Street, Lumiaina Street, Waipio Uka Street, and Ka Uka Boulevard intersections, from the H-1 Freeway to Ka Uka Boulevard. Kamehameha Highway also has an

interchange with Farrington Highway where it continues to operate as a four lane freeway both east and west of the interchange.

2.1.2 Local Access

This section provides a discussion of the existing local roadway system in the vicinity of the proposed Project site, including the roadway designation, number of travel lanes, and traffic flow directions.

Fort Weaver Road – This north-south roadway connects the H-1 Freeway with the Farrington Highway and provides access to the Waipahu residential areas. North of Farrington Highway, Fort Weaver Road becomes Kunia Road. Fort Weaver Road functions as a six-lane expressway between the H-1 Freeway and Laulaunui Street which interchanges at H-1 and Farrington Highway. It is a four-lane principal arterial with a median divider and left turn lanes at cross streets from Farrington Highway to North Road. Makai of North Road, Farrington Highway functions as a two-lane minor arterial.

Fort Barrette Road – This north-south roadway connects the Kalaeloa Redevelopment Area to the Makakilo community and provides access to Farrington Highway and H-1 Freeway. It is a two-lane divided roadway from just makai of Farrington Highway to Franklin D. Roosevelt Avenue. It extends mauka of Farrington Highway as Makakilo Drive, a four-lane roadway with median divider.

Old Fort Weaver Road – Old Fort Weaver Road provides the Honouliuli community access to Farrington Highway and Fort Weaver Road. It is a two-lane roadway between Farrington Highway and Fort Weaver Road

Laulaunui Street is a four-lane east-west minor arterial roadway extending between Kaihuopala'ai Street and Laulaunui Lane. Laulauni Street also intersects with Fort Weaver Road.

Leokū Street is a two- to four-lane north-south minor roadway that extends from Waipahu Street to Leokāne Street and is parallel to Fort Weaver Road.

Kunia Road is an extension of Fort Weaver Road north from Farrington Highway and the H-1 Freeway interchange to provide access into Central O'ahu.

Kupuna Loop is a four lane looped arterial roadway with two lanes in each direction. It provides direct access to Kunia Road at both its origin and terminus.

Renton Road is a two- to four-lane east-west minor arterial roadway through the Renton Village area that connects Fort Weaver Road to the Kapolei Parkway and to Roosevelt Avenue.

2.2 TRANSIT NETWORK

The City and County of Honolulu provides TheBus fixed-route service to the communities adjacent to and in the general vicinity of the proposed Project site, these routes include both suburban trunk routes and express routes. Figure 2-1 presents nearby bus routes. Table 2.1 presents the service frequencies for TheBus routes that service the proposed Project site. TheBus operates seven bus lines that directly serve the proposed Project and its immediate vicinity, they include:

- **Route A City Express** - Route A operates express service that connects Waipahu and Pearlridge with Downtown and the University of Hawai'i. Service is provided at approximately 15 minute intervals between 4:45 am and 10:00 PM on weekdays and 30 minute intervals between 5:00 AM and 8:30 PM on weekends.

- **Route 41 Kapolei Transit Center-** This route serves the Villages of Kapolei areas, including a portion of the Makakilo Drive-Fort Barrette Road. Service is provided approximately at one hour intervals from about 5:00 AM to 9:00 PM, seven days a week.

- **Route 42 'Ewa Beach-** Route 42 provides service along Farrington Highway in the City of Kapolei at half-hour intervals from approximately 6:00 AM to 1:30 AM for westbound travel seven days a week. Eastbound service runs from approximately 4:00 AM to 1:00 am also seven days a week.

- **Route 43 Waipahu Transit Center** – This route provides service along the H-1 Freeway and through the City of Waipahu, connecting Waipahu to downtown Honolulu. Service is provided seven days a week at half-hour intervals from 7:00 AM to 5:00 PM

- **Route 81 Waipahu Express (PM)/ Downtown Express (AM)** - This route provides express service at approximately 15 minute intervals from Waipahu to Downtown during the morning hours between 4:30 AM and 7:30 AM. Evening service frequency to Waipahu varies from 15 to 30 minute intervals and operates between 3:00 PM and 6:20 PM.

- **Route 91 Express Downtown (AM) / 'Ewa Beach Express (PM)** - Service is provided along the H-1 Freeway connecting the Downtown to 'Ewa Beach. Eastbound service on this route runs at 20 minute intervals from 4:30 AM to 7:00 AM, connecting 'Ewa Beach to the Downtown. Westbound service to 'Ewa Beach is provided the PM hours at 20 minute intervals beginning at 3:25 and concluding at 6:15 PM.

- **Route 102 Villages of Kapolei Express-** This route provides 3 morning Honolulu-bound trips and 3 afternoon return trips to the Villages of Kapolei during the peak commute periods. The route provides service along Fort Barrette Road and Farrington Highway in the Villages of Kapolei area.

In addition to TheBus express routes, the Leeward Oahu Transportation Management Association (LOTMA) also sponsors an express bus service along Fort Weaver Road to Honolulu with one morning and one afternoon trip.

Table 2.1
Bus Service near the proposed Project

Route	From	To	Hours of Operation		Headway During Commute Periods			
					Weekday		Weekend	
			Weekday	Weekend/Holiday	AM	PM	AM	PM
A	Waipahu	University	4:22 AM – 10:02 PM	4:52 AM – 9:12 PM	15	15-20	15-30	30
A	University	Waipahu	5:18 AM – 8:48 PM	6:08 AM – 8:31 PM	10-15	10-15	15	30
41	Kapolei	'Ewa	5:00 AM – 9:15 PM	5:00 AM – 9:15 PM	30	30	60	60
41	'Ewa	Kapolei	5:03 AM – 9: 49 PM	5:33 AM – 9:49 PM	30	30	60	60
42	'Ewa	Waikīkī	4:20 AM – 12:54 AM	4:39 AM – 12:44 AM	30	30	20-30	20-30
42	Waikīkī	'Ewa	4:57 AM – 1:47 AM	5:59 AM – 1:29 AM	30	30	30	30
43	Honolulu	Waipahu	7:00 AM – 4:49 PM	7:03 AM – 5:03 PM	30	30	30	30
43	Waipahu	Honolulu	7:15 AM – 5:15 PM	7:15 AM – 5:15 PM	30	30	30	30
81	Waipahu	Honolulu	4:28 AM – 7:34 AM	4:40 AM – 7:00 AM	15-20	-	20	-
81	Honolulu	Waipahu	3:00 PM – 6:18 PM	-	-	20-30	-	-
91	'Ewa	Honolulu	4:30 AM – 7:10 AM	4:35 AM – 6:45 AM	20	-	20-45	-
91	Honolulu	'Ewa	3:25 PM – 6:15 PM	3:40 PM – 5:45 PM	-	20	-	20-30
102	Kapolei	Honolulu	5:30 AM – 6:10 AM	-	20	-	-	-
102	Honolulu	Kapolei	4:00 PM – 5:10 PM	-	-	20	-	-

Source: TheBus, January 2007

NOTES:
Headway is presented in minutes.

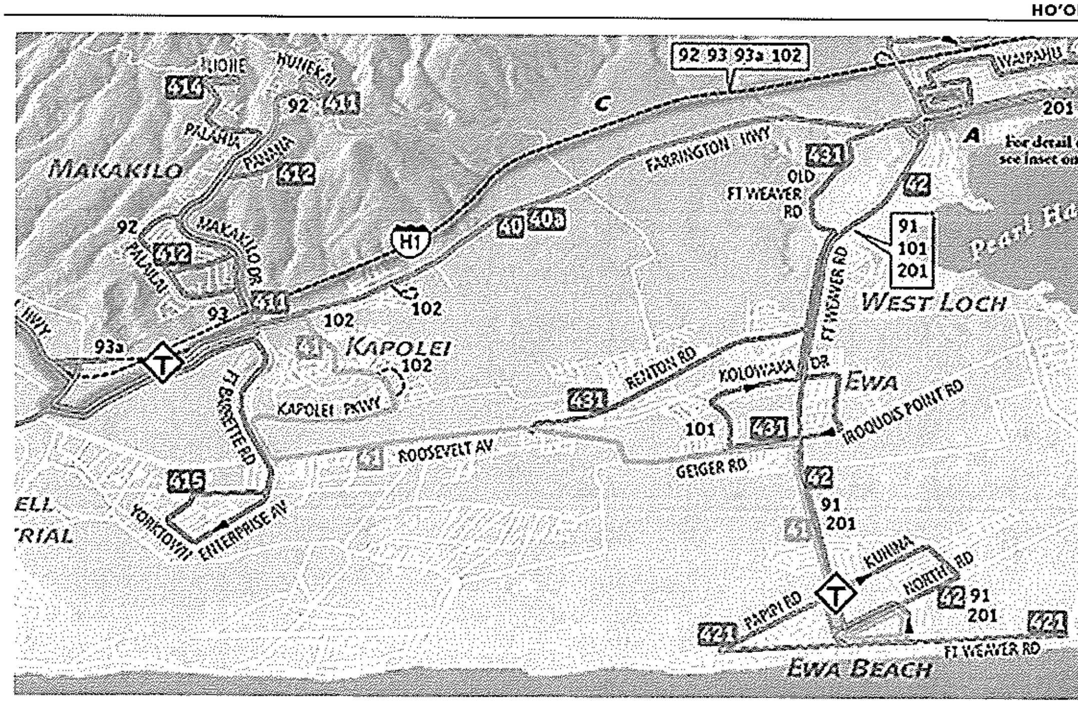

Figure 2-1
EXISTING TRANSIT NETWORK
100061/TRANSIT NETWORK - 01/05/07

2.3 PEDESTRIAN CONDITIONS

Within the vicinity of the proposed Project, sidewalk facilities are provided along both sides of Farrington Highway towards the east-west project limits beyond its intersection with Fort Weaver Road and along its intersection with Fort Barrette Road. Sidewalks are also provided along both sides of Renton Road, Laulaunui Road, Leokū Street, and along Makakilo Drive, as well as the westbound approach of Old Fort Weaver Road near the project area intersections. Crosswalks have also been provided along certain approaches to these intersections to support the sidewalks/bike trails.

2.4 BICYCLE CONDITIONS

A bicycle path is provided along both sides of Fort Weaver Road through the study area. Along the other major roadways, bicycles either use paved shoulder areas, wide outside lanes, or travel within the regular traffic lane.

2.5 TRANSPORTATION DEMAND MANAGEMENT

Since 1990, as Hawai'i's first transportation management organization, the Leeward Oahu Transportation Management Association (LOTMA) has worked to provide and promote alternative transportation options aimed at alleviating traffic congestion, air pollution, and fuel consumption. LOTMA presently sponsors a number of different programs to accommodate the increasing mobility needs of the West and Central Oahu region, including the following:

1. Carpooling and Vanpooling – In an effort to encourage new carpool and vanpool participation, LOTMA has partnered with Vanpool Hawai'i to provide financial start-up subsidies to new vanpool commuters who live in Leeward, Central and North Shore O'ahu.

2. Carpool Matchlist – LOTMA provides the opportunity for commuters living in Leeward, Central, and North Shore O'ahu to join a list of carpoolers which they can be paired with. As an incentive encouraging people to sign up and use this service, LOTMA enters each participant into a drawing for the opportunity to win a gas card valued at $25.00. In addition to the carpool list, LOTMA also provides information on larger carpooling databases offered by the O'ahu Department of Transportation as well as other international ridersharing websites.

3. LOTMA Commuter Express – Offers commuters morning and evening non-stop express service on the freeway express lanes between Central Oahu and Honolulu. Morning service begins at 6:05 AM from the Waipio Gentry Shopping Center and terminates at the Sheraton Waikīkī. Evening service from the Sheraton Waikīkī begins at 4:30 PM and terminates at 6:05 PM at the Miliani Mauka Park and Ride.

4. Emergency Ride Home Program (ERH) – The ERH program offers rides for unplanned personal emergencies including personal/family illness, family crisis, or in the event one's regularly scheduled carpool/vanpool is not available. Participation in the ERH is open to those living or working in Leeward, Central, or North Shore Oahu who carpool/vanpool, or ride the

LOTMA Commuter to work at least once a week. In addition, participants must commute to work by carpool/vanpool, or LOTMA Commuter Express on the day the ERH is needed.

5. LOTMA website – LOTMA regularly updates its website to provide users with the most current information about carpooling, vanpooling, the LOTMA Commuter Express, the Mililani Trolley, and TheBus. In addition, LOTMA also offers special program promotions via its website.

2.6 INTERSECTION OPERATING CONDITIONS

2.6.1 Methodology for Intersection Analysis

Operations of the study intersections were evaluated using Level of Service (LOS) calculations. LOS is a qualitative description of the performance of an intersection based on the average delay per vehicle. Intersection levels of service range from LOS A, which indicates free flow or excellent conditions with short delays, to LOS F, which indicates congested or overloaded conditions with extremely long delays.

Signalized Intersections

Levels of Service for signalized intersections were calculated using the *Highway Capacity Manual 2000* (HCM 2000) methodology. The LOS is based on the average delay (in seconds per vehicle) for the various movements within the intersection. A combined weighted average delay and LOS are presented for each of the signalized intersections. The average delay for signalized intersections was calculated using the Synchro analysis software and is correlated to the level of service designation as shown in Table 2.2.

Table 2.2
Level of Service Criteria – Signalized Intersections

Level of Service	Description of Operations	Average Delay
A	Operations with very low delay occurring with favorable progression and/or short cycle length.	≤ 10.0
B	Operations with low delay occurring with good progression and/or short cycle lengths.	10.1 – 20.0
C	Operations with average delays resulting from fair progression and/or longer cycle lengths. Individual cycle failures begin to appear.	20.1 – 35.0
D	Operations with longer delays due to a combination of unfavorable progression, long cycle lengths, or high V/C ratios. Many vehicles stop and individual cycle failures are noticeable.	35.1 – 55.0
E	Operations with high delay values indicating poor progression, long cycle lengths, and high V/C ratios. Individual cycle failures are frequent occurrences. This is considered to be the limit of acceptable delay.	55.1 – 80.0
F	Operation with delays unacceptable to most drivers occurring due to over saturation, poor progression, or very long cycle lengths.	≥ 80.1

Source: Highway Capacity Manual, Transportation Research Board, 2000

NOTES:
Delay presented in seconds per vehicle.

Unsignalized Intersections

Unsignalized intersections were evaluated using the *Highway Capacity Manual 2000* methodology. The LOS rating is based on the weighted average control delay expressed in seconds per vehicle as illustrated in Table 2.3. Control delay includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration. At two-way controlled intersections, LOS is calculated for each controlled movement, as opposed to the intersection as a whole. For all-way stop controlled locations, LOS is computed for the intersection as a whole.

Table 2.3
Level of Service Criteria – Unsignalized Intersections

Level of Service	Description of Operations	Average Delay
A	No Delay for stop-controlled approaches.	≤ 10.0
B	Operations with minor delays.	10.1 – 15.0
C	Operations with moderate delays.	15.1 – 25.0
D	Operations with some delays.	25.1 – 35.0
E	Operations with high delays, and long queues.	35.1 – 50.0
F	Operations with extreme congestion, with very high delays and long queues unacceptable to most drivers.	≥ 50.1

Source: Highway Capacity Manual, Transportation Research Board, 2000

NOTES:
Delay presented in seconds per vehicle.

2.6.2 Methodology for Freeway Analysis

Freeway segment operating conditions were evaluated using the *HCM* 2000 methodology. HCM methodology computes LOS for basic freeway segments using density as the measure of effectiveness. Based on the values of the input parameters (geometric data, volume, and base free-flow speed) flow rate and speed are determined. Adjustments are typically made to the base free-flow speed to account for lane width, number of lanes, interchange density, and lateral clearance. Using the flow rate and speed, density of the freeway segment is computed. Table 2.4 presents the LOS criteria for freeway segments using density as the performance measure.

Table 2.4
Level of Service Criteria – Basic Freeway Segments

Level of Service	Density
A	0.0 – 11.0
B	11.1 – 18.0
C	18.1 – 26.0
D	26.1 – 35.0
E	35.1 – 45.0
F	> 45.0

Source: Highway Capacity Manual, Transportation Research Board, 2000

NOTES:
DEC – Demand Exceeds Capacity.
Density is presented in passenger cars per hour per lane.

2.6.3 Methodology for Ramp-Freeway Junction Analysis

As in the case of intersections and freeway segments, *HCM 2000* methodology was applied to identify the operating conditions of the Ramp-Freeway junctions. Similar to freeway segments, HCM methodology computes LOS for ramp-freeway junctions using density as the measure of effectiveness. HCM methodology for ramp-freeway junctions computes demand flow rate after making adjustments to account for peak-hour factor, heavy vehicle factor, and driver population factor. Flow rates are computed immediately upstream of ramp influence area for both merging and diverging ramps. Determination of the LOS is then based on the comparison between the computed demand flow rate and the capacity of the ramp influence area. If the capacity if less than the flow rate then the ramp influence area operates at LOS F. For ramp-freeway junctions, lower densities indicate lower service levels and fewer or no delays; whereas, higher densities indicate higher service levels and long queues. Table 2.5 presents the LOS criteria for ramp-freeway junctions.

Table 2.5
Level of Service Criteria – Ramp-Freeway Junctions

Level of Service	Density	Minimum Speed
A	≤ 10.0	58
B	10.1 – 20.0	56
C	20.1 – 28.0	52
D	28.1 – 35.0	46
E	> 35	42
F	DEC	DEC

Source: Highway Capacity Manual, Transportation Research Board, 2000

NOTES:
DEC – Demand Exceeds Capacity.
Density is presented in passenger cars per hour per lane.
Speed is presented in miles per hour.

In the absence of established local criteria to describe the operating conditions of intersections, freeway segments, and ramp-freeway junctions, LOS D or better is typically considered to be acceptable for peak hours, while LOS E or worse are considered undesirable conditions. As such, this criterion was used to identify the operating conditions of intersections, freeway segments, and ramp-freeway junctions for this transportation study.

2.7 EXISTING TRAFFIC CONDITIONS

2.7.1 Existing Intersection Operating Conditions

Existing intersection operating conditions were evaluated for the morning peak hour (6:00 AM to 8:00 AM) and evening peak hour (3:00 PM to 5:00 PM) using *Synchro* software. It should be noted that Existing commute peak hour traffic volumes at key intersections were developed from manual intersection turning movement counts conducted by Wilbur Smith Associates in April 2006. The traffic movements were counted and recorded by traffic surveyors in 15 minute intervals during the peak commute periods. These counts were then analyzed to determine the peak one-hour traffic volumes at each intersection. The off- and on-ramp volumes at the intersection Kunia Road/ H-1 Westbound Ramps were obtained from the State of Hawaii, Department of Transportation's 24-Hour Traffic Count summaries.

A total of 12 intersections were analyzed under existing conditions of which nine are signalized, and three are Two-Way Stop-Controlled (TWSC) intersections. A field visit was conducted to verify the existing intersection lane configurations, intersection control devices, and signal cycle lengths. Figure 2-2 shows the existing geometric configurations at the study intersections and Figure 2-3 exhibits the AM and PM peak hour turning movement volumes at the 12 study intersections under existing conditions.

The existing lane configurations and peak hour turning movement volumes were used to calculate the levels of service for the 12 study intersections under existing peak hour conditions.

The results of the existing LOS analysis are presented in Table 2.6, and the calculation worksheets are included in Appendix A-1.

Under existing the AM peak hour conditions, seven of the 12 study intersections operate at LOS D or better (acceptable conditions), while the following five intersections operate at LOS E or F (unacceptable conditions):

- Kunia Road/ H-1 Westbound On-Ramp
- Fort Weaver Road/ Laulaunui Road
- Fort Weave Road/ Old Fort Weaver Road
- Fort Weaver Road/ Renton Road
- Farrington Highway/ Fort Barrette Road

Similar to AM peak hour conditions, under existing PM peak hour conditions, five study intersections operate at LOS E or F. The remaining seven intersections operate under acceptable conditions. The five intersections operating under unacceptable conditions are:

- Kunia Road/ H-1 Westbound On-Ramp
- Farrington Highway/ Leokū Street
- Fort Weaver Road/ Renton Road
- Farrington Highway/ East Old Fort Weaver Road
- Farrington Highway/ Fort Barrette Road

Figure 2-4 exhibits the LOS and delay values for all the turning movements of the study intersections under existing AM and PM peak hour conditions.

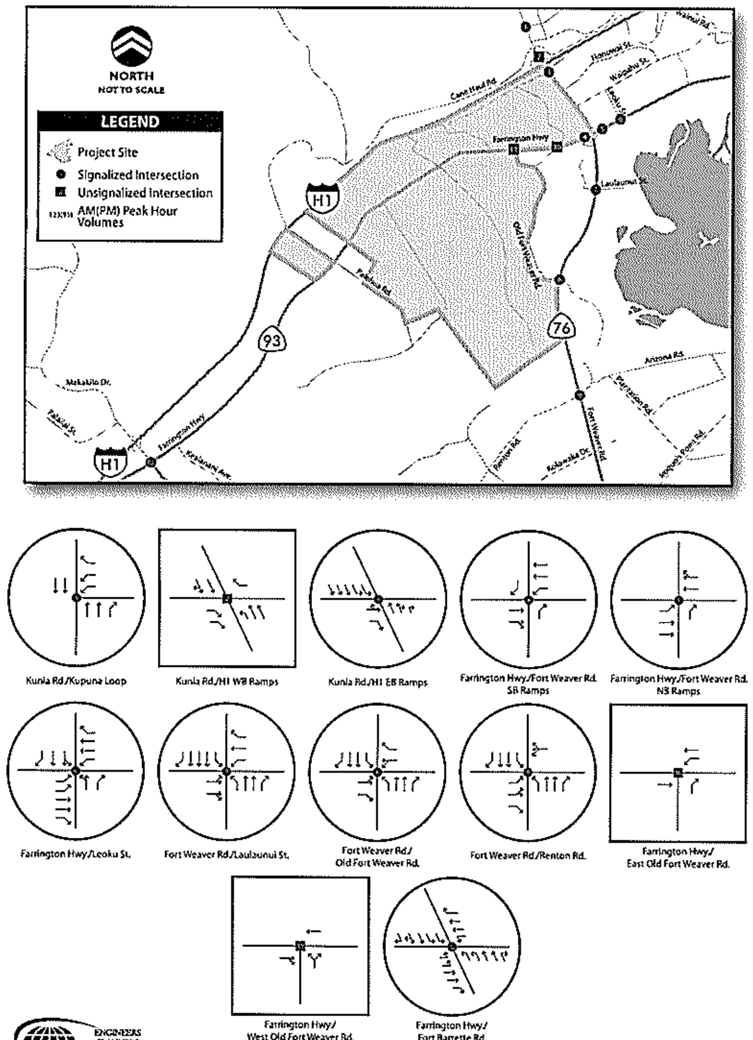

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Figure 2-2
INTERSECTION GEOMETRIC CONFIGURATIONS - EXISTING CONDITIONS
100061/BASE - 12/19/06

HO'OPILI TIAR

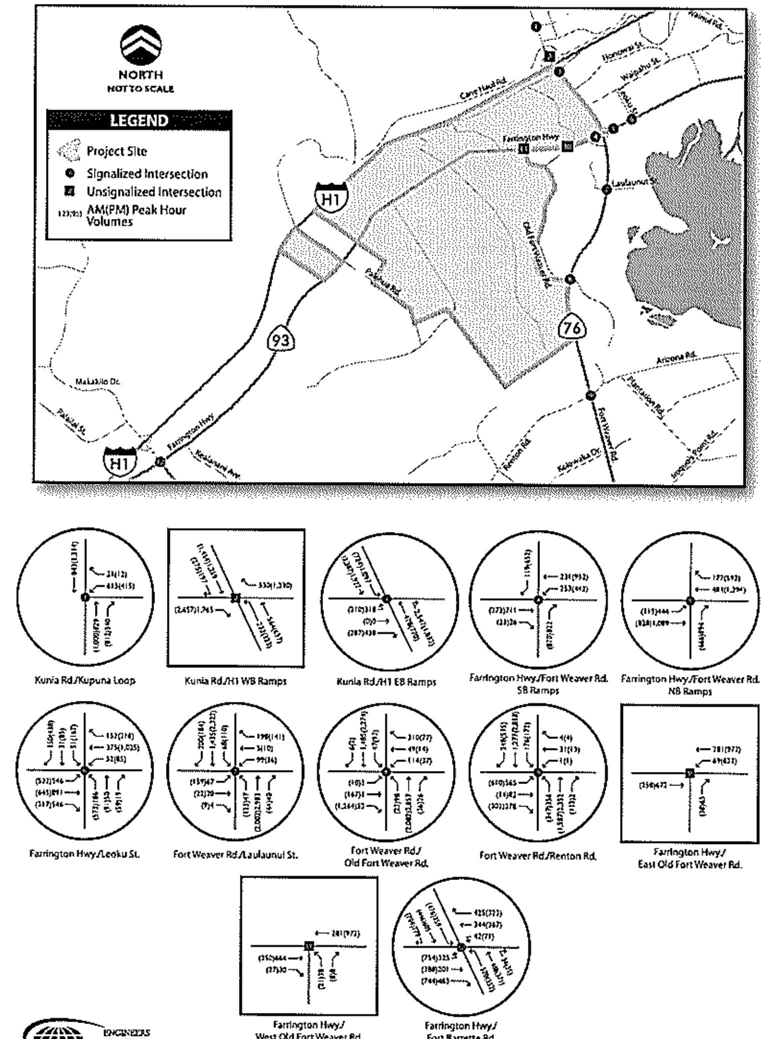

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Figure 2-3
PEAK HOUR INTERSECTION VOLUMES - EXISTING CONDITIONS
100061/BASE - 12/19/06

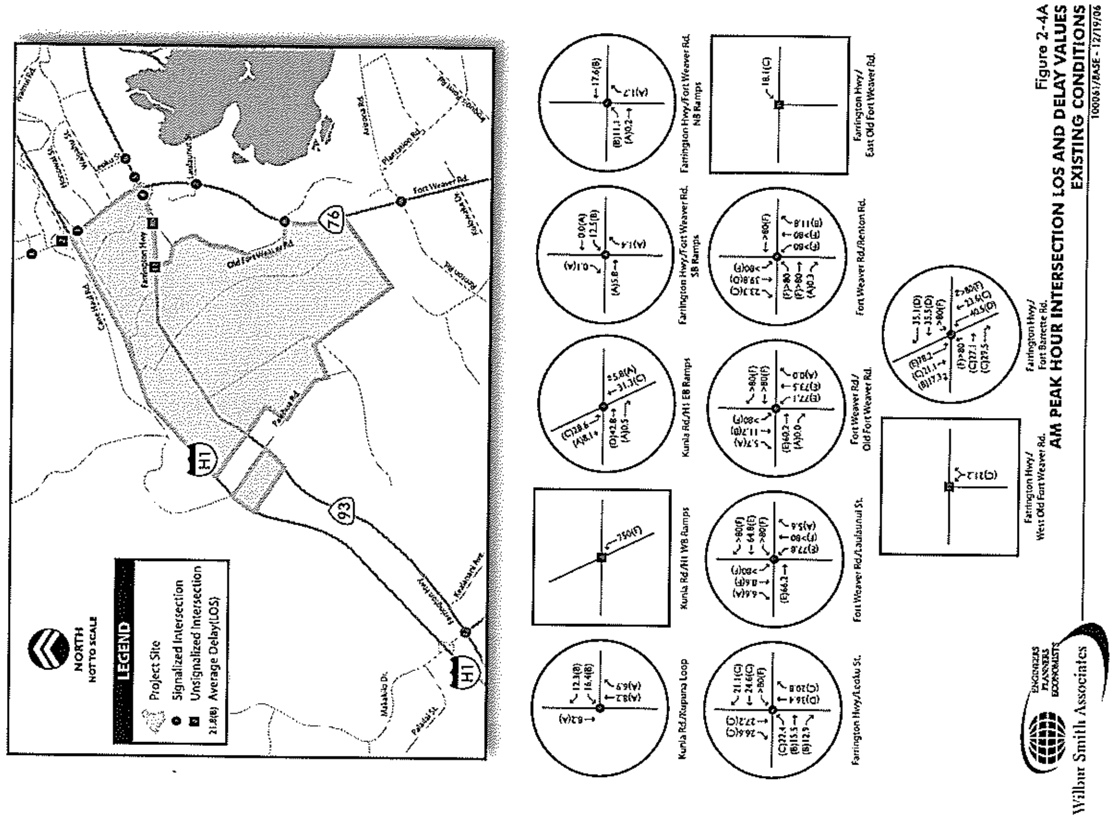


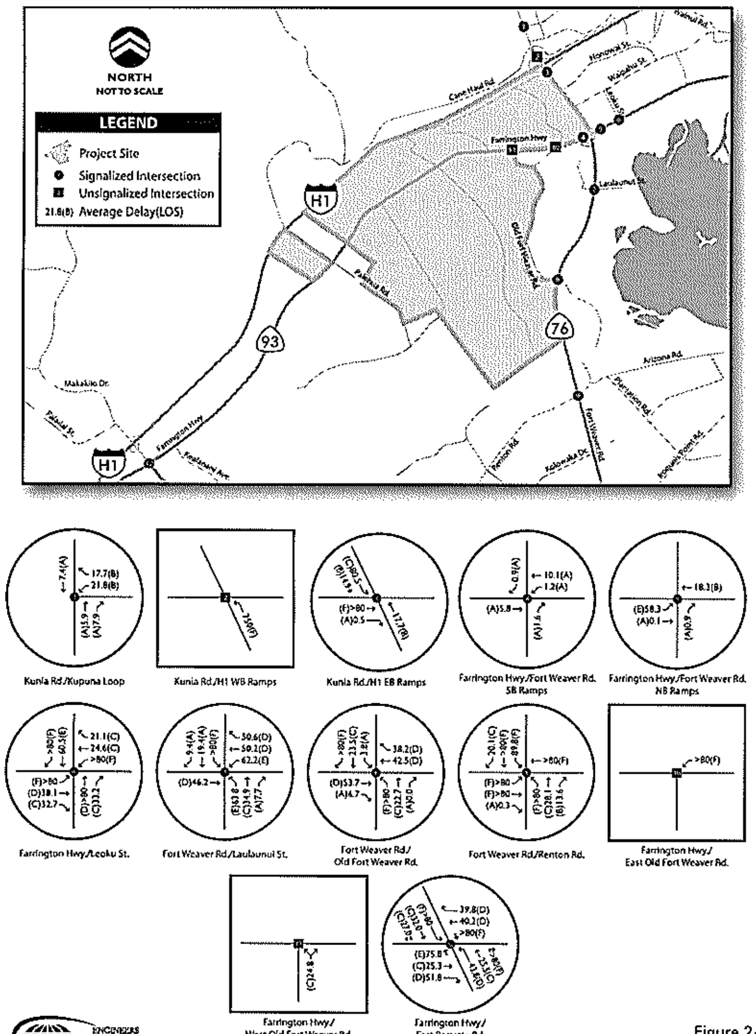
Figure 2-4A
AM PEAK HOUR INTERSECTION LOS AND DELAY VALUES
EXISTING CONDITIONS
100061/BASE - 12/19/06

Table 2.6
Peak Hour Intersection Operations – Existing Conditions

#	Intersection	Control	AM Delay	AM V/C Ratio	AM LOS	PM Delay	PM V/C Ratio	PM LOS
1	Kunia Rd / Kunia Loop	Signal	10.0	0.54	A	8.8	0.62	A
2	Kunia Rd / H-1 WB On-Ramp	TWSC	**723.3 (WB)**	**2.40 (WB)**	**F**	**>1000 (WB)**	**6.30 (WB)**	**F**
3	Kunia Rd / H-1 EB Ramps	Signal	17.8	0.78	B	19.2	0.95	B
4	Farrington Hwy / Fort Weaver Rd. SB Ramps	Signal	4.0	0.55	A	2.4	0.59	A
5	Farrington Hwy / Fort Weaver Rd. NB Ramps	Signal	5.9	0.60	A	14.6	0.95	B
6	Farrington Hwy / Leokū St	Signal	21.9	0.61	C	**108.1**	**1.18**	**F**
7	Fort Weaver Rd / Laulaunui St	Signal	**101.9**	**1.19**	**F**	29.8	0.86	C
8	Fort Weaver Rd / Old Fort Weaver Rd	Signal	**63.0**	**1.12**	**E**	22.8	0.92	C
9	Fort Weaver Rd / Renton Rd	Signal	**98.7**	**1.19**	**F**	**161.5**	**1.40**	**F**
10	Farrington Hwy / East Old Fort Weaver Rd	TWSC	18.1 (SWB)	0.21 (SWB)	C	**89.1 (SWB)**	**1.09 (SWB)**	**F**
11	Farrington Hwy / West Old Fort Weaver Rd	TWSC	21.2 (NB)	0.18 (NB)	C	24.8 (NB)	0.15 (NB)	C
12	Farrington Hwy / Fort Barrette Rd	Signal	**56.4**	**0.99**	**E**	**56.9**	**1.01**	**E**

Source: Wilbur Smith Associates, 2007

NOTES:
AWSC – All-way Stop Control
TWSC – Two-way Stop Control
Signal – Traffic Signal
Delay presented in seconds per vehicle.
Delay and LOS presented for worst approach for two-way stop controlled intersections.
Bold type indicates unacceptable values.



Wilbur Smith Associates

Figure 2-4B
PM PEAK HOUR INTERSECTION LOS AND DELAY VALUES
EXISTING CONDITIONS
100061/BASE - 12/19/06

2.7.2 Existing Freeway Segment Operating Conditions

Roadway and traffic control information was obtained through field reconnaissance by Wilbur Smith Associates (WSA) during April 2006. The roadway inventory included those items needed to estimate roadway capacities specifically, number and width of lanes, shoulder conditions, types of traffic controls, and traffic signal phasing and timing. Peak hour freeway segment volumes were obtained from the 24-Hour Traffic Count Station Summaries of the State of Hawaii, Department of Transportation.

The existing mainline freeway characteristics including number of lanes, volumes and posted speed limits were used to calculate the levels of service for each of the 10 existing freeway segments during each peak hour. The results of the existing freeway segment analysis using *Highway Capacity Software* (HCS), which is developed following the method described in the 2000 *Highway Capacity Manual* (HCM) are presented in Table 2.7 and the calculation worksheets are included in Appendix B-1.

Under AM peak hour conditions, 9 freeway segments operate under acceptable conditions (LOS D or better), while one (1) of the freeway segment, H-1 Eastbound (west of Pāiwa Street) operates under unacceptable conditions, LOS E.

Under PM peak hour conditions, eight of the 10 study freeway segments operate under acceptable conditions (LOS D or better), while the remaining two freeway segments H-1 Westbound (west of Pāiwa Street) and H-1 Westbound (east of Kamehameha Highway) operate under unacceptable conditions (LOS E or worse).

Figure 2-5 presents the existing freeway operating conditions.

Table 2.7
Peak Hour Freeway Segment Operations – Existing Conditions

#	Freeway	Segment	AM Peak			PM Peak		
			Volume	Density	LOS	Volume	Density	LOS
1	H-1 EB	S/O Makakilo Dr.	1582	10.6	A	1762	11.8	B
2	H-1 EB	W/O Kunia Rd.	3808	25.5	C	4077	27.3	D
3	H-1 EB	W/O Pāiwa St.	7067	35.7	E	4446	21.7	C
4	H-1 EB	E/O Kamehameha Hwy.	4468	28.4	D	2652	17.7	B
5	H-2 NB	At Ka Uka Blvd.	1777	11.9	B	3196	21.4	C
6	H-1 WB	S/O Makakilo Dr.	1482	9.9	A	2223	14.9	B
7	H-1 WB	W/O Kunia Rd.	3331	22.3	C	4079	25.1	C
8	H-1 WB	W/O Pāiwa St.	4366	21.3	C	7425	38.6	E
9	H-1 WB	E/O Kamehameha Hwy.	3069	20.5	C	5824	42.8	E
10	H-2 SB	At Ka Uka Blvd.	4078	27.3	D	2534	16.9	B

Source: Wilbur Smith Associates, 2007

NOTES:
Density is given in pc/mi/ln

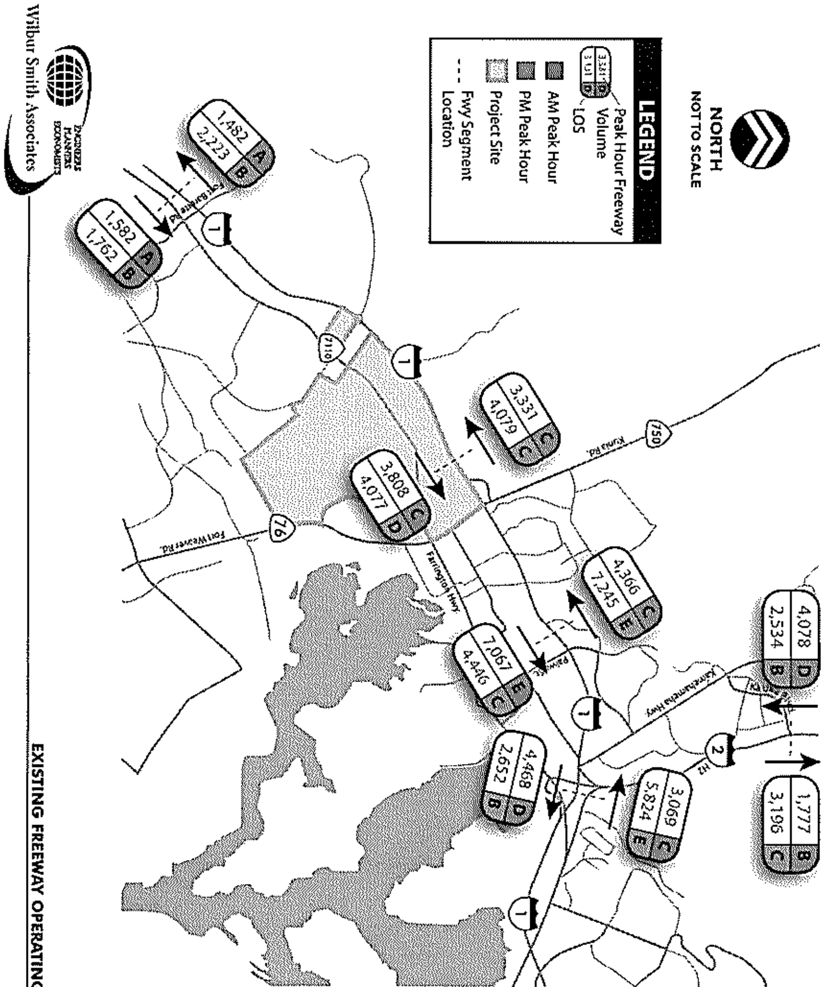


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Figure 2-5
EXISTING FREEWAY OPERATING CONDITIONS
100061/BASE - 12/20/06

2.7.3 Existing Ramp-Freeway Junction Operating Conditions

Similar to freeway segments, *HCS* software was used to analyze the ramp-freeway junctions. Table 2.8 exhibits the operating conditions of the existing ramp-freeway junctions; the calculation worksheets are included in Appendix C-1.

Under existing conditions, eastbound on-ramp at H-1/ Fort Weaver Road has three lanes. It should be noted that *HCS* software has a limitation in that it can only analyze up to a maximum of two lanes per ramp. Therefore, the LOS and density values of ramp-freeway junction H-1/ Fort Weaver Road (Eastbound On-Ramp) could not be determined.

Under existing AM peak hour conditions, four ramp-freeway junctions operate at LOS C or better (acceptable conditions).

Under PM peak hour conditions, two ramp-freeway junctions H-1/ Fort Weaver Road (Westbound Of-Ramp) and H-1/ Fort Weaver Road (Westbound Loop Off-Ramp) operate at LOS F. The remaining two ramp-freeway junctions operate under acceptable conditions.

Table 2.8
Ramp-Freeway Junction Operations – Existing Conditions

#	Location	Ramps	Peak Hour	Density	LOS
1	H-1/ Fort Weaver Road	WB Off-Ramp	AM Peak	31.1	D
2	H-1/ Fort Weaver Road	WB Loop Off-Ramp	AM Peak	20.1	C
3	H-1/ Fort Weaver Road	WB On-Ramp	AM Peak	20.7	C
4	H-1/ Fort Weaver Road	EB Off-Ramp	AM Peak	24.9	C
5	H-1/ Fort Weaver Road	EB On-Ramp	AM Peak	N.D.	N.D.
6	H-1/ Fort Weaver Road	WB Off-Ramp	PM Peak	DEC	F
7	H-1/ Fort Weaver Road	WB Loop Off-Ramp	PM Peak	DEC	F
8	H-1/ Fort Weaver Road	WB On-Ramp	PM Peak	25.1	C
9	H-1/ Fort Weaver Road	EB Off-Ramp	PM Peak	25.8	C
10	H-1/ Fort Weaver Road	EB On-Ramp	PM Peak	N.D.	N.D.

Source: Wilbur Smith Associates, 2007

NOTES:
DEC – Demand Exceeds Capacity
N.D. – Could not be determined
Density is presented in pc/mi/ln.
Bold type indicates LOS F.

Chapter 3
2030 BASELINE CONDITIONS

This chapter discusses the methodology involved in the development of 2030 Baseline Conditions (without the proposed project) traffic volumes, and the operations of the study intersections. These conditions form the basis against which transportation impacts related to the proposed project will be identified.

Year 2030 represents the full buildout year of the Ho'opili Project, with all phases of the proposed project expected to be completed. As such, year 2030 has been selected as the future year of analysis to identify the operating conditions of the transportation network located in the vicinity of the proposed project under with and without Project conditions.

3.1 YEAR 2030 TRANSPORTATION SYSTEM IMPROVEMENTS

This section documents the planned transportation and circulation system improvements currently identified and approved by the Oahu Metropolitan Planning Organization (OMPO). The Oahu Regional Transportation Plan (ORTP) 2030 identifies a number of improvements to existing regional roadways and the construction of new facilities. In addition, some improvements are identified in the ongoing 'Ewa Connectivity study. The regional circulation improvements in the vicinity of the study area are located along the following corridors:

- H-1 Freeway
- Farrington Highway
- Fort Barrette Road
- Fort Weaver Road
- East-West Connector Road
- Kapolei Parkway
- Kunia Road
- Makakilo Drive
- North-South Road

Table 3.1 describes the planned and approved transportation improvement projects that are located in the vicinity of the study area. The corridors planned to be improved, the locations along the corridor, and the programmed improvements at those locations are summarized in Table 3.1.

3.2 STUDY AREA – 2030 BASELINE CONDITIONS

Due to the planned improvement of existing transportation network near the project site, the study area would include the new intersections located along North-South Road under 2030 Baseline Conditions. The following seven new intersections would be studied under Year 2030 Conditions in addition to the 12 study intersections analyzed under Existing Conditions:

- North-South Road/ H-1 Westbound Ramps
- North-South Road/ H-1 Eastbound Ramps
- North-South Road/ Farrington Highway
- North-South Road/ North University of Hawai'i Connector

- North-South Road/ South University of Hawai'i Connector
- North-South Road/ Kapolei Parkway
- East-West Road/ Old Fort Weaver Road

Figure 3-1 depicts the locations of the study intersections for 2030 Baseline Conditions, while Figures 3-2A and 3-2B presents the Year 2030 lane configurations of the study intersections.

The three unsignalized intersections -- Kunia Road/ H-1 Westbound On-Ramp, Farrington Highway/ East Old Fort Weaver Road, and Farrington Highway/ West Old Fort Weaver Road – were analyzed to assess whether installation of traffic signal controls would be appropriate under Year 2030 Conditions. The Peak Hour traffic signal analysis (MUTCD Warrant #3) for the unsignalized study intersections indicated that the forecast conditions at the intersection of Kunia Road with the H-1 Westbound On-Ramp would satisfy the signal warrant analysis. As such, for analysis purposes the intersection of Kunia Road/ H-1 Westbound On-Ramp has been considered as a signalized intersection under Year 2030 Conditions. Traffic signal warrant analysis sheets for Year 2030 Conditions are included in Appendix D-1.

Therefore, Year 2030 Conditions encompass 19 study intersections, of which 17 intersections are signalized and two are two-way stop-controlled intersections. The two unsignalized intersections are Farrington Highway/ East Old Fort Weaver Road and Farrington Highway/ West Old Fort Weaver Road.

The new interchange of the North-South Road with H-1 Freeway would be operational in year 2030. Therefore, under Year 2030 Conditions, the following four additional ramp-freeway junctions would be analyzed along with the five study ramp-freeway junctions studied under Existing Conditions:

- North-South Road/ H-1 (Eastbound On-Ramp)
- North-South Road/ H-1 (Eastbound Off-Ramp)
- North-South Road/ H-1 (Westbound On-Ramp)
- North-South Road/ H-1 (Westbound Off-Ramp)

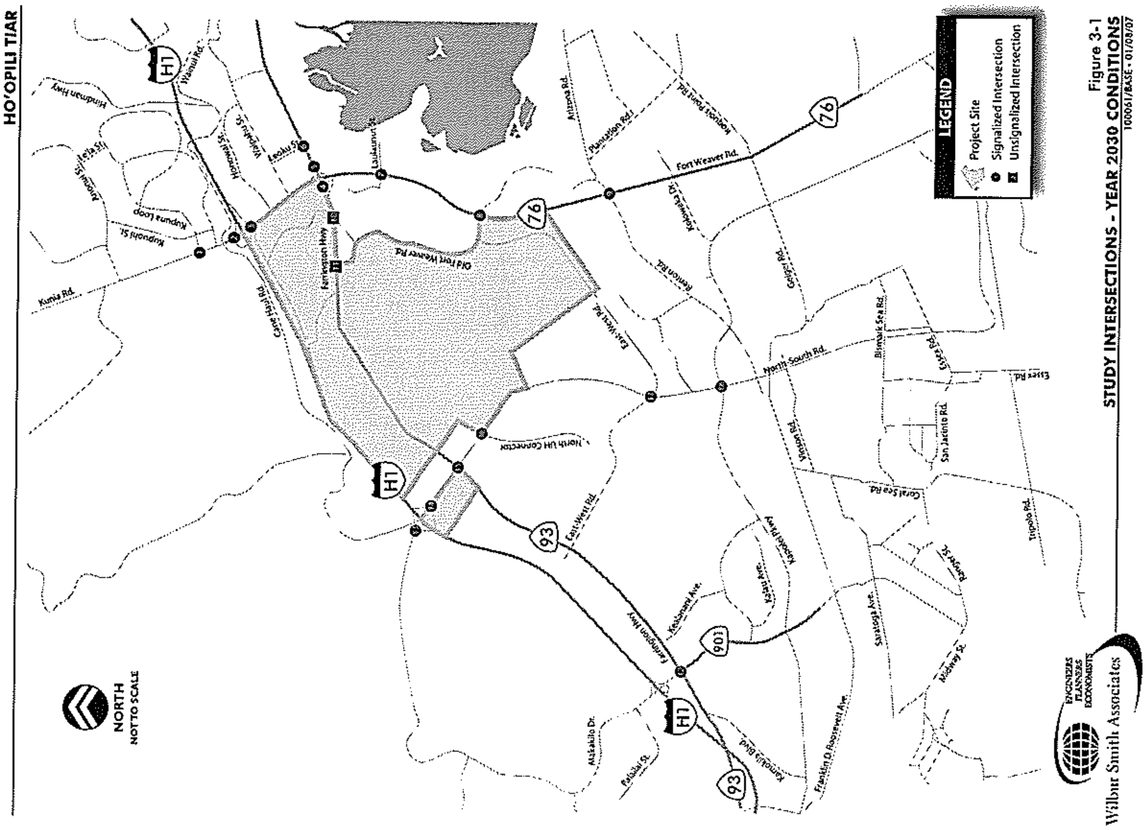

Figure 3-1
STUDY INTERSECTIONS - YEAR 2030 CONDITIONS
100061/BASE - 01/08/07

Table 3.1
Planned and Approved Transportation Network Improvement Projects

#	Roadway	Location	Proposed Improvement
1	H-1 Freeway	Ke'ehi Interchange – Kunia Interchange	Construct WB zipper lane for PM peak period
		City of Kapolei	Construct a new interchange between Pālailai and Makakilo Interchanges
		Makakilo Interchange	Construct a new EB off-ramp and a new WB on-ramp
		Waiawa Interchange – Makakilo Interchange	Construct 1 HOV lane in each direction
		Waiawa Interchange – Paiwa Interchange	Widen H-1 WB from 2 to 3 lanes in AM peak, from 4 to 5 lanes in PM peak
2	Farrington Hwy.	Kapolei.Golf Course Rd. – W/O Fort Weaver Rd.	Widen from 2 to 4 lanes
		W/O Fort Weaver Rd. – Waiawa Interchange	Widen by 1 lane in each direction
3	Fort Barrette Rd.	Farrington Hwy. – Franklin D Roosevelt Ave.	Widen from 2 to 4 lanes
4	Fort Weaver Rd.	Farrington Hwy. – Geiger Rd.	Widen from 4 to 6 lanes
5	Kapolei Pkwy.	Kamokila Blvd. – Fort Barrette Rd.	Construct 6-lane parkway extension
		'Ewa Village Boundary – Renton Rd.	Construct 6-lane parkway extension
		Geiger Rd. – Papipi Rd.	Construct 4-lane parkway extension
		Ali'inui Dr. – Hanua St.	Construct 4-lane parkway extension
		Hānu'a St. – Kalaeloa Blvd.	Construct 6 lane parkway extension
6	Kunia Rd.	Anonui St. – Kupuna Loop	Widen from 2 to 4 lanes
		Kupuna Loop – Farrington Hwy.	Widen from 4 to 6 lanes
		Intersection Kunia Rd./ H-1 EB Ramps	Add 1 lane EB loop on-ramp
7	Makakilo Dr.	Makakilo Dr. – North South Rd.	Extend Makakilo Dr. south to H-1 Freeway as 4-lane roadway
8	North-South Rd.	Kapolei Pkwy. – Interstate Route H-1	Widen from 3 to 6 lines
		Kapolei Pkwy. – Franklin D Roosevelt Ave.	Construct 6-lane extension
9.	East-West Rd	North-South Road – Old Fort Weaver Rd	Construct new road

Source: Oahu Regional Transportation Plan 2030 & on-going EWA Roadway Connectivity Study

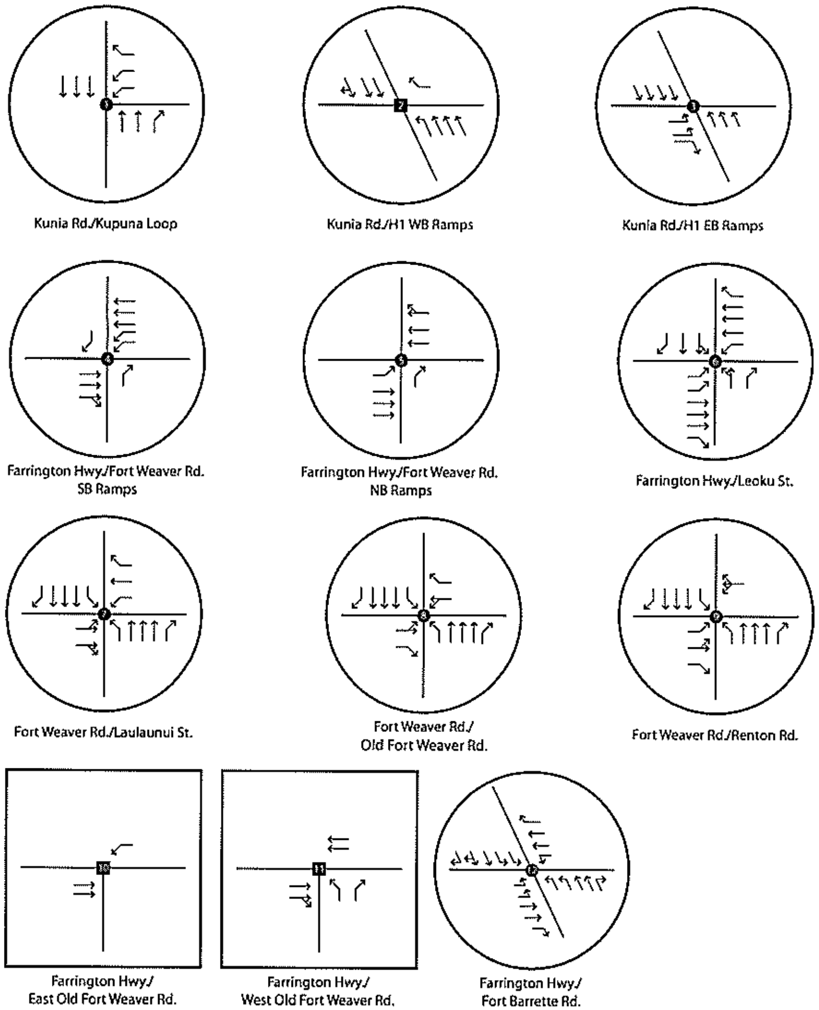

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Figure 3-2A
INTERSECTION GEOMETRIC CONFIGURATIONS
YEAR 2030 (NO PROJECT) CONDITIONS
100061/DEC 2007-12/10/07

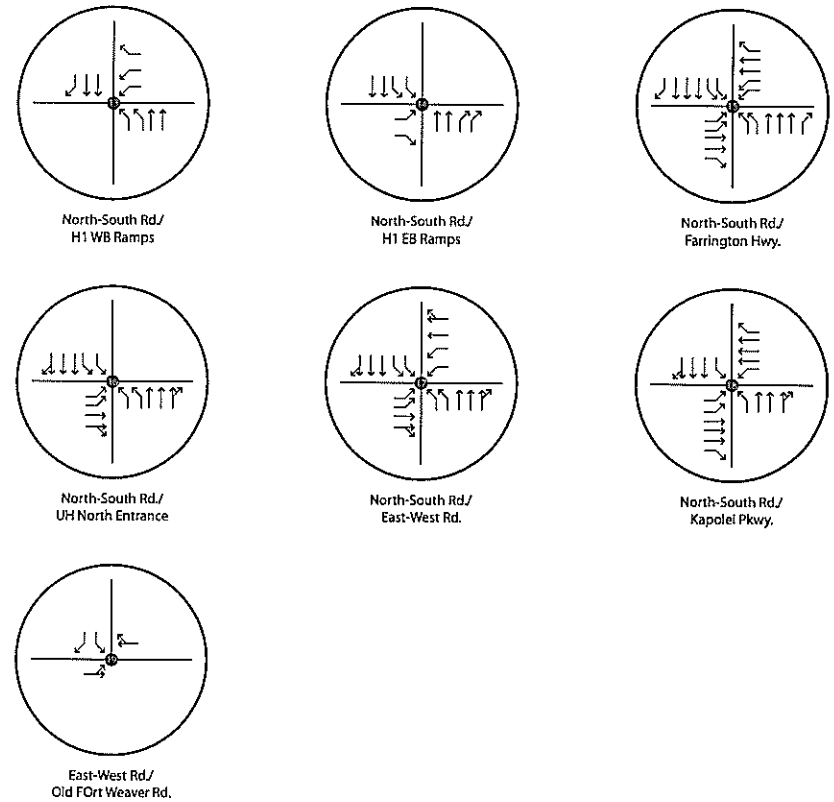

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Figure 3-2B
INTERSECTION GEOMETRIC CONFIGURATIONS
YEAR 2030 (NO PROJECT) CONDITIONS
100061/DEC 2007-12/10/07

3.3 2030 BASELINE CONDITIONS TRAFFIC ESTIMATE

Traffic volumes under Year 2030 Conditions were estimated based on the forecasts provided by the Year 2030 Oahu Metropolitan Planning Organization (OMPO) Transportation Model. Appendix E-1 presents the land use assumptions contained in the OMPO Model. This approach results in a cumulative impact assessment for future conditions and takes into account any anticipated developments expected by year 2030 near the project, plus the expected growth in housing and employment for the remainder of the region.

The OMPO Model study area is divided into 23 districts. The most recent version of the OMPO Model estimates future travel demand for the entire O'ahu region based on the UrbanSim modeling forecasts for year 2030.

Within the OMPO model, the entire study area covering the O'ahu region is divided into approximately 763 geographic areas, known as Transportation Analysis Zones (TAZs). For each TAZ, the model estimates the travel demand based on the population and employment assumptions, determines the origin, destination, and mode of travel for each trip and assigns those trips to the transportation network. This model output was used to determine the traffic volumes at the study intersections and the freeway segments for year 2030.

Since the OMPO model was developed as a tool to forecast future traffic volumes on major regional traffic facilities and on major local streets, post-processing of the model output was conducted to identify future intersection turning movement volumes. The AM and PM peak hour roadway segment volumes for each of the approaches of the intersections under year 2030 conditions as predicted by the OMPO Transportation Model were utilized to calculate the turning movement volumes for year 2030. These Year 2030 intersection turning movement volumes were developed using 'Furness' process. The 'Furness' process used by WSA is in accordance with *NCHRP 255: Highway Traffic Data for Urbanized Area Project Planning & Design (Chapter 8)*. This process involves balancing the intersection volumes using an iterative process to compare them to the existing traffic distribution. The iterative process seeks to balance the total inbound and outbound volumes from each approach as projected by the transportation model.

Figures 3-3A, 3-3B, and 3-3C depict the Year 2030 peak hour intersection turning movement volumes as developed using the methodology described in the preceding paragraphs.

The traffic study conducted for the University of Hawai'i West Oahu campus indicates that several major roadways also considered part of the proposed project would be improved by 2009 and 2025. The following improvements would take place by year 2009: H-1 Freeway and Farrington Highway are assumed to be widened, and a new North-South Road, interchange at H-1 Freeway and connection to the completed Kapolei Parkway are anticipated. Based on the 2030 O'ahu Regional Transportation Plan (ORTP), the high-occupancy vehicle (HOV) lanes on H-1 Freeway are planned to be extended from Waiawa Interchange (H-1/H-2 Merge) to the Makakilo Interchange.

Note that both the State of Hawai'i Department of Transportation (HDOT) and the City and County of Honolulu were consulted on the potential timing of these projects. Road improvements anticipated by Year 2025 include the widening of Fort Barrette Road and Forth Weaver Road, additional roadways proposed by Ho'opili and East Kapolei I and the completion of the East-West Connector Road between Farrington Highway and Fort Weaver Road. As such, these improvements were assumed to be in place under Year 2030 conditions.

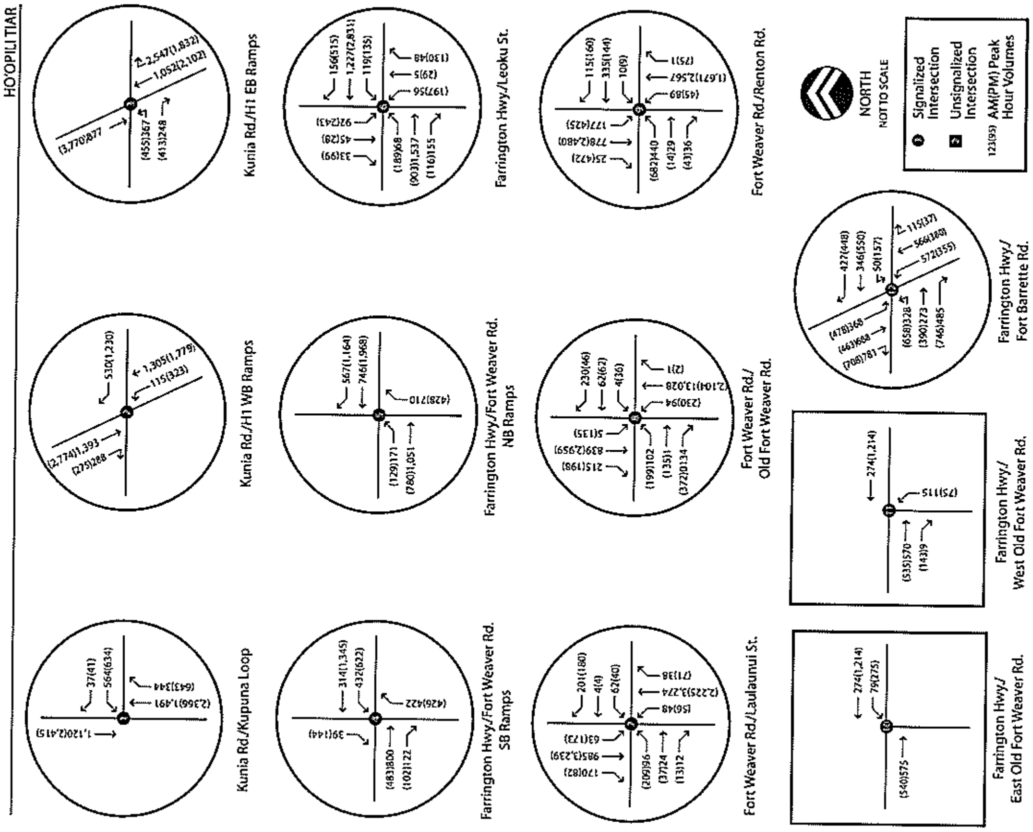

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Figure 3-3B
PEAK HOUR INTERSECTION VOLUMES
YEAR 2030 (NO PROJECT) CONDITIONS

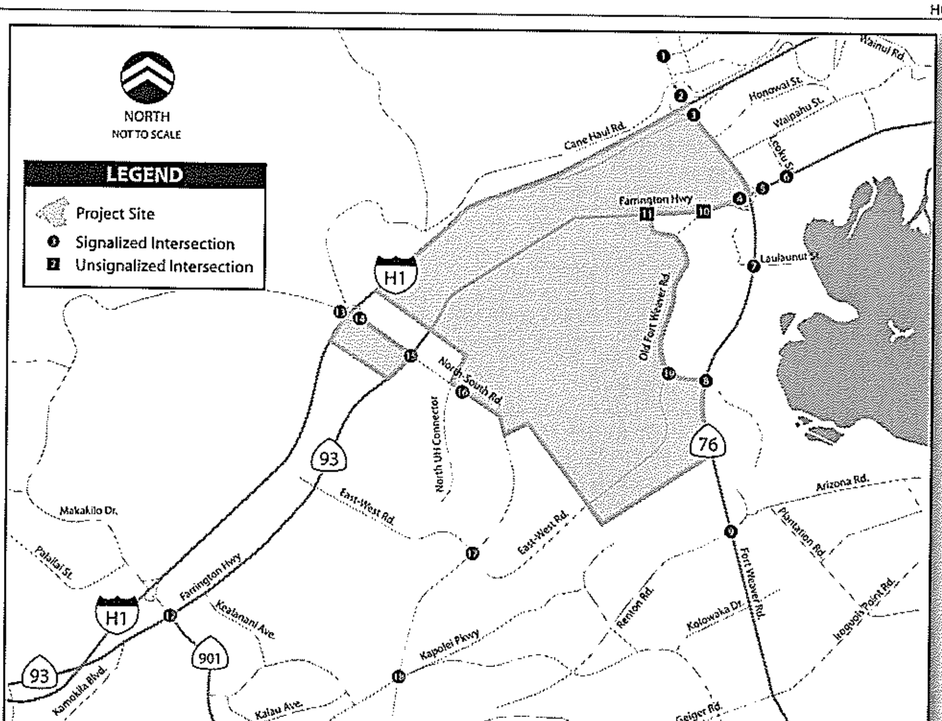

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Figure 3-3A
PEAK HOUR INTERSECTION VOLUMES
YEAR 2030 (NO PROJECT) CONDITIONS
100061/Draft October/Figure 3-3A map - 10/17/07

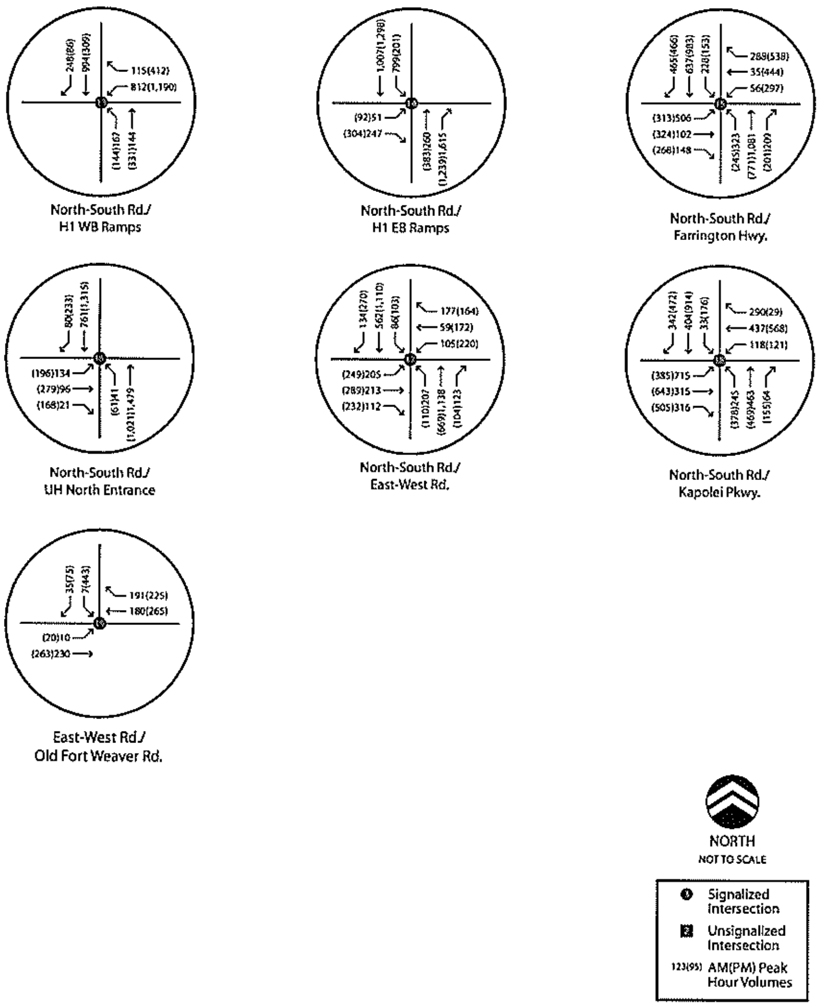

Figure 3-3C
PEAK HOUR INTERSECTION VOLUMES
YEAR 2030 (NO PROJECT) CONDITIONS
100061/DEC 2007-12/10/07

3.4 2030 BASELINE INTERSECTION OPERATING CONDITIONS

Using the volumes presented in Figure 3-3 and with the proposed improvement plans in Year 2030 as discussed in *Section 3.2*, the traffic conditions at the study intersections were calculated for the Year 2030 Baseline AM and PM peak hours. Table 3.2 presents the Year 2030 Baseline delays and LOS values of the study intersections, while the intersection analysis worksheets are included in Appendix A-2.

During the Year 2030 AM peak hour, 17 of the 19 study intersections would operate under acceptable conditions (LOS D or better). The two study intersections that would operate under unacceptable conditions (LOS E or worse) are:

- Fort Weaver Road/ Renton Road
- Farrington Highway/ Fort Barrette Road

During Year 2030 PM peak period, the study intersections would operate at LOS D or better with the exception of the following three intersections:

- Fort Weaver Road/ Renton Road
- Farrington Highway/ West Old Fort Weaver Road
- Farrington Highway/ Fort Barrette Road

The intersection at Farrington Highway/ West Old Fort Weaver Road would operate at LOS F, while the other two intersections would operate at LOS E.

Figures 3-4A1, 3-4A2, and 3-4A3; 3-4B1, 3-4B2, and 3-4BC exhibit the LOS and delay values for each of the turning movements at the study intersections during the AM and PM Peak Hour, respectively.

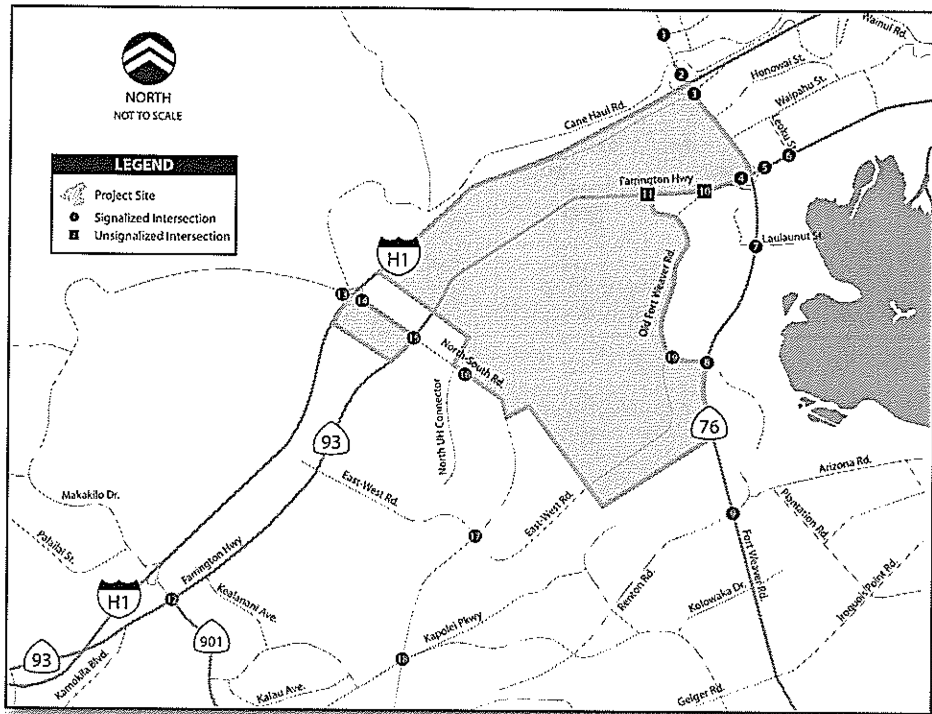

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Figure 3-4A1
AM PEAK HOUR LOS AND DELAY VALUES
YEAR 2030 (NO PROJECT) CONDITIONS
100061/Draft October/Figure 3-4A map - 10/17/07

Table 3.2
Peak Hour Intersection Operations – Year 2030 Conditions

#	Intersection	Control	Year 2030					
			AM Peak			PM Peak		
			Delay	V/C Ratio	LOS	Delay	V/C Ratio	LOS
1	Kunia Rd./ Kunia Loop	Signal	12.8	0.70	B	17.1	0.90	B
2	Kunia Rd./ H-1 WB On-Ramp[A]	Signal	3.3	0.47	A	14.1	0.92	B
3	Kunia Rd./ H-1 EB Ramps	Signal	8.9	0.37	A	8.8	0.85	A
4	Farrington Hwy./ Fort Weaver Rd. SB Ramps	Signal	5.2	0.41	A	14.0	0.42	B
5	Farrington Hwy./ Fort Weaver Rd. NB Ramps	Signal	3.0	0.48	A	8.0	0.83	A
6	Farrington Hwy./ Leokū St.	Signal	18.0	0.63	B	47.7	0.88	D
7	Fort Weaver Rd./ Laulaunui St.	Signal	29.8	0.90	C	26.3	0.89	C
8	Fort Weaver Rd./ Old Fort Weaver Rd.	Signal	16.7	0.89	B	45.0	1.03	D
9	Fort Weaver Rd./ Renton Rd.	Signal	**78.1**	**1.08**	**E**	**63.4**	**1.03**	**E**
10	Farrington Hwy./ East Old Fort Weaver Rd.	TWSC	16.4 (WB)	0.21 (WB)	C	32.0 (WB)	0.71 (WB)	D
11	Farrington Hwy./ West Old Fort Weaver Rd.	TWSC	22.0 (NB)	0.37 (NB)	C	**55.4 (NB)**	**0.55 (NB)**	**F**
12	Farrington Hwy./ Fort Barrette Rd.	Signal	62.7	0.77	**E**	67.5	0.88	E
13	North-South Rd./ H-1 WB Ramps	Signal	32.4	0.68	C	25.6	0.59	C
14	North-South Rd./ H-1 EB Ramps	Signal	38.1	0.74	D	15.7	0.62	B
15	North-South Rd./ Farrington Hwy.	Signal	35.2	0.61	D	35.8	0.76	D
16	North-South Rd./ North UH Connector	Signal	7.3	0.39	A	13.5	0.47	B
17	North-South Rd./ East-West Road	Signal	27.0	0.63	C	28.6	0.62	C
18	North-South Rd./ Kapolei Pkwy.	Signal	34.8	0.75	C	54.2	0.88	D
19	East-West Rd./ Old Fort Weaver Rd.	Signal	22.3	0.24	C	20.6	0.62	C

Source: Wilbur Smith Associates, 2007

NOTES:
A - This location is stop-controlled under existing conditions, but is signalized after meeting the traffic signal warrants under year 2030 conditions.
TWSC – Two-way Stop-Control
Signal – Traffic Signal
Delay represents average delay presented in seconds per vehicle.
Delay and LOS are presented for worst approach for two-way stop controlled intersections.
Bold type indicates LOS E or F.

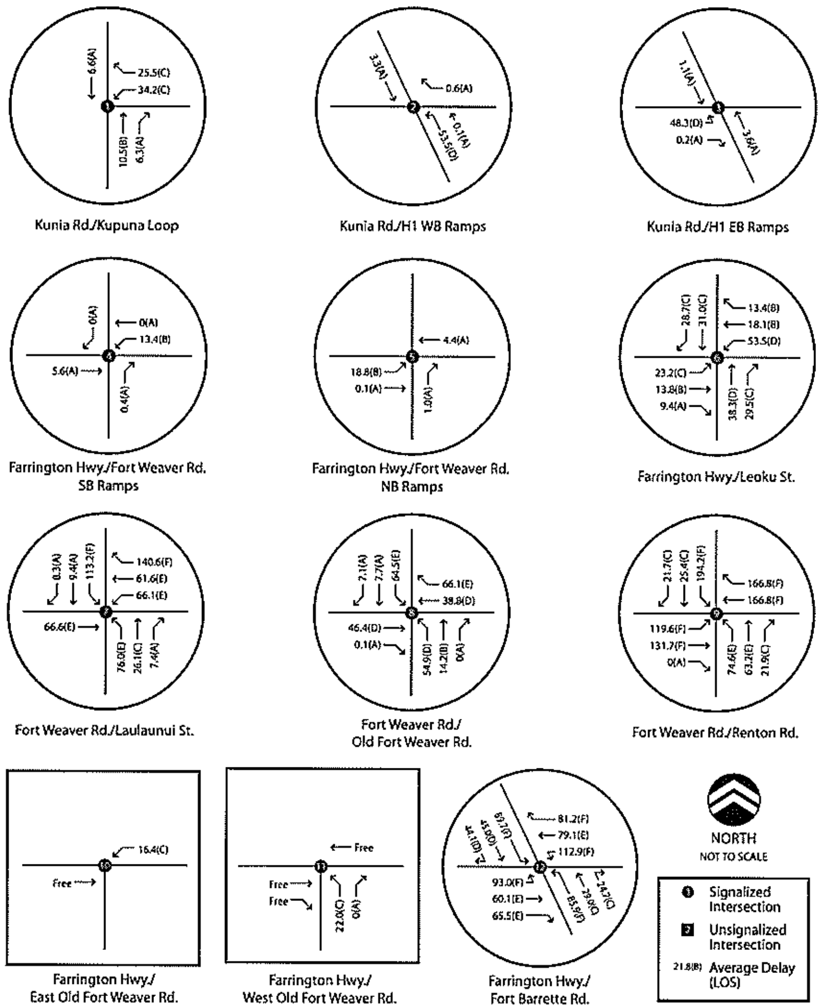

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Figure 3-4A2
AM PEAK HOUR LOS AND DELAY VALUES
YEAR 2030 (NO PROJECT) CONDITIONS

100061/DEC 2007-12/10/07

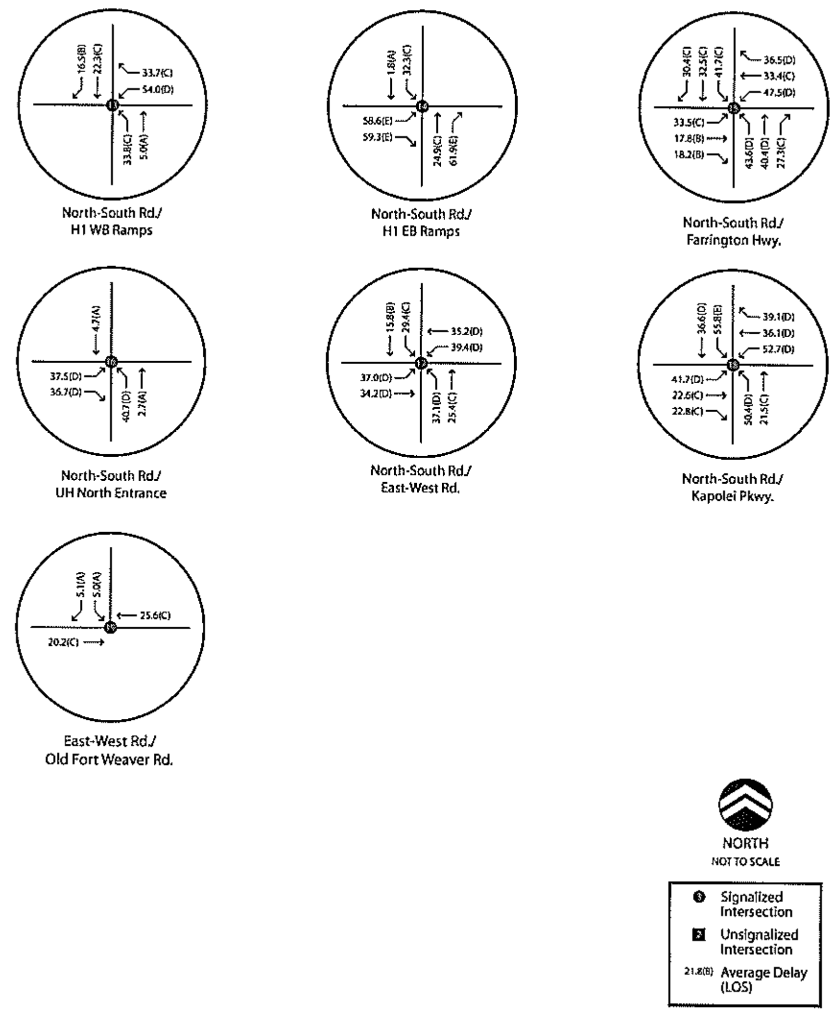

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Figure 3-4A3
AM PEAK HOUR LOS AND DELAY VALUES
YEAR 2030 (NO PROJECT) CONDITIONS

100061/DEC 2007-12/10/07

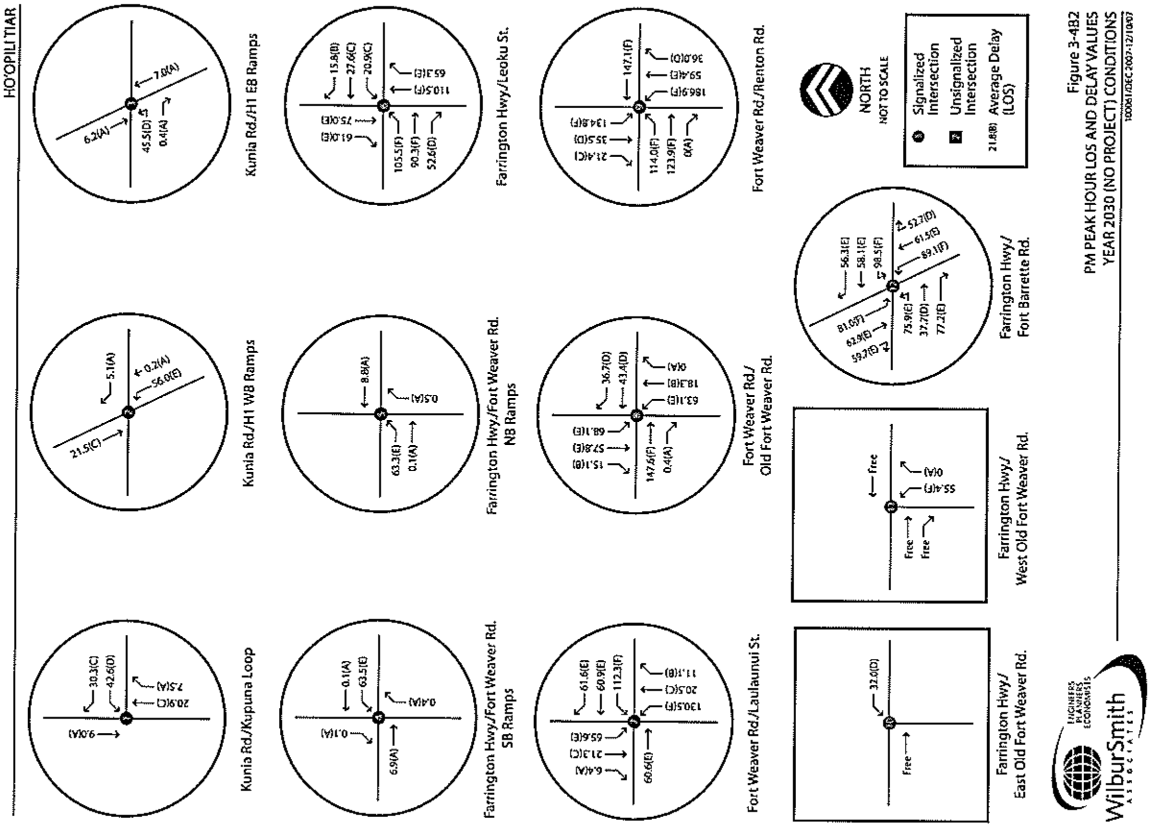

Figure 3-4B2
PM PEAK HOUR LOS AND DELAY VALUES
YEAR 2030 (NO PROJECT) CONDITIONS

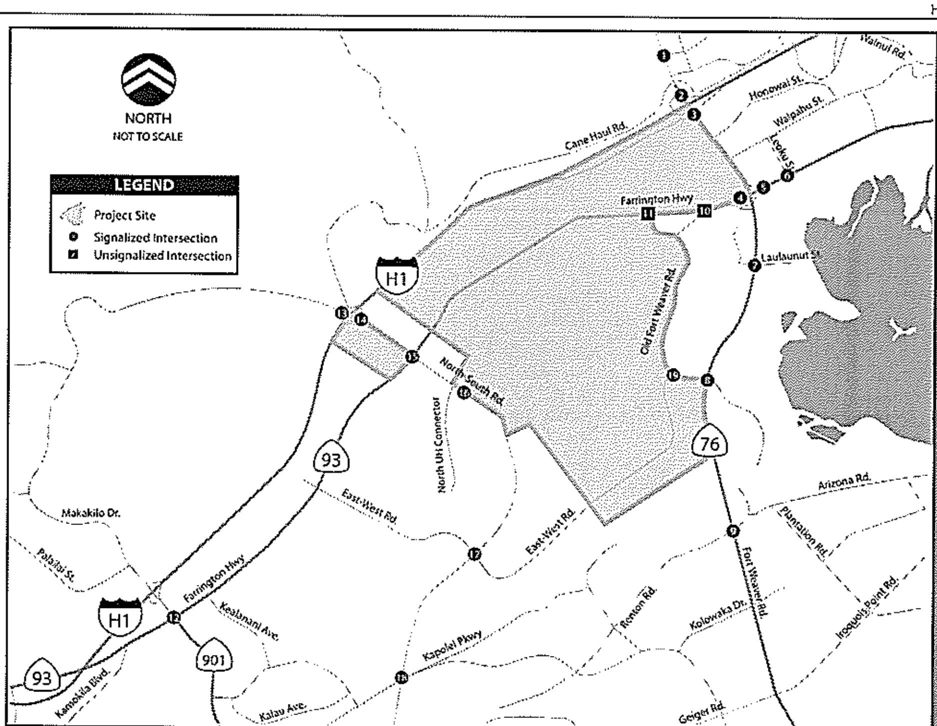

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Figure 3-4B1
PM PEAK HOUR LOS AND DELAY VALUES
YEAR 2030 (NO PROJECT) CONDITIONS
100061/Draft October/Figure 3-4A map - 10/17/07

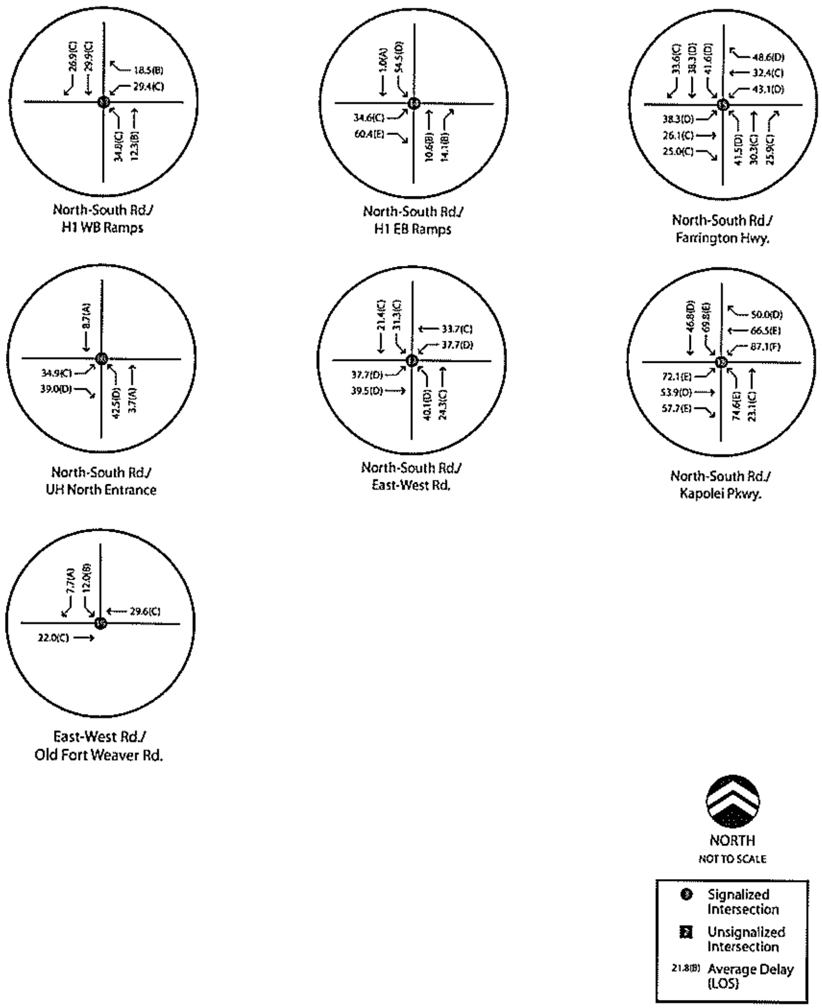

Figure 3-4B3
PM PEAK HOUR LOS AND DELAY VALUES
YEAR 2030 (NO PROJECT) CONDITIONS

3.5 FREEWAY SEGMENT OPERATING CONDITIONS

Table 3.3 presents the operating conditions of the study freeway segments for year 2030 AM and PM peak hours. During the Year 2030 AM peak hour, six of the 10 study freeway segments would operate under acceptable conditions (LOS D or better). Freeway segments that would operate under unacceptable conditions (LOS E or worse) are:

- H-1 Eastbound (south of Makakilo Drive) – LOS E
- H-1 Eastbound (west of Kunia Road) – LOS F
- H-1 Eastbound (west of Pāiwa Street) – LOS E
- H-1 Eastbound (east of Kamehameha Highway) – LOS E

Under Year 2030 PM peak hour conditions, the following four freeway segments would operate under unacceptable conditions:

- H-2 Northbound (at Ka Uka Boulevard) – LOS F
- H-1 Westbound (south of Makakilo Drive) – LOS F
- H-1 Westbound (west of Kunia Road) – LOS E
- H-1 Westbound (east of Kamehameha Highway) – LOS E

The other six freeway segments would operate at LOS D or better. Figure 3-5 exhibits the volumes and LOS values of the study freeway segments under Year 2030 Conditions.

Table 3.3
Peak Hour Freeway Segment Operations – Year 2030 Conditions

#	Freeway	Segment	AM Peak Volume	AM Peak Density[1]	AM Peak LOS	PM Peak Volume	PM Peak Density	PM Peak LOS
1	H-1 EB	S/O Makakilo Dr.	5434	**37.8**	**E**	4680	31.3	D
2	H-1 EB	W/O Kunia Rd.	8197	**>45**	**F**	5833	28.5	D
3	H-1 EB	W/O Pāiwa St.	9906	**43.4**	**E**	7137	27.2	D
4	H-1 EB	E/O Kamehameha Hwy.	7512	**38.8**	**E**	4249	28.4	D
5	H-2 NB	At Ka Uka Blvd.	3184	21.3	C	6220	**>45**	**F**
6	H-1 WB	S/O Makakilo Dr.	3259	21.8	C	6365	**>45**	**F**
7	H-1 WB	W/O Kunia Rd.	3735	18.3	C	7860	**43.3**	**E**
8	H-1 WB	W/O Pāiwa St.	4366	16.6	B	7931	25.2	C
9	H-1 WB	E/O Kamehameha Hwy.	3069	20.5	C	7766	**42.2**	**E**
10	H-2 SB	At Ka Uka Blvd.	6273	30.7	D	4616	22.5	C

Source: Wilbur Smith Associates, 2007

NOTES:
Density is given in pc/mi/ln.
Bold represents LOS E or F.
1 – Lower density does not necessarily indicate a lower LOS. This is because the LOS is calculated based upon a number of factors including: merge influence area, length of the acceleration lane, etc. See Appendix F for the HCM methodology used to calculate the LOS for Freeway Segments.

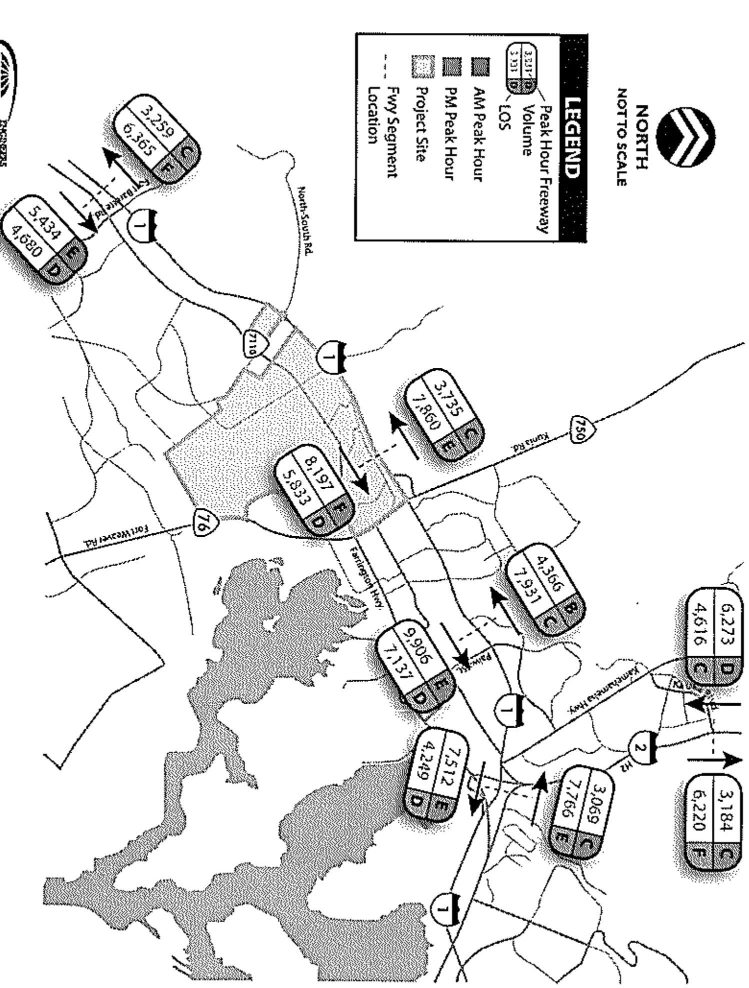

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Figure 3-5
YEAR 2030 (NO PROJECT) FREEWAY OPERATING CONDITIONS
100061/BASE - 12/20/06

3.6 RAMP-FREEWAY JUNCTION OPERATING CONDITIONS

Table 3.4 presents the operating conditions of the ramp-freeway junctions under Year 2030 Conditions (Future Conditions). The calculation worksheets are included in Appendix C-2.

Under Year 2030 AM peak hour conditions, seven of the 10 study ramp-freeway junctions would operate at LOS D or better (acceptable conditions). The three ramp-freeway junctions that would operate under unacceptable conditions are:

- H-1/ Fort Weaver Road (Eastbound Off-Ramp)
- H-1/ Fort Weaver Road (Eastbound On-Ramp)
- H-1/ Fort Weaver Road (Eastbound Loop On-Ramp)

Similar to AM peak hour, during PM peak hour, seven of the 10 study ramp-freeway junctions would operate under acceptable conditions (LOS D or better). The remaining three that would operate under unacceptable conditions (LOS E or worse) are: H-1/ Fort Weaver Road (Westbound Off-Ramp), H-1/ Fort Weaver Road (Westbound Loop Off-Ramp), and H-1/ North-South Road (Westbound Off-Ramp).

Table 3.4
Ramp-Freeway Junction Operations – Year 2030 Conditions

#	Location	Ramps	Peak Hour	Density	LOS
1	H-1/ Fort Weaver Road	WB Off-Ramp	AM Peak	16.0	B
2	H-1/ Fort Weaver Road	WB Loop Off-Ramp	AM Peak	1.3	A
3	H-1/ Fort Weaver Road	WB On-Ramp	AM Peak	15.0	B
4	H-1/ Fort Weaver Road	EB Off-Ramp	AM Peak	37.4	E
5	H-1/ Fort Weaver Road	EB On-Ramp	AM Peak	24.8	F
6	H-1/ Fort Weaver Road	EB Loop On-Ramp	AM Peak	26.3	F
7	H-1/ North-South Road	WB Off-Ramp	AM Peak	20.3	C
8	H-1/ North-South Road	WB On-Ramp	AM Peak	13.5	B
9	H-1/ North-South Road	EB Off-Ramp	AM Peak	25.0	C
10	H-1/ North-South Road	EB On-Ramp	AM Peak	28.8	D
11	H-1/ Fort Weaver Road	WB Off-Ramp	PM Peak	38.0	F
12	H-1/ Fort Weaver Road	WB Loop Off-Ramp	PM Peak	19.9	F
13	H-1/ Fort Weaver Road	WB On-Ramp	PM Peak	26.0	C
14	H-1/ Fort Weaver Road	EB Off-Ramp	PM Peak	28.8	D
15	H-1/ Fort Weaver Road	EB On-Ramp	PM Peak	18.3	B
16	H-1/ Fort Weaver Road	EB Loop On-Ramp	PM Peak	20.4	C
17	H-1/ North-South Road	WB Off-Ramp	PM Peak	41.1	F
18	H-1/ North-South Road	WB On-Ramp	PM Peak	27.7	C
19	H-1/ North-South Road	EB Off-Ramp	PM Peak	21.0	C
20	H-1/ North-South Road	EB On-Ramp	PM Peak	17.0	B

Source: Wilbur Smith Associates, 2007

NOTES:
DEC – Demand Exceeds Capacity
Density is presented in pc/mi/ln.
Bold type indicates LOS F.

Chapter 4
PROJECT TRAFFIC ESTIMATE

This chapter discusses the methodology and assumptions used to estimate the traffic characteristics of the proposed Project. The initial process involves the estimation of trips that would be generated by the proposed Project, and the distribution and assignment of these trips on the area roadways.

This chapter presents the generation distribution, and assignment (routing) of trips to/from the proposed project under the following two scenarios:

- **Scenario A: With Transit Corridor** – Under this scenario, it is assumed that the Honolulu High-Capacity Transit Corridor is constructed and would pass through the proposed Project site. The presence of transit corridor within the project site would affect the numbers of vehicle-trips generated by the proposed project land uses. The transit facility would attract an increased portion of the person-trips generated from the proposed Project; thus increasing the project-related transit trips and reducing the project-related vehicle trips. Thus a transit reduction factor was applied while developing the Project trip generation under this scenario;

  The proposed transit alignment would run diagonal in Ho'opili along the University of Hawai'i Road B, turn down North-South Road in the median, and stop at the Kroc Center in the North-South median. The median would follow the grasslined channel of the realigned Kaloi gultch. Two stops are proposed within Ho'opili, the exact locations of which are still being determined. It should be noted that increased ridership is likely to occur depending on the location of the stops, particularly based on the density of the area surrounding the stop.

- **Scenario B: Without Transit Corridor** – Under this scenario, it is assumed that the Honolulu High-Capacity Transit Corridor is either not constructed under the Year 2030 Conditions (Future Conditions) or is not passing through the proposed project site. In this scenario, no transit reduction factor was applied while developing the project trip generation.

The amount of traffic associated with a project is estimated using a three step process:

1. Trip generation
2. Trip distribution
3. Trip assignment

In the first step, the amount of traffic entering and exiting the Project land uses is estimated on a daily and peak hour basis. In the second step, the directions that vehicles use to approach and depart the project site are estimated. In the final step, the trips are assigned to specific street segments and intersection turning movements.

4.1 PROJECT TRIP GENERATION

This section discusses the methodology involved in the estimation of the project traffic and provides an estimate of the total number of inbound and outbound trips generated by the project during weekday AM and PM peak hours. The methodologies involved in the estimation of project trips are discussed in the following sub-sections. The approach for estimating the project trip generation is as follows:

1. Categorize project land uses into appropriate Institute of Transportation Engineers (ITE) Trip Generation or San Diego Council of Governments (SANDAG) or URBEMIS Categories
2. Identify trip generation rates and/or trip generation equations
3. Apply trip generation reductions
4. Calculate Final Trip Generation

The trip generation model for the project includes adjustments for internal project trips, as well as reductions resulting from the mixed uses and transit oriented development components. Trip Generation rates are reported in Tables 4.1 and 4.2 for Scenario A: With Transit Corridor Scenario and Scenario B: Without Transit Corridor Scenario, respectively.

It should be noted that for those land uses where an equation is applied to calculate the project trip generation, the trip generation rate represents the calculated rate based on the results of the equation. For those uses when a trip generation rate is applied, the ITE based trip generation rate or the SANDAG based trip generation is reported

Using the information provided above, the proposed project under "With Transit Scenario Corridor" is estimated to generate 140,920 daily trips, 7,069 morning peak hour trips (3,183 inbound and 3,886 outbound), and 12,077 evening peak hour trips (6,122 inbound and 5,955 outbound).

Under "Without Transit Corridor Scenario", the proposed project is estimated to generate 158,669 daily trips, 9,172 morning peak hour trips (4,167 inbound and 4,996 outbound), and 13,776 evening peak hour trips (6,970 inbound and 6,806 outbound).

4.1.1 ITE Trip Generation

This calculation involved using Institute of Transportation Engineers (ITE) *Trip Generation, 7th Edition* handbook to evaluate the total traffic generated by the proposed project. The trip generation rates and equations provided in the *ITE Trip Generation, 7th Edition* handbook for the various land uses present in the proposed project were used to calculate the trips generated/attracted by each of the components of the project. For certain land uses, the ITE trip generation rates might not be appropriate to use in this study. The trip generation rates provided by San Diego Association of Governments (SANDAG)[1] were used for identifying the trip generation for the following land uses:

[1]San Diego Traffic Generators, April 2002, San Diego Association of Governments

- Specialty Retail Center
- Regional Park
- Multi-Purpose Recreational Facility

An appropriate ITE category was applied to each of the proposed land uses within the project site. The following section explains each trip generation rate applied for each land use.

Retail Uses: The specialty retail trip generation rate (SANDAG code: Specialty Retail/Strip Commercial) was applied to the retail sections within the Live-Work High Density and Live-Work Mixed Use areas. Specialty retail is described as small strip shopping centers and would be applicable to these developments as it is assumed there is no heavy commercial with the live-work high density and mixed-use areas. The retail developments within the business and commercial areas are assumed to be large shopping centers and ITE code 820 was used to identify the trip generation.

Residential Uses: The project description indicates that the residential uses on the site will contain medium to high-density residential units. These units could consist of condominiums, attached town homes, or small-lot single-family homes. Given the variety of possible housing types on this site, a general residential category (Land Use Code 230 – Residential Condos/Townhouses), was employed. The residential units for both the Live-Work High Density section and the Live-Work Mixed Use are assumed to be Residential Condominiums or Townhouses, which fall under ITE Trip Generation Code 230. The fitted curve equation that best fits this type of land use is an exponential equation that determines the number of trips generated based on the number of dwelling units. Since the equation is not linear the trip generation rate per dwelling unit varies depending on the number of units. In this case, as the number of dwelling units increase, the trip generation rate per unit decreases. This may be explained by carpooling with neighbors or an increase in internal social visits.

Office Uses: The office units for the Live-Work High Density section, the business and commercial areas and within the light industrial and business areas are assumed to be General Office Buildings, which fall under ITE Trip Generation Code 710.

Industrial Uses: The industrial units for the Light Industrial/Business section are assumed to be General Light Industries, which fall under ITE Trip Generation Code 110.

Park Uses: The park units for the Parks within the development include regional parks and multi-purpose recreational facilities, for which the park trip generation rate (SANDAG code: Parks) was applied.

School Uses: The school units for the Schools section include middle schools, high schools and elementary schools which fall under ITE Trip Generation Code 522, ITE Trip Generation Code 530, and ITE Trip Generation Code 520, respectively.

4.1.2 External Trip Estimation

The estimated numbers of vehicle trips, as based on the ITE, San Diego, and URBEMIS trip rates, were adjusted as described in the following paragraphs to estimate the number of vehicle trips that would be made to/from areas outside the Project. These reflect both reductions in the number of vehicle trips (transit, TDM actions) and those trips that would be made within the Project area.

4.1.2.1 Transit Trip Reduction

The 2030 OMPO Travel Demand Forecasting Model (released August 11, 2006) was used to identify the travel mode splits of the trips generated by the proposed project. As per the OMPO model, the proposed project was contained within three Traffic Analysis Zones (TAZs), namely, TAZs 545, 550, and parts of TAZ 546. Based on the OMPO model results, 6.625 percent of the total daily trips generated by the project were attributed to daily transit trips. The total daily trips were then converted to peak hour trips based on the time-of-day factors (OMPO model documentation, December 17, 2002). This data indicated that 26 percent of the trips would occur during the AM peak period and 17.2 percent of the trips would occur during the PM peak period. Overall, this resulted in a peak hour factor of 14.3 percent for the AM peak hour and 10 percent for the PM peak hour.

This resulted in a reduction of 1,747 trips in the AM peak hour and 1,156 trips in the PM peak hour as a result of transit trips. In other words, there was a reduction of around 15% trips generated in the AM Peak hour and a reduction of around 6% trips in the PM peak hour based on the OMPO model results and the on-board survey data.

4.1.2.2 Pass-By Trip Reduction

The numbers of vehicle trips entering or exiting a retail development include both new vehicle trips and additional stops by vehicles that would be traveling through the development. These additional stops by traffic passing the site to use the retail and services uses are referred to as "pass-by trips." Pass-by trips are made as intermediate stops on the way from an origin to a primary trip destination without a route diversion. For example, trips associated with a gas station or a convenience stop near major highways make intermediate stops while traveling between other destinations. The ITE Trip Generation Handbook (*Trip Generation Handbook, An ITE Recommended Practice, Institute of Transportation Engineers, June 2004, Chapter 5 "Passby, Primary, and Diverted Linked Trips"*) provides a methodology and equations for estimating the proportion of the project-related vehicle trips that would be pass-by trips. This ITE methodology was used in this study and applied to appropriate land uses as show in Tables 4-1 and 4-2.

4.1.2.3 Transportation Demand Management (TDM) Reduction

The URBEMIS model (Version 9.2) was applied to determine trip reductions from the TDM program assumed to be in place as part of the proposed project. It should be noted that this model

has been adopted by California's Air Districts and funded by Caltrans to estimate trips for Smart Growth and Transit Oriented Development projects.

WSA assumed that the proposed project would adopt a TDM program composed of the following measures:

- Free transit passes,
- Employee Telecommuting Program with 1.5 percent participating an average of 1.6 days
- Secure bicycle parking (minimum of 1 space per 20 vehicles)
- Shower and changing facilities
- Guaranteed Ride Home
- Carsharing services
- Information provided on transportation alternatives
- Dedicated Employee Transportation Coordinator
- Vanpooling/Carpooling (preferential parking).

The reduced project trip generation is summarized in Tables 4-1 and 4-2.

4.1.2.4 Internal Trip Capture Reduction

Mixed-use trips (internal capture) refer to any project trips that start and end within a development. For example, a project consisting of both residences and office buildings will generate some mixed-use trips if any of the office workers live in the adjacent residences. The guidelines provided in the ITE Trip Generation Handbook (*Trip Generation Handbook, An ITE Recommended Practice, Institute of Transportation Engineers, June 2004, Chapter 7 "Multi-Use Development"*), together with the OMPO Travel Demand Model were used to estimate this trip reduction. The guidelines were also used to determine if it is appropriate to apply an internal capture factor.

The 2030 OMPO Travel Demand Model designated a certain percentage as internal trips, which originate and end in the project site without leaving the TAZ. The internal trip percentages as calculated from the OMPO model data for residential, office, and retail landuses are 8.4 percent, 7.1 percent, and 10.0 percent, respectively. This trip reduction was applied in the Project trip generation calculations as summarized in Tables 4.1 and 4.2.

Estimated External Project Vehicle Trips

Overall, the proposed Project would generate a total of 140,920 daily trips to or from areas external to the Project. During the weekday AM peak hour, the project is expected to generate 7,069 trips (3,183 inbound/3,886 outbound). During the PM peak hour, the proposed project would generate a total of 12,077 trips (6,122 inbound/5,955 outbound).

4.1.5 Trip Generation Values

Tables 4.1 and 4.2 present the project trips generated during the weekday AM and PM peak periods for Scenario A: With Transit Corridor and Scenario B: Without Transit Corridor, respectively.

Table 4.1
External Trip Estimation - Scenario A: With Transit Corridor Scenario

Land Use	ITE Code	Size /c/	Unit	Average Trip Generation Rate /g/			Directional Split				Trip Generation						
							Weekday AM		Weekday PM			Weekday AM Peak Hour			Weekday PM Peak Hour		
				Daily	Weekday AM	Weekday PM	In	Out	In	Out	Daily	In	Out	Total	In	Out	Total
Single-Family Detached Housing /a/	210	5,100	DU	7.59	0.70	0.72	25%	75%	63%	37%	38,717	895	2,685	3,579	2,325	1,365	3,690
Live-Work High Density																	
Residential Condominium/Townhouse /b/	URBEMIS	5,200	DU	2.21	0.23	0.30	17%	83%	67%	33%	18,452	207	1,011	1,218	1,028	507	1,535
Specialty Retail Center /c/	URBEMIS	715,890	ksf	34.87	3% of Daily	9% of Daily	60%	40%	50%	50%	24,963	449	300	749	1,124	1,124	2,247
General Office Building	URBEMIS	393,890	ksf	8.48	1.43	1.32	88%	12%	17%	83%	3,834	494	67	562	88	432	520
Live-Work Mixed Use Commercial HD Residential																	
Residential Condominium/Townhouse /b/	URBEMIS	1,450	DU	2.21	0.30	0.37	17%	83%	67%	33%	6,232	75	364	439	361	178	539
Specialty Retail Center /c/	URBEMIS	123,710	ksf	34.87	3% of Daily	9% of Daily	60%	40%	50%	50%	4,314	77	52	129	194	194	388
Business Commercial																	
General Office Building	710	200,657	ksf	11.37	1.63	1.51	88%	12%	17%	83%	2,281	288	39	327	52	252	304
Shopping Centers /d/																	
Zone F2	820	321,621	ksf	45.12	0.98	4.21	61%	39%	48%	52%	14,511	192	123	315	650	704	1,353
Zone F3	820	354,634	ksf	43.60	0.94	4.07	61%	39%	48%	52%	15,463	204	130	335	693	751	1,444
Zone P1	820	211,335	ksf	52.26	1.16	4.85	61%	39%	48%	52%	11,045	150	96	245	492	533	1,026
Zone V1	820	72,998	ksf	75.82	1.78	6.97	61%	39%	48%	52%	5,535	79	51	130	244	264	509
Zone V3	820	100,582	ksf	67.77	1.56	6.25	61%	39%	48%	52%	6,817	96	61	157	302	327	628
Zone W1	820	339,230	ksf	44.29	0.96	4.13	61%	39%	48%	52%	15,023	199	127	326	673	729	1,402
Light Industrial / Business																	
General Light Industrial	110	800,000	ksf	7.34	1.07	1.23	83%	17%	21%	79%	5,874	709	145	855	206	775	981
General Office Building	710	125,453	ksf	12.66	1.79	1.75	88%	12%	17%	83%	1,589	198	27	225	37	182	219
Parks																	
Regional Parks	SANDAG	33.000	acres	20.00	4% of Daily	8% of Daily	50%	50%	50%	50%	660	13	13	26	27	26	53
Multi-Purpose Recreation Facility	SANDAG	27.000	acres	90.00	2% of Daily	6% of Daily	50%	50%	50%	50%	2,430	25	24	49	73	73	146
Schools																	
Middle School	522	600	Students	1.62	0.41	0.15	55%	45%	52%	48%	972	135	111	246	47	43	90
High School	530	1,000	Students	1.73	0.41	0.31	69%	31%	32%	68%	1,729	281	126	407	99	210	309
Elementary School	520	210	Employees	18.88	7.30	3.41	54%	46%	45%	55%	3,965	828	705	1,533	322	393	715
Total											184,405	5,594	6,257	11,851	9,037	9,062	18,099
Transit Reduction /e/		6.6%									*12,171*	*825*	*922*	*1,747*	*577*	*579*	*1,156*
Internal Trip Reduction														15%			6%
Residential		8.4%									5,326	99	341	440	312	172	484
Light Industrial / Office Building		7.1%									964	120	20	140	22	117	144
Retail		10.0%									9,767	145	94	239	437	463	900
Other (Parks) /h/		80.0%									2,472	30	30	60	80	79	159
Schools /j/																	
Middle School		82%	Students/Staff								800	111	91	202	39	35	74
High School		82%	Students/Staff								1,424	231	104	335	82	173	255
Elementary School		82%	Students/Staff								3,265	682	581	1,263	265	324	589
Subtotal											*24,018*	*1,416*	*1,261*	*2,677*	*1,242*	*1,363*	*2,605*
Pass-by Trip Reduction /f/																	
Zone F2		*27.8%*							48%	52%	377				181	196	377
Zone F3		*27.0%*							48%	52%	390				187	203	390
Zone P1		*31.4%*							48%	52%	322				155	167	322
Zone V3		*39.0%*							48%	52%	245				118	127	245
Zone W1		*27.4%*							48%	52%	384				184	200	384
Subtotal											*1,718*	*0*	*0*	*0*	*825*	*893*	*1,718*
TDM Reduction /i/		3.0%									*5,532*	*165*	*188*	*356*	*271*	*272*	*543*
Total											140,920	3,183	3,886	7,069	6,122	5,955	12,077

Source: Wilbur Smith Associates, September 2007

NOTES:
- /a/ All residential low-medium density units are assumed to be single-family detached housing units.
- /b/ All high density live-work residential units are assumed to be residential condominium/townhouses.
- /c/ All retail uses located within the live-work areas are assumed to be Specialty Retail Centers. URBEMIS trip generation rates have been used for Specialty Retail Center. URBEMIS adjusts trip rates based on residential housing density and also includes adjustments based on pedestrian-friendly projects, in which residential land uses are in close proximity to retail and employment land uses.
- /d/ All retail uses located within the commercial zones are assumed to be Shopping Centers.
- /e/ Transit reduction applied to take into account the trips reduced due to the *Honolulu High Capacity Transit Corridor*.
- /f/ Pass-by trip reduction applied only to commercial trips (shopping centers). It was assumed that there would be no pass-by trips in the AM peak period from 6 AM - 8 AM.
- /g/ Average trip generation rates are obtained as a ratio of the total trip generation rates, calculated using *ITE Trip Generation Handbook*.
- /h/ The 80 percent internal trip reduction for parks in the neighborhood is similar to the internal trip reduction for schools.
- /i/ TDM reduction takes into account trip reduction due to TDM alternatives such as staggered work week, telecommuting etc.
- /j/ Internal trip reduction due to schools assumes walking, bicycling and drop-offs by private transit car as the main modes of transportation used by students and staff.

4.2 PROJECT TRIP DISTRIBUTION

This section provides a description of various travel patterns of the project trips from and to the project under Year 2030 Baseline Plus Project Conditions. The Year 2030 OMPO Transportation Model was used to identify the trip distribution of the project. Using the OMPO Model, a select link analysis was performed using the OMPO model to determine separate trip distribution percentages for each land use: office, retail, and residential. Each of these trip distributions present the percentage of vehicles traveling between the project site and each of the different areas surrounding the project site.

Table 4.3 summarizes the trip distribution patterns provided by the OMPO Model under the Year 2030 conditions; Figures 4-1 A, 4-1 B, 4-1 C exhibit the trip distribution patterns for residential, office, and retail land uses, respectively. These three figures present the trip distribution percentages only for the external vehicle trips.

4.3 PROJECT TRIP ASSIGNMENT

Trips generated solely by the proposed Ho'opili Development during the peak hour under Scenario A: With Transit Corridor are presented in Figures 4-2A, 4-2B, and 4-2C; while project trips generated during the peak hour under Scenario B: Without the Transit Corridor are presented in Figures 4-3A, 4-3B, and 4-3C.

Trips generated by the proposed Ho'opili Development are assigned to the roadway system based on the trip generation and trip distribution described in Section 4.1 and 4.2. The resulting intersection turning movement volumes under plus project conditions are discussed and presented in Chapter 5.

Table 4.2
External Trip Estimation - Scenario B: Without Transit Corridor Scenario

Land Use	ITE Code	Size /c/	Unit	Avg Trip Gen Rate /g/: Daily	Weekday AM	Weekday PM	Dir. Split Weekday AM: In	Out	Weekday PM: In	Out	Trip Generation: Daily	Weekday AM Peak Hour: In	Out	Total	Weekday PM Peak Hour: In	Out	Total
Single-Family Detached Housing /a/	210	5,100	DU	7.59	0.70	0.72	25%	75%	63%	37%	38,717	895	2,685	3,579	2,325	1,365	3,690
Live-Work High Density																	
Residential Condominium/Townhouse /b/	URBEMIS	5,200	DU	2.21	0.23	0.30	17%	83%	67%	33%	18,452	207	1,011	1,218	1,028	507	1,535
Specialty Retail Center /c/	URBEMIS	715,890	ksf	34.87	3% of Daily	9% of Daily	60%	40%	50%	50%	24,963	449	300	749	1,124	1,124	2,247
General Office Building	URBEMIS	393,890	ksf	8.48	1.43	1.32	88%	12%	17%	83%	3,334	494	67	562	88	432	520
Live-Work Mixed Use Commercial HD Residential																	
Residential Condominium/Townhouse /b/	URBEMIS	1,450	DU	2.21	0.30	0.37	17%	83%	67%	33%	6,232	75	364	439	361	178	539
Specialty Retail Center /c/	URBEMIS	123,710	ksf	34.87	3% of Daily	9% of Daily	60%	40%	50%	50%	4,314	77	52	129	194	194	388
Business Commercial																	
General Office Building	710	200.657	ksf	11.37	1.63	1.51	88%	12%	17%	83%	2,281	288	39	327	52	252	304
Shopping Centers /d/																	
Zone F2	820	321.621	ksf	45.12	0.98	4.21	61%	39%	48%	52%	14,511	192	123	315	650	704	1,353
Zone F3	820	354.634	ksf	43.60	0.94	4.07	61%	39%	48%	52%	15,463	204	130	335	693	751	1,444
Zone P1	820	211.333	ksf	52.26	1.16	4.85	61%	39%	48%	52%	11,045	150	96	245	492	533	1,026
Zone V1	820	72.998	ksf	75.82	1.78	6.97	61%	39%	48%	52%	5,535	79	51	130	244	264	509
Zone V3	820	100.592	ksf	67.77	1.56	6.25	61%	39%	48%	52%	6,817	96	61	157	302	327	628
Zone W1	820	339.230	ksf	44.29	0.96	4.13	61%	39%	48%	52%	15,023	199	127	326	673	729	1,402
Light Industrial / Business																	
General Light Industrial	110	800.600	ksf	7.34	1.07	1.23	83%	17%	21%	79%	5,874	709	145	855	206	775	981
General Office Building	710	125.453	ksf	12.66	1.79	1.75	88%	12%	17%	83%	1,589	198	27	225	37	182	219
Parks																	
Regional Parks	SANDAG	33.000	acres	20.00	4% of Daily	8% of Daily	50%	50%	50%	50%	660	13	13	26	27	26	53
Multi-Purpose Recreation Facility	SANDAG	27.000	acres	90.00	2% of Daily	6% of Daily	50%	50%	50%	50%	2,430	25	24	49	73	73	146
Schools																	
Middle School	522	600	Students	1.62	0.41	0.15	55%	45%	52%	48%	972	135	111	246	47	43	90
High School	530	1,000	Students	1.73	0.41	0.31	69%	31%	32%	68%	1,729	281	126	407	99	210	309
Elementary School	520	210	Employees	18.88	7.30	3.41	54%	46%	45%	55%	3,965	828	705	1,533	322	393	715
Total											184,465	5,594	6,257	11,851	9,037	9,062	18,099
Transit Reduction /e/		0.0%									0	0	0	0	0	0	0
Internal Trip Reduction														0%			0%
Residential		8.4%									5,326	99	341	440	312	172	484
Light Industrial / Office Building		7.1%									964	120	20	140	27	117	144
Retail		10.0%									9,767	145	94	239	437	463	900
Other (Parks) /h/		80.0%									2,472	30	30	60	80	79	159
Schools /j/																	
Middle School		82%	Students/Staff								800	111	91	202	39	35	74
High School		82%	Students/Staff								1,424	231	104	335	82	173	255
Elementary School		82%	Students/Staff								3,265	682	581	1,263	265	324	589
Subtotal											24,015	1,418	1,261	2,679	1,242	1,363	2,605
Pass-by Trip Reduction /f/																	
Zone F2		27.8%							48%	52%	377				181	196	377
Zone F3		27.0%							48%	52%	390				187	203	390
Zone P1		31.4%							48%	52%	322				155	167	322
Zone V3		39.0%							48%	52%	245				118	127	245
Zone W1		27.4%							48%	52%	384				184	200	384
Subtotal											1,718	0	0	0	825	893	1,718
TDM Reduction /i/		0.0%									0	0	0	0	0	0	0
Total											158,664	4,176	4,996	9,172	6,970	6,806	13,776

Source: Wilbur Smith Associates, September 2007

NOTES
/a/ All residential low-medium density units are assumed to be single-family detached housing units.
/b/ All high density live-work residential units are assumed to be residential condominiums/townhouses.
/c/ All retail uses located within the live-work zones are assumed to be Specialty Retail Centers. URBEMIS trip generation rates have been used for Specialty Retail Center. URBEMIS adjusts trip rates based on residential housing density and also includes adjustments based on pedestrian-friendly projects, in which residential land uses are in close proximity to retail and employment land uses.
/d/ All retail units located within the commercial zones are assumed to be Shopping Centers.
/e/ Transit reduction applied to take into account the trips reduced due to the Honolulu High Capacity Transit Corridor.
/f/ Pass-by trip reduction applied only to commercial trips (shopping centers). It was assumed that there would be no pass-by trips in the AM peak period from 6 AM-8 AM.
/g/ Average trip generation rates are obtained as a ratio of the total trip generation rates, calculated using ITE Trip Generation Handbook.
/h/ The 80 percent internal trip reduction for parks in the neighborhood is similar to the internal trip reduction for schools.
/i/ TDM reduction to take into account trip reduction due to TDM alternatives such as staggered work week, telecommuting etc.
/j/ Internal trip reduction due to schools assumes walking, bicycling and drop-offs by private transit [illegible] as the main modes of transportation used by students and staff.

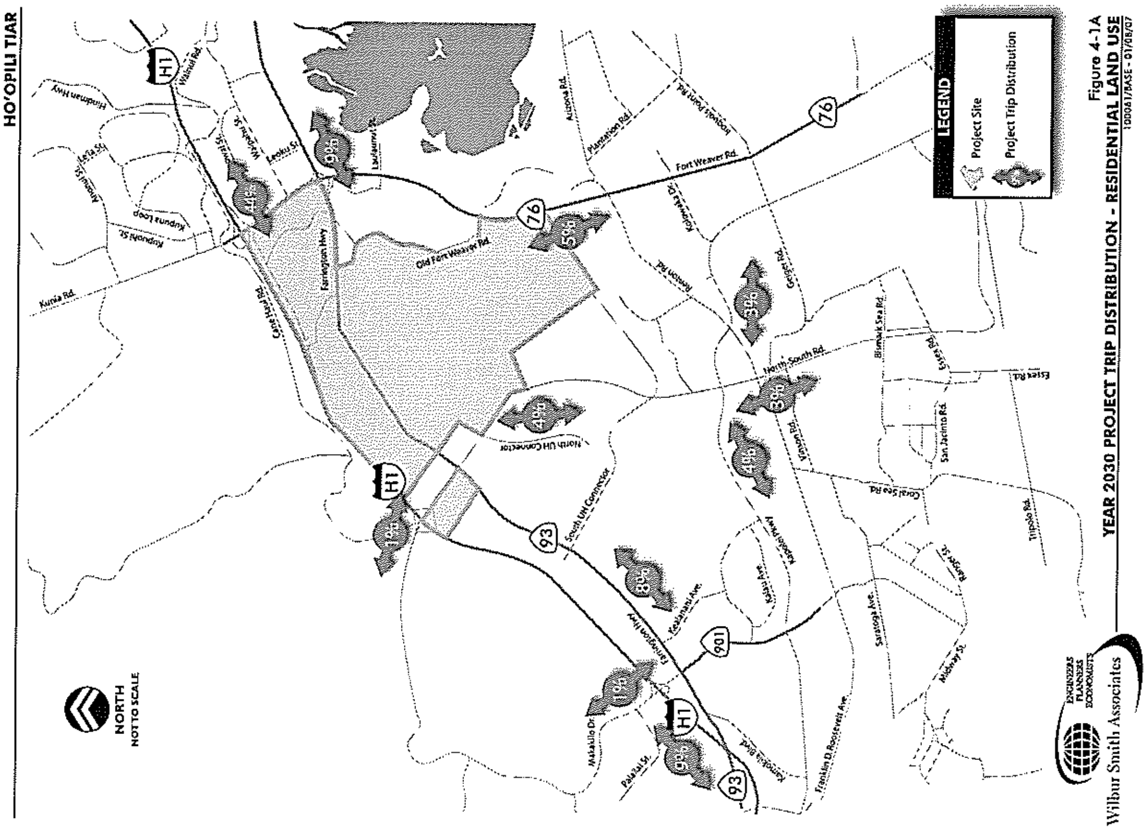

Table 4.3
Project Trip Distribution

#	Screenline: Roadway	Screenline: Location	Landuse: Residential	Landuse: Office	Landuse: Retail
1	Kunia Rd	N/O Kunia Loop	6.3%	3.9%	2.9%
2	Kunia Loop	E/O Kunia Rd	2.1%	3.5%	4.5%
3	Farrington Hwy	E/O Leoku St	8.5%	8.4%	9.1%
4	Laulaunui St	E/O Fort Weaver Rd	0.6%	0.9%	1.2%
5	Kawa Dr	E/O Fort Weaver Rd	0.7%	2.3%	4.6%
6	Renton Rd	E/O Fort Weaver Rd	0.4%	2.1%	4.1%
7	Fort Weaver Rd	S/O Renton Rd	3.7%	7.4%	9.0%
8	North-South Rd	N/O H-1	0.6%	2.4%	3.6%
9	N UHWO Connector	W/O North-South Rd	2.9%	3.2%	4.4%
10	S UHWO Connector	W/O North-South Rd	0.9%	1.1%	1.3%
11	Kapolei Parkway	W/O North South Rd	3.8%	4.4%	3.6%
12	North South Rd	S/O Kapolei Parkway	2.2%	1.1%	0.7%
13	Renton Rd	W/O Kapolei Parkway	0.0%	0.1%	0.1%
14	Kapolei Parkway	S/O Renton Rd	1.8%	3.8%	4.5%
15	Pahika	S/O Renton Rd	0.6%	0.6%	0.4%
16	Makakilo Dr	N/O H-1	0.7%	2.4%	2.6%
17	H-1	W/O Makakilo Dr	8.3%	8.7%	8.7%
18	Farrington Hwy	W/O Fort Barette Rd	3.1%	3.2%	2.6%
19	Fort Barette Rd	S/O Farrington Hwy	3.1%	3.3%	2.7%
20	H-1	E/O Kunia Rd	40.0%	29.3%	17.4%
21	Farrington Hwy	W/O North-South Rd	1.2%	1.0%	1.0%
22	Internal		8.4%	7.1%	10.0%
	Total		**100.00%**	**100.00%**	**100.00%**

Source: Wilbur Smith Associates, 2007

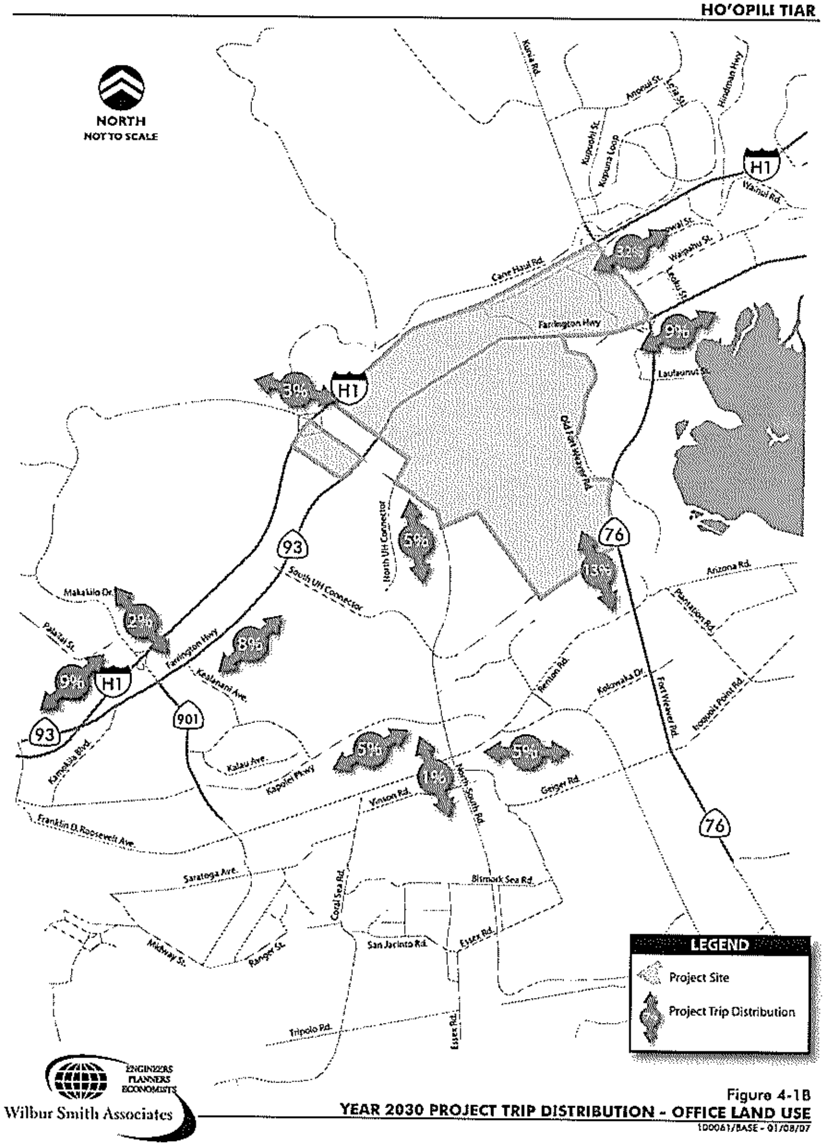

Figure 4-1B
YEAR 2030 PROJECT TRIP DISTRIBUTION - OFFICE LAND USE
100061/BASE - 01/08/07

HO'OPILI TIAR

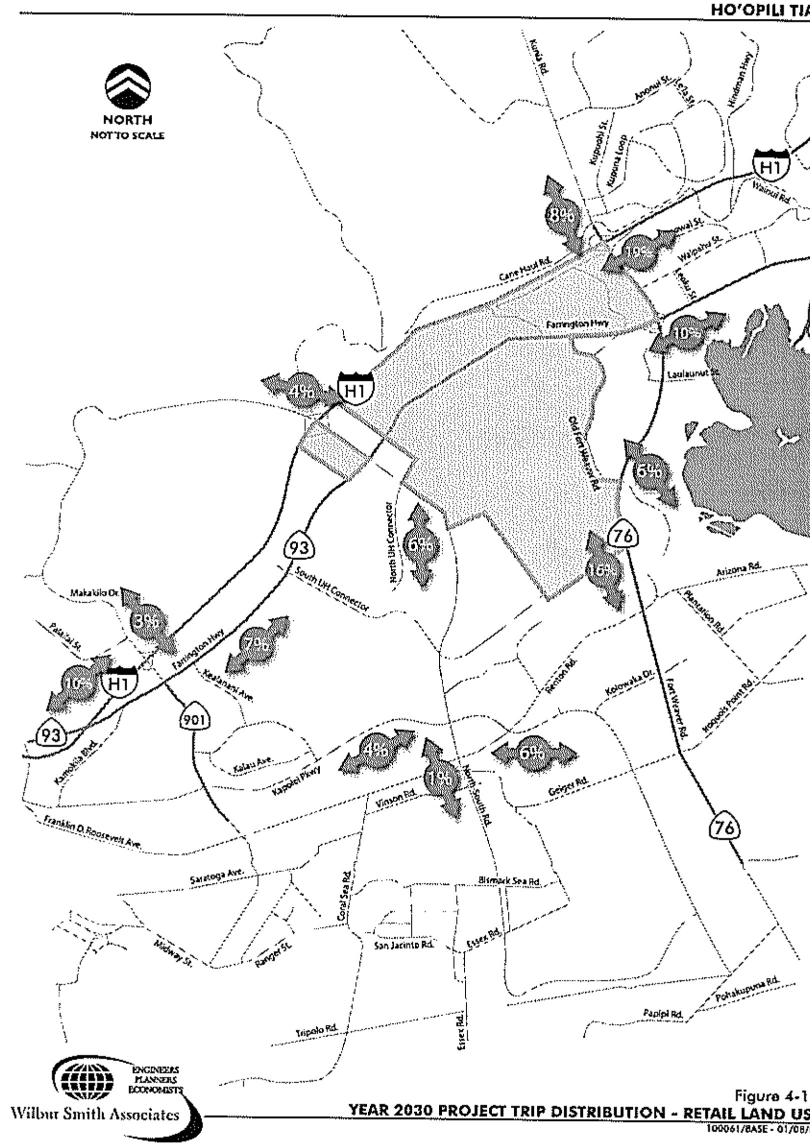

Figure 4-1C
YEAR 2030 PROJECT TRIP DISTRIBUTION - RETAIL LAND USE
100061/BASE - 01/08/07

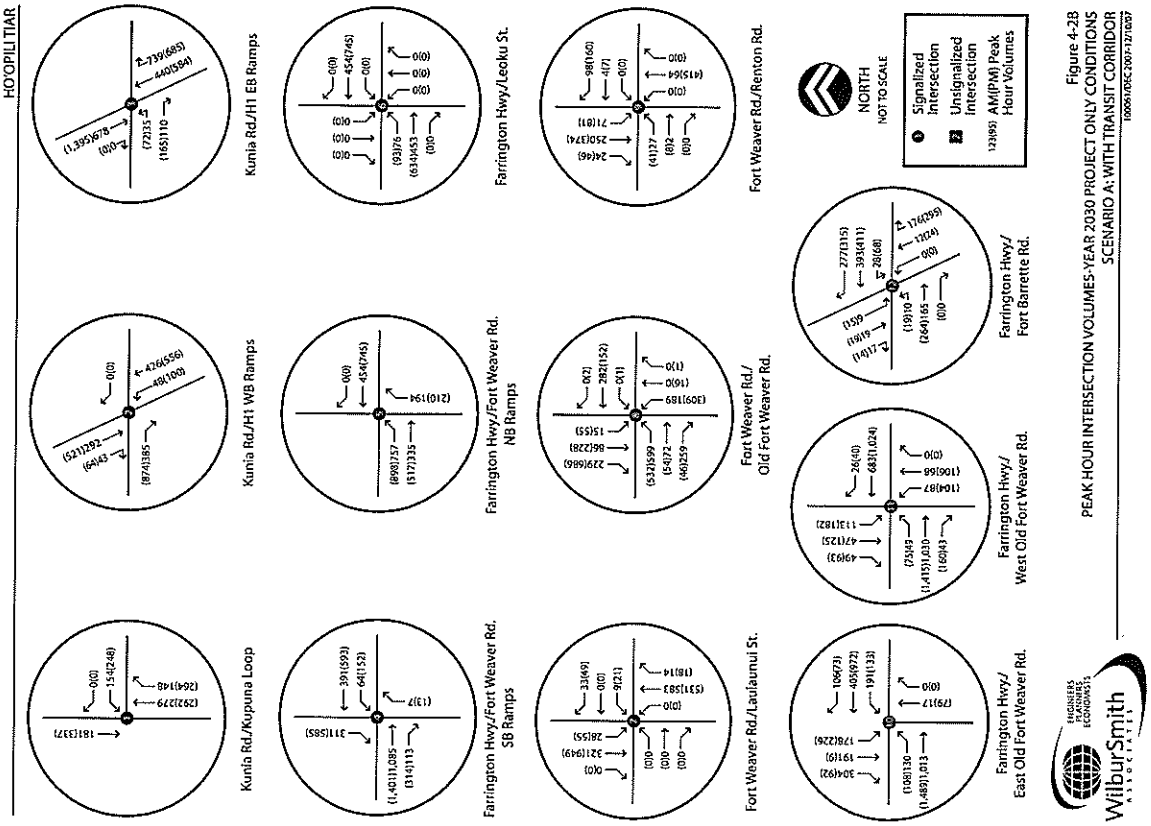

Figure 4-2B
PEAK HOUR INTERSECTION VOLUMES-YEAR 2030 PROJECT ONLY CONDITIONS
SCENARIO A: WITH TRANSIT CORRIDOR

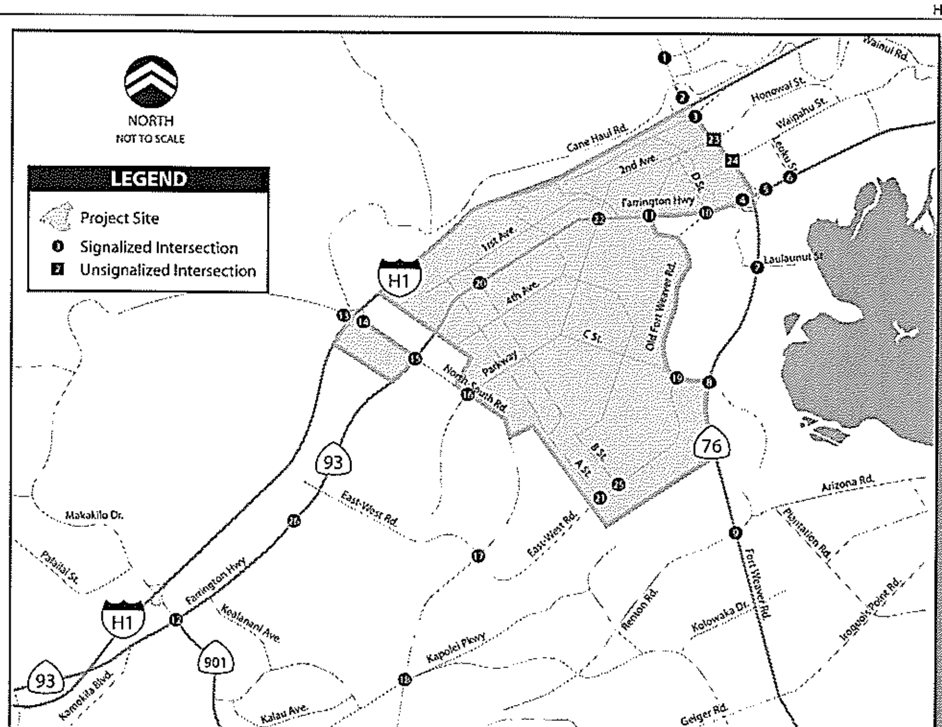

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Figure 4-2A
PEAK HOUR INTERSECTION VOLUMES-YEAR 2030 PROJECT ONLY CONDITIONS
SCENARIO A: WITH TRANSIT CORRIDOR
100061/Draft October - 10/17/07

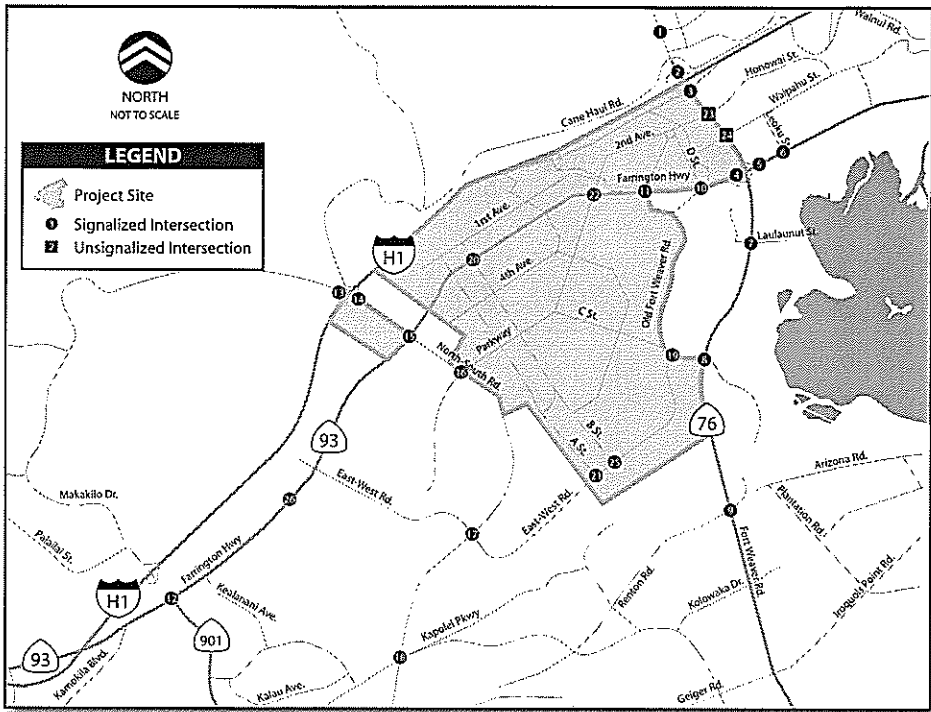

Figure 4-3A
PEAK HOUR INTERSECTION VOLUMES-YEAR 2030 PROJECT ONLY CONDITIONS
SCENARIO B: WITHOUT TRANSIT CORRIDOR
100061/Draft October - 10/17/07

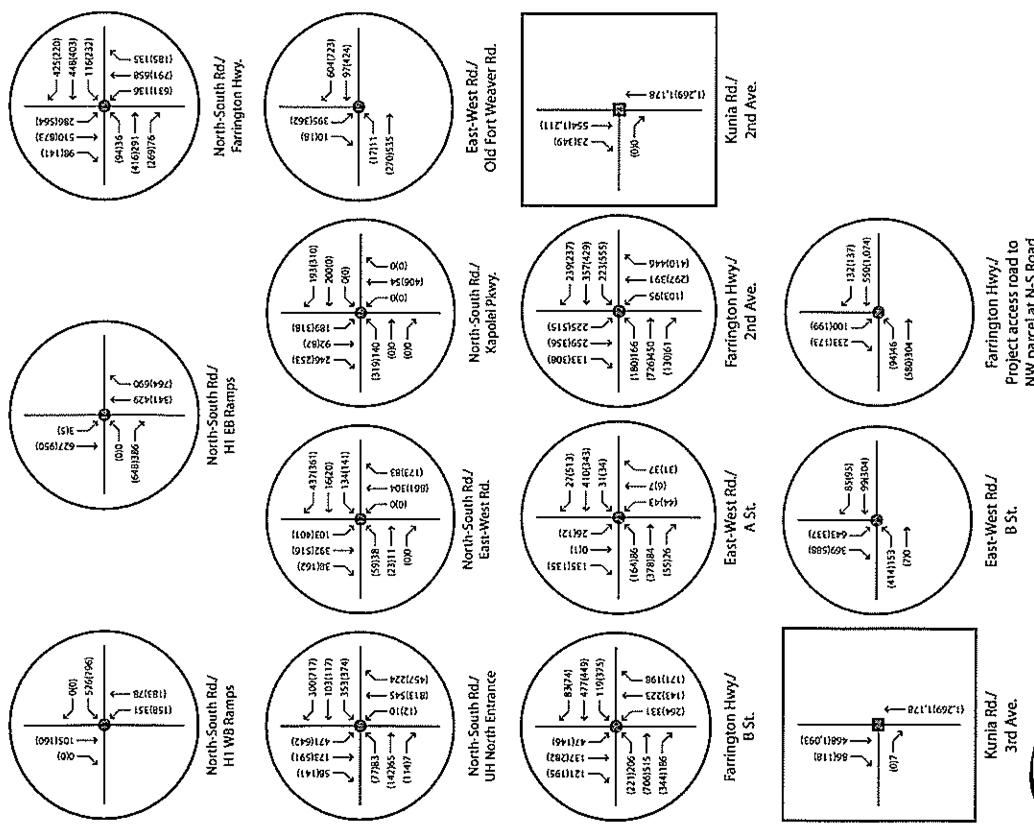

Figure 4-2C
PEAK HOUR INTERSECTION VOLUMES-YEAR 2030 PROJECT ONLY CONDITIONS
SCENARIO A: WITH TRANSIT CORRIDOR
100061/DEC 2007-12/10/07

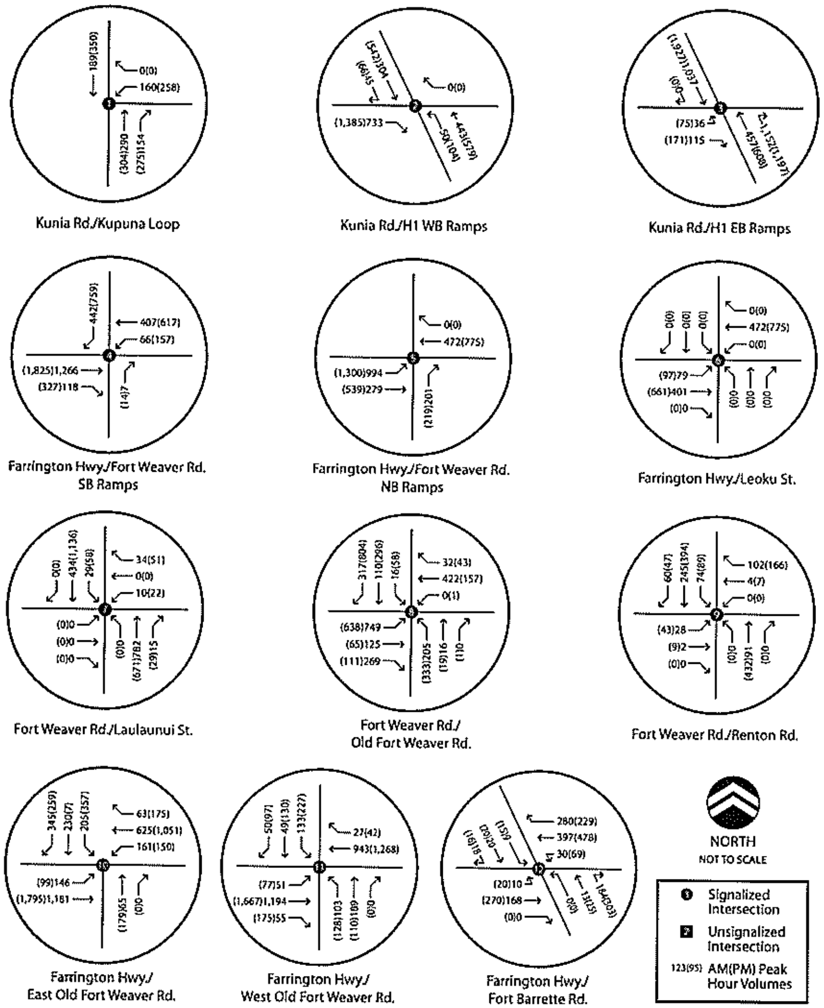

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Figure 4-3B
PEAK HOUR INTERSECTION VOLUMES-YEAR 2030 PLUS PROJECT ONLY CONDITIONS
SCENARIO B: WITHOUT TRANSIT CORRIDOR

100061/DEC 2007-12/10/07

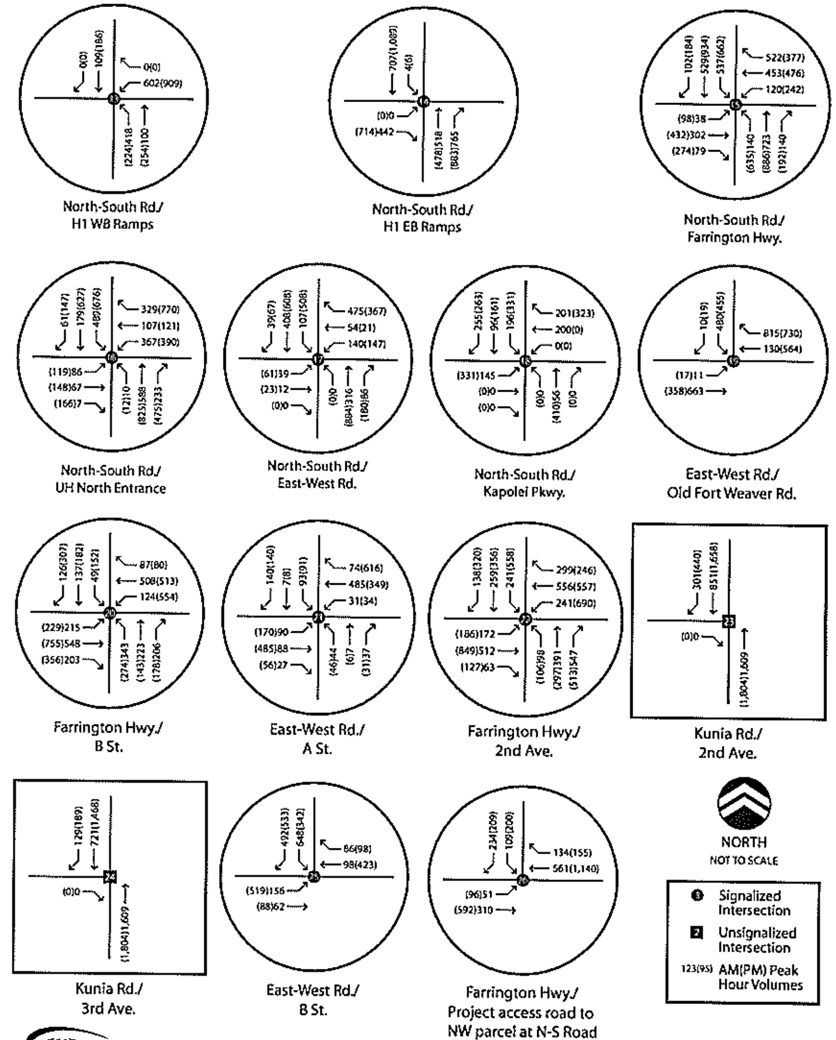

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Figure 4-3C
PEAK HOUR INTERSECTION VOLUMES-YEAR 2030 PROJECT ONLY CONDITIONS
SCENARIO B: WITHOUT TRANSIT CORRIDOR

100061/DEC 2007-12/10/07

Chapter 5
YEAR 2030 BASELINE PLUS PROJECT CONDITIONS

This chapter describes the Year 2030 transportation conditions including intersection, freeway, and freeway-ramp junction operations as a result of the construction of the proposed Project. Additionally, the transportation impacts associated with the proposed project were identified.

The operating conditions of the study intersections, freeway segments, and ramp-freeway junctions were studied under two scenarios as described in *Chapter 4:* "Without Transit Corridor Scenario A" and "With Transit Corridor Scenario B",. Levels of Service of the study intersections, freeway segments, and ramp-freeway junctions under Scenarios A and B were identified using the same methodologies as described in Chapter 2 for existing conditions.

5.1 THRESHOLDS OF SIGNIFICANCE

Neither the City and County of Honolulu nor the State of Hawai'i have guidelines for identifying the transportation impacts caused by a project. Therefore, WSA used the guidelines provided in *Sections 5.1.1, 5.1.2, and 5.1.3* to identify the transportation impacts at the intersections, freeway segments, and ramp-freeway junctions.

5.1.1 Intersections

The thresholds of significance for the intersections are as follows:

1. A project would cause a transportation impact at an intersection if it degrades the LOS of the intersection to LOS E or worse.
2. A project would cause a transportation impact at an intersection operating at LOS E or F if it degrades the volume-to-capacity ratio of the intersection by more than 10 percent.

5.1.2 Freeway Segments

The thresholds of significance for the freeway segments are as follows:

1. A project would cause a transportation impact at a freeway segment if it degrades the LOS of the freeway segment to LOS E or worse.

5.1.3 Ramp-Freeway Junctions

The thresholds of significance for the ramp-freeway junctions are as follows:

1. A project would cause a transportation impact at a ramp-freeway junction if it degrades the LOS of the ramp-freeway to LOS E or worse.

5.2 SCENARIO A: WITH TRANSIT CORRIDOR

5.2.1 Study Area – Scenario A

Figure 5-1 presents the proposed internal circulation within the project site. The names of the major streets have been assumed for analysis purposes. As part of the Ho'opili project, several new study intersections would be created between Project roadways and the major area roadways located adjacent to the project site. The new study intersections that are located within the project site and included in this analysis are:

- Farrington Highway/ B Street
- East-West Road/ A Street
- Farrington Highway/ Parkway/ 2nd Avenue
- Kunia Road/ 2nd Avenue
- Kunia Road/ 3rd Avenue
- East-West Road/ B Street
- Farrington Hwy/ Project Access Road to NW Parcel

Traffic signal warrant analysis has been performed on the new study intersections under Year 2030 Baseline plus Project conditions "With Transit Corridor Scenario" (Scenario A) and all the intersections except the following two, which are both right-turn-in-only intersections, satisfied the MUTCD Warrant #3 for installation of a traffic signal:

- Kunia Road/ 2nd Avenue
- Kunia Road/ 3rd Avenue

For this analysis, the other 5 intersections of the major Project roadways with the major roadways were assumed to be signalized. The intersections Kunia Road/ 2nd Avenue as well as Kunia Road/ 3rd Avenue would only allow right turns from Kunia Road into the Project site and are assumed to be free-flow.

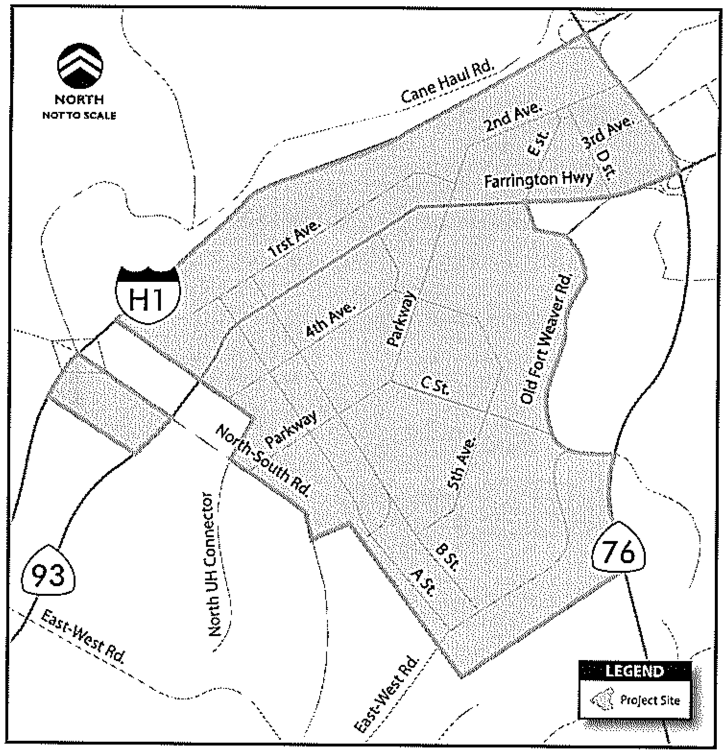

Figure 5-1
PROJECT INTERNAL CIRCULATION
100061/BASE - 01/09/07

To accommodate the increased traffic due to the Project, the proposed geometric layout of the following four study intersections are proposed for modification from the lanes used in the Year 2030 Baseline Conditions:

- Farrington Highway/ East Old Fort Weaver Road
- Farrington Highway/ West Old Fort Weaver Road
- North-South Road/ North University of Hawai'i Connector

Of the above three intersections, the two intersections Farrington Highway/ East Old Fort Weaver Road and Farrington Highway/ West Old Fort Weaver Road are unsignalized under Year 2030 Baseline Conditions. Traffic signal warrant analysis has been performed on both these intersections under Year 2030 Baseline plus Project conditions "With Transit Corridor Scenario" and both the intersections have satisfied the criteria to allow consideration of signal installation. Therefore, for the purpose of this analysis, intersections Farrington Highway/ East Old Fort Weaver Road and Farrington Highway/ West Old Fort Weaver Road have been considered to be signalized under 'With Transit Corridor Scenario".

Additionally, to accommodate the increased traffic volumes along the roadways adjacent to the Project site, increased traffic lanes would be provided at the following three study intersections:

Farrington Highway/ East Old Fort Weaver Road

1. Install traffic signal.
2. Eastbound Approach: Construct one additional through lane and one exclusive left-turn lane.
3. Westbound Approach: Construct one additional shared through-right lane.
4. Southbound Approach: Construct one shared left-through-right lane and one exclusive left-turn lane.
5. Northbound Approach: Construct one additional shared left-through-right lane.

Farrington Highway/ West Old Fort Weaver Road

1. Install traffic signal.
2. Eastbound Approach: Convert existing exclusive right-turn lane to shared through-right lane, construct one exclusive left-turn lane.
3. Westbound Approach: Construct one additional shared through-right lane.
4. Southbound Approach: Construct one shared through-right lane and one exclusive left-turn lane
5. Northbound Approach: Convert existing exclusive left-turn lane to shared left-through-right lane.

North-South Road/ North University of Hawaii Connector

1. Eastbound Approach: Convert existing exclusive right-turn lane to shared through-right lane.
2. Westbound Approach: Construct one through lane, two exclusive left-turn lanes, and two exclusive right-turn lanes.
3. Southbound Approach: Construct two additional exclusive left-turn lanes.
4. Northbound Approach: Construct one additional exclusive right-turn lane.

Figure 5-2 displays all the study intersections under Year 2030 Baseline plus Project conditions "With Transit Corridor Scenario"; whereas, Figures 5-3A and 5-3B presents the proposed geometric configurations of the new study intersections and the three modified study intersections under Year 2030 Baseline plus Project conditions "With Transit Corridor Scenario", as described above.

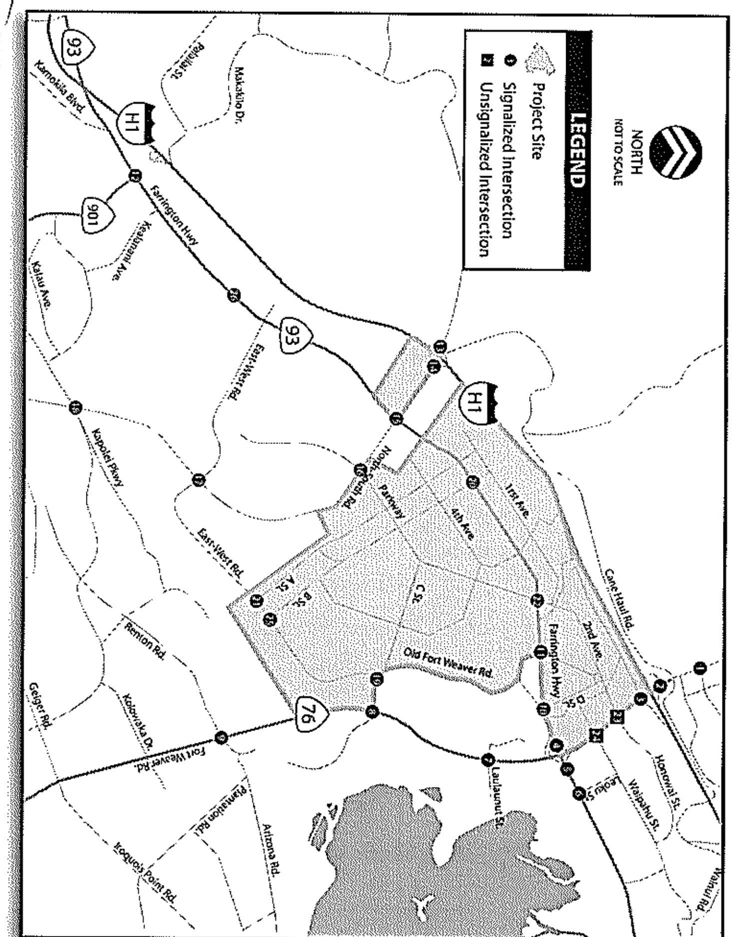

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Figure 5-2
STUDY INTERSECTIONS
YEAR 2030 + PROJECT CONDITIONS
100061/Draft October - 10/17/07

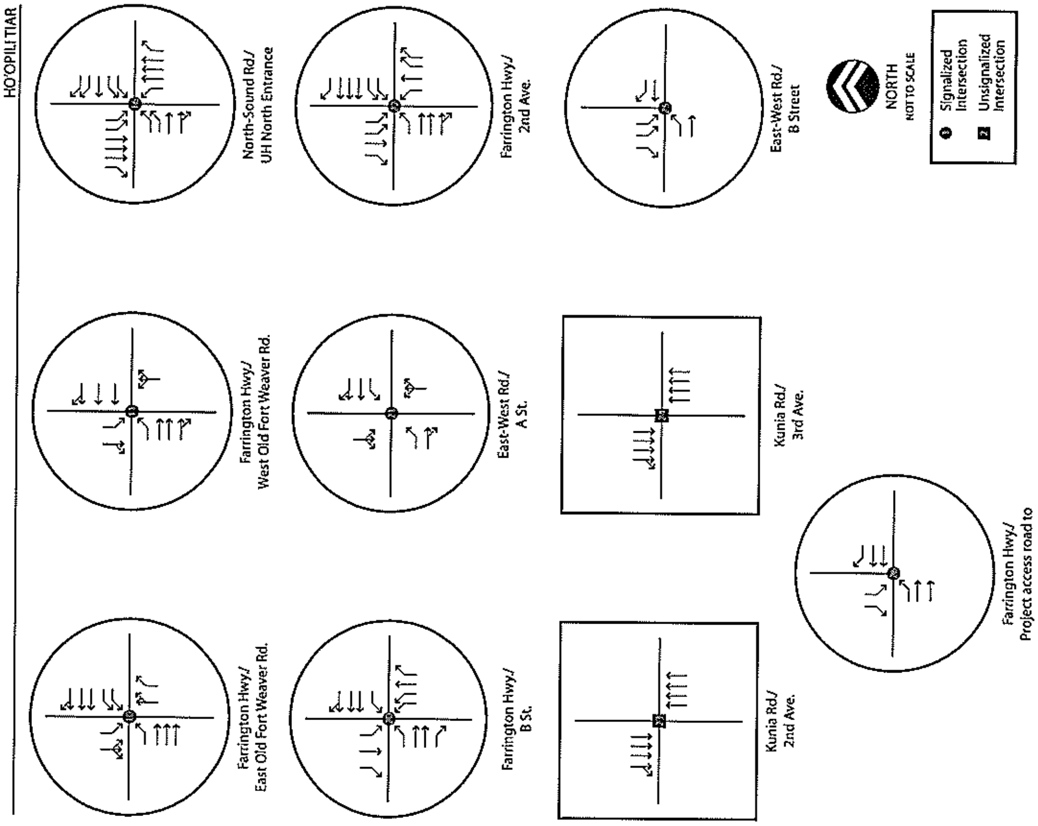

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Figure 5-3B
PROPOSED GEOMETRIES OF NEW INTERSECTIONS
YEAR 2030 PLUS PROJECT CONDITIONS
100061/Draft October - 10/19/07

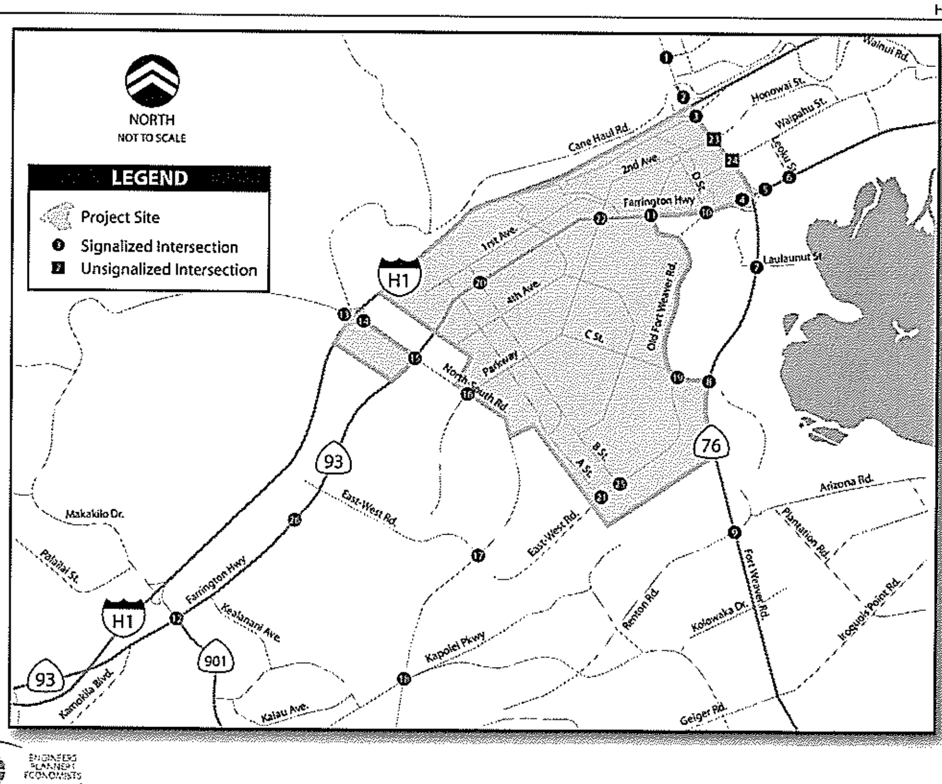

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Figure 5-3A
PROPOSED GEOMETRIES OF NEW INTERSECTIONS
YEAR 2030 PLUS PROJECT CONDITIONS
100061/Draft October - 10/17/07

5.2.2 Intersection Operating Conditions – Scenario A

Using the trip distribution pattern described in *Chapter 4*, the project trips generated under "With Transit Corridor Scenario" were distributed throughout the study area. The resulting turning movement volumes at the study intersections under Year 2030 Baseline plus Project conditions "With Transit Corridor Scenario" are exhibited in Figures 5-4 A, 5-4 B, and 5-4 C.

The LOS of the study intersections, the study freeway segments, and the study freeway-ramp junctions were calculated using the same methodologies described in *Chapter 2*. The study intersection operations under Year 2030 Baseline plus Project conditions "With Transit Corridor Scenario" are presented in Table 5.1. The LOS and delay values of the study intersections located outside the proposed Project site (external intersections) are exhibited in Tables 5.1 (a) and 5.2 (a) for AM and PM peak hour conditions respectively, while Tables 5.1 (b) and 5.2 (b) display the operations of the study intersections located within the proposed project site (internal intersections) under AM and PM peak hour conditions, respectively. Also identified in Tables 5.1 and 5.2 are the locations of transportation impacts under Year 2030 Baseline plus Project conditions "With Transit Corridor Scenario".

During the AM peak hour, 22 of the 26 study intersections would operate under acceptable conditions (LOS D or better). The 4 intersections that would operate at LOS E or F are:

- Fort Weaver Road/ Old Fort Weaver Road
- Fort Weaver Road/ Renton Road
- Farrington Highway/ Fort Barrette Road
- North-South Road/ Farrington Highway

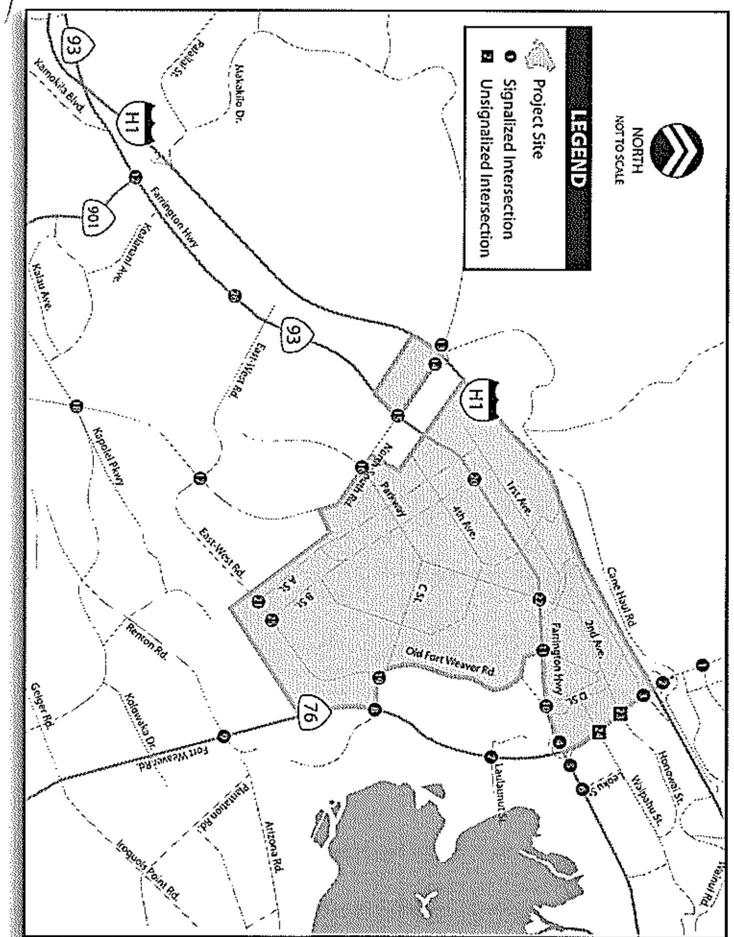

Figure 5-4A
PEAK HOUR INTERSECTION VOLUMES-YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO A: WITH TRANSIT CORRIDOR

100061/Draft October/Figure 5-4 map - 10/17/07

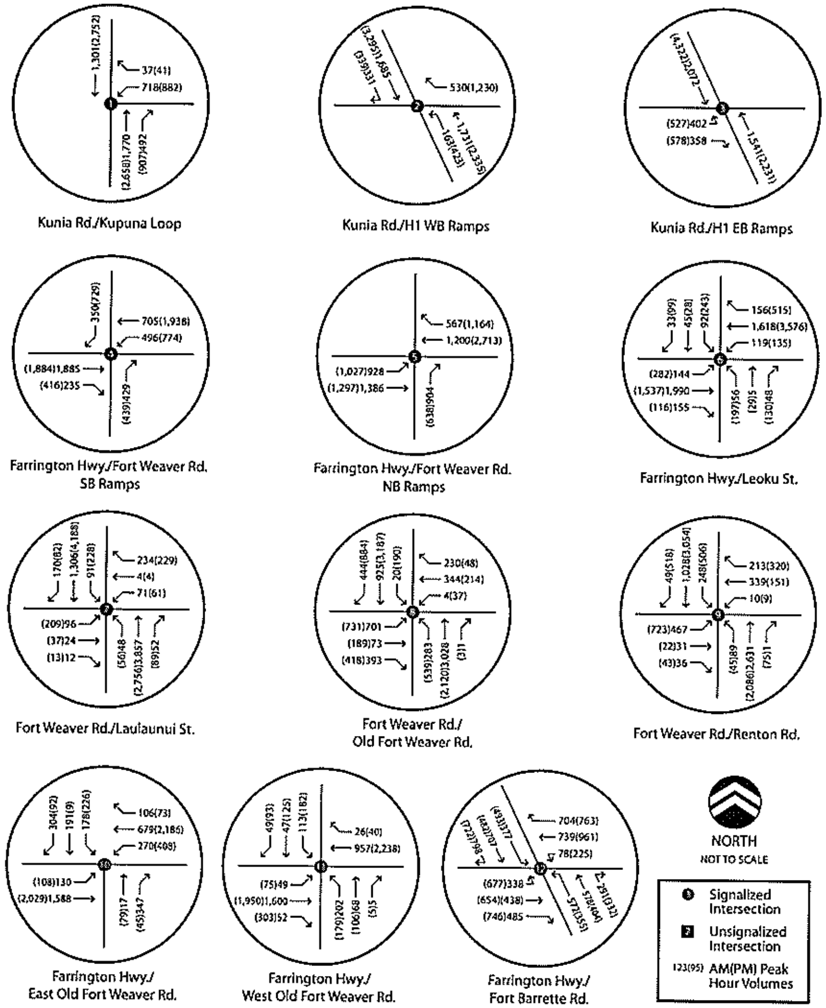

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Figure 5-4B
PEAK HOUR INTERSECTION VOLUMES-YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO A: WITH TRANSIT CORRIDOR

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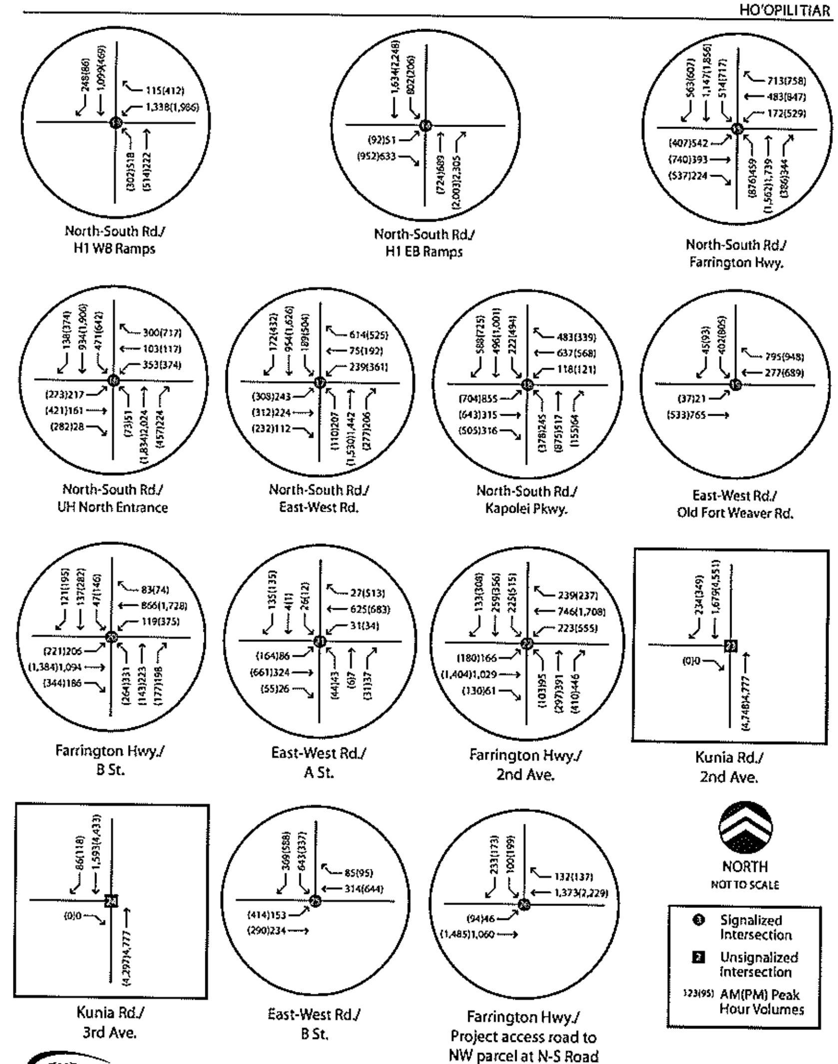

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Figure 5-4C
PEAK HOUR INTERSECTION VOLUMES-YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO A: WITH TRANSIT CORRIDOR

100061/DEC 2007-12/10/07

Table 5.1 (b)
AM Peak Hour Intersection Operations – Year 2030 Conditions Scenario A (Internal Intersections)

#	Intersection	Control	Year 2030			Year 2030 plus Project			Impact?
			Delay	V/C Ratio	LOS	Delay	V/C Ratio	LOS	
20	Farrington Hwy./ B St.	Signal	-	-	-	30.2	0.69	C	N.A.
21	East-West Rd./ A St.	Signal	-	-	-	21.0	0.59	C	N.A.
22	Farrington Hwy./ Parkway/ 2nd Ave.	Signal	-	-	-	33.0	0.65	C	N.A.
23	Kunia Rd./ 2nd Ave.	OWSC	-	-	-	0.0 (NB)	0.76 (NB)	A	N.A.
24	Kunia Rd./ 3rd Ave.	OWSC	-	-	-	11.9 (EB)	0.01 (EB)	B	N.A.
25	East-West Rd./ B St.	Signal	-	-	-	27.3	0.82	C	N.A.
26	Farrington Hwy/Project Access Road to NW Parcel at N-S Road	Signal	-	-	-	17.8	0.65	B	N.A.

Source: Wilbur Smith Associates – 2007

NOTES:
OWSC – One-way Stop-Control
N.A. – Not Applicable
Signal – Traffic Signal
Delay represents average delay presented in seconds per vehicle.
Delay and LOS are presented for worst approach for two-way stop controlled intersections.
Bold type indicates LOS E or F.

Source: Wilbur Smith Associates – 2007

Table 5.1 (a)
AM Peak Hour Intersection Operations – Year 2030 Conditions Scenario A (External Intersections)

#	Intersection	Control	Year 2030			Year 2030 plus Project			Impact?
			Delay	V/C Ratio	LOS	Delay	V/C Ratio	LOS	
1	Kunia Rd./ Kunia Loop	Signal	12.8	0.70	B	15.7	0.78	B	No
2	Kunia Rd./ H-1 WB On-Ramp[A]	TWSC	3.3	0.47	A	4.5	0.58	A	No
3	Kunia Rd./ H-1 EB Ramps	Signal	8.9	0.37	A	8.4	0.52	A	No
4	Farrington Hwy./ Fort Weaver Rd. SB Ramps	Signal	5.2	0.41	A	9.9	0.66	A	No
5	Farrington Hwy./ Fort Weaver Rd. NB Ramps	Signal	3.0	0.48	A	25.4	0.92	C	No
6	Farrington Hwy./ Leokū St.	Signal	18.0	0.63	B	19.2	0.73	B	No
7	Fort Weaver Rd./ Laulaunui St.	Signal	29.8	0.90	C	42.6	0.99	D	No
8	Fort Weaver Rd./ Old Fort Weaver Rd.	Signal	16.7	0.89	B	**176.6**	**1.69**	**F**	**Yes**
9	Fort Weaver Rd./ Renton Rd.	Signal	**78.1**	**1.08**	**E**	**111.8**	**1.23**	**F**	**Yes**
10	Farrington Hwy./ East Old Fort Weaver Rd.[B]	TWSC	16.4 (WB)	0.21 (WB)	C	31.4	0.81	C	No
11	Farrington Hwy./ West Old Fort Weaver Rd.[B]	TWSC	22.0 (NB)	0.37 (NB)	C	17.2	0.62	B	No
12	Farrington Hwy./ Fort Barrette Rd.	Signal	**62.7**	**0.77**	**E**	**75.9**	**0.93**	**E**	**Yes**
13	North-South Rd./ H-1 WB Ramps	Signal	42.7	0.95	D	42.2	0.95	D	No
14	North-South Rd./ H-1 EB Ramps/	Signal	38.1	0.74	D	30.0	0.92	C	No
15	North-South Rd./ Farrington Hwy.	Signal	35.2	0.61	D	**76.7**	**1.04**	**E**	**Yes**
16	North-South Rd./ North UH Connector	Signal	7.3	0.39	A	38.6	0.87	D	No
17	North-South Rd./ East-West Rd.	Signal	27.0	0.63	C	37.0	0.79	D	No
18	North-South Rd./ Kapolei Pkwy.	Signal	34.8	0.75	C	43.1	0.86	D	No
19	East-West Rd./ Old Fort Weaver Rd.	Signal	22.3	0.24	C	14.3	0.61	B	No

NOTES:
A - This location is stop-controlled under existing conditions, but is signalized after meeting the traffic signal warrants under year 2030 conditions.
B - This location is stop-controlled under year 2030 conditions, but is signalized after meeting the traffic signal warrants under year 2030 plus project conditions.
TWSC – Two-way Stop-Control
Signal – Traffic Signal
Delay represents average delay presented in seconds per vehicle.
Delay and LOS are presented for worst approach for two-way stop controlled intersections.
Bold type indicates LOS E or F.

Table 5.2 (a)
PM Peak Hour Intersection Operations – Year 2030 Conditions Scenario A (External Intersections)

#	Intersection	Control	Year 2030			Year 2030 plus Project			Impact?
			Delay	V/C Ratio	LOS	Delay	V/C Ratio	LOS	
1	Kunia Rd./ Kunia Loop	Signal	17.1	0.90	B	36.8	1.05	D	No
2	Kunia Rd./ H-1 WB On-Ramp[A]	TWSC	14.1	0.92	B	18.6	1.03	B	No
3	Kunia Rd./ H-1 EB Ramps	Signal	8.8	0.85	A	11.3	0.90	B	No
4	Farrington Hwy./ Fort Weaver Rd. SB Ramps	Signal	14.0	0.42	B	10.0	0.80	B	No
5	Farrington Hwy./ Fort Weaver Rd. NB Ramps	Signal	8.0	0.83	A	**134.2**	**1.41**	**F**	Yes
6	Farrington Hwy./ Leokū St.	Signal	47.4	0.88	D	**61.9**	**1.05**	**E**	Yes
7	Fort Weaver Rd./ Laulaunui St.	Signal	26.3	0.89	C	44.9	1.01	D	No
8	Fort Weaver Rd./ Old Fort Weaver Rd.	Signal	45.0	1.03	D	**289.5**	**2.01**	**F**	Yes
9	Fort Weaver Rd./ Renton Rd.	Signal	**63.4**	**1.03**	**E**	**125.3**	**1.25**	**F**	Yes
10	Farrington Hwy./ East Old Fort Weaver Rd.[B]	TWSC	32.0 (WB)	0.71 (WB)	D	20.6	0.75	C	No
11	Farrington Hwy./ West Old Fort Weaver Rd.[B]	TWSC	55.4 (NB)	0.55 (NB)	F	25.9	0.88	C	No
12	Farrington Hwy./ Fort Barrette Rd.	Signal	**67.5**	**0.88**	**E**	**74.4**	**0.91**	**E**	Yes
13	North-South Rd./ H-1 WB Ramps	Signal	25.6	0.59	C	38.2	0.86	D	No
14	North-South Rd./ H-1 EB Ramps	Signal	15.7	0.62	B	**87.5**	**1.30**	**F**	Yes
15	North-South Rd./ Farrington Hwy.	Signal	35.8	0.76	D	**136.3**	**1.28**	**F**	Yes
16	North-South Rd./ North UH Connector	Signal	13.5	0.47	B	49.0	0.92	D	No
17	North-South Rd./ East-West Rd.	Signal	34.3	0.76	C	43.1	0.87	D	No
18	North-South Rd./ Kapolei Pkwy.	Signal	54.2	0.88	D	**58.5**	**0.95**	**E**	Yes
19	East-West Rd./ Old Fort Weaver Rd.	Signal	20.6	0.62	C	**62.6**	**0.56**	**E**	Yes

Source: Wilbur Smith Associates – 2007

NOTES:
A - This location is stop-controlled under existing conditions, but is signalized after meeting the traffic signal warrants under year 2030 conditions.
B - This location is stop-controlled under year 2030 conditions, but is signalized after meeting the traffic signal warrants under year 2030 plus project conditions.
TWSC – Two-way Stop-Control
Signal – Traffic Signal
Delay represents average delay presented in seconds per vehicle.
Delay and LOS are presented for worst approach for two-way stop controlled intersections.
Bold type indicates LOS E or F.

Under Year 2030 Baseline plus Project "With Transit Corridor Scenario" PM peak hour conditions, 9 of the 26 study intersections would operate under unacceptable conditions (LOS E or worse). The other 17 study intersections would operate at acceptable conditions (LOS D or better). The study intersections operating at LOS E or F in the PM peak hour are:

- Farrington Highway/ Fort Weaver Road Northbound Ramps
- Farrington Highway/ Leokū Street
- Fort Weaver Road/ Old Fort Weaver Road
- Fort Weaver Road/ Renton Road
- Farrington Highway/ Fort Barrette Road
- North-South Road/ H-1 Eastbound Ramps
- North-South Road/ Farrington Highway
- North-South Road/ Kapolei Parkway
- East-West Road/ Old Fort Weaver Road

Of these, five intersections would operate at LOS E and five intersections would operate at LOS F.

The Farrington Highway intersection with Fort Barrette Road would operate at LOS E without or with the Project and is not significantly impacted by the Project.

Of the 4 intersections operating at LOS E or F conditions during the AM peak hour, all 4 would also operate unacceptably during the PM peak hour. Therefore under the "With Transit Corridor Scenario", the project traffic would result in transportation impacts at a total of 9 intersections during one or both peak hours.

Synchro calculation worksheets under Year 2025 Baseline plus Project conditions "With Transit Corridor Scenario" are included in Appendix A-3; Figure 5-5A1, 5-5A2, 5-5A3, 5-5B1, 5-5B2, and 5-5B3 present the LOS and delay values of all the turning movements at the study intersections under Year 2030 Baseline plus Project "With Transit Corridor Scenario" AM and PM peak hour conditions.

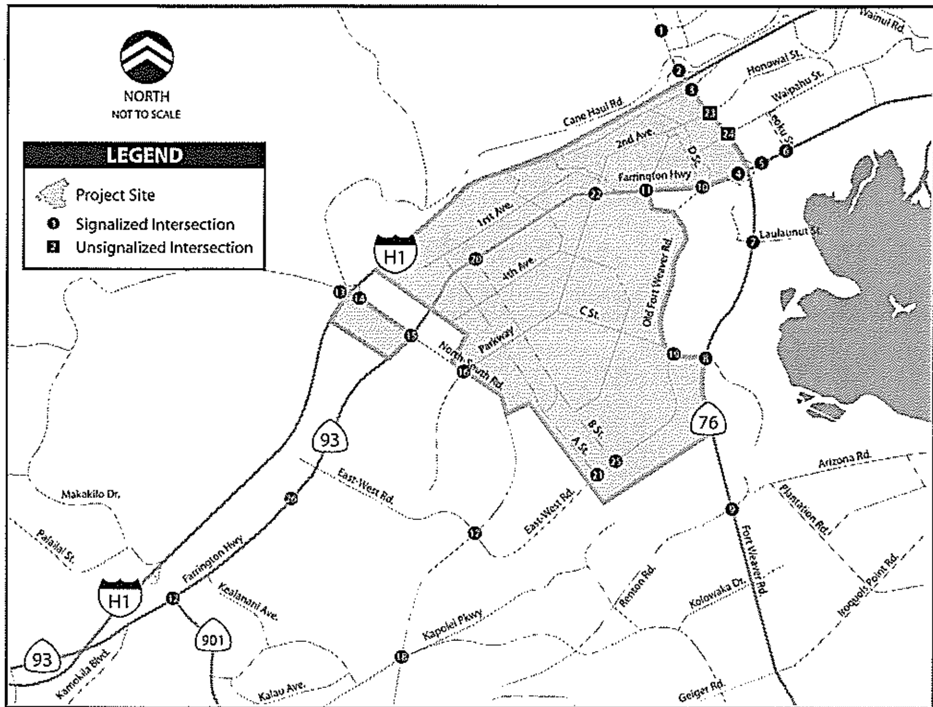

Figure 5-5A1
AM PEAK HOUR LOS & DELAY VALUES-YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO A: WITH TRANSIT CORRIDOR
100061/Draft October - 10/17/07

Table 5.2 (b)
PM Peak Hour Intersection Operations – Year 2030 Conditions Scenario A (Internal Intersections)

#	Intersection	Control	Year 2030			Year 2030 plus Project			Impact?
			Delay	V/C Ratio	LOS	Delay	V/C Ratio	LOS	
20	Farrington Hwy./ B St.	Signal	-	-	-	41.7	0.88	D	N.A.
21	East-West Rd./ A St.	Signal	-	-	-	17.5	0.61	B	N.A.
22	Farrington Hwy./ Parkway/ 2nd Ave.	Signal	-	-	-	**71.1**	**1.07**	**E**	N.A.
23	Kunia Rd./ 2nd Ave.	OWSC	-	-	-	0.0 (SB)	0.83 (SB)	A	N.A.
24	Kunia Rd./ 3rd Ave.	OWSC	-	-	-	0.0 (SB)	0.81 (SB)	A	N.A.
25	East-West Rd./ B St.	Signal	-	-	-	46.6	0.92	D	N.A.
26	Farrington Hwy/Project Access Road to NW Parcel at N-S Road	Signal	-	-	-	16.3	1.18	B	N.A.

Source: Wilbur Smith Associates – 2007

NOTES:
OWSC – All-way Stop-Control
N.A. – Not Applicable
Signal – Traffic Signal
Delay represents average delay presented in seconds per vehicle.
Delay and LOS are presented for worst approach for two-way stop controlled intersections.
Bold type indicates LOS E or F.

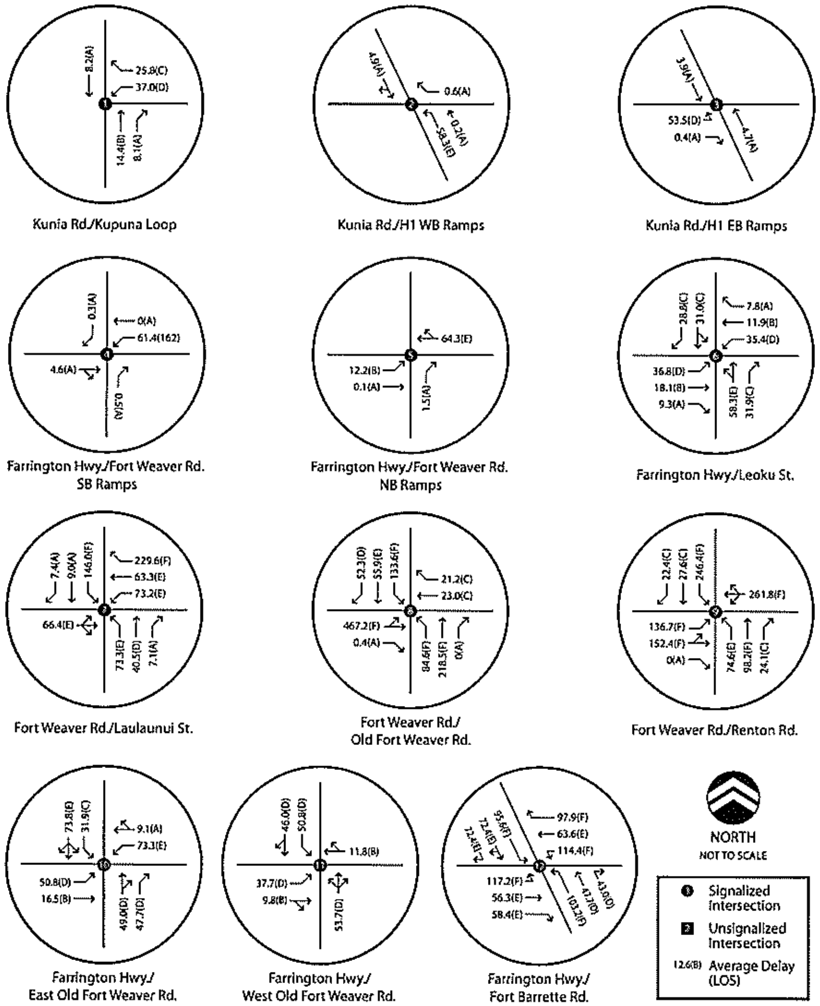

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Figure 5-5A2
AM PEAK HOUR LOS & DELAY VALUES-YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO A: WITH TRANSIT CORRIDOR
100061/Draft October - 10/19/07

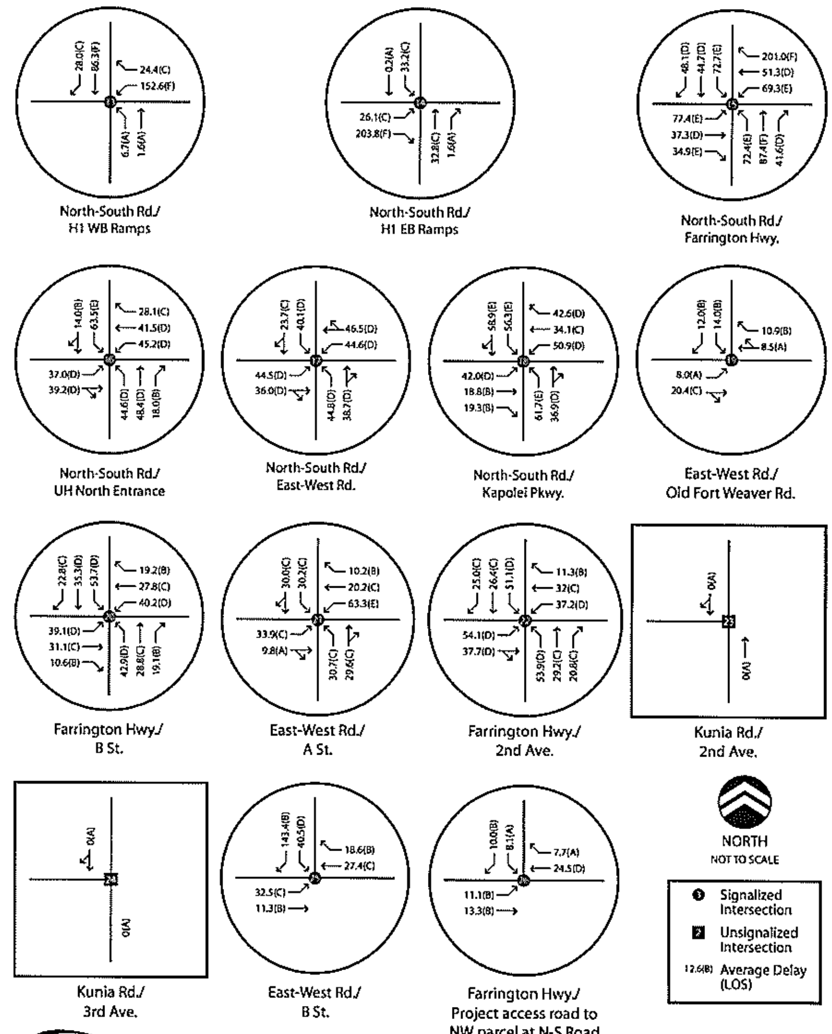

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Figure 5-5A3
AM PEAK HOUR LOS & DELAY VALUES-YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO A: WITH TRANSIT CORRIDOR
100061/DEC 2007-12/10/07

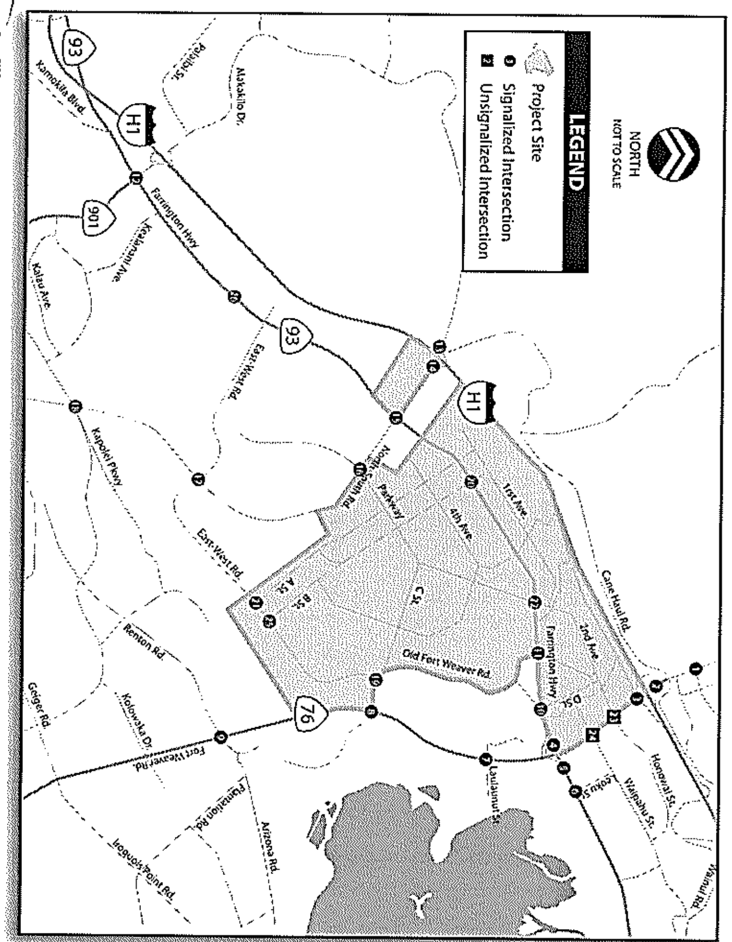

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Figure 5-5B1
PM PEAK HOUR LOS & DELAY VALUES-YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO A: WITH TRANSIT CORRIDOR
100061/Draft October - 10/17/07

HO'OPILI TIAR

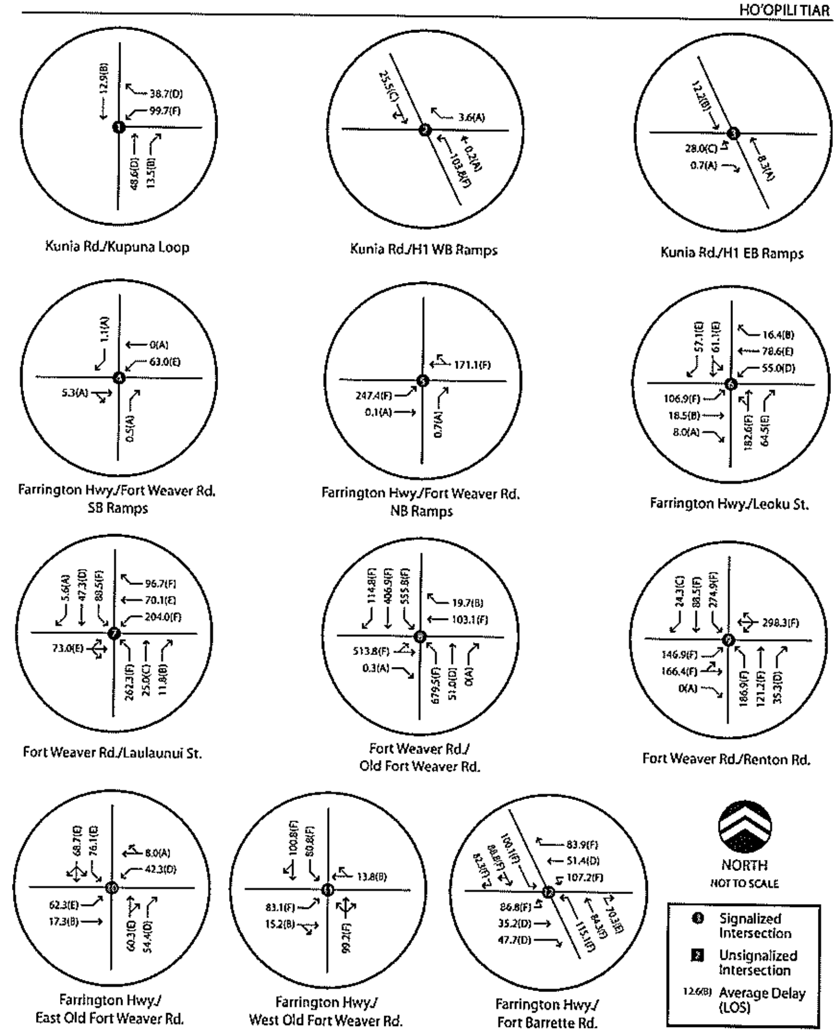

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Figure 5-5B2
PM PEAK HOUR LOS & DELAY VALUES-YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO A: WITH TRANSIT CORRIDOR
100061/DEC 2007-12/10/07

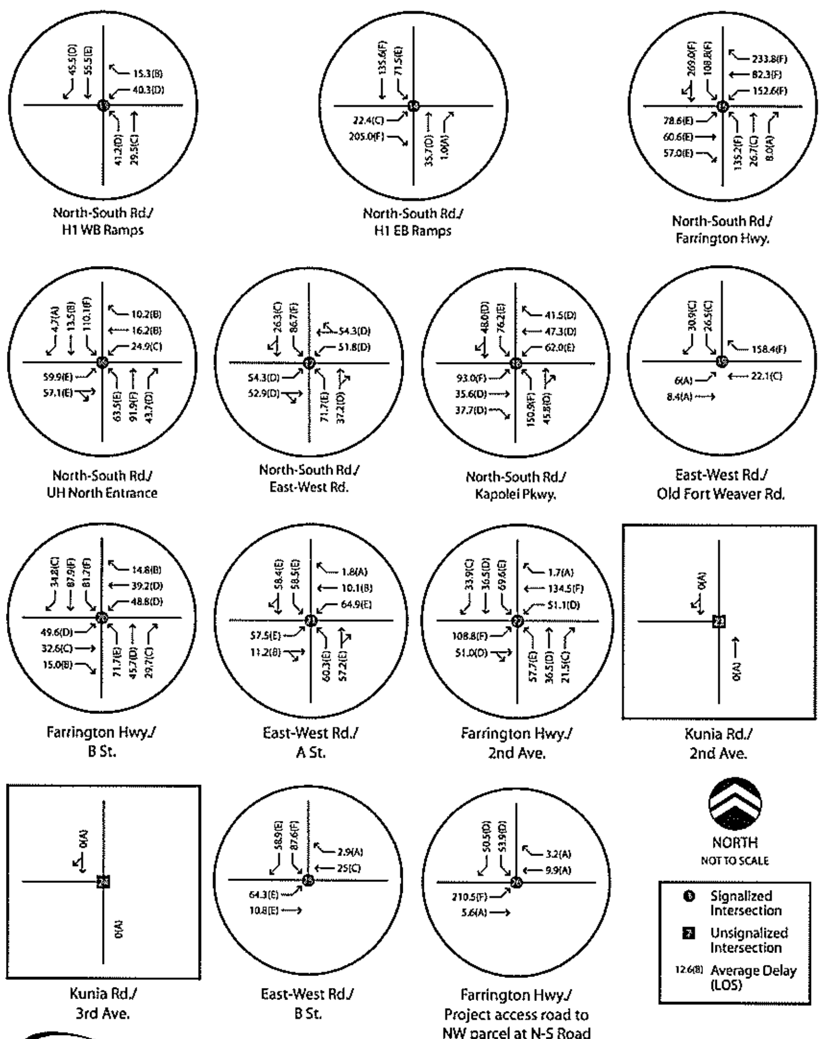

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Figure 5-5B3
PM PEAK HOUR LOS & DELAY VALUES-YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO A: WITH TRANSIT CORRIDOR

100061/DEC 2007-12/10/07

5.2.3 Freeway Operating Conditions – Scenario A

Figure 5-6 presents the freeway segment operations for Year 2030 Baseline plus Project conditions "With Transit Corridor Scenario" and Table 5.3 compares the freeway segment operations under Year 2030 Baseline plus Project conditions with that for the baseline Year 2030 conditions.

For the morning peak period, four freeway segments would operate under unacceptable conditions (LOS E or worse), of which freeway segments H-1 Eastbound south of Makakilo Drive and H-1 Eastbound west of Kunia Road would operate at LOS E and LOS F, respectively under both Year 2030 Baseline and Year 2030 Baseline plus Project "With Transit Corridor Scenario" conditions. The other two freeway segments that would operate at LOS E or F in the Year 2030 plus Project scenario are H-1 Eastbound west of Pāiwa Street, and H-1 Eastbound east of Kamehameha Highway.

For the afternoon peak period, 7 of the 10 study freeway segments would operate under unacceptable conditions (LOS E or worse). Of the seven, two freeway segments operate at LOS F under both Year 2030 Baseline and Year 2030 Baseline plus Project conditions. The other five freeway segments operating under unacceptable conditions are H-1 Eastbound south of Makakilo Drive, H-1 Eastbound west of Pāiwa Street, H-1 Eastbound east of Kamehameha Highway, H-1 Westbound west of Kunia Road, and H-1 Westbound east of Kamehameha Highway.

Therefore, the proposed Project would result in potential cumulative impacts under "With Transit Corridor Scenario" at the following five freeway segments:

- H-1 Eastbound (south of Makakilo Drive)
- H-1 Eastbound (west of Pāiwa Street)
- H-1 Eastbound (east of Kamehameha Highway)
- H-1 Westbound (west of Kunia Road)
- H-1 Westbound (east of Kamehameha Highway)

Table 5.3
Peak Hour Freeway Segment Operations – Year 2030 Conditions Scenario A

#	Freeway	Segment	Year 2030 Volume	Year 2030 Density	Year 2030 LOS	Year 2030 plus Project Volume	Year 2030 plus Project Density	Year 2030 plus Project LOS	Impact?
AM Peak									
1	H-1 EB	S/O Makakilo Dr.	5434	**37.8**	**E**	5892	**43.9**	**E**	No
2	H-1 EB	W/O Kunia Rd.	8197	**>45**	**F**	9143	**>45**	**F**	No
3	H-1 EB	W/O Pāiwa St.	9906	**43.4**	**E**	11906	**>45**	**F**	**Yes**
4	H-1 EB	E/O Kamehameha Hwy.	7512	**38.8**	**E**	8435	**>45**	**F**	**Yes**
5	H-2 NB	At Ka Uka Blvd.	3184	21.3	C	3597	24.1	C	No
6	H-1 WB	S/O Makakilo Dr.	3259	21.8	C	3756	25.1	C	No
7	H-1 WB	W/O Kunia Rd.	3735	18.3	C	4491	21.9	C	No
8	H-1 WB	W/O Pāiwa St.	4366	16.6	B	5858	22.3	C	No
9	H-1 WB	E/O Kamehameha Hwy.	3069	20.5	C	3757	25.1	C	No
10	H-2 SB	At Ka Uka Blvd.	6273	30.7	D	6581	32.5	D	No
PM Peak									
1	H-1 EB	S/O Makakilo Dr.	4680	31.3	D	5334	**36.7**	**E**	**Yes**
2	H-1 EB	W/O Kunia Rd.	5833	28.5	D	6891	34.5	D	No
3	H-1 EB	W/O Pāiwa St.	7137	27.2	D	9139	**37.0**	**E**	**Yes**
4	H-1 EB	E/O Kamehameha Hwy.	4249	28.4	D	5173	**35.2**	**E**	**Yes**
5	H-2 NB	At Ka Uka Blvd.	6220	**>45**	**F**	6663	**>45**	**F**	No
6	H-1 WB	S/O Makakilo Dr.	6365	**>45**	**F**	7022	**>45**	**F**	No
7	H-1 WB	W/O Kunia Rd.	7860	**43.3**	**E**	8875	**>45**	**F**	**Yes**
8	H-1 WB	W/O Pāiwa St.	7931	25.2	C	10131	32.9	D	No
9	H-1 WB	E/O Kamehameha Hwy.	7766	**42.2**	**E**	8781	**>45**	**F**	**Yes**
10	H-2 SB	At Ka Uka Blvd.	4616	22.5	C	5070	24.8	C	No

Source: Wilbur Smith Associates, 2007

NOTES:
Density is given in pc/mi/ln.
Bold represents LOS E or F.

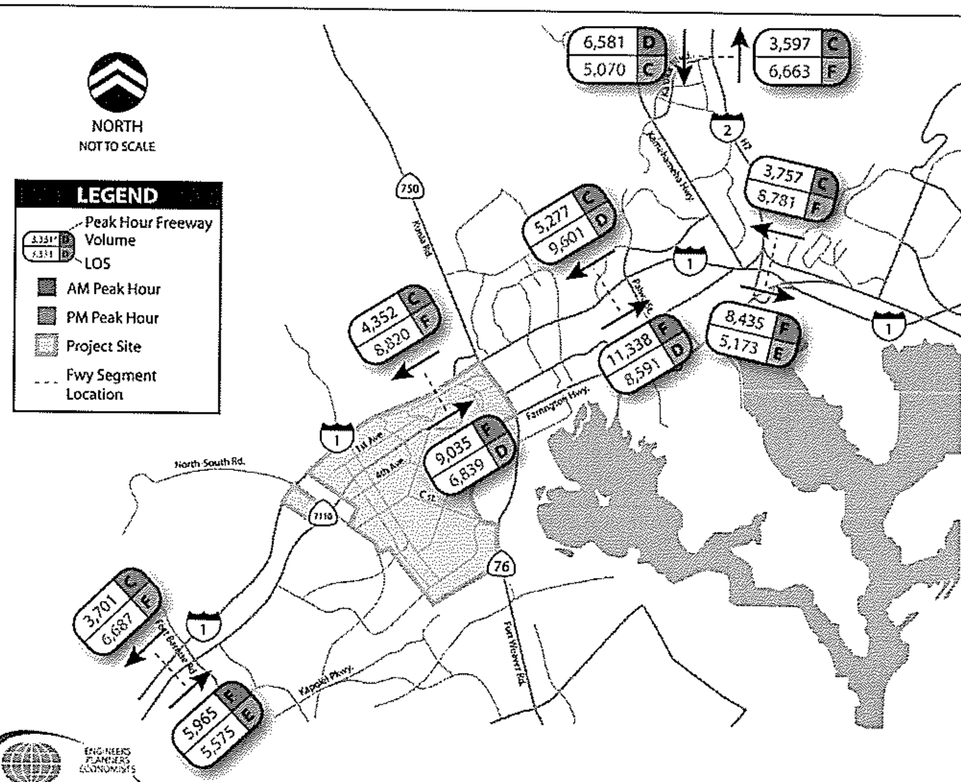

Figure 5-6
YEAR 2030 PLUS PROJECT FREEWAY OPERATING CONDITIONS
SCENARIO A: WITH TRANSIT CORRIDOR

5.2.4 Freeway-Ramp Junction Operating Conditions – Scenario A

Table 5.4 presents the density and LOS values of the study ramp-freeway junctions under Year 2030 Baseline plus Project "With Transit Corridor Scenario". The North-South Road Interchange ramps were analyzed based on the planned initial diamond-type interchange configuration (Refer to Appendix E-2). Additionally, it should be noted that the analysis for the North-South Road Interchange was based on a ramp acceleration/deceleration lane length of 500 ft (in the absence of detailed information).

During Year 2030 plus Project "With Transit Corridor Scenario" AM peak hour, 7 of the 10 ramp-freeway junctions would operate under acceptable conditions (LOS D or better) with the Project. The four ramp-freeway junctions that would operate at LOS E or F conditions are: H-1/ Fort Weaver Road (Eastbound Off-Ramp), H-1/ Fort Weaver Road (Eastbound On-Ramp), and H-1/ North-South Road (Eastbound On-Ramp).

Similar to the AM peak hour, 7 of the 10 study ramp-freeway junctions would operate under acceptable conditions (LOS D or better) during the PM peak hour. The remaining three ramp-freeway junctions that would operate under unacceptable conditions (LOS E or F) are: H-1/ Fort Weaver Road (Westbound Loop Off-Ramp), H-1/ Fort Weaver Road (Eastbound On-Ramp), and H-1/ Fort Weaver Road (Westbound On-Ramp). Two of these ramp-freeway junctions would worsen to unacceptable levels with the addition of the Project traffic:

- H-1/ Fort Weaver Road (Eastbound On-Ramp)
- H-1/ North-South Road (Westbound On-Ramp)

In considering both peak hours, the Project would significantly affect conditions at a total of five ramp junctions:

- H-1/ Fort Weaver Road (Westbound Loop Off-Ramp)
- H-1/ Fort Weaver Road (Eastbound Off-Ramp)
- H-1/ Fort Weaver Road (Eastbound On-Ramp)
- H-1/ North-South Road (Westbound On-Ramp)
- H-1/ North-South Road (Eastbound On-Ramp)

Table 5.4
Peak Hour Ramp-Freeway Junction Operations – Year 2030 Conditions Scenario A

#	Location	Ramps	Peak Hour	2030 Baseline		2030 Scenario A	
				Density[1]	LOS	Density	LOS
1	H-1/ Fort Weaver Road	WB Off-Ramp	AM Peak	16.0	B	16.0	B
2	H-1/ Fort Weaver Road	WB Loop Off-Ramp	AM Peak	1.3	A	8.2	A
3	H-1/ Fort Weaver Road	WB On-Ramp	AM Peak	15.0	B	15.7	B
4	H-1/ Fort Weaver Road	EB Off-Ramp	AM Peak	37.4	E	38.9	**F**
5	H-1/ Fort Weaver Road	EB On-Ramp	AM Peak	24.8	**F**	36.1	**F**
6	H-1/ Fort Weaver Road	EB Loop On-Ramp	AM Peak	26.3	**F**	26.3	**F**
7	H-1/ North-South Road	WB Off-Ramp	AM Peak	20.3	C	26.3	C
8	H-1/ North-South Road	WB On-Ramp	AM Peak	13.5	B	16.9	B
9	H-1/ North-South Road	EB Off-Ramp	AM Peak	25.0	C	29.1	D
10	H-1/ North-South Road	EB On-Ramp	AM Peak	28.8	D	38.3	**F**
1	H-1/ Fort Weaver Road	WB Off-Ramp	PM Peak	38.0	**F**	38.0	**F**
2	H-1/ Fort Weaver Road	WB Loop Off-Ramp	PM Peak	19.9	**F**	30.7	**F**
3	H-1/ Fort Weaver Road	WB On-Ramp	PM Peak	26.0	C	26.3	C
4	H-1/ Fort Weaver Road	EB Off-Ramp	PM Peak	28.8	D	31.1	D
5	H-1/ Fort Weaver Road	EB On-Ramp	PM Peak	18.3	B	29.3	**F**
6	H-1/ Fort Weaver Road	EB Loop On-Ramp	PM Peak	20.4	C	20.4	C
7	H-1/ North-South Road	WB Off-Ramp	PM Peak	41.1	**F**	49.3	**F**
8	H-1/ North-South Road	WB On-Ramp	PM Peak	27.7	C	27.1	**F**
9	H-1/ North-South Road	EB Off-Ramp	PM Peak	21.0	C	27.3	C
10	H-1/ North-South Road	EB On-Ramp	PM Peak	17.0	B	25.8	C

Source: Wilbur Smith Associates, 2007

NOTES:
DEC – Demand Exceeds Capacity
Density is presented in pc/mi/ln.
Bold type indicates LOS F.

1 – Lower density does not necessarily indicate a lower LOS. This is because the LOS is calculated based upon a number of factors including: merge influence area, length of the acceleration lane, etc. See Appendix F for the HCM methodology used to calculate the LOS for Freeway Segments.

5.3 SCENARIO B: WITHOUT TRANSIT CORRIDOR

5.3.1 Project Study Area – Scenario B

Under Year 2025 Baseline plus Project conditions "Without Transit Corridor Scenario" (Scenario B), the study area and the proposed geometric configurations of 15 new study intersections as well as three modified study intersections would remain same as discussed in *Section 5.1.1* under Year 2025 Baseline plus Project conditions "With Transit Corridor Scenario" (Figures 5-2 and 5-3).

5.3.2 Intersection Operating Conditions – Scenario B

The intersection turning movement volumes under Year 2030 Baseline plus Project conditions "Without Transit Corridor Scenario" are exhibited in Figure 5-7 A, 5-7 B, and 5-7 C .

The intersection operations under Year 2030 Baseline plus Project conditions "Without Transit Corridor Scenario" are presented in Tables 5.5 and 5.6. The LOS and delay values of the study intersections located outside the proposed project site (external intersections) are exhibited in Table 5.5 (a) and 5.6 (a) for AM and PM peak hour conditions respectively, while Tables 5.5 (b) and 5.6 (b) display the operations of the study intersections located within the proposed project site (internal intersections) for AM and PM peak hour conditions.

During the AM peak period, the intersection operations under "Without Transit Corridor Scenario" are similar to that under "With Transit Scenario." Of the 26 study intersections, 20 would operate under acceptable conditions (LOS D or better) and the following six intersections would operate at LOS E or F:

- Fort Weaver Road/ Old Fort Weaver Road
- Fort Weaver Road/ Renton Road
- Farrington Highway/Fort Barrette Road
- North-South Road/ H-1 Westbound Ramps
- North-South Road/ Farrington Highway
- North-South Road/ Kapolei Parkway

During the PM peak period, the intersection operations under "Without Transit Corridor Scenario" marginally worsen compared to "With Transit Scenario." Of the 26 study intersections, 17 would operate under acceptable conditions (LOS D or better) and the following nine intersections would operate at LOS E or F:

- Farrington Hwy/ Fort Weaver Road Northbound Ramps
- Farrington Hwy/ Leokū Street
- Fort Weaver Road/ Laulaunui Street
- Fort Weaver Road/ Old Fort Weaver Road
- Fort Weaver Road/ Renton Road
- Farrington Highway/Fort Barrette Road
- North-South Road/ H-1 Eastbound Ramps
- North-South Road/ Farrington Highway
- North-South Road/ Kapolei Parkway

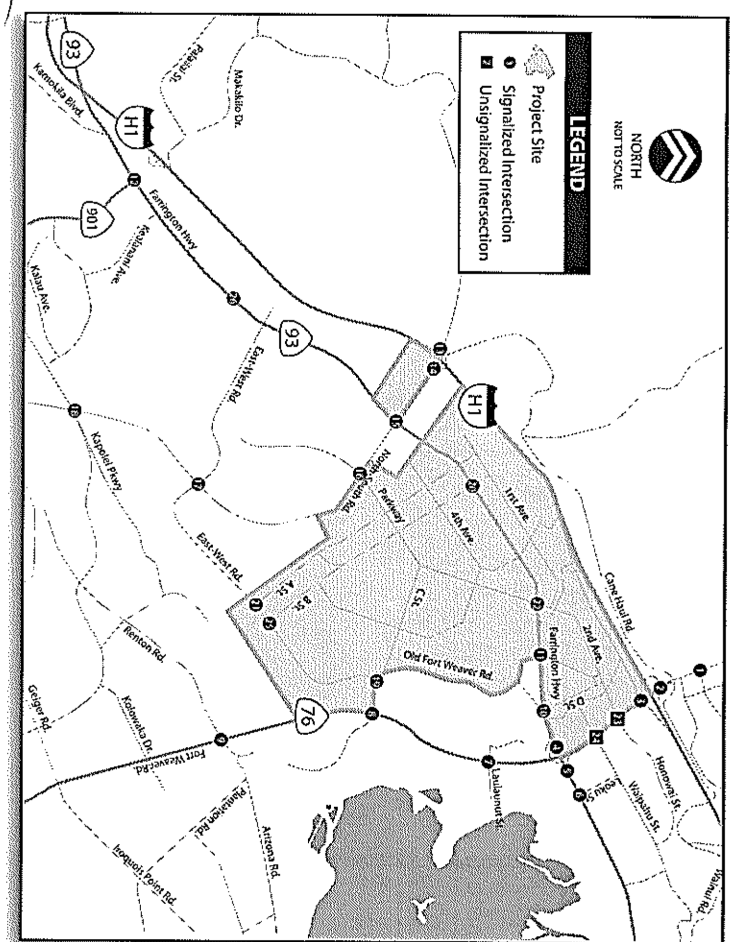

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Figure 5-7A
PEAK HOUR INTERSECTION VOLUMES-YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO B: WITHOUT TRANSIT CORRIDOR

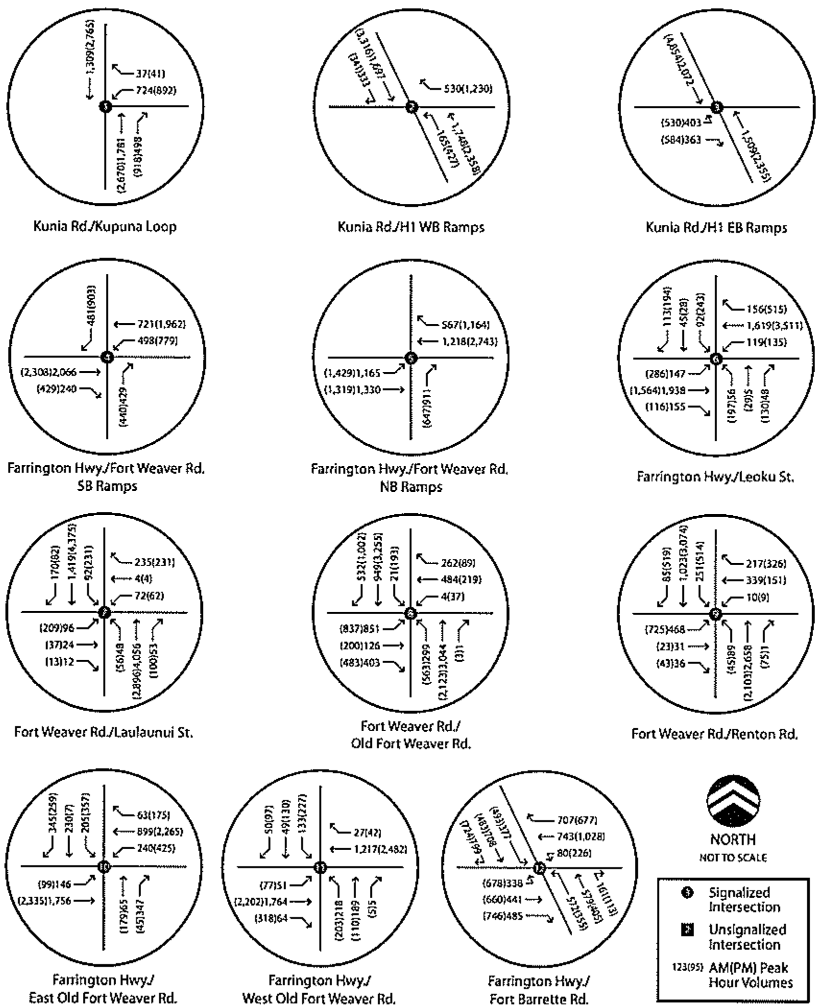

Figure 5-7B
PEAK HOUR INTERSECTION VOLUMES-YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO B: WITHOUT TRANSIT CORRIDOR

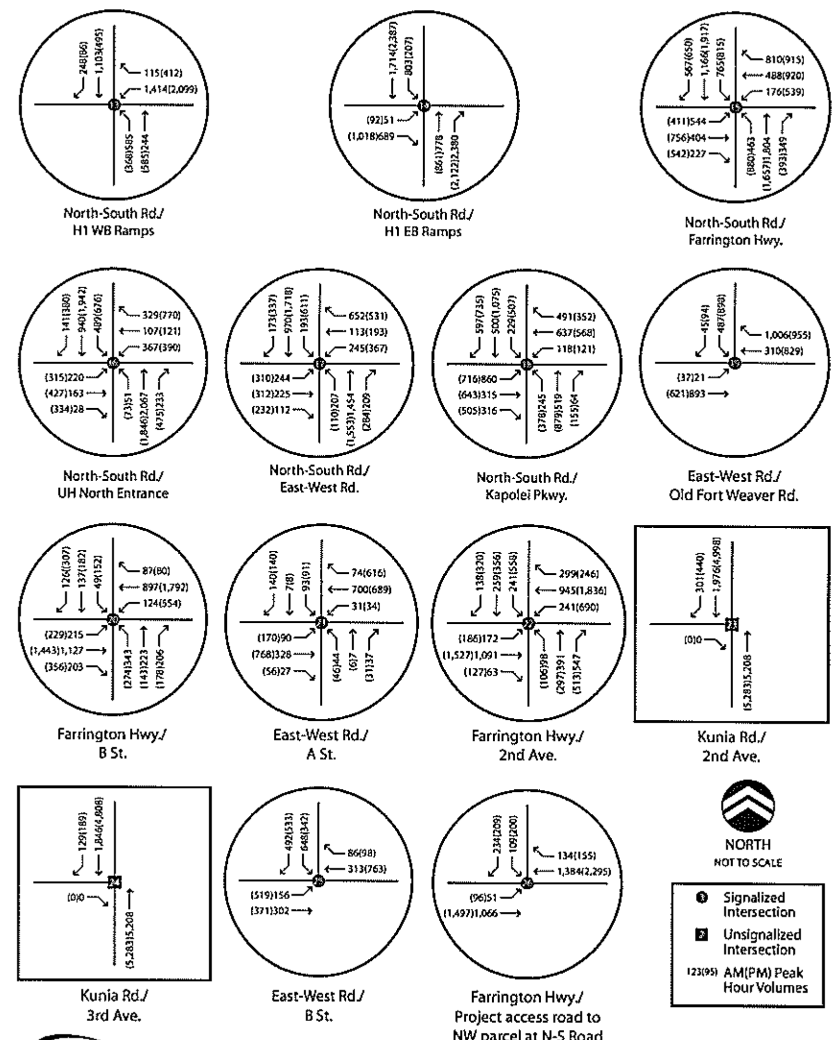

Figure 5-7C
PEAK HOUR INTERSECTION VOLUMES-YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO B: WITHOUT TRANSIT CORRIDOR

Table 5.5 (b)
AM Peak Hour Intersection Operations – Year 2030 Conditions Scenario B (Internal Intersections)

#	Intersection	Control	Year 2030			Year 2030 plus Project			Impact?
			Delay	V/C Ratio	LOS	Delay	V/C Ratio	LOS	
20	Farrington Hwy./ B St.	Signal	-	-	-	30.6	0.71	C	N.A.
21	East-West Rd./ A St.	Signal	-	-	-	24.6	0.69	C	N.A.
22	Farrington Hwy./ Parkway/ 2nd Ave.	Signal	-	-	-	33.2	0.66	C	N.A.
23	Kunia Rd./ 2nd Ave.	OWSC	-	-	-	0.0 (NB)	0.83 (NB)	A	N.A.
24	Kunia Rd./ 3rd Ave.	OWSC	-	-	-	12.3 (EB)	0.02 (EB)	B	N.A.
25	East-West Rd./ B St.	Signal	-	-	-	23.9	0.84	C	N.A.
26	Farrington Hwy/Project Access Road to NW Parcel at N-S Road	Signal	-	-	-	18.3	0.66	B	N.A.

Source: Wilbur Smith Associates – 2007

NOTES:
AWSC – All-way Stop-Control
TWSC – Two-way Stop-Control
N.A. – Not Applicable
Signal – Traffic Signal
Delay represents average delay presented in seconds per vehicle.
Delay and LOS are presented for worst approach for two-way stop controlled intersections.
Bold type indicates LOS E or F.

Table 5.5 (a)
AM Peak Hour Intersection Operations – Year 2030 Conditions Scenario B (External Intersections)

#	Intersection	Control	Year 2030			Year 2030 plus Project			Impact?
			Delay	V/C Ratio	LOS	Delay	V/C Ratio	LOS	
1	Kunia Rd./ Kunia Loop	Signal	12.8	0.70	B	17.9	0.85	B	No
2	Kunia Rd./ H-1 WB On-Ramp[A]	TWSC	3.3	0.47	A	4.5	0.59	A	No
3	Kunia Rd./ H-1 EB Ramps	Signal	8.9	0.37	A	8.4	0.52	A	No
4	Farrington Hwy./ Fort Weaver Rd. SB Ramps	Signal	5.2	0.41	A	10.3	0.71	B	No
5	Farrington Hwy./ Fort Weaver Rd. NB Ramps	Signal	3.0	0.48	A	38.4	1.07	D	No
6	Farrington Hwy./ Leokū St.	Signal	18.0	0.63	B	23.6	0.66	C	No
7	Fort Weaver Rd./ Laulaunui St.	Signal	29.8	0.90	C	53.9	1.03	D	No
8	Fort Weaver Rd./ Old Fort Weaver Rd.	Signal	16.7	0.89	B	**268.8**	**2.43**	**F**	**Yes**
9	Fort Weaver Rd./ Renton Rd.	Signal	**78.1**	**1.08**	**E**	**114.8**	**1.24**	**F**	**Yes**
10	Farrington Hwy./ East Old Fort Weaver Rd.[B]	TWSC	16.4 (WB)	0.21 (WB)	C	40.1	0.91	D	No
11	Farrington Hwy./ West Old Fort Weaver Rd.[B]	TWSC	22.0 (NB)	0.37 (NB)	C	24.8	0.77	C	No
12	Farrington Hwy./ Fort Barrette Rd.	Signal	**62.7**	**0.77**	**E**	**71.6**	**0.90**	**E**	**Yes**
13	North-South Rd./ H-1 WB Ramps	Signal	32.4	0.68	C	**99.4**	**1.00**	**F**	**Yes**
14	North-South Rd./ H-1 EB Ramps	Signal	38.1	0.74	D	37.3	0.98	D	No
15	North-South Rd./ Farrington Hwy.	Signal	35.2	0.61	D	**105.4**	**1.23**	**F**	**Yes**
16	North-South Rd./ North UH Connector	Signal	7.3	0.39	A	33.4	0.76	C	No
17	North-South Rd./ East-West Rd.	Signal	27.0	0.63	C	40.8	0.77	D	No
18	North-South Rd./ Kapolei Pkwy.	Signal	34.8	0.75	C	**62.7**	**0.92**	**E**	**Yes**
19	East-West Rd./ Old Fort Weaver Rd.	Signal	22.3	0.24	C	14.1	0.74	B	No

Source: Wilbur Smith Associates – 2007

NOTES:
A - This location is stop-controlled under existing conditions, but is signalized after meeting the traffic signal warrants under year 2030 conditions.
B - This location is stop-controlled under year 2030 conditions, but is signalized after meeting the traffic signal warrants under year 2030 plus project conditions.
TWSC – Two-way Stop-Control
Signal – Traffic Signal
Delay represents average delay presented in seconds per vehicle.
Delay and LOS are presented for worst approach for two-way stop controlled intersections.
Bold type indicates LOS E or F.

Table 5.6 (b)
PM Peak Hour Intersection Operations – Year 2030 Conditions Scenario B (Internal Intersections)

#	Intersection	Control	Year 2030			Year 2030 plus Project			Impact?
			Delay	V/C Ratio	LOS	Delay	V/C Ratio	LOS	
20	Farrington Hwy./ B St.	Signal	-	-	-	38.4	0.87	D	N.A.
21	East-West Rd./ A St.	Signal	-	-	-	26.2	0.74	C	N.A.
22	Farrington Hwy./ Parkway/ 2nd Ave.	Signal	-	-	-	42.8	0.97	D	N.A.
23	Kunia Rd./ 2nd Ave.	OWSC	-	-	-	0.0 (SB)	0.91 (SB)	A	N.A.
24	Kunia Rd./ 3rd Ave.	OWSC	-	-	-	0 (SB)	0.12 (SB)	A	N.A.
25	East-West Rd./ B St.	Signal	-	-	-	60.8	1.01	E	N.A.
26	Farrington Hwy/Project Access Road to NW Parcel at N-S Road	Signal	-	-	-	17.0	1.21	B	N.A.

Source: Wilbur Smith Associates – 2007

NOTES:
AWSC – All-way Stop-Control
TWSC – Two-way Stop-Control
N.A. – Not Applicable
Signal – Traffic Signal
Delay represents average delay presented in seconds per vehicle.
Delay and LOS are presented for worst approach for two-way stop controlled intersections.
Bold type indicates LOS E or F.

Table 5.6 (a)
PM Peak Hour Intersection Operations – Year 2030 Conditions Scenario B (External Intersections)

#	Intersection	Control	Year 2030			Year 2030 plus Project			Impact?
			Delay	V/C Ratio	LOS	Delay	V/C Ratio	LOS	
1	Kunia Rd./ Kunia Loop	Signal	17.1	0.90	B	40.1	1.04	D	No
2	Kunia Rd./ H-1 WB On-Ramp[A]	TWSC	14.1	0.92	B	15.4	0.97	B	No
3	Kunia Rd./ H-1 EB Ramps	Signal	8.8	0.85	A	19.4	0.93	B	No
4	Farrington Hwy./ Fort Weaver Rd. SB Ramps	Signal	14.0	0.42	B	9.4	0.78	A	No
5	Farrington Hwy./ Fort Weaver Rd. NB Ramps	Signal	8.0	0.83	A	**221.0**	**1.65**	**F**	**Yes**
6	Farrington Hwy./ Leokū St.	Signal	47.4	0.88	D	**57.6**	**1.01**	**E**	**Yes**
7	Fort Weaver Rd./ Laulaunui St.	Signal	26.3	0.89	C	**56.3**	**1.05**	**E**	**Yes**
8	Fort Weaver Rd./ Old Fort Weaver Rd.	Signal	45.0	1.03	D	**322.9**	**2.17**	**F**	**Yes**
9	Fort Weaver Rd./ Renton Rd.	Signal	**63.4**	**1.03**	E	**130.6**	**1.30**	**F**	**Yes**
10	Farrington Hwy./ East Old Fort Weaver Rd.[B]	TWSC	32.0 (WB)	0.71 (WB)	D	40.9	0.91	D	No
11	Farrington Hwy./ West Old Fort Weaver Rd.[B]	TWSC	55.4 (NB)	0.55 (NB)	F	30.5	0.89	C	No
12	Farrington Hwy./ Fort Barrette Rd.	Signal	**67.5**	**0.88**	E	**67.0**	**0.86**	**E**	**Yes**
13	North-South Rd./ H-1 WB Ramps	Signal	25.6	0.59	C	54.0	0.94	D	No
14	North-South Rd./ H-1 EB Ramps	Signal	15.7	0.62	B	**105.4**	**1.39**	**F**	**Yes**
15	North-South Rd./ Farrington Hwy.	Signal	35.8	0.76	D	**117.1**	**1.27**	**F**	**Yes**
16	North-South Rd./ North UH Connector	Signal	13.5	0.47	B	50.3	0.94	D	No
17	North-South Rd./ East-West Rd.	Signal	34.3	0.76	C	45.9	0.85	D	No
18	North-South Rd./ Kapolei Pkwy.	Signal	54.2	0.88	D	**68.3**	**0.95**	**E**	**Yes**
19	East-West Rd./ Old Fort Weaver Rd.	Signal	20.6	0.62	C	13.6	0.72	B	No

Source: Wilbur Smith Associates – 2007

NOTES:
A - This location is stop-controlled under existing conditions, but is signalized after meeting the traffic signal warrants under year 2030 conditions.
B - This location is stop-controlled under year 2030 conditions, but is signalized after meeting the traffic signal warrants under year 2030 plus project conditions.
TWSC – Two-way Stop-Control
Signal – Traffic Signal
Delay represents average delay presented in seconds per vehicle.
Delay and LOS are presented for worst approach for two-way stop controlled intersections.
Bold type indicates LOS E or F.

Overall, in considering both peak hours, under Year 2030 Baseline plus Project conditions "Without Transit Corridor Scenario", 10 of the 26 study intersections would operate under unacceptable conditions (LOS E or worse). The other 16 study intersections would operate under acceptable conditions (LOS D or better). The study intersections operating at LOS E or F are:

- Farrington Highway/ Fort Weaver Road Northbound Ramps
- Farrington Highway / Leokū Street
- Fort Weaver Road/ Laulaunui Street
- Fort Weaver Road/ Old Fort Weaver Road
- Fort Weaver Road/ Renton Road
- Farrington Highway/Fort Barrette Road
- North-South Road/ H-1 Eastbound Ramps
- North-South Road/ Farrington Highway
- North-South Road/ Kapolei Parkway

Intersections Farrington Highway/ Leokū Street, Fort Weaver Road/ Laulaunui Street, Farrington Highway/Fort Barrette Road, and North-South Road/ Kapolei Parkway would operate at LOS E, while the remaining 6 intersections would operate at LOS F.

Of the 10 intersections operating under unacceptable conditions during the PM peak hour, six intersections also operate unacceptably during the AM peak hour. Even though the Fort Weaver Road/ Old Fort Weaver Road intersection would operate at LOS F under both Year 2030 Baseline and Year 2030 Baseline plus Project "Without Transit Corridor Scenario" conditions, the difference in volume-to-capacity ratio is greater than 10 percent. Therefore under "Without Transit Corridor Scenario", the proposed Project would result in transportation impacts at all 10 intersections operating under unacceptable conditions during the PM peak period. A detailed description is presented in *Section 6.2.2*.

Synchro calculation worksheets under Year 2030 Baseline plus Project conditions "Without Transit Corridor Scenario" are included in Appendix A-4; whereas, Figures 5-8A1, 5-8A2, 5-8A3, 5-8B1, 5-8B2, and 5-8B3 present the LOS and delay values of all the turning movements at the study intersections under Year 2030 Baseline plus Project "Without Transit Corridor Scenario" AM and PM peak hour conditions.

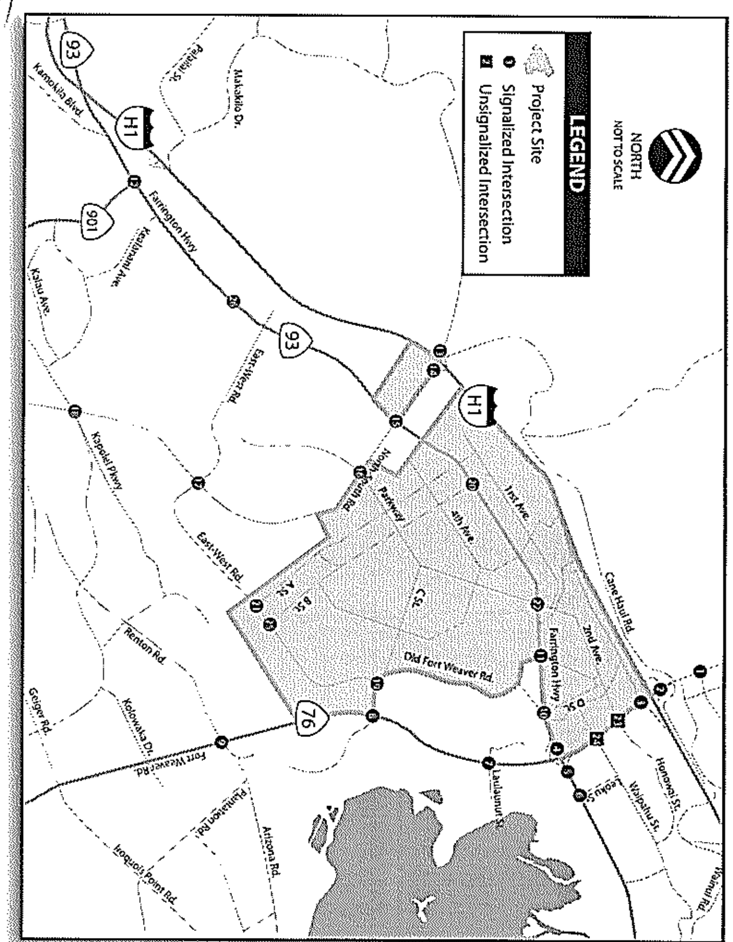

Figure 5-8A1
AM PEAK HOUR LOS & DELAY VALUES-YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO B: WITHOUT TRANSIT CORRIDOR
100061/Draft October - 10/17/07

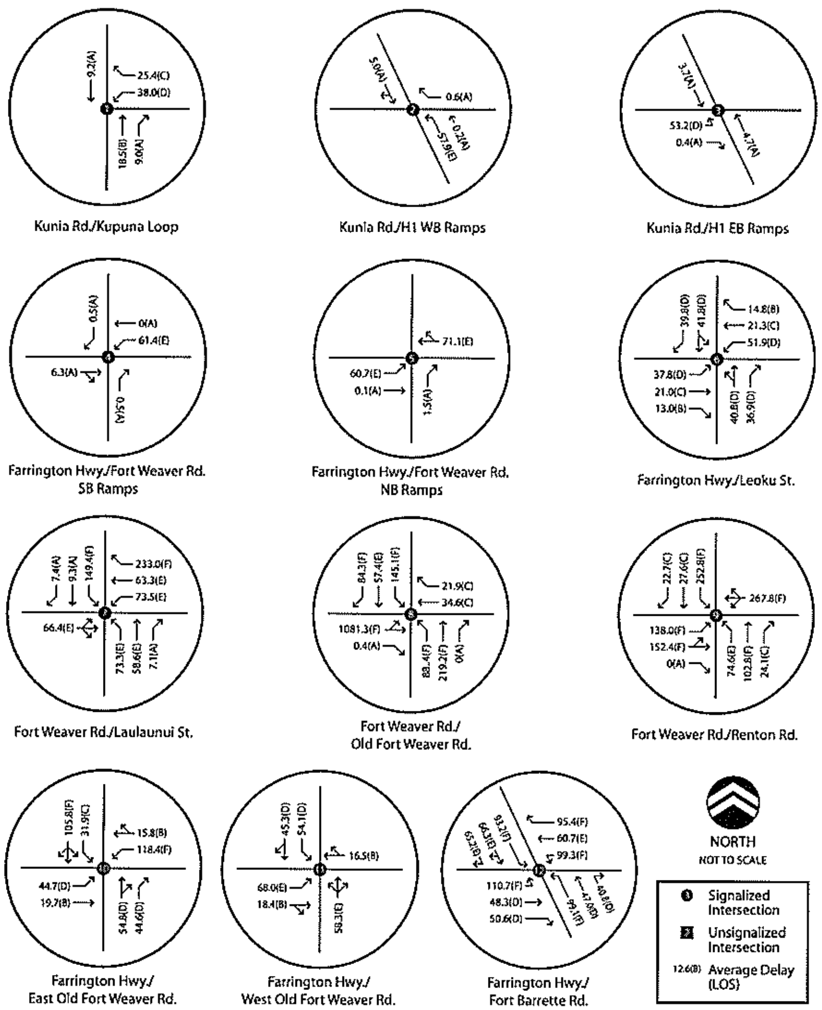

Figure 5-8A2
AM PEAK HOUR LOS & DELAY VALUES-YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO B: WITHOUT TRANSIT CORRIDOR

HO'OPILI TIAR

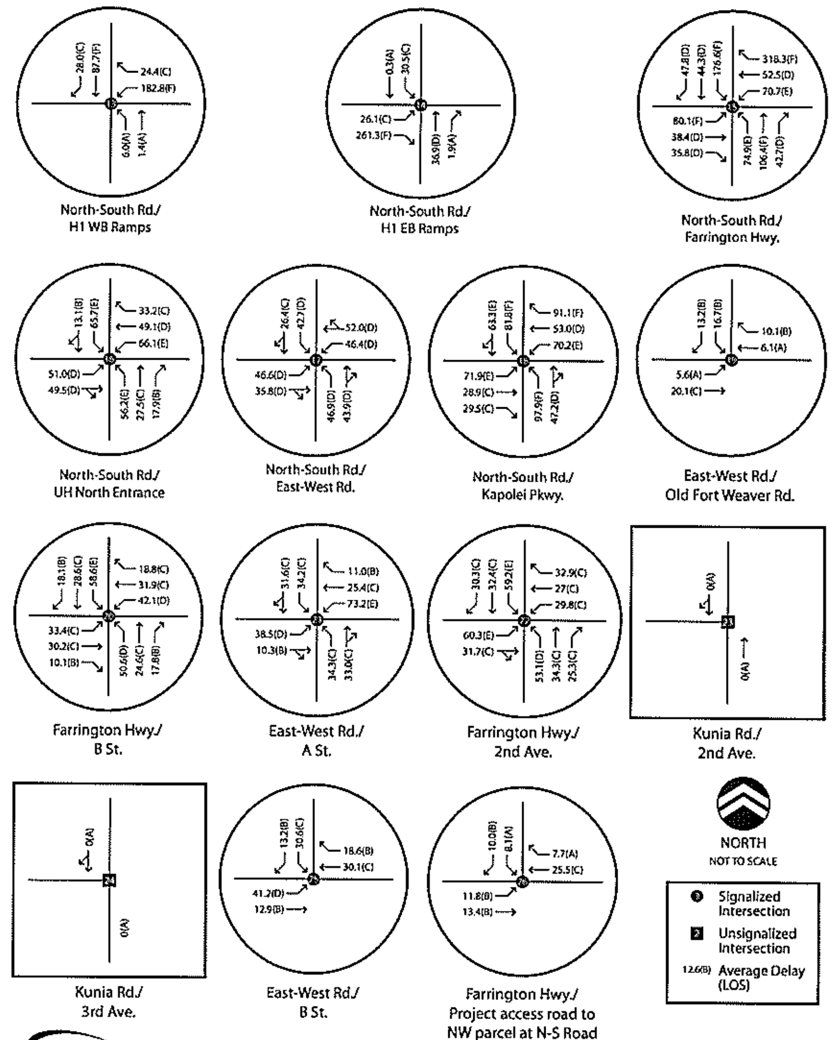

Figure 5-8A3
AM PEAK HOUR LOS & DELAY VALUES-YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO B: WITHOUT TRANSIT CORRIDOR

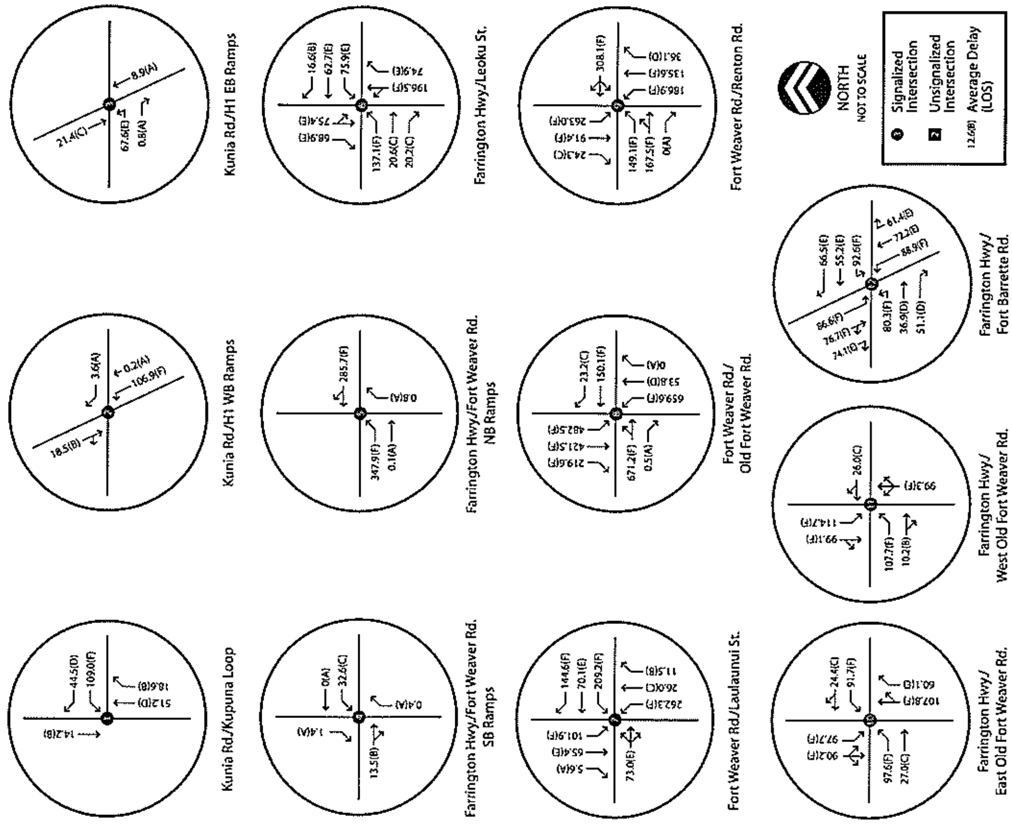

Figure 5-8B2
PM PEAK HOUR LOS & DELAY VALUES-YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO B: WITHOUT TRANSIT CORRIDOR
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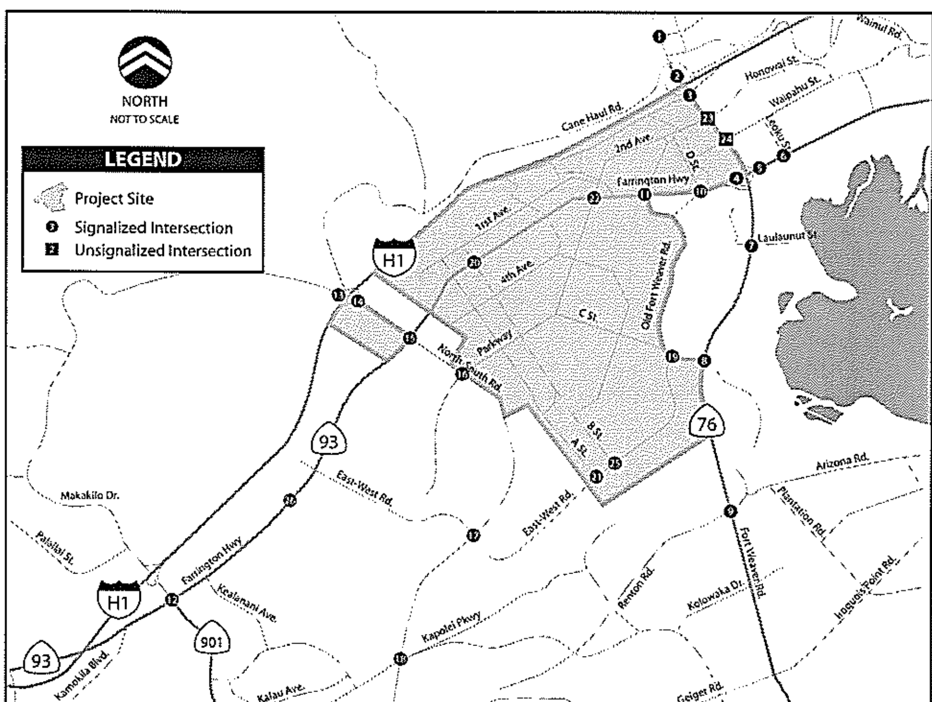

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Figure 5-8B1
PM PEAK HOUR LOS & DELAY VALUES-YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO B: WITHOUT TRANSIT CORRIDOR
100061/Draft October - 10/17/07

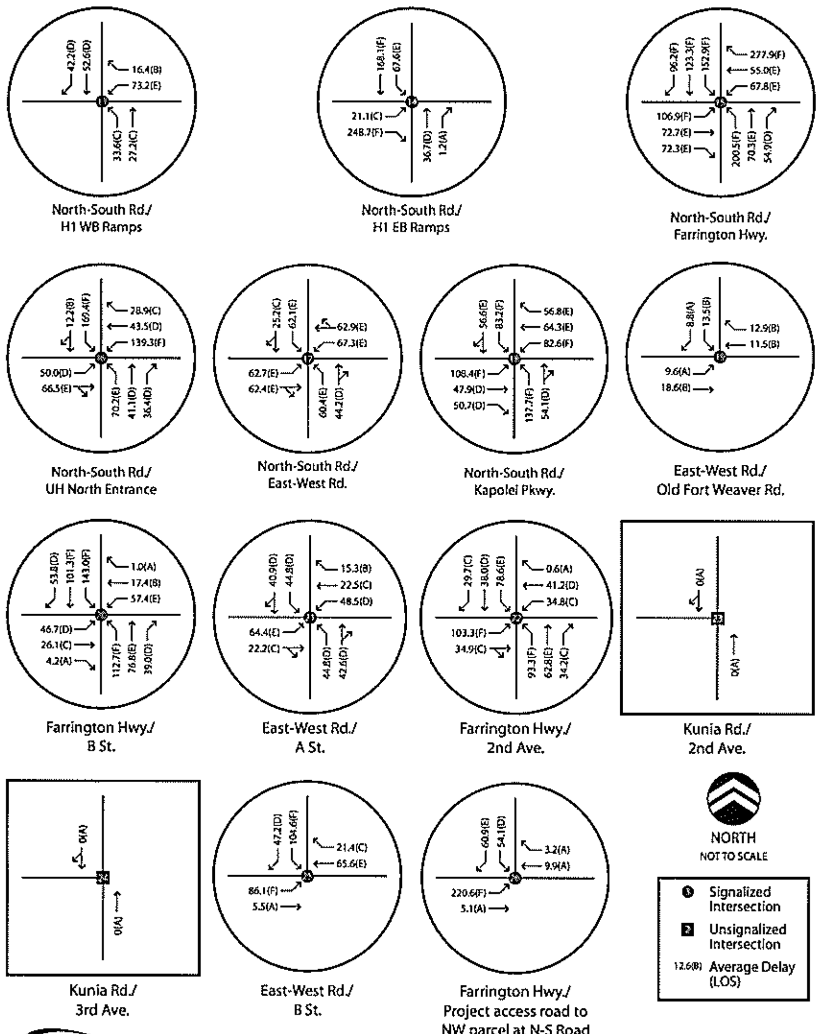

Figure 5-8B3
PM PEAK HOUR LOS & DELAY VALUES-YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO B: WITHOUT TRANSIT CORRIDOR

100061/DEC 2007-12/10/07

5.3.3 Freeway Operating Conditions - Scenario B

Figure 5-9 presents the freeway segment operations under Year 2030 Baseline plus Project conditions "Without Transit Corridor Scenario." Table 5.7 compares the freeway segment operations under Year 2030 Baseline plus Project conditions with that under Year 2030 Baseline conditions.

Similar to "With Transit Corridor Scenario, during the AM peak period, four freeway segments would operate under unacceptable conditions (LOS E or worse), of which freeway segments H-1 Eastbound (south of Makakilo Drive) and H-1 Eastbound (west of Kunia Road) would operate at LOS E and LOS F, respectively under both Year 2030 Baseline and Year 2030 Baseline plus Project "Without Transit Corridor Scenario" conditions. The other two freeway segments that would operate at LOS E or F under Year 2030 Baseline plus Project conditions are H-1 Eastbound (west of Pāiwa Street), and H-1 Eastbound (east of Kamehameha Highway).

During PM peak period, two of the 10 study freeway segments would operate under acceptable conditions (LOS D or better); all other eight freeway segments operate under unacceptable conditions (LOS E or worse). Of the eight segments, two freeway segments operate at LOS F under Year 2030 Baseline as well as Year 2030 Baseline plus Project conditions. The other six freeway segments operating under unacceptable conditions are H-1 Eastbound (south of Makakilo Drive), H-1 Eastbound (west of Kunia Road), H-1 Eastbound (west of Pāiwa Street), H-1 Eastbound (east of Kamehameha Highway), H-1 Westbound (west of Kunia Road), and H-1 Westbound (east of Kamehameha Highway). It should be noted that while the freeway segments H-2 Northbound/ At Ka Uka Boulevard and H-1 Westbound/ S/O Makakilo Drive operate at LOS F under 2030 plus Project conditions, no impact would result at these locations as they would already operate unsatisfactorily under 2030 Baseline conditions.

Therefore, the proposed Project would result in potential cumulative impacts under "Without Transit Corridor Scenario" at the following six freeway segments:

- H-1 Eastbound (south of Makakilo Drive)
- H-1 Eastbound (west of Kunia Road)
- H-1 Eastbound (west of Pāiwa Street)
- H-1 Eastbound (east of Kamehameha Highway)
- H-1 Westbound (west of Kunia Road)
- H-1 Westbound (east of Kamehameha Highway

Table 5.7
Peak Hour Freeway Segment Operations – Year 2030 Conditions Scenario B

#	Freeway	Segment	Year 2030 Volume	Year 2030 Density	Year 2030 LOS	Year 2030 plus Project Volume	Year 2030 plus Project Density	Year 2030 plus Project LOS	Impact?
AM Peak									
1	H-1 EB	S/O Makakilo Dr.	5434	**37.8**	E	5928	**44.5**	E	No
2	H-1 EB	W/O Kunia Rd.	8197	**>45**	F	9217	**>45**	F	No
3	H-1 EB	W/O Pāiwa St.	9906	**43.4**	E	12062	**>45**	F	Yes
4	H-1 EB	E/O Kamehameha Hwy.	7512	**38.8**	E	8507	**>45**	F	Yes
5	H-2 NB	At Ka Uka Blvd.	3184	21.3	C	3629	24.3	C	No
6	H-1 WB	S/O Makakilo Dr.	3259	21.8	C	3794	25.4	C	No
7	H-1 WB	W/O Kunia Rd.	3735	18.3	C	4549	22.2	C	No
8	H-1 WB	W/O Pāiwa St.	4366	16.6	B	5974	22.8	C	No
9	H-1 WB	E/O Kamehameha Hwy.	3069	20.5	C	3811	25.5	C	No
10	H-2 SB	At Ka Uka Blvd.	6273	30.7	D	6605	32.6	D	No
PM Peak									
1	H-1 EB	S/O Makakilo Dr.	4680	31.3	D	5392	**38.7**	E	Yes
2	H-1 EB	W/O Kunia Rd.	5833	28.5	D	6985	**35.1**	E	Yes
3	H-1 EB	W/O Pāiwa St.	7137	27.2	D	9309	**38.2**	E	Yes
4	H-1 EB	E/O Kamehameha Hwy.	4249	28.4	D	5251	**35.9**	E	Yes
5	H-2 NB	At Ka Uka Blvd.	6220	>45	F	6668	>45	F	No
6	H-1 WB	S/O Makakilo Dr.	6365	>45	F	7080	>45	F	No
7	H-1 WB	W/O Kunia Rd.	7860	43.3	E	8964	>45	F	Yes
8	H-1 WB	W/O Pāiwa St.	7931	25.2	C	10317	33.7	D	No
9	H-1 WB	E/O Kamehameha Hwy.	7766	**42.2**	E	8867	>45	F	Yes
10	H-2 SB	At Ka Uka Blvd.	4616	22.5	C	5108	25.0	C	No

Source: Wilbur Smith Associates, 2007

NOTES:
Density is given in pc/mi/ln.
Bold represents LOS E or F.

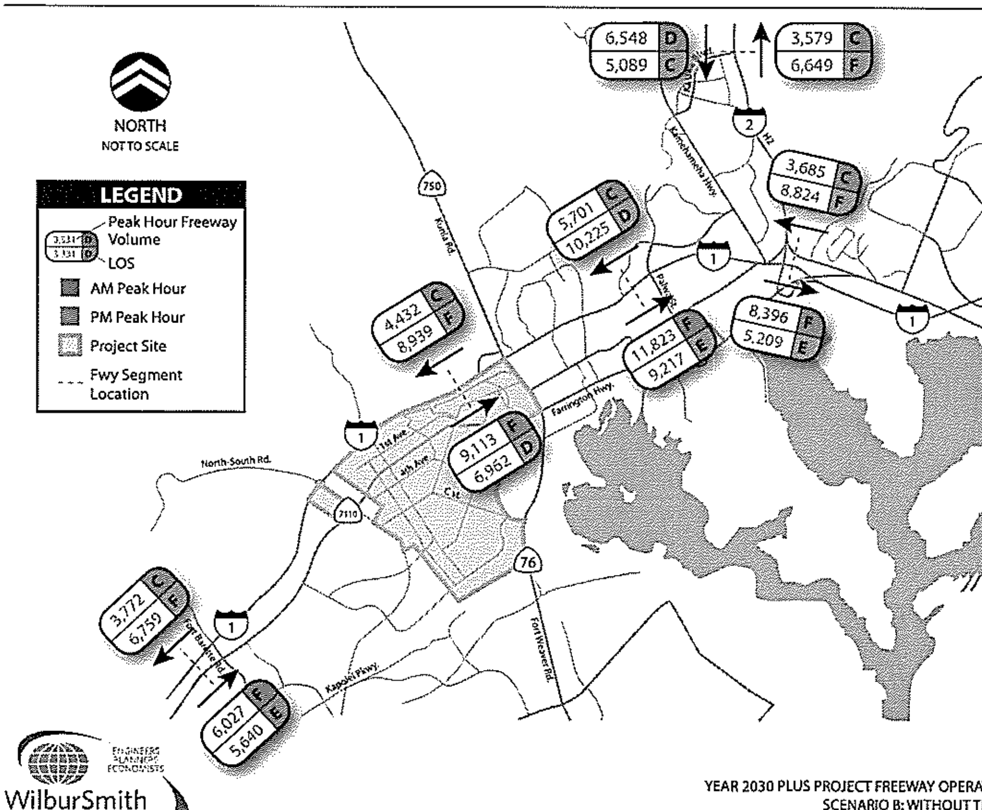

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Figure 5-9
YEAR 2030 PLUS PROJECT FREEWAY OPERATING CONDITIONS
SCENARIO B: WITHOUT TRANSIT CORRIDOR
100061/DEC 2007-12/10/07

5.3.4 Freeway-Ramp Junction Operating Conditions – Scenario B

Table 5.8 exhibits the density and LOS values of the study ramp-freeway junctions under Year 2030 Baseline plus Project "Without Transit Corridor Scenario". As previously mentioned, the analysis performed for the North-South Road Interchange was based on a ramp acceleration/deceleration lane length of 500 feet.

For the Year 2030 Baseline plus Project "Without Transit Corridor Scenario," eight of the 10 ramp-freeway junctions would operate under acceptable conditions during the AM peak hour. The two ramp-freeway junctions that would operate under unacceptable conditions are: H-1/ Fort Weaver Road (Eastbound On-Ramp), and H-1/ North-South Road (Eastbound On-Ramp).

During the PM peak hour, six of the 10 study ramp-freeway junctions would operate under acceptable conditions (LOS D or better). The remaining four ramp-freeway junctions that would operate under unacceptable conditions (LOS E or worse) are: H-1/ Fort Weaver Road (Westbound Loop Off-Ramp), H-1/ Fort Weaver Road (Westbound On-Ramp), H-1/ Fort Weaver Road (Eastbound On-Ramp), and H-1/ North-South Road (Westbound On-Ramp).

Therefore under Year 2030 Baseline plus Project "Without Transit Corridor Scenario" conditions, the proposed Project would cause transportation impacts at the following five ramp-freeway junctions:

- H-1/ Fort Weaver Road (Westbound Loop Off-Ramp)
- H-1/ Fort Weaver Road (Westbound On-Ramp)
- H-1/ Fort Weaver Road (Eastbound On-Ramp)
- H-1/ North-South Road (Westbound On-Ramp)
- H-1/ North-South Road (Eastbound On-Ramp)

Table 5.8
Peak Hour Ramp-Freeway Junction Operations – Year 2030 Conditions Scenario B

#	Location	Ramps	Peak Hour	2030 Baseline		2030 Scenario B	
				Density[1]	LOS	Density	LOS
1	H-1/ Fort Weaver Road	WB Off-Ramp	AM Peak	16.0	B	16.0	B
2	H-1/ Fort Weaver Road	WB Loop Off-Ramp	AM Peak	1.3	A	9.6	A
3	H-1/ Fort Weaver Road	WB On-Ramp	AM Peak	15.0	B	15.7	B
4	H-1/ Fort Weaver Road	EB Off-Ramp	AM Peak	37.4	E	39.0	F
5	H-1/ Fort Weaver Road	EB On-Ramp	AM Peak	24.8	F	37.7	F
6	H-1/ Fort Weaver Road	EB Loop On-Ramp	AM Peak	26.3	F	26.3	F
7	H-1/ North-South Road	WB Off-Ramp	AM Peak	20.3	C	26.9	C
8	H-1/ North-South Road	WB On-Ramp	AM Peak	13.5	B	17.2	B
9	H-1/ North-South Road	EB Off-Ramp	AM Peak	25.0	C	29.6	D
10	H-1/ North-South Road	EB On-Ramp	AM Peak	28.8	D	37.4	F
1	H-1/ Fort Weaver Road	WB Off-Ramp	PM Peak	38.0	F	38.0	F
2	H-1/ Fort Weaver Road	WB Loop Off-Ramp	PM Peak	19.9	F	33.0	F
3	H-1/ Fort Weaver Road	WB On-Ramp	PM Peak	26.0	C	26.3	F
4	H-1/ Fort Weaver Road	EB Off-Ramp	PM Peak	28.8	D	31.3	D
5	H-1/ Fort Weaver Road	EB On-Ramp	PM Peak	18.3	B	31.3	F
6	H-1/ Fort Weaver Road	EB Loop On-Ramp	PM Peak	20.4	C	20.4	C
7	H-1/ North-South Road	WB Off-Ramp	PM Peak	41.1	F	50.2	F
8	H-1/ North-South Road	WB On-Ramp	PM Peak	27.7	C	27.2	F
9	H-1/ North-South Road	EB Off-Ramp	PM Peak	21.0	C	27.9	C
10	H-1/ North-South Road	EB On-Ramp	PM Peak	17.0	B	26.7	C

Source: Wilbur Smith Associates, 2007

NOTES:
DEC – Demand Exceeds Capacity
Density is presented in pc/mi/ln.
Bold type indicates LOS F.
1 – Lower density does not necessarily indicate a lower LOS. This is because the LOS is calculated based upon a number of factors including: merge influence area, length of the acceleration lane, etc. See Appendix F for the HCM methodology used to calculate the LOS for Freeway Segments.

Chapter 6
PROJECT IMPACTS AND MITIGATION MEASURES

This chapter identifies potential transportation impacts on the roadway network due to travel demand generated by the proposed Project. Recommended improvements to the surrounding transportation system are proposed at the locations where significant impacts are identified. In addition, descriptions pertaining to project site access, on-site circulation, and transit services as well as pedestrian facilities that would be located within the project site are provided.

Some of the mitigation measures in this TIAR propose additional laneage at the intersections analyzed. Land acquisition and dedication for additional rights of way where land is owned or controlled by the Project is readily accommodated. Land acquisition outside the Project site, if necessary, may require assistance from City and State as part of the overall regional plan of roadway improvements. As such, in cases where there may be contention regarding land acquisition, the appropriate governmental bodies should actively seek to acquire said land or otherwise protect it for future use. Most of the off-site roadway improvements are the result of the cumulative traffic increases from both adjacent developments and from through traffic, therefore regional consideration should be taken into account when determining responsibility for implementation.

6.1 SCENARIO A: WITH TRANSIT CORRIDOR

6.1.1 Project Impacts - Year 2030 plus Project Conditions "Scenario A"

As indicated in *Section 5.2.2*, the proposed Project would cause transportation impacts at the following 9 study intersections under Year 2030 Baseline plus Project conditions "With Transit Corridor Scenario":

- Farrington Highway/Fort Weaver NB Ramps
- Farrington Highway/ Leokū St.
- Fort Weaver Road/ Old Fort Weaver Road
- Fort Weaver Road/ Renton Road
- Farrington Highway/ Fort Barrette Road
- North-South Road/H-1 EB Ramps
- North-South Rd./Farrington Highway
- North-South Rd. Kapolei Pkwy
- East-West Rd./Old Fort Weaver Rd.

Tables 6.1(a), 6.1(b), 6.2(a), and 6.2(b) present the AM and PM peak hour intersection operations for Year 2030 Scenario B with Mitigations Conditions. Descriptions of transportation impacts and the proposed improvements to mitigate them at each of the above identified intersections are discussed in *Section 6.1.2*.

Table 6.1 (a)
AM Peak Hour Intersection Operations – Year 2030 Conditions Scenario A with Mitigations (External Intersections)

#	Intersection	Control	Year 2030 plus Project			Mitigation Measures			Impact?
			Delay	V/C Ratio	LOS	Delay	V/C Ratio	LOS	
1	Kunia Rd./ Kunia Loop	Signal	15.7	0.78	B	15.8	0.78	B	No
2	Kunia Rd./ H-1 WB On-Ramp[A]	TWSC	4.5	0.58	A	4.5	0.58	A	No
3	Kunia Rd./ H-1 EB Ramps	Signal	8.4	0.52	A	7.7	0.52	A	No
4	Farrington Hwy./ Fort Weaver Rd. SB Ramps	Signal	9.9	0.66	A	5.7	0.66	A	No
5	Farrington Hwy./ Fort Weaver Rd. NB Ramps	Signal	25.4	0.92	C	13.0	0.63	B	No
6	Farrington Hwy./ Leokū St.	Signal	19.2	0.73	B	19.3	0.72	B	No
7	Fort Weaver Rd./ Laulaunui St.	Signal	42.6	0.99	D	44.2	0.98	D	No
8	Fort Weaver Rd./ Old Fort Weaver Rd.	Signal	**176.6**	**1.69**	**F**	37.5	0.98	D	No
9	Fort Weaver Rd./ Renton Rd.	Signal	**111.8**	**1.23**	**F**	**59.2**	**1.01**	**E**	**Yes**
10	Farrington Hwy./ East Old Fort Weaver Rd.[B]	TWSC	31.4	0.81	C	37.1	0.81	D	No
11	Farrington Hwy./ West Old Fort Weaver Rd.[B]	TWSC	17.2	0.62	B	18.1	0.57	B	No
12	Farrington Hwy./ Fort Barrette Rd.	Signal	**75.9**	**0.93**	**E**	48.9	0.88	D	No
13	North-South Rd./ H-1 WB Ramps	Signal	42.7	0.95	D	42.2	0.95	D	No
14	North-South Rd./ H-1 EB Ramps	Signal	30.0	0.92	C	14.7	0.74	B	No
15	North-South Rd./ Farrington Hwy.	Signal	**76.7**	**1.04**	**E**	46.8	0.84	D	No
16	North-South Rd./ North UH Connector	Signal	38.6	0.87	D	38.7	0.87	D	No
17	North-South Rd./ East-West Rd.	Signal	37.0	0.79	D	35.1	0.74	D	No
18	North-South Rd./ Kapolei Pkwy.	Signal	43.1	0.86	D	36.1	0.76	D	No
19	East-West Rd./ Old Fort Weaver Rd.	Signal	14.3	0.61	B	20.5	0.59	C	No

Source: Wilbur Smith Associates

Table 6.2 (a)
PM Peak Hour Intersection Operations – Year 2030 Conditions Scenario A with Mitigations (External Intersections)

#	Intersection	Control	Year 2030 plus Project			Mitigation Measures			Impact?
			Delay	V/C Ratio	LOS	Delay	V/C Ratio	LOS	
1	Kunia Rd./ Kunia Loop	Signal	36.8	1.05	D	37.5	1.05	D	No
2	Kunia Rd./ H-1 WB On-Ramp[A]	TWSC	18.6	1.03	B	22.9	1.03	C	No
3	Kunia Rd./ H-1 EB Ramps	Signal	11.3	0.90	B	8.2	0.90	A	No
4	Farrington Hwy./ Fort Weaver Rd. SB Ramps	Signal	10.0	0.80	B	10.0	0.80	A	No
5	Farrington Hwy./ Fort Weaver Rd. NB Ramps	Signal	**134.2**	**1.41**	**F**	34.7	1.10	C	No
6	Farrington Hwy./ Leokū St.	Signal	**61.9**	**1.05**	**E**	**69.4**	**1.07**	**E**	**Yes**
7	Fort Weaver Rd./ Laulaunui St.	Signal	44.9	1.01	D	46.1	1.02	D	No
8	Fort Weaver Rd./ Old Fort Weaver Rd.	Signal	**289.5**	**2.01**	**F**	**62.8**	**1.10**	**E**	**Yes**
9	Fort Weaver Rd./ Renton Rd.	Signal	**125.3**	**1.25**	**F**	**60.4**	**0.99**	**E**	**Yes**
10	Farrington Hwy./ East Old Fort Weaver Rd.[B]	TWSC	20.6	0.75	C	22.2	0.76	C	No
11	Farrington Hwy./ West Old Fort Weaver Rd.[B]	TWSC	25.9	0.88	C	20.5	0.82	C	No
12	Farrington Hwy./ Fort Barrette Rd.	Signal	**74.4**	**0.91**	**E**	53.0	0.93	D	No
13	North-South Rd./ H-1 WB Ramps	Signal	38.2	0.86	D	36.1	0.86	D	No
14	North-South Rd./ H-1 EB Ramps	Signal	**87.5**	**1.30**	**F**	42.7	1.08	D	No
15	North-South Rd./ Farrington Hwy.	Signal	**136.3**	**1.28**	**F**	53.9	0.98	D	No
16	North-South Rd./ North UH Connector	Signal	49.0	0.92	D	44.3	0.89	D	No
17	North-South Rd./ East-West Rd.	Signal	43.1	0.87	D	40.5	0.78	D	No
18	North-South Rd./ Kapolei Pkwy.	Signal	**58.5**	**0.95**	**E**	51.8	0.87	D	No
19	East-West Rd./ Old Fort Weaver Rd.	Signal	**62.6**	**0.56**	**E**	16.3	0.69	B	No

Source: Wilbur Smith Associates

Table 6.1 (b)
AM Peak Hour Intersection Operations – Year 2030 Conditions Scenario A with Mitigations (Internal Intersections)

#	Intersection	Control	Year 2030 plus Project			Mitigation Measures			Impact?
			Delay	V/C Ratio	LOS	Delay	V/C Ratio	LOS	
20	Farrington Hwy./ B St.	Signal	30.2	0.69	C	30.3	0.66	C	No
21	East-West Rd./ A St.	Signal	21.0	0.59	C	20.4	0.59	C	No
22	Farrington Hwy./ Parkway/ 2nd Ave.	Signal	33.0	0.65	C	40.3	0.60	D	No
23	Kunia Rd./ 2nd Ave.	OWSC	0.0 (NB)	0.76 (NB)	A	0.0 (NB)	0.76 (NB)	A	No
24	Kunia Rd./ 3rd Ave.	OWSC	11.9 (EB)	0.01 (EB)	B	11.9 (EB)	0.01 (EB)	B	No
25	East-West Rd./ B St.	Signal	27.3	0.82	C	32.3	0.75	C	No
26	Farrington Hwy/Project Access Road to NW Parcel at N-S Road	Signal	17.8	0.65	B	15.2	0.55	B	No

Source: Wilbur Smith Associates

Table 6.2 (b)
PM Peak Hour Intersection Operations – Year 2030 Conditions Scenario A with Mitigations (Internal Intersections)

#	Intersection	Control	Year 2030 plus Project			Mitigation Measures			Impact?
			Delay	V/C Ratio	LOS	Delay	V/C Ratio	LOS	
20	Farrington Hwy./ B St.	Signal	41.7	0.88	D	40.4	0.87	D	No
21	East-West Rd./ A St.	Signal	17.5	0.61	B	16.9	0.61	B	No
22	Farrington Hwy./ Parkway/ 2nd Ave.	Signal	71.1	1.07	E	48.3	0.98	D	No
23	Kunia Rd./ 2nd Ave.	OWSC	13.9 (SB)	0.03 (SB)	B	0.0 (SB)	0.83 (SB)	B	No
24	Kunia Rd./ 3rd Ave.	OWSC	13.8 (EB)	0.10 (EB)	B	0.0 (SB)	0.81 (EB)	A	No
25	East-West Rd./ B St.	Signal	46.6	0.92	D	59.4	0.92	E	**Yes**
26	Farrington Hwy/Project Access Road to NW Parcel at N-S Road	Signal	16.3	1.18	B	16.3	1.18	B	No.

Source: Wilbur Smith Associates

6.1.2: Mitigation Measures - Year 2030 plus Project Conditions "Scenario A"

Improvements have been identified to mitigate impacts at the above intersections with these including 1) additional traffic lanes at intersections and/or changed usage of existing lanes; 2) by programming an alternate signal timing plans that would be in operation during specified peak commute periods; and 3) by restricting pedestrian crossings on one or more of the intersection approaches in order to allow unconstrained right-turn movement.

The application of contra-flow lanes should be considered for the existing and new major roadways in the region, particularly Fort Weaver Road and sections of Farrington Highway. Contra-flow lanes have not been proposed as Project mitigation because the forecast directional flows during the peak periods do not strongly favor such operations on these facilities. However, the potential for future contra-flow lanes should be accommodated within the design of the new and widened major roadways in the event that the actual future peak period directional volumes would result in efficient use of contra-flow lanes. Such contra-flow lanes could be open to general traffic use or could be limited to public transit and/or carpools in order to further encourage use of transportation alternatives to driving.

Several of the offsite intersection improvements may require additional right-of-way to accommodate the additional turn lane(s). Since the traffic problems at those locations would result from the cumulative traffic increases from other ongoing and new developments, the assistance of the City or State may be appropriate to facilitate the acquisition of rights-of-way needed for the improvement, or reservation and protection of rights-of-way that may be needed to implement these future improvements.

Impact 6.1.2A: Transportation Impact at Farrington Highway/ Fort Weaver Road Northbound Ramps under "With Transit Corridor Scenario"

For the Year 2030 Baseline scenario, the Farrington Highway intersection with the Fort Weaver Road northbound ramps would operate at LOS A conditions during AM and PM peak hours. For the Year 2030 Baseline plus Project "With Transit Corridor Scenario," conditions at the intersection would worsen to LOS D and LOS F during the AM and PM peak hours respectively. Since the proposed Project would worsen the operating conditions of this intersection to LOS F during the PM peak hour, roadway modifications are proposed to mitigate the transportation impact. The primary contributor of the forecast delays is the high eastbound left-turn volumes (928 vph in AM peak hour and 1027 vph in PM peak hour) and high westbound right-turn volumes (567 vph during AM peak hour and 1164 during PM peak hour).

Mitigation: The following mitigation measures are proposed:

1. Eastbound Approach: Construct one additional exclusive left-turn lane to provide dual left-turn lanes.
2. Westbound Approach: Convert existing shared through-right lane to through lane and construct a separate right-turn lane.

3. Signal Optimization: Optimization of intersection splits and cycle lengths along with the intersection offsets.

Impact after Mitigation: Less-than-significant level.

With the proposed mitigation measures, the operating conditions of the intersection Farrington Highway/ Fort Weaver Road Northbound Ramps would improve to LOS B and LOS C during the AM and PM peak hour conditions respectively.

Impact 6.1.2B: Transportation Impact at Farrington Highway/ Leokū Street under "With Transit Corridor Scenario"

Under Year 2030 Baseline Conditions, intersection Farrington Highway/ Leokū Street would operate at operate at LOS B (volume-to-capacity ratio of 0.63) during the AM peak hour and deteriorate to LOS D (volume to capacity ratio 0.88) during the PM peak hour. Under Baseline Year 2030 plus project "With Transit Corridor Conditions", the intersection would continue to operate at LOS B during the AM (volume-to-capacity ratio of 0.73) but worsen to LOS E during the PM (volume to capacity ratio 1.05) peak periods. As such, a transportation impact would result.

Mitigation: The majority of the Project-related traffic volumes would be added to the westbound through movements along Farrington Highway. Note that this section on Farrington Highway is planned to be widened to a six-lane roadway by Year 2030. To mitigate this impact, additional lanes would need to be constructed to accommodate through traffic, requiring acquisition of a new right-of-way. As such, it would not be feasible to add additional through lanes along Farrington Highway due to right-of-way constraints. However, implementation of the Transportation Demand Management (TDM) strategies discussed in *Section 6.3* could reduce the peak hour traffic volumes and Project impacts at this intersection.

Impact after Mitigation: Significant and unavoidable.

Impact 6.1.2C: Transportation Impact at Fort Weaver Road/ Old Fort Weaver Road under "With Transit Corridor Scenario"

Under Year 2030 Baseline Conditions, intersection Fort Weaver Road/ Old Fort Weaver Road would operate at operate at LOS B (volume-to-capacity ratio of 0.89) during the AM peak hour and deteriorate to LOS D (volume to capacity ratio 1.03) during the PM peak hour. Under Baseline Year 2030 plus project "With Transit Corridor Conditions", the intersection would worsen to LOS F during the AM (volume-to-capacity ratio of 1.69) and PM (volume to capacity ratio 2.01) peak periods. As such, a transportation impact would result.

Mitigation: The following mitigation measures are proposed to improve the operating conditions at this intersection:

1. Northbound Approach: Construct one additional exclusive left-turn lane to provide dual left turn lanes. Convert one of the existing through lanes to a shared through-right lane.
2. Eastbound Approach: Convert existing shared through-left turn lane to a through lane and construct 3 exclusive left turn lanes to allow a triple left-turn movement from Old Fort Weaver Road. Right-of-way acquisition may be required for the eastbound approach.
3. Signal Timing: For the eastbound and westbound directions, convert the signal timing from permitted to split phasing. In addition, provide free right-turns for eastbound and westbound movements.

Impact After Mitigation: Less than significant impact during the AM peak hour. Significant and unavoidable impact for the PM peak hour.

With the proposed mitigation measures, the intersection would improve from LOS F to LOS D during the AM peak hour but operate at LOS E for the PM peak hour. The delays may encourage some of the forecast traffic to use alternative routes to/from the Project and other land uses along the Old Fort Weaver Road.

Impact 6.1.2D: Transportation Impact at Fort Weaver Road/ Renton Road under "With Transit Corridor Scenario"

Under Year 2030 Baseline Conditions, intersection Fort Weaver Road/ Renton Road would operate at LOS E with a volume-to-capacity ratio of 1.08 during the AM peak hour and LOS E with a volume-to-capacity ratio of 1.03 during the PM peak hour. Under Year 2030 Baseline plus Project "With Transit Scenario" conditions, the intersection would worsen to LOS F during the AM (volume-to-capacity ratio of 1.23) and PM (volume-to-capacity ratio of 1.25) peak hours.

Mitigation: The following mitigation measures are proposed:

1. Westbound Approach: Convert existing shared left-through-right lane to shared through-left lane and construct one exclusive right-turn lane.

With the proposed mitigation measure, this intersection would operate at LOS E for both AM and PM peak hours. However, the additional lane would offset the estimated Project impacts and result in an improvement in average delays and volume-to-capacity ratios in both the AM and PM peak hours as compared to the Baseline conditions without the Project.

Impact after Mitigation: Less-than-significant level.

Impact 6.1.2E: Transportation Impact at Farrington Highway/ Fort Barrette Road under "With Transit Corridor Scenario"

Under Year 2030 Baseline Conditions, intersection Farrington Highway/ Fort Barrette Road would operate at LOS E for both AM and PM peak hours. Under Year 2030 Baseline plus Project "With Transit Scenario" conditions, the intersection would continue to operate at LOS E for both AM and PM peak hours, but the volume-to-capacity ratio would worsen by more than 10 percent for the AM peak hour. Since the proposed Project would worsen the volume-to-capacity ratio for the AM peak hour by more than 10 percent, a transportation impact would result. High left-turn volumes from south-westbound Farrington Highway are primarily responsible for worsening the intersection operating conditions under Year 2030 Baseline plus Project "With Transit Corridor Scenario" conditions.

Mitigation: The following mitigation measure is proposed:

1. <u>Signal Timing: Change the cycle length from 210 seconds to 120 seconds. Also, convert the southeast and northwest right-turn phases from permitted to permitted plus overlap phases.</u>
2. <u>Signal Optimization</u>: Optimization of intersection splits and cycle lengths along with the intersection offsets.

Impact after Mitigation: Less-than-significant level.

With the proposed mitigation measure, the operating conditions of this intersection would improve to LOS D for both AM and PM peak hours.

Impact 6.1.2F: Transportation Impact at North-South Road/ H-1 Eastbound Ramps under "With Transit Corridor Scenario"

Under Year 2030 Baseline Conditions, intersection North-South Road/ H-1 Eastbound Ramps would operate at LOS D during the AM peak hour and LOS B during the PM peak hour. Under Year 2030 Baseline plus Project "With Transit Scenario" conditions, the intersection would continue to operate at LOS D under AM peak hour conditions but would worsen to LOS F during the PM peak hour conditions. Since the proposed Project would worsen the operating conditions of this intersection to LOS F during PM peak hour conditions, a transportation impact would result.

Mitigation: The following mitigation measures are proposed:

1. <u>Eastbound Approach</u>: Construct one additional right-turn lane to provide dual right-turn lanes.

Impact after Mitigation: Less-than-significant level.

With the proposed mitigation measures, the operating conditions of this intersection would operate at LOS C during the AM peak hour but would improve the LOS from LOS F to LOS D during the PM peak hour.

Impact 6.1.2G: Transportation Impact at Farrington Highway/ North-South Road under "With Transit Corridor Scenario"

Under Year 2030 Baseline Conditions, intersection Farrington Highway/ North-South Road would operate at LOS D during both the AM and PM peak hours. Under Year 2030 Baseline plus Project "With Transit Scenario" conditions, this intersection would operate at LOS E for the AM peak hour and LOS F for the PM peak hour. Since the proposed Project would worsen the operating conditions of this intersection from LOS D to LOS E for the AM peak hour and LOS F during the PM peak hour, a transportation impact would result.

Mitigation Option 1: Proposed as part of the Ho'opili TIAR

1. <u>Southeast-bound Approach</u>: Convert the shared through-right lane to an exclusive right-turn lane
2. <u>Southwest-bound Approach</u>: Construct one additional exclusive right-turn lane to provide dual right-turn lanes.
3. <u>Northwest-bound Approach</u>: Construct an additional left-turn lane to provide three exclusive left-turn lanes. This would also require widening Farrington Highway west of the intersection to provide three westbound departure lanes to receive the triple left-turn lane movement.

Impact after Mitigation: Less-than-significant level.

With the proposed mitigation measures, this intersection would operate at LOS D for both AM and PM peak hours.

Mitigation Option 2: Incorporated from the University of Hawai'i West O'ahu Traffic Study Report

As an alternative to the above mitigation measure, the mitigation measure proposed as part of the University of Hawai'i West O'ahu (UHWO) could also be implemented as a mitigation measure at this intersection. The UHWO Traffic Study Report suggests that a grade separation could be provided to improve future conditions. The potential configuration for grade separation would be to carry the Farrington Highway eastbound and westbound through movements over the intersection. The North-South Road through lanes would remain as an at-grade facility and all turning movements would occur at the at-grade intersection. By removing the Farrington Highway through movements from the intersection, more signal green time could be allocated to the other movements to better accommodate the projected traffic volumes.

Impact 6.1.2H: Transportation Impact at North-South Road/ Kapolei Parkway under "With Transit Corridor Scenario"

Under Year 2030 Baseline Conditions, the North-South Road/Kapolei Parkway intersection would operate at LOS C during the AM peak hour and LOS D during the PM peak hour. Under Year 2030 Baseline plus project "With Transit Corridor Scenario, the intersection operates at LOS D for the AM peak hour and operates at LOS E during the PM peak hour. Since the intersection would operate at LOS level E, a transportation impact would result.

Mitigation:

1. Southbound Approach: Convert shared through-right lane to exclusive right-turn lane to provide three through lanes and one right-turn lane.
2. Northbound Approach: Convert shared through-right lane to exclusive right-turn lane to provide three through lanes and one right-turn lane.

With this mitigation, the intersection would operate at LOS D during the AM and the PM peak periods.

Impact after Mitigation: Less-than-significant level.

Figures 6-1A and 6-1B exhibit the proposed intersection improvements under Year 2030 Baseline plus Project "With Transit Corridor Scenario".

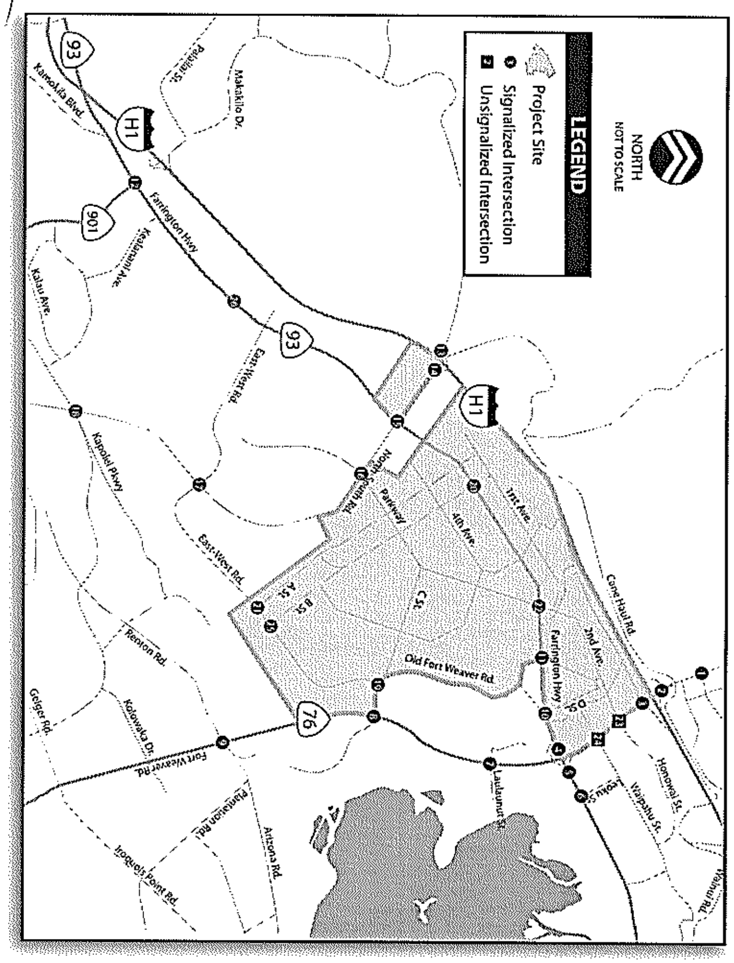
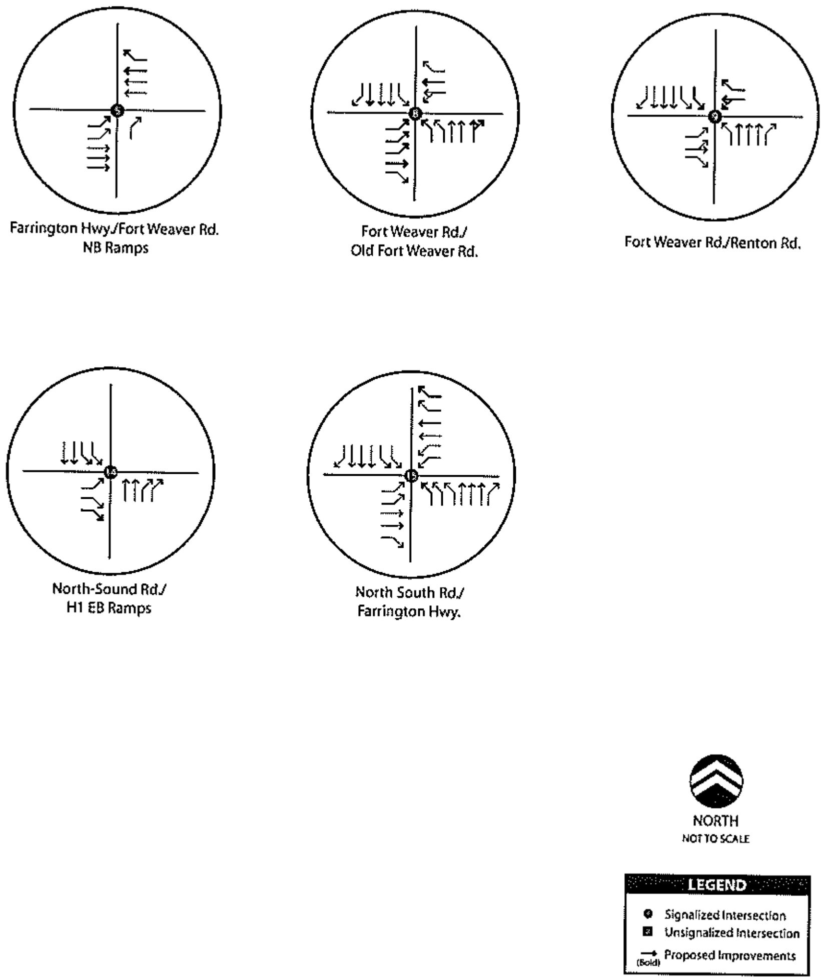


Figure 6-1A
PROPOSED INTERSECTION IMPROVEMENTS-YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO A: WITH TRANSIT CORRIDOR
100061/Draft October - 10/17/07



Wilbur Smith Associates

Figure 6-1B
PROPOSED INTERSECTION IMPROVEMENTS-YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO A: WITH TRANSIT CORRIDOR SCENARIO

100061/DEC 2007-12/10/07

6.2 SCENARIO B: WITHOUT TRANSIT CORRIDOR

6.2.1 Project Impacts - Year 2030 plus Project Conditions "Scenario B"

As described in *Section 5.3.2*, the proposed Project would cause transportation impacts at the following 9 study intersections under Year 2030 Baseline plus Project conditions "Without Transit Corridor Scenario":

- Farrington Highway/ Fort Weaver Road Northbound Ramps
- Farrington Highway/ Leokū Street
- Fort Weaver Road/ Laulaunui Street
- Fort Weaver Road/ Old Fort Weaver Road
- Fort Weaver Road/ Renton Road
- Farrington Highway/ Fort Barrette Road
- North-South Road/ H-1 Eastbound Ramps
- North-South Road/ Farrington Highway
- North-South Road/ Kapolei Parkway

Descriptions of transportation impacts and the proposed improvements to mitigate them at each of the above identified intersections are discussed in *Section 6.2.2*. Tables 6.3(a), 6.3(b), 6.4(a), and 6.4(b) present the AM and PM peak hour intersection operations for Year 2030 Scenario B with Mitigations Conditions.

Table 6.3(b)
AM Peak Hour Intersection Operations – Year 2030 Conditions Scenario B with Mitigations (Internal Intersections)

#	Intersection	Control	Year 2030 plus Project			Mitigation Measures			Impact?
			Delay	V/C Ratio	LOS	Delay	V/C Ratio	LOS	
20	Farrington Hwy./ B St.	Signal	30.6	0.71	C	31.0	0.70	C	No
21	East-West Rd./ A St.	Signal	24.6	0.69	C	24.4	0.72	C	No
22	Farrington Hwy./ Parkway/ 2nd Ave.	Signal	33.2	0.66	C	46.0	0.66	D	No
23	Kunia Rd./ 2nd Ave.	OWSC	0.0 (NB)	0.83 (NB)	A	0.0 (NB)	0.83 (NB)	A	No
24	Kunia Rd./ 3rd Ave.	OWSC	12.3 (EB)	0.02 (EB)	B	12.3 (EB)	0.02	B	No
25	East-West Rd./ B St.	Signal	23.9	0.84	C	28.6	0.71	C	No
26	Farrington Hwy/Project Access Road to NW Parcel at N-S Road	Signal	18.3	0.66	B	15.3	0.55	B	No

Source: Wilbur Smith Associates

Table 6.3 (a)
AM Peak Hour Intersection Operations – Year 2030 Conditions Scenario B with Mitigations (External Intersections)

#	Intersection	Control	Year 2030 plus Project			Mitigation Measures			Impact?
			Delay	V/C Ratio	LOS	Delay	V/C Ratio	LOS	
1	Kunia Rd./ Kunia Loop	Signal	17.9	0.85	B	17.9	0.85	B	No
2	Kunia Rd./ H-1 WB On-Ramp[A]	TWSC	4.5	0.59	A	4.5	0.59	A	No
3	Kunia Rd./ H-1 EB Ramps	Signal	8.4	0.52	A	8.4	0.52	A	No
4	Farrington Hwy./ Fort Weaver Rd. SB Ramps	Signal	10.3	0.71	B	11.7	0.71	B	No
5	Farrington Hwy./ Fort Weaver Rd. NB Ramps	Signal	38.4	1.07	D	16.0	0.71	B	No
6	Farrington Hwy./ Leokū St.	Signal	23.6	0.66	C	19.3	0.66	B	No
7	Fort Weaver Rd./ Laulaunui St.	Signal	53.9	1.03	D	52.0	1.02	D	No
8	Fort Weaver Rd./ Old Fort Weaver Rd.	Signal	**268.8**	**2.43**	**F**	**97.2**	**1.14**	**F**	**Yes**
9	Fort Weaver Rd./ Renton Rd.	Signal	**114.8**	**1.24**	**F**	**60.5**	**0.98**	**E**	No
10	Farrington Hwy./ East Old Fort Weaver Rd.[B]	TWSC	40.1	0.91	D	42.4	0.91	D	No
11	Farrington Hwy./ West Old Fort Weaver Rd.[B]	TWSC	24.8	0.77	C	20.5	0.65	C	No
12	Farrington Hwy./ Fort Barrette Rd.	Signal	**71.6**	**0.90**	**E**	52.0	0.97	D	No
13	North-South Rd./ H-1 WB Ramps	Signal	**99.4**	**1.00**	**F**	50.1	1.00	D	No
14	North-South Rd./ H-1 EB Ramps	Signal	37.3	0.98	D	14.6	0.80	B	No
15	North-South Rd./ Farrington Hwy.	Signal	**105.4**	**1.23**	**F**	46.5	0.98	D	No
16	North-South Rd./ North UH Connector	Signal	33.4	0.76	C	33.4	0.76	C	No
17	North-South Rd./ East-West Rd.	Signal	40.8	0.77	D	41.1	0.81	D	No
18	North-South Rd./ Kapolei Pkwy.	Signal	**62.7**	**0.92**	**E**	42.5	0.85	D	No
19	East-West Rd./ Old Fort Weaver Rd.	Signal	14.1	0.74	B	19.7	0.69	B	No

Source: Wilbur Smith Associates

Table 6.4(b)
PM Peak Hour Intersection Operations – Year 2030 Conditions Scenario B with Mitigations (Internal Intersections)

#	Intersection	Control	Year 2030			Year 2030 plus Project			Impact?
			Delay	V/C Ratio	LOS	Delay	V/C Ratio	LOS	
20	Farrington Hwy./ B St.	Signal	38.4	0.87	D	45.4	0.91	D	No
21	East-West Rd./ A St.	Signal	26.2	0.74	C	32.1	0.69	C	No
22	Farrington Hwy./ Parkway/ 2nd Ave.	Signal	42.8	0.97	D	47.1	0.97	D	No
23	Kunia Rd./ 2nd Ave.	OWSC	0.0 (SB)	0.91 (SB)	A	0.0 (SB)	0.91 (SB)	A	No
24	Kunia Rd./ 3rd Ave.	OWSC	0.0 (SB)	0.12 (SB)	A	0.0 (SB)	0.88 (SB)	A	No
25	East-West Rd./ B St.	Signal	60.8	**1.01**	E	50.5	0.85	D	No
26	Farrington Hwy/Project Access Road to NW Parcel at N-S Road	Signal	17.0	1.21	B	17.0	12.1	B	No

Source: Wilbur Smith Associates

Table 6.4 (a)
PM Peak Hour Intersection Operations – Year 2030 Conditions Scenario B with Mitigations(External Intersections)

#	Intersection	Control	Year 2030 plus Project			Mitigation Measures			Impact?
			Delay	V/C Ratio	LOS	Delay	V/C Ratio	LOS	
1	Kunia Rd./ Kunia Loop	Signal	40.1	1.04	D	40.8	1.04	D	No
2	Kunia Rd./ H-1 WB On-Ramp[A]	TWSC	15.4	0.97	B	14.2	0.97	B	No
3	Kunia Rd./ H-1 EB Ramps	Signal	19.4	0.93	B	16.4	0.93	B	No
4	Farrington Hwy./ Fort Weaver Rd. SB Ramps	Signal	9.4	0.78	A	8.8	0.77	A	No
5	Farrington Hwy./ Fort Weaver Rd. NB Ramps	Signal	**221.0**	**1.65**	F	48.1	1.23	D	No
6	Farrington Hwy./ Leokū St.	Signal	**57.6**	**1.01**	E	**66.5**	**1.03**	E	**Yes**
7	Fort Weaver Rd./ Laulaunui St.	Signal	**56.3**	**1.05**	E	54.1	1.05	D	No
8	Fort Weaver Rd./ Old Fort Weaver Rd.	Signal	**322.9**	**2.17**	F	**86.2**	**1.20**	F	**Yes**
9	Fort Weaver Rd./ Renton Rd.	Signal	**130.6**	**1.30**	F	**57.1**	**1.08**	E	**Yes**
10	Farrington Hwy./ East Old Fort Weaver Rd.[B]	TWSC	40.9	0.91	D	37.3	0.89	D	No
11	Farrington Hwy./ West Old Fort Weaver Rd.[B]	TWSC	30.5	0.89	C	25.2	0.82	C	No
12	Farrington Hwy./ Fort Barrette Rd.	Signal	**67.0**	**0.86**	E	52.9	0.87	D	No
13	North-South Rd./ H-1 WB Ramps	Signal	54.0	0.94	D	54.1	0.94	D	No
14	North-South Rd./ H-1 EB Ramps	Signal	**105.4**	**1.39**	F	22.0	0.86	C	No
15	North-South Rd./ Farrington Hwy.	Signal	**117.1**	**1.27**	F	**69.1**	**1.08**	E	**Yes**
16	North-South Rd./ North UH Connector	Signal	50.3	0.94	D	51.4	0.94	D	No
17	North-South Rd./ East-West Rd.	Signal	45.9	0.85	D	44.7	0.91	D	No
18	North-South Rd./ Kapolei Pkwy.	Signal	**68.3**	**0.95**	E	48.8	0.87	D	No
19	East-West Rd./ Old Fort Weaver Rd.	Signal	13.6	0.72	B	32.8	0.64	C	No

Source: Wilbur Smith Associates

6.2.2 Mitigation Measures - Year 2030 plus Project Conditions "Scenario B"

Impact 6.2.2A: Transportation Impact at Farrington Highway/ Fort Weaver Road Northbound Ramps under "Without Transit Corridor Scenario"

Under Year 2030 Baseline Conditions, intersection Farrington Highway/ Fort Weaver Road Northbound Ramps would operate at LOS A during both AM and PM peak hours. Under Year 2030 Baseline plus Project "Without Transit Scenario" conditions, the LOS of the intersection would worsen to LOS D during the AM peak hour and LOS F during both the PM peak hour. Since the proposed Project would worsen the operating conditions of this intersection to LOS F during the PM peak hour, a transportation impact would result. The primary contributor of the forecast delays is the high eastbound left-turn volumes (1165 vph in the AM peak hour and 1429 vph in the PM peak hour) and high westbound right-turn volumes (567 vph during AM peak hour and 1164 during PM peak hour).

Mitigation: The following mitigation measures are proposed:

1. Eastbound Approach: Construct one additional exclusive left-turn lane to provide dual left-turn lanes.
2. Westbound Approach: Convert existing shared through-right lane to through lane and construct a separate free right-turn lane.

Impact after Mitigation: Less-than-significant level.

With the proposed mitigations, the operating condition of this intersection would improve from LOS D to LOS B during the AM peak hour and from LOS F to LOS D during the PM peak hour.

Impact 6.2.2B: Transportation Impact at Farrington Highway/ Leokū Street under "Without Transit Corridor Scenario"

Under Year 2030 Baseline conditions, intersection Farrington Highway/ Leokū Street would operate at LOS B during the AM peak hour and LOS D during the PM peak hour. Under Year 2030 Baseline plus Project "Without Transit Scenario" conditions, the LOS of the intersection would operate at LOS C during AM peak hour, but would worsen to LOS E during the PM peak hour. Since the associated trips from the proposed Project would worsen the LOS from LOS D to LOS E during the PM peak hour, this would result in a significant impact that this intersection. High volumes on the westbound approach to Farrington Highway is primarily responsible for the poor operating conditions at this intersection.

Mitigation: The majority of the project-related traffic volumes would be added to the eastbound and westbound through movements along Farrington Highway. To mitigate this impact, additional lanes would need to be constructed to accommodate through traffic, requiring acquisition of a new right-of-way. Note that this section of Farrington Highway is planned to be widened to a six-lane roadway by Year 2030. As such these actions would not be feasible.

However, the Transportation Demand Management (TDM) strategies discussed in *Section 6.3* are proposed to reduce the peak hour traffic volumes and Project impacts at this intersection.

Impact after Mitigation: Significant and unavoidable.

Impact 6.2.2C: Transportation Impact at Fort Weaver Road/ Laulaunui Street under "Without Transit Corridor Scenario"

Under Year 2030 Baseline Conditions, intersection Fort Weaver Road/ Laulaunui Street would operate at LOS C for both AM and PM peak hours. Under Year 2030 Baseline plus Project "Without Transit Scenario" conditions, the LOS of the intersection would worsen to LOS D for the AM peak hour and LOS E during the PM peak hour. Since the proposed Project would worsen the operating conditions of this intersection to LOS E during the PM peak hour, a transportation impact would result.

Mitigation:

1. Signal Optimization: Optimization of intersection splits and cycle lengths along with the intersection offsets.
2. Eastbound Approach: Construct an exclusive left-turn lane in addition to the shared through-left lane.

Impact after Mitigation: Less-than-significant level.

With the proposed mitigation measures, the intersection would continue to operate at LOS D for the AM peak hour, but would improve operational conditions for the PM peak hour from LOS E to LOS D.

Impact 6.2.2D: Transportation Impact at Fort Weaver Road/ Old Fort Weaver Road under "Without Transit Corridor Scenario"

Under Year 2030 Baseline Conditions, intersection Fort Weaver Road/ Old Fort Weaver Road would operate at LOS B during the AM peak hour and LOS D during the PM peak hour. Under Year 2030 Baseline plus Project "Without Transit Scenario" conditions, the LOS of the intersection would worsen to LOS F under both AM and PM peak hours with volume-to-capacity ratios of 2.43 and 2.17 during AM and PM peak hours, respectively. Since the proposed project would worsen the LOS for both AM and PM peak hours, this will result in a significant impact at this intersection.

Mitigation: The proposed project would add the majority of traffic volumes to the northbound, southbound, and eastbound approaches at the intersection of Fort Weaver Road/ Old Fort Weaver Road. The following mitigation measures are proposed to improve the operating conditions of eastbound left-turning, northbound left-turning and southbound right-turning movements of this intersection:

1. Northbound Approach: Construct one additional exclusive left-turn lane to provide dual left-turn lanes. Convert exclusive right-turn lane to shared through-right since there isn't sufficient traffic to warrant an exclusive right-turn lane.
2. Eastbound Approach: Convert existing shared through-left lane to a through lane and construct triple left-turn lanes. Right-of-way acquisition may be required for the eastbound approach.
3. Signal Optimization: Optimization of intersection splits and cycle lengths along with the intersection offsets.

Impact after Mitigation: Significant and Unavoidable

Due to limited right of way in the westbound direction, additional capacity cannot be provided in this direction. With the proposed mitigation measures, the intersection would continue to operate at LOS F for both AM and PM peak hours. However, with the proposed mitigation measures, the volume-to-capacity ratio would improve from 2.43 for the AM peak hour to 1.14 and from 2.17 for the PM peak hour to 1.20. Some of the traffic forecast to use this intersection to access the Project and other land uses along Old Fort Weaver Road may have to use alternative routes.

Impact 6.2.2E: Transportation Impact at Fort Weaver Road/ Renton Road under "Without Transit Corridor Scenario"

Under Year 2030 Baseline Conditions, intersection Fort Weaver Road/ Renton Road would operate at LOS E during both AM and PM peak hours. Under Year 2030 Baseline plus Project "Without Transit Scenario" conditions, the operational conditions would worsen and the intersection would operate at LOS F for both AM and PM peak hours. Since the proposed Project would worsen LOS for both AM and PM peak hours to LOS F, a transportation impact would result.

Mitigation: The following mitigation measures are proposed:

1. Southbound Approach: Construct one additional exclusive left-turn lane to provide dual left-turn lanes.
2. Westbound Approach: Convert existing shared left-through-right lane to shared through-left lane and construct one exclusive right-turn lane.
3. Eastbound Approach: Due to limited right-of-way, additional capacity cannot be provided in this direction.

Impact after Mitigation: Significant and Unavoidable

With the proposed mitigation measures, this intersection would operate at LOS E for both AM and PM peak hours.

Impact 6.2.2F: Transportation Impact at Farrington Highway/ Fort Barrette Road under "Without Transit Corridor Scenario"

west direction to connect to North-South Road at the ninth vehicular access point from the south edge of the Proposed Project.

INTERNAL ROADWAYS

As previously stated, the proposed Project would include construction of numerous internal streets to accommodate on-site circulation. Included in this section are descriptions of the internal street network.

First Avenue is an east-west avenue connector street that runs from Second Avenue to A Street providing internal roadway connections from the fifth vehicular access point to the project site.

Second Avenue is an east-west avenue connector street that runs from Fort Weaver Road to Farrington Highway providing internal roadway connections between the first to the fifth vehicular access points.

Third Avenue is an east-west avenue connector street that runs from Fort Weaver Road to Second Avenue providing internal roadway connections between the second vehicular access point and Second Avenue via E and D streets.

Fourth Avenue is an east-west avenue connector street that runs between Parkway and C Street providing key internal connections to the core of the Proposed Project.

Fifth Avenue is a north-south avenue connector street that turns between Parkway and B Street providing internal roadway connections near the core of the Proposed Project.

A Street is a north-south street that runs between First Avenue and East-West Road.

B Street is a north-south street that runs between Farrington Highway and East-West Road providing internal roadway connections between the sixth vehicular access point and the Proposed Project.

C Street is an east-west street that runs between Fort Weaver Road and Parkway providing key internal roadway connections via the eighth vehicular access point, Old Fort Weaver Road, and East-West Road, to the Proposed Project.

D Street is a north-south street that runs between Second Avenue and Farrington Highway providing internal roadway connections via Third Street, E Street, Second Avenue, and Farrington Highway to the Proposed Project.

E Street is a north-south street that runs between Second Avenue and Farrington Highway providing internal roadway connections via Third Street, Farrington Highway to the Proposed Project.

Under Year 2030 Baseline Conditions, intersection Farrington Highway/ Fort Barrette Road would operate at LOS E for both AM and PM peak hours. Under Year 2030 Baseline plus Project "Without Transit Scenario" conditions, the LOS of the intersection would remain at LOS E during AM peak hour conditions, but the volume-to-capacity ratio would worsen from 0.77 to 0.90. For the PM peak hour, the LOS would worsen from LOS E to LOS F. Since the proposed Project would worsen the operating conditions of this intersection to LOS F during PM peak hour conditions, a transportation impact would result. High left-turn volumes from south-westbound Farrington Highway are primarily responsible for worsening the intersection operating conditions under Year 2030 Baseline plus Project "Without Transit Corridor Scenario" conditions.

Mitigation: The following mitigation measure is proposed:

1. Signal Timing: Change the cycle length from 210 seconds to 120 seconds. Also, convert the southeast and northwest right-turn phases from permitted to permitted plus overlap phases.
2. Signal Optimization: Optimization of intersection splits and cycle lengths along with the intersection offsets.

Impact after Mitigation: Less-than-significant level.

With the proposed mitigation measure, the operating condition of this intersection would improve from LOS F to LOS D for both AM and PM peak hours.

Impact 6.2.2G: Transportation Impact at North-South Road/ H-1 Eastbound Ramps under "Without Transit Corridor Scenario"

Under Year 2030 Baseline Conditions, intersection North-South Road/ H-1 Eastbound Ramps would operate at LOS D during the AM peak hour and LOS B during the PM peak hour. Under Year 2030 Baseline plus Project "Without Transit Scenario" conditions, the intersection would continue to operate at LOS D for the AM peak hour but would worsen to LOS F during the PM peak hour. Since the proposed Project would worsen the operating conditions of this intersection to LOS F during the PM peak hour conditions, a transportation impact would result.

Mitigation: The following mitigation measures are proposed:

1. Southeast-bound Approach: Construct one additional through lane to provide three through lanes.
2. Eastbound Approach: Construct one additional right-turn lane to provide dual right-turn lanes.

Impact after Mitigation: Less-than-significant level.

With the proposed mitigation measures, the operating condition of this intersection would improve from LOS F to LOS C during the PM peak hour.

Impact 6.2.2H: Transportation Impact at Farrington Highway/ North-South Road under "Without Transit Corridor Scenario"

Under Year 2030 Baseline Conditions, intersection Farrington Highway/ North-South Road would operate at LOS D during both the AM and PM peak hours. Under Year 2030 Baseline plus Project "Without Transit Scenario" conditions, this intersection would operate at LOS F with volume-to-capacity ratios of 1.23 and 1.27 during the AM and PM peak hours, respectively. Since the proposed Project would worsen the operating conditions of this intersection to LOS F during AM and PM peak hour conditions, a transportation impact would result.

Mitigation Option 1: Proposed as part of the Ho'opili TIAR

1. Southwest-bound Approach: Construct one additional exclusive right-turn lane to provide dual right-turn lanes.
2. Southeast-bound Approach: Convert the existing permissive right-turn to a free right-turn.
3. Northeast-bound Approach: Convert the existing permissive right-turn to a dual free right-turn. Construct an additional right-turn lane.
4. Northwest-bound Approach: Construct an additional left-turn lane to provide triple left-turn lanes.
5. Signal Timing: Change the cycle length from 150 seconds to 140 seconds.

Additionally, TDM strategies discussed in *Section 6.3* are proposed to reduce the peak hour intersection traffic volumes.

Impact after Mitigation: Less than significant for the AM peak hour but significant and unavoidable for the PM peak hour.

With the proposed mitigation measures, this intersection would operate at LOS D under AM peak hour conditions and LOS E during PM peak hour conditions, while the volume-to-capacity ratios would improve from 1.23 to 0.98 during the AM peak hours and from 1.27 to 1.08 during the PM peak hours, respectively. In addition, the intersection delays would improve from 105 to 47 seconds during the AM peak hour and from 117 to 69 seconds during the PM peak hour.

Mitigation Option 2: Incorporated from the University of Hawai'i West O'ahu Traffic Study Report

As an alternative to the above mitigation measure, the mitigation measure proposed as part of the University of Hawai'i West O'ahu (UHWO) could also be implemented as a mitigation measure at this intersection. The UHWO Traffic Study Report suggests a potential configuration for a grade separation to carry the Farrington Highway through movements over the intersection. North-South Road through lanes would remain as an at-grade facility and all turning movements would occur at-grade at the intersection. By removing the Farrington Highway through movements from the intersection, more green time could be allocated to the other movements to accommodate the projected traffic volumes.

Impact 6.2.21: Transportation Impact at North-South Road/ Kapolei Parkway under "Without Transit Corridor Scenario"

Under Year 2030 Baseline Conditions, intersection North-South Road/ Kapolei Parkway would operate at LOS C during the AM peak hour and LOS D during the PM peak hour. Under Year 2030 Baseline plus Project "Without Transit Scenario" conditions, the LOS of the intersection would be LOS E during both AM and PM peak hour conditions. Since the proposed Project would worsen the operating conditions of this intersection to LOS E during both AM and PM peak hour conditions, a transportation impact would result. High southbound left turn volumes (507 during PM peak hour and 229 during AM peak hour) and high southbound right turn volumes (735 vph during PM peak hour and 597 vph during AM peak hour) are the primary contributors to the intersection's poor operating conditions under Year 2030 Baseline plus Project "Without Transit Corridor Scenario" conditions.

Mitigation: The following mitigation measure is proposed:

1. Southbound Approach: Convert shared through-right lane to exclusive right-turn lane to provide three through lanes and one right-turn lane.

With the mitigation, the intersection would operate at LOS D during the AM and the PM peak periods.

Impact after Mitigation: Less-than-significant level.

Figures 6-2A and 6-2B exhibit the proposed intersection improvements under Year 2030 Baseline plus Project "Without Transit Corridor Scenario".

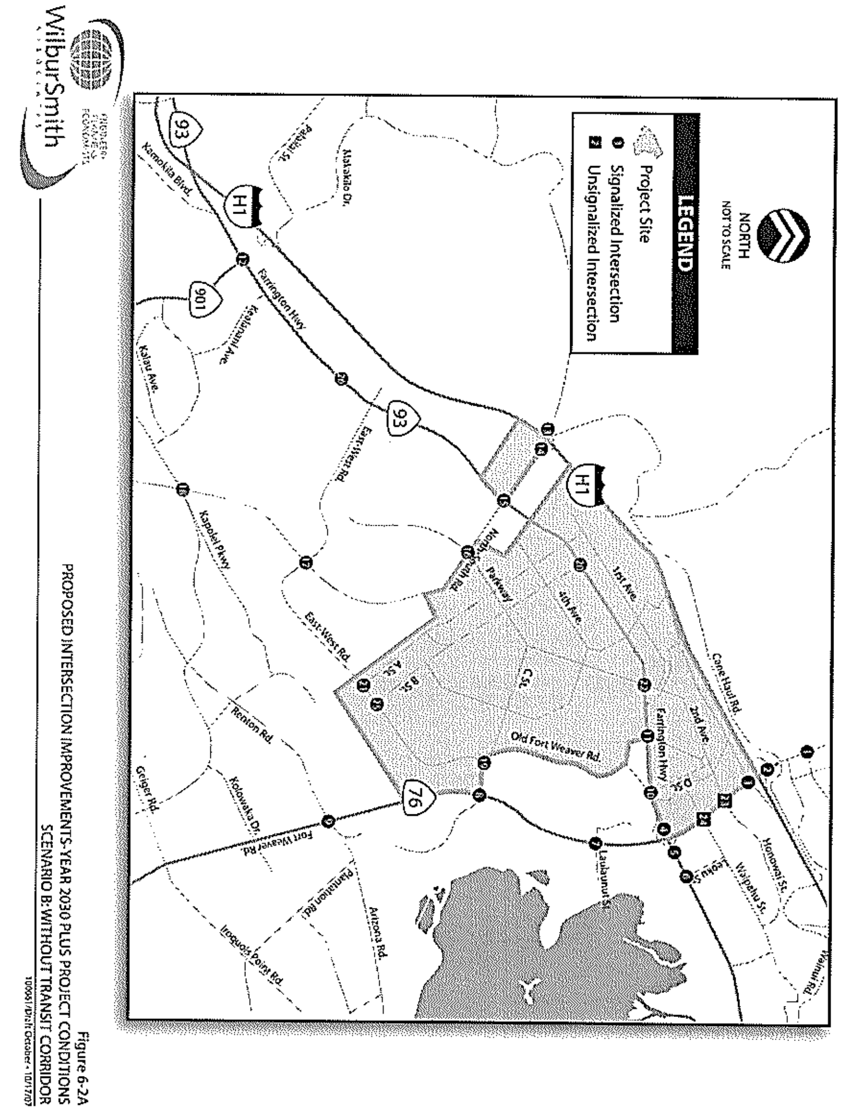


Figure 6-2A
PROPOSED INTERSECTION IMPROVEMENTS-YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO B: WITHOUT TRANSIT CORRIDOR

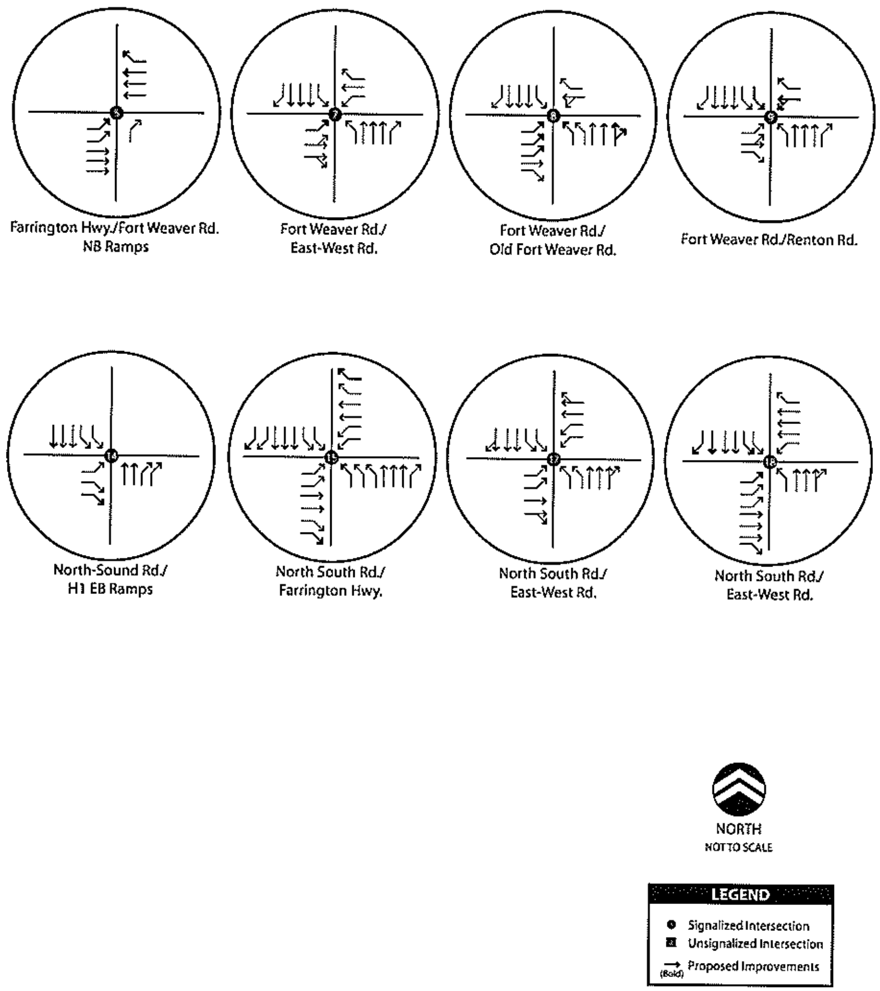


Figure 6-28
PROPOSED INTERSECTION IMPROVEMENTS-YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO B: WITHOUT TRANSIT CORRIDOR SCENARIO

100061/DEC 2007-12/10/07

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6.3 TRANSPORTATION DEMAND STRATEGIES

Transportation Demand Management (TDM) strategies address traffic congestion by reducing the amount of vehicle miles traveled, thereby reducing overall travel demand. The aim of these strategies is focused on promoting travel alternatives such as increased transit usage, walking, and bicycling to help achieve this goal. It should be noted that TDM strategies can be used in combination to create a comprehensive TDM Program that can affect a significant portion of total travel. Furthermore, TDM strategies can be tailored to achieve many objectives, specifically helping change travel behavior by correcting misperceptions regarding the true costs involved with driving and finding suitable alternatives. As previously noted, the Leeward Oahu Transportation Management Association (LOTMA) provides TDM services in the vicinity of the proposed Project. It is anticipated that the proposed Project will continue to support the existing programs and services in place. It should be noted however that based on the proposed Project's trip generation during the AM and PM peak hours, the Project Sponsor may want to consider additional TDM strategies as a means of managing and improving travel demand. The following strategies are suggested for consideration:

- **Carsharing** – Project Sponsors could make carsharing available for residents of the Proposed development. Carsharing would provide residents access to a car on an "as needed" basis without incurring the fixed costs associated with owning and operating a personal automobile. Users could pick up a car at a designated vehicle location (typically located throughout a given jurisdiction) and would be charged a standard fee for its usage. The rate would typically include gas, maintenance, and insurance.

- **Carpool/Vanpool** – Developers and employers could promote carpool or vanpool programs for commuters who either live or work in the proposed Project and share the same schedule, through subsidizing the cost of vehicles and fuel costs. The remaining costs would be divided among program participants who would pay a fee for mileage used.

- **Preferential HOV Parking** – Developers or employers could provide incentives for use of alternative modes of travel to the single occupancy vehicle by reserving close-in, secure, covered, or otherwise preferable parking spaces for high-occupancy vehicles. It should be noted that the carpool spaces should be those closest to the building entrance or elevator, however not closer than parking designated for use of the disabled.

- **Rent subsidies** – Developers of residential developments could offer tenants rent subsidies (reductions in rent) equivalent to the amount of money they would typically pay for a parking space included in the price of their rent if they forego the use of a parking space. For example, suppose each 1 bedroom unit is allocated one parking stall. Tenants who do not own or choose not to have a car would receive a reduction off their monthly rent equivalent to the value/cost of the parking stall.

- **Transit Subsidies** – Developers and employers could encourage the use of transit by offering a discounted monthly pass to its residents and employees.

- **Bicycle Parking and Shower Facilities** – Both businesses and developers can provide bicycle parking, storage, and shower facilities to promote and encourage the use of bicycles for work and home trips. It is important to consider the provision of both short-term and long-term parking facilities. Notably, long term bicycle parking should be provided for residents or those who stay at the site for several hours and offer secure and weather protected places to store bicycles. In contrast, short-term parking should be provided for shoppers, customers, and other visitors who park for two hours or less, and be located in readily accessible places (e.g. within 50 feet of the entrance the cyclists use).

- **Staggered Class Schedules** – The University of Hawai'i and Department of Education (DOE) schools should consider following an alternative class schedules where courses begin at 9:00 AM so as to avoid the peak commute period (6:00AM to 8:00 AM).

6.4 SITE ACCESS AND ON-SITE CIRCULATION

The proposed Project would be primarily accessed along major defined roadways including, Farrington Highway, Fort Weaver Road, and North-South Road. Circulation within the proposed Project however would be made possible through a number of different access points. The vehicular circulation within the site includes ten new major internal streets and nine primary vehicular access locations. Note that a map of the Project site is included in Appendix E. The first access point is located at the intersection of Fort Weaver Road and Second Avenue, a new east-west internal road that would be constructed as part of the Proposed Project. A secondary vehicular access point is proposed at the junction of a new east-west internal street, named Third Avenue, with Fort Weaver Road. Third Avenue extends west connecting Fort Weaver Road to Second Avenue via two new north-south internal streets, E and D Streets. It should be noted that two vehicular access points at Fort Weaver Road would only allow southbound right turns into the Project.

A third vehicular access point would be located at the intersection of D Street, Farrington Highway, and Old Fort Weaver Road East. A fourth vehicular access point would be located immediately adjacent to the third, at the intersection of E Street, Farrington Highway, and Old Fort Weaver Road West. As Farrington Highway continues in the west direction, the fifth vehicular entrance will be located along Farrington Highway accessible from Second Avenue to the north (with connecting access to a new east-west internal street named First Avenue) and Parkway, a new north-south internal street to the south. A sixth access point is proposed at the intersection of Farrington Highway and a new north-south internal street named "B Street."

The proposed Project would also include additional vehicular access points from the west and south. A seventh access point would be located at the intersection of North-South Road and Parkway, providing access to/from the west side of the project site. It should be noted that Parkway runs east-west and would connect with yet another east-west internal street named C Street. C Street extends further east to connect with Old Fort Weaver Road and East-West Road where the eighth vehicular entrance/exit would be located. East-West Road continues in the

6.5 MULTI-MODAL TRANSPORTATION

As previously described, TheBus transit service is provided in the vicinity of the proposed Ho'Opili development. Given the size and nature of the proposed development the Project Sponsor should work closely with the City and County, and TheBus staff to identify possibilities for future expanded bus service in the vicinity of the Proposed Project. As part of this process, discussions between the Project Sponsor, the City and TheBus staff should include provision of bus stops and shelters and the identification of their appropriate placement such that they serve local schools, commercial, and recreational facilities in the area. In addition, the project should ensure that connecting pedestrian linkages are provided for future proposed bus stop locations. Proposed changes to should be carried out in accordance with existing American with Disabilities Act Accessibility Guidelines (ADAAG).

The City's planned guideway project will offer prime multi-modal transportation to the residents and visitors to Ho'opili. The Ho'opili land use plan effectively promotes and encourages the use of the guideway through its full range of mixed land uses, including a wide range of places of live, work, shop, recreate and learn and will aspire to achieve a job-housing balance. Furthermore, the project is designed to maximize connectivity (transit, pedestrian, bicycle and vehicular) with surrounding streets and communities (including DHHL and UHWO), while minimizing cul-de-sacs and dead-end streets. It is worth noting that the final selection of the transit station locations will also encourage higher levels of development intensity as well as density as they tend to concentrate around transit stations. As such, the guideway provides multiple opportunities to promote and advance multi-modal transportation within the Ho'opili development and its surrounding areas.

Chapter 7
CONCLUSION

To assess the transportation impacts associated with the construction of the proposed Ho'opili Development in O'ahu, Hawai'i, a Traffic Impact Analysis Report was conducted. The analysis evaluated the operations of twelve key intersections under Existing Conditions and thirty-four key intersections for Future 2030 Baseline Conditions, Future 2030 plus Project Conditions "With Transit Corridor Scenario", and Future 2030 plus Project Conditions "Without Transit Corridor Scenario" during the morning and evening peak hours.

The proposed Project includes approximately 2835 thousand square feet (ksf) of retail/office building floor area, 925 ksf of industrial building floor area, and approximately 11,750 dwelling units as per the Ho'opili Town master plan. The site is located in the 'Ewa District of O'ahu, within close proximity of the H-1 Freeway, Farrington Highway, and State Route 76 (Fort Weaver Road). The proposed Project "With Transit Scenario Corridor" Project is estimated to generate 140,920 daily trips, 7,069 morning peak hour trips (3,183 inbound and 3,886 outbound), and 12,077 evening peak hour trips (6,122 inbound and 5,955 outbound). The Proposed project "Without Transit Corridor Scenario" would generate 158,669 daily trips, 9,172 morning peak hour trips (4,176 inbound and 4,996 outbound), and 13,776 evening peak hour trips (6,970 inbound and 6,806 outbound).

Impacts of the proposed project on the study intersections were evaluated with level of service calculations. The results of the analysis indicate that the proposed Project would result in significant impacts to only one intersection under 2030 Baseline plus Project conditions "With Transit Corridor Scenario." In addition, the proposed Project would also result in significant impacts at two intersections under 2030 Baseline plus Project conditions "Without Transit Corridor Scenario."

Vehicular access to the proposed Project site would be made possible via multiple points. From the north, vehicles would approach the Project from the Kunia Road/ H-1 interchange and have access to the site at the intersections of Fort Weaver Road/ Second Avenue1[1] and Fort Weaver Road/ Third Avenue[1]. Access in to the Project site from the south would be provided from the intersections of North-South Road/East-West Road and Fort Weaver Road/C Street. From the west vehicles would approach the proposed Project from the Farrington Highway/North-South Road intersection and gain access to the site at the intersection of Farrington Highway/B Street[1]. As vehicles travel from the east there are more opportunities to enter the Project site at the following access points along Farrington Highway; Farrington Highway/Second Avenue, Farrington Highway/West Old Fort Weaver Road, and Farrington Highway/East Old Fort Weaver Road.

[1] See Chapter 6 for description of the street. It should be noted that use of this street is only assumed as part of this study.

APPENDIX

APPENDIX A

INTERSECTION LOS ANALYSIS

APPENDIX A-1

EXISTING CONDITIONS

HCM Signalized Intersection Capacity Analysis
1: Kunia Loop & Kunia Road

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↰	↱	↑↑	↱		↓↓
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0		4.0
Lane Util. Factor	0.97	1.00	0.95	1.00		0.95
Frt	1.00	0.85	1.00	0.85		1.00
Flt Protected	0.95	1.00	1.00	1.00		1.00
Satd. Flow (prot)	3433	1583	3539	1583		3539
Flt Permitted	0.95	1.00	1.00	1.00		1.00
Satd. Flow (perm)	3433	1583	3539	1583		3539
Volume (vph)	613	21	829	340	0	843
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	666	23	901	370	0	916
RTOR Reduction (vph)	0	16	0	171	0	0
Lane Group Flow (vph)	666	7	901	199	0	916
Turn Type		Perm		Perm		
Protected Phases	8		2			6
Permitted Phases		8		2		
Actuated Green, G (s)	15.5	15.5	27.2	27.2		27.2
Effective Green, g (s)	15.5	15.5	27.2	27.2		27.2
Actuated g/C Ratio	0.31	0.31	0.54	0.54		0.54
Clearance Time (s)	4.0	4.0	4.0	4.0		4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0		3.0
Lane Grp Cap (vph)	1050	484	1899	849		1899
v/s Ratio Prot	c0.19		0.25			c0.26
v/s Ratio Perm		0.00		0.13		
v/c Ratio	0.63	0.01	0.47	0.23		0.48
Uniform Delay, d1	15.2	12.3	7.3	6.2		7.3
Progression Factor	1.00	1.00	1.00	1.00		1.00
Incremental Delay, d2	1.3	0.0	0.9	0.6		0.9
Delay (s)	16.4	12.3	8.2	6.9		8.2
Level of Service	B	B	A	A		A
Approach Delay (s)	16.3		7.8			8.2
Approach LOS	B		A			A

Intersection Summary			
HCM Average Control Delay	10.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	50.7	Sum of lost time (s)	8.0
Intersection Capacity Utilization	47.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
2: H-1 WB On-Ramp & Kunia Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations					↑			↑↱				
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	0	0	0	232	0	0	1259	197	0	0	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	0	252	0	0	1368	214	0	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)								1180			617	
pX, platoon unblocked	0.94	0.94	0.94	0.94	0.94					0.94		
vC, conflicting volume	1602	1476	791	684	1583	0	0			1583		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1576	1442	714	600	1556	0	0			1556		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	100	100	100	0	100	100			100		
cM capacity (veh/h)	0	123	351	362	105	1084	1622			396		

Direction, Lane #	WB 1	SE 1	SE 2
Volume Total	252	912	670
Volume Left	0	0	0
Volume Right	0	0	214
cSH	105	1700	1700
Volume to Capacity	2.40	0.54	0.39
Queue Length 95th (ft)	564	0	0
Control Delay (s)	723.3	0.0	0.0
Lane LOS	F		
Approach Delay (s)	723.3	0.0	
Approach LOS	F		

Intersection Summary			
Average Delay	99.4		
Intersection Capacity Utilization	106.2%	ICU Level of Service	G
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
3: H-1 Off Ramp & Kunia Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations		↰	↱				↰↰	↑↑↑			↑↑	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0				4.0	4.0			4.0	
Lane Util. Factor		1.00	1.00				0.97	0.91			0.95	
Frt		1.00	0.85				1.00	1.00			1.00	
Flt Protected		0.95	1.00				0.95	1.00			1.00	
Satd. Flow (prot)		1770	1583				3433	5085			3539	
Flt Permitted		0.95	1.00				0.95	1.00			1.00	
Satd. Flow (perm)		1770	1583				3433	5085			3539	
Volume (vph)	318	0	438	0	0	0	1097	1927	0	0	478	0
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	346	0	476	0	0	0	1192	2095	0	0	520	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	346	476	0	0	0	1192	2095	0	0	520	0
Turn Type	Split		Free				Prot					
Protected Phases	4	4					1	6			2	
Permitted Phases			Free									
Actuated Green, G (s)		17.0	74.0				28.9	49.0			16.1	
Effective Green, g (s)		17.0	74.0				28.9	49.0			16.1	
Actuated g/C Ratio		0.23	1.00				0.39	0.66			0.22	
Clearance Time (s)		4.0					4.0	4.0			4.0	
Vehicle Extension (s)		3.0					3.0	3.0			3.0	
Lane Grp Cap (vph)		407	1583				1341	3367			770	
v/s Ratio Prot		c0.20					c0.35	c0.41			0.15	
v/s Ratio Perm			0.30									
v/c Ratio		0.85	0.30				0.89	0.62			0.68	
Uniform Delay, d1		27.3	0.0				21.1	7.2			26.6	
Progression Factor		1.00	1.00				1.00	1.00			1.00	
Incremental Delay, d2		15.5	0.5				7.5	0.9			4.7	
Delay (s)		42.8	0.5				28.6	8.1			31.3	
Level of Service		D	A				C	A			C	
Approach Delay (s)		18.3			0.0			15.5			31.3	
Approach LOS		B			A			B			C	

Intersection Summary			
HCM Average Control Delay	17.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	74.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	72.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
4: Farrington Hwy & Fort Weaver Road SB Ramp

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↱		↰	↑↑				↱			↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0				4.0			4.0
Lane Util. Factor		0.95		1.00	0.95				1.00			1.00
Frt		0.99		1.00	1.00				0.86			0.86
Flt Protected		1.00		0.95	1.00				1.00			1.00
Satd. Flow (prot)		3521		1770	3539				1611			1611
Flt Permitted		1.00		0.95	1.00				1.00			1.00
Satd. Flow (perm)		3521		1770	3539				1611			1611
Volume (vph)	0	711	26	253	231	0	0	0	822	0	0	119
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	773	28	275	251	0	0	0	893	0	0	129
RTOR Reduction (vph)	0	3	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	798	0	275	251	0	0	0	893	0	0	129
Turn Type				Prot					Free			Free
Protected Phases		2		1	6							
Permitted Phases									Free			Free
Actuated Green, G (s)		37.8		14.2	60.0				60.0			60.0
Effective Green, g (s)		37.8		14.2	60.0				60.0			60.0
Actuated g/C Ratio		0.63		0.24	1.00				1.00			1.00
Clearance Time (s)		4.0		4.0	4.0							
Vehicle Extension (s)		3.0		3.0	3.0							
Lane Grp Cap (vph)		2218		419	3539				1611			1611
v/s Ratio Prot		0.23		0.16	0.07							
v/s Ratio Perm									c0.55			0.08
v/c Ratio		0.36		0.66	0.07				0.55			0.08
Uniform Delay, d1		5.3		20.7	0.0				0.0			0.0
Progression Factor		1.00		0.46	1.00				1.00			1.00
Incremental Delay, d2		0.5		3.1	0.0				1.4			0.1
Delay (s)		5.8		12.5	0.0				1.4			0.1
Level of Service		A		B	A				A			A
Approach Delay (s)		5.8			6.5			1.4			0.1	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	4.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	0.0
Intersection Capacity Utilization	41.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
5: Farrington Hwy & Fort Weaver Road NB Ramps

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑			↑↑↱				↱			
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0				4.0			
Lane Util. Factor	1.00	0.95			0.95				1.00			
Frt	1.00	1.00			0.96				0.86			
Flt Protected	0.95	1.00			1.00				1.00			
Satd. Flow (prot)	1770	3539			3397				1611			
Flt Permitted	0.95	1.00			1.00				1.00			
Satd. Flow (perm)	1770	3539			3397				1611			
Volume (vph)	444	1089	0	0	484	177	0	0	894	0	0	0
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	483	1184	0	0	526	192	0	0	972	0	0	0
RTOR Reduction (vph)	0	0	0	0	62	0	0	0	0	0	0	0
Lane Group Flow (vph)	483	1184	0	0	656	0	0	0	972	0	0	0
Turn Type	Prot								Free			
Protected Phases	5	2			6							
Permitted Phases									Free			
Actuated Green, G (s)	31.0	60.0			21.0				60.0			
Effective Green, g (s)	31.0	60.0			21.0				60.0			
Actuated g/C Ratio	0.52	1.00			0.35				1.00			
Clearance Time (s)	4.0	4.0			4.0							
Vehicle Extension (s)	3.0	3.0			3.0							
Lane Grp Cap (vph)	915	3539			1189				1611			
v/s Ratio Prot	0.27	0.33			0.19							
v/s Ratio Perm									c0.60			
v/c Ratio	0.53	0.33			0.55				0.60			
Uniform Delay, d1	9.6	0.0			15.7				0.0			
Progression Factor	1.10	1.00			1.00				1.00			
Incremental Delay, d2	0.5	0.2			1.8				1.7			
Delay (s)	11.1	0.2			17.6				1.7			
Level of Service	B	A			B				A			
Approach Delay (s)		3.4			17.6			1.7			0.0	
Approach LOS		A			B			A			A	

Intersection Summary			
HCM Average Control Delay	5.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	0.0
Intersection Capacity Utilization	50.3%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
6: Farrington Hwy & Leoku Street

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑	↱	↰	↑↑	↱		↰↑	↱		↰↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95	1.00		1.00	1.00		0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00		0.97	1.00
Satd. Flow (prot)	3433	3539	1583	1770	3539	1583		1792	1583		3433	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00		0.97	1.00
Satd. Flow (perm)	3433	3539	1583	1770	3539	1583		1792	1583		3433	1583
Volume (vph)	546	891	546	52	375	152	186	50	19	51	31	150
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	593	968	593	57	408	165	202	54	21	55	34	163
RTOR Reduction (vph)	0	0	342	0	0	133	0	0	11	0	0	148
Lane Group Flow (vph)	593	968	251	57	408	32	0	256	10	0	89	15
Turn Type	Prot		Perm	Prot		Perm	Split		Perm	Split		Perm
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			6
Actuated Green, G (s)	16.7	26.8	26.8	2.2	12.3	12.3		12.4	12.4		5.9	5.9
Effective Green, g (s)	16.7	26.8	26.8	2.2	12.3	12.3		12.4	12.4		5.9	5.9
Actuated g/C Ratio	0.26	0.42	0.42	0.03	0.19	0.19		0.20	0.20		0.09	0.09
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	906	1498	670	62	688	308		351	310		320	148
v/s Ratio Prot	c0.17	c0.27		0.03	0.12			c0.14			c0.03	
v/s Ratio Perm			0.16			0.02			0.01			0.01
v/c Ratio	0.65	0.65	0.37	0.92	0.59	0.10		0.73	0.03		0.28	0.10
Uniform Delay, d1	20.7	14.5	12.5	30.5	23.2	21.0		23.9	20.6		26.7	26.3
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00
Incremental Delay, d2	1.7	1.0	0.4	84.9	1.4	0.1		12.5	0.2		0.5	0.3
Delay (s)	22.4	15.5	12.9	115.3	24.6	21.1		36.4	20.8		27.2	26.6
Level of Service	C	B	B	F	C	C		D	C		C	C
Approach Delay (s)		16.7			31.9			35.2			26.8	
Approach LOS		B			C			D			C	

Intersection Summary			
HCM Average Control Delay	21.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	63.3	Sum of lost time (s)	12.0
Intersection Capacity Utilization	57.6%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
7: Laulaunui Street & Fort Weaver Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		0.95		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.91	1.00
Frt		0.99		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.96		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		3393		1770	1863	1583	1770	3539	1583	1770	5085	1583
Flt Permitted		0.96		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		3393		1770	1863	1583	1770	3539	1583	1770	5085	1583
Volume (vph)	67	20	4	99	5	198	47	2983	40	68	1435	200
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	73	22	4	108	5	215	51	3242	43	74	1560	217
RTOR Reduction (vph)	0	2	0	0	0	99	0	0	6	0	0	61
Lane Group Flow (vph)	0	97	0	108	5	116	51	3242	37	74	1560	156
Turn Type	Split			Split		Perm	Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases						8			2			6
Actuated Green, G (s)		9.5		8.0	8.0	8.0	7.0	105.0	105.0	5.9	103.9	103.9
Effective Green, g (s)		9.5		8.0	8.0	8.0	7.0	105.0	105.0	5.9	103.9	103.9
Actuated g/C Ratio		0.07		0.06	0.06	0.06	0.05	0.73	0.73	0.04	0.72	0.72
Clearance Time (s)		4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		223		98	103	88	86	2573	1151	72	3659	1139
v/s Ratio Prot		c0.03		0.06	0.00		0.03	c0.92		c0.04	0.31	
v/s Ratio Perm						c0.07			0.02			0.10
v/c Ratio		0.44		1.10	0.05	1.32	0.59	1.26	0.03	1.03	0.43	0.14
Uniform Delay, d1		64.9		68.2	64.6	68.2	67.3	19.7	5.5	69.2	8.2	6.3
Progression Factor		1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		1.4		121.1	0.2	202.2	10.5	120.3	0.1	114.0	0.4	0.3
Delay (s)		66.2		189.3	64.8	270.4	77.8	140.0	5.6	183.2	8.6	6.6
Level of Service		E		F	E	F	E	F	A	F	A	A
Approach Delay (s)		66.2			240.5			137.3			15.3	
Approach LOS		E			F			F			B	

Intersection Summary			
HCM Average Control Delay	101.9	HCM Level of Service	F
HCM Volume to Capacity ratio	1.19		
Actuated Cycle Length (s)	144.4	Sum of lost time (s)	16.0
Intersection Capacity Utilization	108.4%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
8: Old Fort Weaver Road & Fort Weaver Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.98	1.00		0.97	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1817	1583		1800	1583	1770	3539	1583	1770	3539	1583
Flt Permitted		0.80	1.00		0.79	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		1482	1583		1468	1583	1770	3539	1583	1770	3539	1583
Volume (vph)	3	3	52	114	49	210	98	2857	26	47	1485	6
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	3	3	57	124	53	228	107	3105	28	51	1614	7
RTOR Reduction (vph)	0	0	0	0	0	37	0	0	0	0	0	2
Lane Group Flow (vph)	0	6	57	0	177	191	107	3105	28	51	1614	5
Turn Type	Perm		Free	Perm		Perm	Prot		Free	Prot		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		Free	8		8			Free			6
Actuated Green, G (s)		16.0	150.0		16.0	16.0	13.4	118.0	150.0	4.0	108.6	108.6
Effective Green, g (s)		16.0	150.0		16.0	16.0	13.4	118.0	150.0	4.0	108.6	108.6
Actuated g/C Ratio		0.11	1.00		0.11	0.11	0.09	0.79	1.00	0.03	0.72	0.72
Clearance Time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)		158	1583		157	169	158	2784	1583	47	2562	1146
v/s Ratio Prot							0.06	c0.88		c0.03	0.46	
v/s Ratio Perm		0.00	0.04		0.12	c0.12			0.02			0.00
v/c Ratio		0.04	0.04		1.13	1.13	0.68	1.12	0.02	1.09	0.63	0.00
Uniform Delay, d1		60.1	0.0		67.0	67.0	66.2	16.0	0.0	73.0	10.5	5.7
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		0.1	0.0		110.1	109.3	10.9	57.5	0.0	157.2	1.2	0.0
Delay (s)		60.2	0.0		177.1	176.3	77.1	73.5	0.0	230.2	11.7	5.7
Level of Service		E	A		F	F	E	E	A	F	B	A
Approach Delay (s)		5.8			176.6			73.0			18.3	
Approach LOS		A			F			E			B	

Intersection Summary			
HCM Average Control Delay	63.0	HCM Level of Service	E
HCM Volume to Capacity ratio	1.12		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	105.3%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
9: Renton Road & Fort Weaver Road

Existing AM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↰↑	↱		✣		↰	↑↑	↱	↰	↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.95	0.95	1.00		1.00		1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85		0.99		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1705	1583		1835		1770	3539	1583	1770	3539	1583
Flt Permitted	0.95	0.96	1.00		1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1705	1583		1835		1770	3539	1583	1770	3539	1583
Volume (vph)	565	82	278	1	31	4	356	2352	2	176	1277	248
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	614	89	302	1	34	4	387	2557	2	191	1388	270
RTOR Reduction (vph)	0	0	0	0	3	0	0	0	0	0	0	143
Lane Group Flow (vph)	342	361	302	0	36	0	387	2557	2	191	1388	127
Turn Type	Split		Free	Split			Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			Free						2			6
Actuated Green, G (s)	27.0	27.0	149.2		3.2		33.0	90.0	90.0	13.0	70.0	70.0
Effective Green, g (s)	27.0	27.0	149.2		3.2		33.0	90.0	90.0	13.0	70.0	70.0
Actuated g/C Ratio	0.18	0.18	1.00		0.02		0.22	0.60	0.60	0.09	0.47	0.47
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	304	309	1583		39		391	2135	955	154	1660	743
v/s Ratio Prot	0.20	c0.21			c0.02		0.22	c0.72		c0.11	0.39	
v/s Ratio Perm			0.19						0.00			0.08
v/c Ratio	1.12	1.17	0.19		0.92		0.99	1.20	0.00	1.24	0.84	0.17
Uniform Delay, d1	61.1	61.1	0.0		72.9		57.9	29.6	11.8	68.1	34.6	22.8
Progression Factor	1.00	1.00	1.00		1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	89.7	104.9	0.3		113.6		42.3	93.8	0.0	151.2	5.2	0.5
Delay (s)	150.8	166.0	0.3		186.5		100.2	123.4	11.8	219.3	39.8	23.3
Level of Service	F	F	A		F		F	F	B	F	D	C
Approach Delay (s)		111.0			186.5			120.3			55.9	
Approach LOS		F			F			F			E	

Intersection Summary			
HCM Average Control Delay	98.7	HCM Level of Service	F
HCM Volume to Capacity ratio	1.19		
Actuated Cycle Length (s)	149.2	Sum of lost time (s)	16.0
Intersection Capacity Utilization	109.2%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
10: Farrington Hwy & East Old Fort Weaver Road

Existing AM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↑									↑	
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	672	0	0	0	0	0	0	0	0	69	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	730	0	0	0	0	0	0	0	0	75	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)					846							
pX, platoon unblocked												
vC, conflicting volume	0			730			768	730	730	730	730	0
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	0			730			768	730	730	730	730	0
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	100	79	100
cM capacity (veh/h)	1623			874			266	349	422	338	349	1085

Direction, Lane #	EB 1	SW 1
Volume Total	730	75
Volume Left	0	0
Volume Right	0	0
cSH	1700	349
Volume to Capacity	0.43	0.21
Queue Length 95th (ft)	0	20
Control Delay (s)	0.0	18.1
Lane LOS		C
Approach Delay (s)	0.0	18.1
Approach LOS		C

Intersection Summary			
Average Delay	1.7		
Intersection Capacity Utilization	56.8%	ICU Level of Service	B
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
11: Farrington Hwy & West Old Fort Weaver Road

Existing AM Peak

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↱			↑	Y	
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	664	30	0	281	38	8
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	722	33	0	305	41	9
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			754		1043	738
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			754		1043	738
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		84	98
cM capacity (veh/h)			856		254	418

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	754	305	50
Volume Left	0	0	41
Volume Right	33	0	9
cSH	1700	1700	272
Volume to Capacity	0.44	0.18	0.18
Queue Length 95th (ft)	0	0	16
Control Delay (s)	0.0	0.0	21.2
Lane LOS			C
Approach Delay (s)	0.0	0.0	21.2
Approach LOS			C

Intersection Summary			
Average Delay	1.0		
Intersection Capacity Utilization	46.8%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
12: Farrington Hwy & Fort Barrette Road

Existing AM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰↰	↑↑	↱	↰	↑↑	↱	↰↰	↑↱	↱	↰↰	↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95	1.00	0.97	0.91	0.91	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3539	1583	1770	3539	1583	3433	3390	1441	3433	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3539	1583	1770	3539	1583	3433	3390	1441	3433	3539	1583
Volume (vph)	325	201	483	42	344	425	570	488	34	359	605	779
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	353	218	525	46	374	462	620	530	37	390	658	847
RTOR Reduction (vph)	0	0	339	0	0	317	0	0	23	0	0	172
Lane Group Flow (vph)	353	218	186	46	374	145	620	530	14	390	658	675
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	7	4		3	8		1	6		5	2	
Permitted Phases			4			8			6			2
Actuated Green, G (s)	9.0	22.7	22.7	2.4	16.1	16.1	16.0	34.8	34.8	14.3	33.1	33.1
Effective Green, g (s)	9.0	22.7	22.7	2.4	16.1	16.1	16.0	34.8	34.8	14.3	33.1	33.1
Actuated g/C Ratio	0.10	0.25	0.25	0.03	0.18	0.18	0.18	0.39	0.39	0.16	0.37	0.37
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	343	891	398	47	632	283	609	1308	556	544	1299	581
v/s Ratio Prot	c0.10	0.06		0.03	c0.11		c0.18	0.16		0.11	0.19	
v/s Ratio Perm			0.12			0.09			0.01			c0.43
v/c Ratio	1.03	0.24	0.47	0.98	0.59	0.51	1.02	0.41	0.03	0.72	0.51	1.16
Uniform Delay, d1	40.6	26.9	28.6	43.9	34.0	33.5	37.1	20.2	17.2	36.0	22.2	28.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	56.3	0.1	0.9	122.0	1.5	1.6	41.1	0.9	0.1	4.5	1.4	91.0
Delay (s)	96.9	27.1	29.5	165.9	35.5	35.1	78.2	21.1	17.3	40.5	23.6	119.5
Level of Service	F	C	C	F	D	D	E	C	B	D	C	F
Approach Delay (s)		50.7			42.1			50.8			70.0	
Approach LOS		D			D			D			E	

Intersection Summary			
HCM Average Control Delay	56.4	HCM Level of Service	E
HCM Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	90.2	Sum of lost time (s)	16.0
Intersection Capacity Utilization	80.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
1: Kunia Loop & Kunia Road

Existing PM

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↰	↱	↑↑	↱		↑↑
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0		4.0
Lane Util. Factor	0.97	1.00	0.95	1.00		0.95
Frt	1.00	0.85	1.00	0.85		1.00
Flt Protected	0.95	1.00	1.00	1.00		1.00
Satd. Flow (prot)	3433	1583	3539	1583		3539
Flt Permitted	0.95	1.00	1.00	1.00		1.00
Satd. Flow (perm)	3433	1583	3539	1583		3539
Volume (vph)	415	12	1000	812	0	1314
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	451	13	1087	883	0	1428
RTOR Reduction (vph)	0	10	0	313	0	0
Lane Group Flow (vph)	451	3	1087	570	0	1428
Turn Type		Perm		Perm		
Protected Phases	8		2			6
Permitted Phases		8		2		
Actuated Green, G (s)	12.4	12.4	37.1	37.1		37.1
Effective Green, g (s)	12.4	12.4	37.1	37.1		37.1
Actuated g/C Ratio	0.22	0.22	0.65	0.65		0.65
Clearance Time (s)	4.0	4.0	4.0	4.0		4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0		3.0
Lane Grp Cap (vph)	740	341	2283	1021		2283
v/s Ratio Prot	c0.13		0.31			c0.40
v/s Ratio Perm		0.00		0.36		
v/c Ratio	0.61	0.01	0.48	0.56		0.63
Uniform Delay, d1	20.4	17.7	5.2	5.7		6.1
Progression Factor	1.00	1.00	1.00	1.00		1.00
Incremental Delay, d2	1.4	0.0	0.7	2.2		1.3
Delay (s)	21.8	17.7	5.9	7.9		7.4
Level of Service	C	B	A	A		A
Approach Delay (s)	21.7		6.8			7.4
Approach LOS	C		A			A

Intersection Summary			
HCM Average Control Delay	8.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	57.5	Sum of lost time (s)	8.0
Intersection Capacity Utilization	54.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
2: H-1 WB On-Ramp & Kunia Road

Existing PM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations					↑			↑↑↱				
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	0	0	0	323	0	0	1454	275	0	0	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	0	351	0	0	1580	299	0	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)								1180			617	
pX, platoon unblocked	0.75	0.75	0.75	0.75	0.75					0.75		
vC, conflicting volume	1905	1730	940	790	1879	0	0			1879		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1873	1638	577	377	1838	0	0			1838		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	100	100	100	0	100	100			100		
cM capacity (veh/h)	0	74	342	414	56	1084	1622			244		

Direction, Lane #	WB 1	SE 1	SE 2
Volume Total	351	1054	826
Volume Left	0	0	0
Volume Right	0	0	299
cSH	56	1700	1700
Volume to Capacity	6.30	0.62	0.49
Queue Length 95th (ft)	Err	0	0
Control Delay (s)	Err	0.0	0.0
Lane LOS	F		
Approach Delay (s)	Err	0.0	
Approach LOS	F		

Intersection Summary			
Average Delay	1573.9		
Intersection Capacity Utilization	162.7%	ICU Level of Service	H
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
3: H-1 Off Ramp & Kunia Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations		↰	↱				↰↰	↑↑↑			↑↑	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0				4.0	4.0			4.0	
Lane Util. Factor		1.00	1.00				0.97	0.91			0.95	
Frt		1.00	0.85				1.00	1.00			1.00	
Flt Protected		0.95	1.00				0.95	1.00			1.00	
Satd. Flow (prot)		1770	1583				3433	5085			3539	
Flt Permitted		0.95	1.00				0.95	1.00			1.00	
Satd. Flow (perm)		1770	1583				3433	5085			3539	
Volume (vph)	210	0	287	0	0	0	724	3387	0	0	770	0
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	228	0	312	0	0	0	787	3682	0	0	837	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	228	312	0	0	0	787	3682	0	0	837	0
Turn Type	Split		Free				Prot					
Protected Phases	4	4					1	6			2	
Permitted Phases			Free									
Actuated Green, G (s)		10.0	75.0				21.1	57.0			31.9	
Effective Green, g (s)		10.0	75.0				21.1	57.0			31.9	
Actuated g/C Ratio		0.13	1.00				0.28	0.76			0.43	
Clearance Time (s)		4.0					4.0	4.0			4.0	
Vehicle Extension (s)		3.0					3.0	3.0			3.0	
Lane Grp Cap (vph)		236	1583				966	3865			1505	
v/s Ratio Prot		c0.13					0.23	c0.72			0.24	
v/s Ratio Perm			0.20									
v/c Ratio		0.97	0.20				0.81	0.95			0.56	
Uniform Delay, d1		32.3	0.0				25.1	7.8			16.2	
Progression Factor		1.00	1.00				1.00	1.00			1.00	
Incremental Delay, d2		48.6	0.3				5.4	7.0			1.5	
Delay (s)		80.9	0.3				30.5	14.9			17.7	
Level of Service		F	A				C	B			B	
Approach Delay (s)		34.3			0.0			17.6			17.7	
Approach LOS		C			A			B			B	

Intersection Summary			
HCM Average Control Delay	19.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	83.7%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
4: Farrington Hwy & Fort Weaver Road SB Ramp

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↱		↰	↑↑				↱			↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0				4.0			4.0
Lane Util. Factor		0.95		1.00	0.95				1.00			1.00
Frt		0.99		1.00	1.00				0.86			0.86
Flt Protected		1.00		0.95	1.00				1.00			1.00
Satd. Flow (prot)		3498		1770	3539				1611			1611
Flt Permitted		1.00		0.95	1.00				1.00			1.00
Satd. Flow (perm)		3498		1770	3539				1611			1611
Volume (vph)	0	273	23	442	952	0	0	0	870	0	0	652
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	297	25	480	1035	0	0	0	946	0	0	709
RTOR Reduction (vph)	0	11	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	311	0	480	1035	0	0	0	946	0	0	709
Turn Type				Prot					Free			Free
Protected Phases		2		1	6							
Permitted Phases									Free			Free
Actuated Green, G (s)		17.0		35.0	60.0				60.0			60.0
Effective Green, g (s)		17.0		35.0	60.0				60.0			60.0
Actuated g/C Ratio		0.28		0.58	1.00				1.00			1.00
Clearance Time (s)		4.0		4.0	4.0							
Vehicle Extension (s)		3.0		3.0	3.0							
Lane Grp Cap (vph)		991		1033	3539				1611			1611
v/s Ratio Prot		0.09		0.27	0.29							
v/s Ratio Perm									c0.59			0.44
v/c Ratio		0.31		0.46	0.29				0.59			0.44
Uniform Delay, d1		16.9		7.1	0.0				0.0			0.0
Progression Factor		1.00		0.15	1.00				1.00			1.00
Incremental Delay, d2		0.8		0.1	0.1				1.6			0.9
Delay (s)		17.7		1.2	0.1				1.6			0.9
Level of Service		B		A	A				A			A
Approach Delay (s)		17.7			0.4			1.6			0.9	
Approach LOS		B			A			A			A	

Intersection Summary			
HCM Average Control Delay	2.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	0.0
Intersection Capacity Utilization	39.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
5: Farrington Hwy & Fort Weaver Road NB Ramps

Existing PM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑			↑↱				↱			
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0				4.0			
Lane Util. Factor	1.00	0.95			0.95				1.00			
Frt	1.00	1.00			0.96				0.86			
Flt Protected	0.95	1.00			1.00				1.00			
Satd. Flow (prot)	1770	3539			3381				1611			
Flt Permitted	0.95	1.00			1.00				1.00			
Satd. Flow (perm)	1770	3539			3381				1611			
Volume (vph)	315	828	0	0	1394	592	0	0	666	0	0	0
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	342	900	0	0	1515	643	0	0	724	0	0	0
RTOR Reduction (vph)	0	0	0	0	38	0	0	0	0	0	0	0
Lane Group Flow (vph)	342	900	0	0	2120	0	0	0	724	0	0	0
Turn Type	Prot								Free			
Protected Phases	5	2			6							
Permitted Phases									Free			
Actuated Green, G (s)	12.0	60.0			40.0				60.0			
Effective Green, g (s)	12.0	60.0			40.0				60.0			
Actuated g/C Ratio	0.20	1.00			0.67				1.00			
Clearance Time (s)	4.0	4.0			4.0							
Vehicle Extension (s)	3.0	3.0			3.0							
Lane Grp Cap (vph)	354	3539			2254				1611			
v/s Ratio Prot	c0.19	0.25			c0.63							
v/s Ratio Perm									0.45			
v/c Ratio	0.97	0.25			0.94				0.45			
Uniform Delay, d1	23.8	0.0			8.9				0.0			
Progression Factor	0.96	1.00			1.00				1.00			
Incremental Delay, d2	35.3	0.1			9.4				0.9			
Delay (s)	58.3	0.1			18.3				0.9			
Level of Service	E	A			B				A			
Approach Delay (s)		16.2			18.3			0.9			0.0	
Approach LOS		B			B			A			A	

Intersection Summary			
HCM Average Control Delay	14.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	81.6%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
6: Farrington Hwy & Leoku Street

Existing PM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑	↱	↰	↑↑	↱		↰↑	↱		↰↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95	1.00		1.00	1.00		0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00		0.97	1.00
Satd. Flow (prot)	3433	3539	1583	1770	3539	1583		1786	1583		3425	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00		0.97	1.00
Satd. Flow (perm)	3433	3539	1583	1770	3539	1583		1786	1583		3425	1583
Volume (vph)	532	645	317	85	1025	316	573	91	59	167	85	438
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	578	701	345	92	1114	343	623	99	64	182	92	476
RTOR Reduction (vph)	0	0	226	0	0	196	0	0	7	0	0	222
Lane Group Flow (vph)	578	701	119	92	1114	147	0	722	57	0	274	254
Turn Type	Prot		Perm	Prot		Perm	Split		Perm	Split		Perm
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			6
Actuated Green, G (s)	20.0	48.3	48.3	11.7	40.0	40.0		46.0	46.0		18.0	18.0
Effective Green, g (s)	20.0	48.3	48.3	11.7	40.0	40.0		46.0	46.0		18.0	18.0
Actuated g/C Ratio	0.14	0.34	0.34	0.08	0.29	0.29		0.33	0.33		0.13	0.13
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	490	1221	546	148	1011	452		587	520		440	204
v/s Ratio Prot	c0.17	0.20		0.05	c0.31			c0.40			0.08	
v/s Ratio Perm			0.08			0.09			0.04			c0.16
v/c Ratio	1.18	0.57	0.22	0.62	1.10	0.33		1.23	0.11		0.62	1.24
Uniform Delay, d1	60.0	37.4	32.5	62.0	50.0	39.4		47.0	32.7		57.8	61.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00
Incremental Delay, d2	100.3	0.7	0.2	7.9	60.4	0.4		117.9	0.4		2.7	144.1
Delay (s)	160.3	38.1	32.7	69.9	110.4	39.8		164.9	33.2		60.5	205.1
Level of Service	F	D	C	E	F	D		F	C		E	F
Approach Delay (s)		80.4			92.4			154.2			152.3	
Approach LOS		F			F			F			F	

Intersection Summary			
HCM Average Control Delay	108.1	HCM Level of Service	F
HCM Volume to Capacity ratio	1.18		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	102.0%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
7: Laulaunui Street & Fort Weaver Road

Existing PM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱		↰	↑	↱	↰	↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		0.95		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.91	1.00
Frt		0.99		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.96		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		3373		1770	1863	1583	1770	3539	1583	1770	5085	1583
Flt Permitted		0.96		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		3373		1770	1863	1583	1770	3539	1583	1770	5085	1583
Volume (vph)	159	22	9	36	10	141	123	2002	44	110	2323	184
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	173	24	10	39	11	153	134	2176	48	120	2525	200
RTOR Reduction (vph)	0	4	0	0	0	142	0	0	14	0	0	80
Lane Group Flow (vph)	0	203	0	39	11	11	134	2176	34	120	2525	120
Turn Type	Split			Split		Perm	Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases						8			2			6
Actuated Green, G (s)		11.6		4.0	4.0	4.0	10.5	66.0	66.0	8.0	63.5	63.5
Effective Green, g (s)		11.6		4.0	4.0	4.0	10.5	66.0	66.0	8.0	63.5	63.5
Actuated g/C Ratio		0.11		0.04	0.04	0.04	0.10	0.62	0.62	0.08	0.60	0.60
Clearance Time (s)		4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		371		67	71	60	176	2212	989	134	3058	952
v/s Ratio Prot		c0.06		c0.02	0.01		c0.08	c0.61		0.07	0.50	
v/s Ratio Perm						0.01			0.02			0.08
v/c Ratio		0.87dl		0.58	0.15	0.18	0.76	0.98	0.03	0.90	0.83	0.13
Uniform Delay, d1		44.5		50.0	49.2	49.2	46.3	19.3	7.6	48.4	16.7	9.1
Progression Factor		1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		1.7		12.2	1.0	1.4	17.5	15.7	0.1	47.3	2.7	0.3
Delay (s)		46.2		62.2	50.2	50.6	63.8	34.9	7.7	95.7	19.4	9.4
Level of Service		D		E	D	D	E	C	A	F	B	A
Approach Delay (s)		46.2			52.8			36.0			21.9	
Approach LOS		D			D			D			C	

Intersection Summary			
HCM Average Control Delay	29.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	105.6	Sum of lost time (s)	12.0
Intersection Capacity Utilization	86.9%	ICU Level of Service	E
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
8: Old Fort Weaver Road & Fort Weaver Road

Existing PM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑	↱		↰↑	↱	↰	↑↑	↱	↰	↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		1.00	1.00		0.96	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1857	1583		1797	1583	1770	3539	1583	1770	3539	1583
Flt Permitted		0.98	1.00		0.47	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		1833	1583		884	1583	1770	3539	1583	1770	3539	1583
Volume (vph)	10	167	1264	37	14	77	23	2082	36	92	2274	2
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	182	1374	40	15	84	25	2263	39	100	2472	2
RTOR Reduction (vph)	0	0	0	0	0	62	0	0	0	0	0	1
Lane Group Flow (vph)	0	193	1374	0	55	22	25	2263	39	100	2472	1
Turn Type	Perm		Free	Perm		Perm	Prot		Free	Prot		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		Free	8		8			Free			6
Actuated Green, G (s)		14.1	101.1		14.1	14.1	1.6	69.0	101.1	6.0	73.4	73.4
Effective Green, g (s)		14.1	101.1		14.1	14.1	1.6	69.0	101.1	6.0	73.4	73.4
Actuated g/C Ratio		0.14	1.00		0.14	0.14	0.02	0.68	1.00	0.06	0.73	0.73
Clearance Time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)		256	1583		123	221	28	2415	1583	105	2569	1149
v/s Ratio Prot							0.01	0.64		0.06	c0.70	
v/s Ratio Perm		0.11	c0.87		0.06	0.01			0.02			0.00
v/c Ratio		0.75	0.87		0.45	0.10	0.89	0.94	0.02	0.95	0.96	0.00
Uniform Delay, d1		41.8	0.0		39.9	38.0	49.7	14.1	0.0	47.4	12.6	3.8
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		11.9	6.7		2.6	0.2	123.8	8.5	0.0	72.2	10.9	0.0
Delay (s)		53.7	6.7		42.5	38.2	173.4	22.7	0.0	119.6	23.5	3.8
Level of Service		D	A		D	D	F	C	A	F	C	A
Approach Delay (s)		12.5			39.9			23.9			27.2	
Approach LOS		B			D			C			C	

Intersection Summary			
HCM Average Control Delay	22.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	101.1	Sum of lost time (s)	0.0
Intersection Capacity Utilization	92.2%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
9: Renton Road & Fort Weaver Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↰↑	↱		✥		↰	↑↑	↱	↰	↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.95	0.95	1.00		1.00		1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85		0.97		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.95	1.00		1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1689	1583		1805		1770	3539	1583	1770	3539	1583
Flt Permitted	0.95	0.95	1.00		1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1689	1583		1805		1770	3539	1583	1770	3539	1583
Volume (vph)	610	14	302	1	13	4	347	1587	113	172	2818	515
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	663	15	328	1	14	4	377	1725	123	187	3063	560
RTOR Reduction (vph)	0	0	0	0	4	0	0	0	9	0	0	139
Lane Group Flow (vph)	332	346	328	0	15	0	377	1725	114	187	3063	421
Turn Type	Split		Free	Split			Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			Free						2			6
Actuated Green, G (s)	24.0	24.0	148.4		2.3		21.0	87.7	87.7	18.4	85.1	85.1
Effective Green, g (s)	24.0	24.0	148.4		2.3		21.0	87.7	87.7	18.4	85.1	85.1
Actuated g/C Ratio	0.16	0.16	1.00		0.02		0.14	0.59	0.59	0.12	0.57	0.57
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	272	273	1583		28		250	2091	936	219	2029	908
v/s Ratio Prot	0.20	c0.20			0.01		c0.21	0.49		0.11	c0.87	
v/s Ratio Perm			c0.21						0.07			0.27
v/c Ratio	1.22	1.27	0.21		0.54		1.51	0.82	0.12	0.85	1.51	0.46
Uniform Delay, d1	62.2	62.2	0.0		72.5		63.7	24.2	13.4	63.7	31.6	18.4
Progression Factor	1.00	1.00	1.00		1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	127.7	146.1	0.3		18.4		248.3	3.9	0.3	26.1	231.9	1.7
Delay (s)	189.9	208.3	0.3		90.9		312.0	28.1	13.6	89.8	263.6	20.1
Level of Service	F	F	A		F		F	C	B	F	F	C
Approach Delay (s)		134.4			90.9			75.4			219.3	
Approach LOS		F			F			E			F	

Intersection Summary			
HCM Average Control Delay	161.5	HCM Level of Service	F
HCM Volume to Capacity ratio	1.40		
Actuated Cycle Length (s)	148.4	Sum of lost time (s)	12.0
Intersection Capacity Utilization	131.1%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
10: Farrington Hwy & East Old Fort Weaver Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↑									↑	
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	258	0	0	0	0	0	0	0	0	632	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	280	0	0	0	0	0	0	0	0	687	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)					846							
pX, platoon unblocked												
vC, conflicting volume	0			280			624	280	280	280	280	0
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	0			280			624	280	280	280	280	0
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			0	100	100	100	0	100
cM capacity (veh/h)	1623			1282			0	628	758	672	628	1085

Direction, Lane #	EB 1	SW 1
Volume Total	280	687
Volume Left	0	0
Volume Right	0	0
cSH	1700	628
Volume to Capacity	0.16	1.09
Queue Length 95th (ft)	0	504
Control Delay (s)	0.0	89.1
Lane LOS		F
Approach Delay (s)	0.0	89.1
Approach LOS		F

Intersection Summary			
Average Delay	63.2		
Intersection Capacity Utilization	71.4%	ICU Level of Service	C
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
11: Farrington Hwy & West Old Fort Weaver Road

Existing PM

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	250	27	0	972	21	8
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	272	29	0	1057	23	9
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			301		1343	286
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			301		1343	286
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		86	99
cM capacity (veh/h)			1260		168	753

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	301	1057	32
Volume Left	0	0	23
Volume Right	29	0	9
cSH	1700	1700	213
Volume to Capacity	0.18	0.62	0.15
Queue Length 95th (ft)	0	0	13
Control Delay (s)	0.0	0.0	24.8
Lane LOS			C
Approach Delay (s)	0.0	0.0	24.8
Approach LOS			C

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	61.2%	ICU Level of Service	B
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
12: Farrington Hwy & Fort Barrette Road

Existing PM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95	1.00	0.97	0.91	0.91	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3539	1583	1770	3539	1583	3433	3390	1441	3433	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3539	1583	1770	3539	1583	3433	3390	1441	3433	3539	1583
Volume (vph)	754	388	744	71	267	323	352	371	35	476	446	704
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	820	422	809	77	290	351	383	403	38	517	485	765
RTOR Reduction (vph)	0	0	332	0	0	244	0	0	28	0	0	171
Lane Group Flow (vph)	820	422	477	77	290	107	383	403	10	517	485	594
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	7	4		3	8		1	6		5	2	
Permitted Phases			4			8			6			2
Actuated Green, G (s)	23.0	32.6	32.6	5.0	14.6	14.6	11.0	26.0	26.0	19.0	34.0	34.0
Effective Green, g (s)	23.0	32.6	32.6	5.0	14.6	14.6	11.0	26.0	26.0	19.0	34.0	34.0
Actuated g/C Ratio	0.23	0.33	0.33	0.05	0.15	0.15	0.11	0.26	0.26	0.19	0.34	0.34
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	801	1170	523	90	524	234	383	894	380	662	1220	546
v/s Ratio Prot	c0.24	0.12		0.04	0.08		c0.11	0.12		0.15	0.14	
v/s Ratio Perm			c0.30			0.07			0.01			c0.38
v/c Ratio	1.02	0.36	0.91	0.86	0.55	0.46	1.00	0.45	0.03	0.78	0.40	1.09
Uniform Delay, d1	37.8	25.1	31.6	46.4	39.0	38.4	43.8	30.3	26.9	37.8	24.5	32.3
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	38.0	0.2	20.2	50.6	1.3	1.4	46.0	1.6	0.1	6.0	1.0	64.6
Delay (s)	75.8	25.3	51.8	97.1	40.2	39.8	89.8	32.0	27.0	43.8	25.5	96.9
Level of Service	E	C	D	F	D	D	F	C	C	D	C	F
Approach Delay (s)		55.9			46.1			58.6			61.7	
Approach LOS		E			D			E			E	

Intersection Summary			
HCM Average Control Delay	56.9	HCM Level of Service	E
HCM Volume to Capacity ratio	1.01		
Actuated Cycle Length (s)	98.6	Sum of lost time (s)	12.0
Intersection Capacity Utilization	74.4%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

APPENDIX A-2

YEAR 2030 CONDITIONS

HCM Signalized Intersection Capacity Analysis
1: Kunia Loop & Kunia Road

Year 2030 AM

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↰	↱	↑↑	↱		↑↑↑
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0		4.0
Lane Util. Factor	0.97	1.00	0.95	1.00		0.91
Frt	1.00	0.85	1.00	0.85		1.00
Flt Protected	0.95	1.00	1.00	1.00		1.00
Satd. Flow (prot)	3433	1583	3539	1583		5085
Flt Permitted	0.95	1.00	1.00	1.00		1.00
Satd. Flow (perm)	3433	1583	3539	1583		5085
Volume (vph)	564	37	1491	344	0	1120
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	613	40	1621	374	0	1217
RTOR Reduction (vph)	0	19	0	124	0	0
Lane Group Flow (vph)	613	21	1621	250	0	1217
Turn Type		Perm		Perm		
Protected Phases	8		2			6
Permitted Phases		8		2		
Actuated Green, G (s)	21.0	21.0	58.2	58.2		58.2
Effective Green, g (s)	21.0	21.0	58.2	58.2		58.2
Actuated g/C Ratio	0.24	0.24	0.67	0.67		0.67
Clearance Time (s)	4.0	4.0	4.0	4.0		4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0		3.0
Lane Grp Cap (vph)	827	381	2362	1057		3394
v/s Ratio Prot	c0.18		c0.46			0.24
v/s Ratio Perm		0.01		0.16		
v/c Ratio	0.74	0.06	0.69	0.24		0.36
Uniform Delay, d1	30.6	25.5	8.9	5.7		6.3
Progression Factor	1.00	1.00	1.00	1.00		1.00
Incremental Delay, d2	3.6	0.1	1.6	0.5		0.3
Delay (s)	34.2	25.5	10.5	6.3		6.6
Level of Service	C	C	B	A		A
Approach Delay (s)	33.7		9.7			6.6
Approach LOS	C		A			A

Intersection Summary			
HCM Average Control Delay	12.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	87.2	Sum of lost time (s)	8.0
Intersection Capacity Utilization	64.0%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
2: H-1 WB On-Ramp & Kunia Road

Year 2030 AM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations						↱	↰	↑↑↑			↑↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)						4.0	4.0	4.0			4.0	
Lane Util. Factor						1.00	1.00	0.91			0.91	
Frt						0.86	1.00	1.00			0.97	
Flt Protected						1.00	0.95	1.00			1.00	
Satd. Flow (prot)						1611	1770	5085			4955	
Flt Permitted						1.00	0.95	1.00			1.00	
Satd. Flow (perm)						1611	1770	5085			4955	
Volume (vph)	0	0	0	0	0	530	115	1305	0	0	1393	288
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	0	0	576	125	1418	0	0	1514	313
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	16	0
Lane Group Flow (vph)	0	0	0	0	0	576	125	1418	0	0	1811	0
Turn Type						Free	Prot					
Protected Phases							5	2			6	
Permitted Phases						Free						
Actuated Green, G (s)						100.0	11.2	100.0			80.8	
Effective Green, g (s)						100.0	11.2	100.0			80.8	
Actuated g/C Ratio						1.00	0.11	1.00			0.81	
Clearance Time (s)							4.0	4.0			4.0	
Vehicle Extension (s)							3.0	3.0			3.0	
Lane Grp Cap (vph)						1611	198	5085			4004	
v/s Ratio Prot							c0.07	0.28			c0.37	
v/s Ratio Perm						0.36						
v/c Ratio						0.36	0.63	0.28			0.45	
Uniform Delay, d1						0.0	42.4	0.0			2.9	
Progression Factor						1.00	1.12	1.00			1.00	
Incremental Delay, d2						0.6	6.0	0.1			0.4	
Delay (s)						0.6	53.5	0.1			3.3	
Level of Service						A	D	A			A	
Approach Delay (s)		0.0			0.6			4.5			3.3	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	3.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	46.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
3: H-1 EB & Kunia Road

Year 2030 AM

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations	↰↰	↱	↑↑↑↑			↑↑↑
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0			4.0
Lane Util. Factor	0.97	1.00	0.86			0.91
Frt	1.00	0.85	1.00			1.00
Flt Protected	0.95	1.00	1.00			1.00
Satd. Flow (prot)	3433	1583	6408			5085
Flt Permitted	0.95	1.00	1.00			1.00
Satd. Flow (perm)	3433	1583	6408			5085
Volume (vph)	367	248	877	0	0	1052
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	399	270	953	0	0	1143
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	399	270	953	0	0	1143
Turn Type		Free				
Protected Phases	4		6			2
Permitted Phases		Free				
Actuated Green, G (s)	14.9	100.0	77.1			77.1
Effective Green, g (s)	14.9	100.0	77.1			77.1
Actuated g/C Ratio	0.15	1.00	0.77			0.77
Clearance Time (s)	4.0		4.0			4.0
Vehicle Extension (s)	3.0		3.0			3.0
Lane Grp Cap (vph)	512	1583	4941			3921
v/s Ratio Prot	c0.12		0.15			c0.22
v/s Ratio Perm		0.17				
v/c Ratio	0.78	0.17	0.19			0.29
Uniform Delay, d1	41.0	0.0	3.1			3.4
Progression Factor	1.00	1.00	0.34			1.00
Incremental Delay, d2	7.4	0.2	0.1			0.2
Delay (s)	48.3	0.2	1.1			3.6
Level of Service	D	A	A			A
Approach Delay (s)	28.9		1.1			3.6
Approach LOS	C		A			A

Intersection Summary			
HCM Average Control Delay	8.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.37		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	49.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
4: Farrington Hwy & Fort Weaver Road SB Ramp

Year 2030 AM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↑↱		↰↰	↑↑↑				↱			↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0				4.0			4.0
Lane Util. Factor		0.91		0.97	0.91				1.00			1.00
Frt		0.98		1.00	1.00				0.86			0.86
Flt Protected		1.00		0.95	1.00				1.00			1.00
Satd. Flow (prot)		4984		3433	5085				1611			1611
Flt Permitted		1.00		0.95	1.00				1.00			1.00
Satd. Flow (perm)		4984		3433	5085				1611			1611
Volume (vph)	0	800	122	432	314	0	0	0	422	0	0	39
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	870	133	470	341	0	0	0	459	0	0	42
RTOR Reduction (vph)	0	39	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	964	0	470	341	0	0	0	459	0	0	42
Turn Type				Prot					Free			Free
Protected Phases		2		1	6							
Permitted Phases									Free			Free
Actuated Green, G (s)		21.7		10.3	40.0				40.0			40.0
Effective Green, g (s)		21.7		10.3	40.0				40.0			40.0
Actuated g/C Ratio		0.54		0.26	1.00				1.00			1.00
Clearance Time (s)		4.0		4.0	4.0							
Vehicle Extension (s)		3.0		3.0	3.0							
Lane Grp Cap (vph)		2704		884	5085				1611			1611
v/s Ratio Prot		c0.19		c0.14	0.07							
v/s Ratio Perm									0.28			0.03
v/c Ratio		0.36		0.53	0.07				0.28			0.03
Uniform Delay, d1		5.2		12.8	0.0				0.0			0.0
Progression Factor		1.00		1.00	1.00				1.00			1.00
Incremental Delay, d2		0.4		0.6	0.0				0.4			0.0
Delay (s)		5.6		13.4	0.0				0.4			0.0
Level of Service		A		B	A				A			A
Approach Delay (s)		5.6			7.8			0.4			0.0	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	5.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	40.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	37.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
5: Farrington Hwy & Fort Weaver Road NB Ramps

Year 2030 AM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↑			↑↑↱				↱			
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0				4.0			
Lane Util. Factor	1.00	0.91			0.91				1.00			
Frt	1.00	1.00			0.94				0.86			
Flt Protected	0.95	1.00			1.00				1.00			
Satd. Flow (prot)	1770	5085			4756				1611			
Flt Permitted	0.95	1.00			1.00				1.00			
Satd. Flow (perm)	1770	5085			4756				1611			
Volume (vph)	171	1051	0	0	746	567	0	0	710	0	0	0
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	186	1142	0	0	811	616	0	0	772	0	0	0
RTOR Reduction (vph)	0	0	0	0	203	0	0	0	0	0	0	0
Lane Group Flow (vph)	186	1142	0	0	1224	0	0	0	772	0	0	0
Turn Type	Prot								Free			
Protected Phases	5	2			6							
Permitted Phases									Free			
Actuated Green, G (s)	8.4	45.0			28.6				45.0			
Effective Green, g (s)	8.4	45.0			28.6				45.0			
Actuated g/C Ratio	0.19	1.00			0.64				1.00			
Clearance Time (s)	4.0	4.0			4.0							
Vehicle Extension (s)	3.0	3.0			3.0							
Lane Grp Cap (vph)	330	5085			3023				1611			
v/s Ratio Prot	0.11	0.22			0.26							
v/s Ratio Perm									c0.48			
v/c Ratio	0.56	0.22			0.40				0.48			
Uniform Delay, d1	16.6	0.0			4.0				0.0			
Progression Factor	1.00	1.00			1.00				1.00			
Incremental Delay, d2	2.2	0.1			0.4				1.0			
Delay (s)	18.8	0.1			4.4				1.0			
Level of Service	B	A			A				A			
Approach Delay (s)		2.7			4.4			1.0			0.0	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	3.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	45.0	Sum of lost time (s)	0.0
Intersection Capacity Utilization	43.3%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
6: Farrington Hwy & Leoku Street

Year 2030 AM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑↑	↱	↰	↑↑↑	↱		↰↑	↱		↰↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	1.00	0.91	1.00		1.00	1.00		0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00		0.97	1.00
Satd. Flow (prot)	3433	5085	1583	1770	5085	1583		1780	1583		3424	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00		0.97	1.00
Satd. Flow (perm)	3433	5085	1583	1770	5085	1583		1780	1583		3424	1583
Volume (vph)	68	1537	155	119	1227	156	56	5	48	92	45	33
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	74	1671	168	129	1334	170	61	5	52	100	49	36
RTOR Reduction (vph)	0	0	84	0	0	103	0	0	47	0	0	33
Lane Group Flow (vph)	74	1671	84	129	1334	67	0	66	5	0	149	3
Turn Type	Prot		Perm	Prot		Perm	Split		Perm	Split		Perm
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			6
Actuated Green, G (s)	13.5	34.6	34.6	6.4	27.5	27.5		6.1	6.1		6.5	6.5
Effective Green, g (s)	13.5	34.6	34.6	6.4	27.5	27.5		6.1	6.1		6.5	6.5
Actuated g/C Ratio	0.19	0.50	0.50	0.09	0.40	0.40		0.09	0.09		0.09	0.09
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	666	2528	787	163	2009	625		156	139		320	148
v/s Ratio Prot	0.02	c0.33		c0.07	0.26			c0.04			c0.04	
v/s Ratio Perm			0.05			0.04			0.00			0.00
v/c Ratio	0.11	0.66	0.11	0.79	0.66	0.11		0.42	0.03		0.47	0.02
Uniform Delay, d1	23.1	13.1	9.3	30.9	17.3	13.3		30.1	29.1		29.9	28.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00
Incremental Delay, d2	0.1	0.7	0.1	22.5	0.8	0.1		8.2	0.4		1.1	0.1
Delay (s)	23.2	13.8	9.4	53.5	18.1	13.4		38.3	29.5		31.0	28.7
Level of Service	C	B	A	D	B	B		D	C		C	C
Approach Delay (s)		13.7			20.4			34.4			30.5	
Approach LOS		B			C			C			C	

Intersection Summary			
HCM Average Control Delay	18.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	69.6	Sum of lost time (s)	16.0
Intersection Capacity Utilization	58.1%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
7: Laulaunui Street & Fort Weaver Road

Year 2030 AM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱		↰	↑	↱	↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		*0.99		1.00	1.00	1.00	1.00	*0.99	1.00	1.00	*0.99	1.00
Frt		0.99		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.96		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		3510		1770	1863	1583	1770	5532	1583	1770	5532	1583
Flt Permitted		0.96		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		3510		1770	1863	1583	1770	5532	1583	1770	5532	1583
Volume (vph)	96	24	12	62	4	201	48	3274	38	63	985	170
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	104	26	13	67	4	218	52	3559	41	68	1071	185
RTOR Reduction (vph)	0	6	0	0	0	90	0	0	8	0	0	59
Lane Group Flow (vph)	0	137	0	67	4	128	52	3559	33	68	1071	126
Turn Type	Split			Split		Perm	Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases						8			2			6
Actuated Green, G (s)		11.0		12.0	12.0	12.0	7.5	100.0	100.0	6.8	99.3	99.3
Effective Green, g (s)		11.0		12.0	12.0	12.0	7.5	100.0	100.0	6.8	99.3	99.3
Actuated g/C Ratio		0.08		0.08	0.08	0.08	0.05	0.69	0.69	0.05	0.68	0.68
Clearance Time (s)		4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		265		146	153	130	91	3794	1086	83	3768	1078
v/s Ratio Prot		c0.04		0.04	0.00		0.03	c0.64		c0.04	0.19	
v/s Ratio Perm						c0.08			0.02			0.08
v/c Ratio		0.52		0.46	0.03	0.99	0.57	0.94	0.03	0.82	0.28	0.12
Uniform Delay, d1		64.9		63.8	61.5	66.8	67.6	20.2	7.3	68.9	9.2	8.1
Progression Factor		1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		1.7		2.3	0.1	73.8	8.4	5.9	0.1	44.3	0.2	0.2
Delay (s)		66.6		66.1	61.6	140.6	76.0	26.1	7.4	113.2	9.4	8.3
Level of Service		E		E	E	F	E	C	A	F	A	A
Approach Delay (s)		66.6			122.2			26.6			14.6	
Approach LOS		E			F			C			B	

Intersection Summary			
HCM Average Control Delay	29.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	145.8	Sum of lost time (s)	16.0
Intersection Capacity Utilization	91.0%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
8: Old Fort Weaver Road & Fort Weaver Road

Year 2030 AM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑	↱		↰↑	↱	↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.95	1.00		1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1775	1583		1858	1583	1770	5085	1583	1770	5085	1583
Flt Permitted		0.68	1.00		0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		1259	1583		1836	1583	1770	5085	1583	1770	5085	1583
Volume (vph)	102	1	134	4	62	230	94	3028	1	5	839	215
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	111	1	146	4	67	250	102	3291	1	5	912	234
RTOR Reduction (vph)	0	0	0	0	0	56	0	0	0	0	0	82
Lane Group Flow (vph)	0	112	146	0	71	194	102	3291	1	5	912	152
Turn Type	Perm		Free	Perm		Perm	Prot		Free	Prot		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		Free	8		8			Free			6
Actuated Green, G (s)		14.5	100.4		14.5	14.5	8.7	73.1	100.4	0.8	65.2	65.2
Effective Green, g (s)		14.5	100.4		14.5	14.5	8.7	73.1	100.4	0.8	65.2	65.2
Actuated g/C Ratio		0.14	1.00		0.14	0.14	0.09	0.73	1.00	0.01	0.65	0.65
Clearance Time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)		182	1583		265	229	153	3702	1583	14	3302	1028
v/s Ratio Prot							c0.06	c0.65		0.00	0.18	
v/s Ratio Perm		0.09	0.09		0.04	c0.12			0.00			0.10
v/c Ratio		0.62	0.09		0.27	0.85	0.67	0.89	0.00	0.36	0.28	0.15
Uniform Delay, d1		40.3	0.0		38.2	41.9	44.4	10.5	0.0	49.5	7.5	6.8
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		6.1	0.1		0.5	24.2	10.5	3.6	0.0	14.9	0.2	0.3
Delay (s)		46.4	0.1		38.8	66.1	54.9	14.2	0.0	64.5	7.7	7.1
Level of Service		D	A		D	E	D	B	A	E	A	A
Approach Delay (s)		20.2			60.1			15.4			7.9	
Approach LOS		C			E			B			A	

Intersection Summary			
HCM Average Control Delay	16.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	100.4	Sum of lost time (s)	12.0
Intersection Capacity Utilization	88.5%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
9: Renton Road & Fort Weaver Road

Year 2030 AM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↰↑	↱		✢		↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*0.99	*0.99	1.00		1.00		1.00	*0.99	1.00	1.00	*0.99	1.00
Frt	1.00	1.00	0.85		0.97		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1752	1766	1583		1798		1770	5532	1583	1770	5532	1583
Flt Permitted	0.95	0.96	1.00		1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1752	1766	1583		1798		1770	5532	1583	1770	5532	1583
Volume (vph)	440	29	36	10	335	115	89	2567	1	177	778	25
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	444	29	36	10	338	116	90	2593	1	179	786	25
RTOR Reduction (vph)	0	0	0	0	8	0	0	0	0	0	0	13
Lane Group Flow (vph)	231	242	36	0	456	0	90	2593	1	179	786	12
Turn Type	Split		Free	Split			Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			Free						2			6
Actuated Green, G (s)	20.0	20.0	150.0		32.0		12.3	69.0	69.0	13.0	69.7	69.7
Effective Green, g (s)	20.0	20.0	150.0		32.0		12.3	69.0	69.0	13.0	69.7	69.7
Actuated g/C Ratio	0.13	0.13	1.00		0.21		0.08	0.46	0.46	0.09	0.46	0.46
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	234	235	1583		384		145	2545	728	153	2571	736
v/s Ratio Prot	0.13	c0.14			c0.25		0.05	c0.47		c0.10	0.14	
v/s Ratio Perm			c0.02						0.00			0.01
v/c Ratio	0.99	1.03	0.02		1.19		0.62	1.02	0.00	1.17	0.31	0.02
Uniform Delay, d1	64.9	65.0	0.0		59.0		66.6	40.5	21.9	68.5	25.1	21.7
Progression Factor	1.00	1.00	1.00		1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	54.7	66.7	0.0		107.8		8.0	22.7	0.0	125.7	0.3	0.0
Delay (s)	119.6	131.7	0.0		166.8		74.6	63.2	21.9	194.2	25.4	21.7
Level of Service	F	F	A		F		E	E	C	F	C	C
Approach Delay (s)		116.9			166.8			63.6			55.8	
Approach LOS		F			F			E			E	

Intersection Summary			
HCM Average Control Delay	78.1	HCM Level of Service	E
HCM Volume to Capacity ratio	1.08		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	110.9%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
10: Farrington Hwy & East Old Fort Weaver Road

Year 2030 AM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBR	SWL	SWR
Lane Configurations		↑↑							↰	
Sign Control		Free			Free		Stop		Stop	
Grade		0%			0%		0%		0%	
Volume (veh/h)	0	570	0	0	0	0	0	0	79	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	620	0	0	0	0	0	0	86	0
Pedestrians										
Lane Width (ft)										
Walking Speed (ft/s)										
Percent Blockage										
Right turn flare (veh)										
Median type							None		None	
Median storage veh)										
Upstream signal (ft)					942					
pX, platoon unblocked										
vC, conflicting volume	0			620			662	620	620	0
vC1, stage 1 conf vol										
vC2, stage 2 conf vol										
vCu, unblocked vol	0			620			662	620	620	0
tC, single (s)	4.1			4.1			7.5	6.5	6.5	6.9
tC, 2 stage (s)										
tF (s)	2.2			2.2			3.5	4.0	4.0	3.3
p0 queue free %	100			100			100	100	79	100
cM capacity (veh/h)	1622			957			290	403	403	1084

Direction, Lane #	EB 1	EB 2	SW 1
Volume Total	310	310	86
Volume Left	0	0	0
Volume Right	0	0	0
cSH	1700	1700	403
Volume to Capacity	0.18	0.18	0.21
Queue Length 95th (ft)	0	0	20
Control Delay (s)	0.0	0.0	16.4
Lane LOS			C
Approach Delay (s)	0.0		16.4
Approach LOS			C

Intersection Summary			
Average Delay	2.0		
Intersection Capacity Utilization	43.9%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
11: Farrington Hwy & West Old Fort Weaver Road

Year 2030 AM

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↱			↑↑	↰	↱
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	570	9	0	274	115	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	620	10	0	298	125	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			629		773	315
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			629		773	315
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		63	100
cM capacity (veh/h)			949		335	681

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2
Volume Total	413	216	149	149	125	0
Volume Left	0	0	0	0	125	0
Volume Right	0	10	0	0	0	0
cSH	1700	1700	1700	1700	335	1700
Volume to Capacity	0.24	0.13	0.09	0.09	0.37	0.00
Queue Length 95th (ft)	0	0	0	0	42	0
Control Delay (s)	0.0	0.0	0.0	0.0	22.0	0.0
Lane LOS					C	A
Approach Delay (s)	0.0		0.0		22.0	
Approach LOS					C	

Intersection Summary			
Average Delay	2.6		
Intersection Capacity Utilization	29.1%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
12: Fort Barrette Road & Farrington Hwy

Year 2030 AM

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰↰	↑↱	↱	↰↰	↑↑	↱	↰↰	↑↑	↱	↰	↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	0.91	0.97	0.95	1.00	0.97	0.95	1.00	1.00	0.95	1.00
Frt	1.00	0.96	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3252	1441	3433	3539	1583	3433	3539	1583	1770	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3252	1441	3433	3539	1583	3433	3539	1583	1770	3539	1583
Volume (vph)	368	688	781	572	566	115	328	273	485	50	346	427
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	400	748	849	622	615	125	357	297	527	54	376	464
RTOR Reduction (vph)	0	15	159	0	0	63	0	0	315	0	0	305
Lane Group Flow (vph)	400	1013	410	622	615	62	357	297	212	54	376	159
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases			6			2			4			8
Actuated Green, G (s)	26.1	81.0	81.0	37.9	92.8	92.8	23.2	43.4	43.4	8.1	28.3	28.3
Effective Green, g (s)	26.1	81.0	81.0	37.9	92.8	92.8	23.2	43.4	43.4	8.1	28.3	28.3
Actuated g/C Ratio	0.14	0.43	0.43	0.20	0.50	0.50	0.12	0.23	0.23	0.04	0.15	0.15
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	481	1413	626	698	1762	788	427	824	369	77	537	240
v/s Ratio Prot	0.12	c0.31		c0.18	0.17		c0.10	0.08		0.03	c0.11	
v/s Ratio Perm			0.28			0.04			0.13			0.10
v/c Ratio	0.83	0.72	0.66	0.89	0.35	0.08	0.84	0.36	0.57	0.70	0.70	0.66
Uniform Delay, d1	78.0	43.3	41.7	72.2	28.4	24.5	79.7	59.9	63.3	88.0	75.0	74.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	11.7	1.8	2.5	13.6	0.5	0.2	13.3	0.3	2.2	25.0	4.1	6.7
Delay (s)	89.7	45.0	44.1	85.9	29.0	24.7	93.0	60.1	65.5	112.9	79.1	81.2
Level of Service	F	D	D	F	C	C	F	E	E	F	E	F
Approach Delay (s)		53.7			54.6			72.5			82.2	
Approach LOS		D			D			E			F	

Intersection Summary			
HCM Average Control Delay	62.7	HCM Level of Service	E
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	186.4	Sum of lost time (s)	16.0
Intersection Capacity Utilization	75.9%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
13: WB Ramps & North-South Road

Year 2030 AM

Movement	WBL2	WBL	WBR	NBL	NBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰↰		↱				↑↑	↱	↰↰	↑↑	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0				4.0	4.0	4.0	4.0	
Lane Util. Factor	0.97		1.00				0.95	1.00	0.97	0.95	
Frt	1.00		0.85				1.00	0.85	1.00	1.00	
Flt Protected	0.95		1.00				1.00	1.00	0.95	1.00	
Satd. Flow (prot)	3433		1583				3539	1583	3433	3539	
Flt Permitted	0.95		1.00				1.00	1.00	0.95	1.00	
Satd. Flow (perm)	3433		1583				3539	1583	3433	3539	
Volume (vph)	812	0	115	0	0	0	994	248	167	144	0
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	883	0	125	0	0	0	1080	270	182	157	0
RTOR Reduction (vph)	0	0	89	0	0	0	0	122	0	0	0
Lane Group Flow (vph)	883	0	36	0	0	0	1080	148	182	157	0
Turn Type	Prot		custom					Perm	Prot		
Protected Phases	8		8				6		5	2	
Permitted Phases								6			
Actuated Green, G (s)	37.6		37.6				68.5	68.5	11.9	84.4	
Effective Green, g (s)	37.6		37.6				68.5	68.5	11.9	84.4	
Actuated g/C Ratio	0.29		0.29				0.53	0.53	0.09	0.65	
Clearance Time (s)	4.0		4.0				4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0		3.0				3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	993		458				1865	834	314	2298	
v/s Ratio Prot	c0.26		0.02				c0.31		c0.05	0.04	
v/s Ratio Perm								0.09			
v/c Ratio	0.89		0.08				0.58	0.18	0.58	0.07	
Uniform Delay, d1	44.2		33.6				20.9	16.0	56.7	8.4	
Progression Factor	1.00		1.00				1.00	1.00	0.55	0.59	
Incremental Delay, d2	9.8		0.1				1.3	0.5	2.6	0.1	
Delay (s)	54.0		33.7				22.3	16.5	33.8	5.0	
Level of Service	D		C				C	B	C	A	
Approach Delay (s)		51.5		0.0			21.1			20.4	
Approach LOS		D		A			C			C	

Intersection Summary			
HCM Average Control Delay	32.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	86.0%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
14: EB Ramps & North-South Road

Year 2030 AM

Movement	EBL2	EBL	EBR	SBL	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰		↱			↰↰	↑↑			↑↑	↱↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0			4.0	4.0			4.0	4.0
Lane Util. Factor	1.00		1.00			0.97	*0.99			*0.99	*0.99
Frt	1.00		0.85			1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (prot)	1770		1583			3433	3688			3688	3135
Flt Permitted	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (perm)	1770		1583			3433	3688			3688	3135
Volume (vph)	51	0	247	0	0	799	1007	0	0	260	1615
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	52	0	249	0	0	807	1017	0	0	263	1631
RTOR Reduction (vph)	0	0	197	0	0	0	0	0	0	0	368
Lane Group Flow (vph)	52	0	52	0	0	807	1017	0	0	263	1263
Turn Type	Prot		custom			Prot					Perm
Protected Phases	4		4			1	6			2	
Permitted Phases											2
Actuated Green, G (s)	10.2		10.2			55.0	111.8			52.8	52.8
Effective Green, g (s)	10.2		10.2			55.0	111.8			52.8	52.8
Actuated g/C Ratio	0.08		0.08			0.42	0.86			0.41	0.41
Clearance Time (s)	4.0		4.0			4.0	4.0			4.0	4.0
Vehicle Extension (s)	3.0		3.0			3.0	3.0			3.0	3.0
Lane Grp Cap (vph)	139		124			1452	3172			1498	1273
v/s Ratio Prot	0.03		c0.03			c0.24	0.28			0.07	
v/s Ratio Perm											c0.40
v/c Ratio	0.37		0.42			0.56	0.32			0.18	0.99
Uniform Delay, d1	56.9		57.1			28.3	1.8			24.7	38.4
Progression Factor	1.00		1.00			1.13	0.90			1.00	1.00
Incremental Delay, d2	1.7		2.3			0.3	0.2			0.3	23.5
Delay (s)	58.6		59.3			32.3	1.8			24.9	61.9
Level of Service	E		E			C	A			C	E
Approach Delay (s)		59.2		0.0			15.3			56.8	
Approach LOS		E		A			B			E	

Intersection Summary			
HCM Average Control Delay	38.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	86.0%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
15: North-South Road & Farrington Hwy

Year 2030 AM

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰↰	↑↑↑	↱	↰↰	↑↑↑	↱	↰↰	↑↑	↱	↰↰	↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91	1.00	0.97	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5085	1583	3433	3539	1583	3433	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5085	1583	3433	3539	1583	3433	3539	1583
Volume (vph)	228	637	465	323	1081	209	506	102	148	56	35	288
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	248	692	505	351	1175	227	550	111	161	61	38	313
RTOR Reduction (vph)	0	0	382	0	0	167	0	0	96	0	0	244
Lane Group Flow (vph)	248	692	123	351	1175	60	550	111	65	61	38	69
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases			6			2			4			8
Actuated Green, G (s)	12.1	23.6	23.6	14.1	25.6	25.6	26.0	39.0	39.0	3.9	16.9	16.9
Effective Green, g (s)	12.1	23.6	23.6	14.1	25.6	25.6	26.0	39.0	39.0	3.9	16.9	16.9
Actuated g/C Ratio	0.13	0.24	0.24	0.15	0.27	0.27	0.27	0.40	0.40	0.04	0.17	0.17
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	430	1242	387	501	1348	420	924	1429	639	139	619	277
v/s Ratio Prot	0.07	0.14		c0.10	c0.23		c0.16	0.03		0.02	0.01	
v/s Ratio Perm			0.08			0.04			0.04			c0.04
v/c Ratio	0.58	0.56	0.32	0.70	0.87	0.14	0.60	0.08	0.10	0.44	0.06	0.25
Uniform Delay, d1	39.8	31.9	29.9	39.2	33.9	27.1	30.7	17.7	17.9	45.3	33.2	34.4
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.9	0.5	0.5	4.4	6.5	0.2	2.8	0.1	0.3	2.2	0.2	2.1
Delay (s)	41.7	32.5	30.4	43.6	40.4	27.3	33.5	17.8	18.2	47.5	33.4	36.5
Level of Service	D	C	C	D	D	C	C	B	B	D	C	D
Approach Delay (s)		33.3			39.3			28.4			37.8	
Approach LOS		C			D			C			D	

Intersection Summary			
HCM Average Control Delay	35.2	HCM Level of Service	D
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	96.6	Sum of lost time (s)	12.0
Intersection Capacity Utilization	63.2%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
16: North-South Road & North UH Connector

Year 2030 AM

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰↰	↑↑↑↱		↰↰	↑↑↑↱		↰↰	↑↑↱				
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0		4.0	4.0				
Lane Util. Factor	0.97	0.91			0.91		0.97	0.95				
Frt	1.00	1.00			0.99		1.00	0.97				
Flt Protected	0.95	1.00			1.00		0.95	1.00				
Satd. Flow (prot)	3433	5085			5013		3433	3443				
Flt Permitted	0.95	1.00			1.00		0.95	1.00				
Satd. Flow (perm)	3433	5085			5013		3433	3443				
Volume (vph)	41	1479	0	0	761	80	134	96	21	0	0	0
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	45	1608	0	0	827	87	146	104	23	0	0	0
RTOR Reduction (vph)	0	0	0	0	6	0	0	21	0	0	0	0
Lane Group Flow (vph)	45	1608	0	0	908	0	146	106	0	0	0	0
Turn Type	Prot			Perm			Split					
Protected Phases	5	2			6		4	4				
Permitted Phases				6								
Actuated Green, G (s)	4.4	70.3			61.9		9.0	9.0				
Effective Green, g (s)	4.4	70.3			61.9		9.0	9.0				
Actuated g/C Ratio	0.05	0.81			0.71		0.10	0.10				
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0				
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0				
Lane Grp Cap (vph)	173	4095			3554		354	355				
v/s Ratio Prot	0.01	c0.32			0.18		c0.04	0.03				
v/s Ratio Perm												
v/c Ratio	0.26	0.39			0.26		0.41	0.30				
Uniform Delay, d1	39.9	2.4			4.5		36.7	36.2				
Progression Factor	1.00	1.00			1.00		1.00	1.00				
Incremental Delay, d2	0.8	0.3			0.2		0.8	0.5				
Delay (s)	40.7	2.7			4.7		37.5	36.7				
Level of Service	D	A			A		D	D				
Approach Delay (s)		3.7			4.7			37.1			0.0	
Approach LOS		A			A			D			A	

Intersection Summary			
HCM Average Control Delay	7.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.39		
Actuated Cycle Length (s)	87.3	Sum of lost time (s)	8.0
Intersection Capacity Utilization	39.1%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
17: East-West Road & North-South Road

Year 2030 AM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↱		↰↰	↑↱		↰↰	↑↑↱		↰↰	↑↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	0.97	0.95		0.97	0.95		0.97	0.91		0.97	0.91	
Frt	1.00	0.95		1.00	0.89		1.00	0.99		1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	3433	3356		3433	3141		3433	5011		3433	4938	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	3433	3356		3433	3141		3433	5011		3433	4938	
Volume (vph)	205	213	112	105	59	177	207	1138	123	86	562	134
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	223	232	122	114	64	192	225	1237	134	93	611	146
RTOR Reduction (vph)	0	72	0	0	169	0	0	12	0	0	35	0
Lane Group Flow (vph)	223	282	0	114	87	0	225	1359	0	93	722	0
Turn Type	Prot			Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases												
Actuated Green, G (s)	10.8	14.2		6.9	10.3		10.8	33.1		17.1	39.4	
Effective Green, g (s)	10.8	14.2		6.9	10.3		10.8	33.1		17.1	39.4	
Actuated g/C Ratio	0.12	0.16		0.08	0.12		0.12	0.38		0.20	0.45	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	425	546		271	371		425	1900		672	2229	
v/s Ratio Prot	c0.06	c0.08		0.03	0.03		c0.07	c0.27		0.03	c0.15	
v/s Ratio Perm												
v/c Ratio	0.52	0.52		0.42	0.23		0.53	0.72		0.14	0.32	
Uniform Delay, d1	35.8	33.4		38.3	34.9		35.9	23.1		29.0	15.4	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.2	0.8		1.1	0.3		1.2	2.3		0.4	0.4	
Delay (s)	37.0	34.2		39.4	35.2		37.1	25.4		29.4	15.8	
Level of Service	D	C		D	D		D	C		C	B	
Approach Delay (s)		35.3			36.5			27.1			17.3	
Approach LOS		D			D			C			B	

Intersection Summary			
HCM Average Control Delay	27.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	87.3	Sum of lost time (s)	20.0
Intersection Capacity Utilization	54.6%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
18: North-South Road & Kapolei Parkway

Year 2030 AM

Movement	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰	↑↑↱		↰	↑↑↱		↰↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.91		1.00	0.91		0.97	0.91	1.00	1.00	0.91	1.00
Frt	1.00	0.98		1.00	0.93		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	4992		1770	4735		3433	5085	1583	1770	5085	1583
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	4992		1770	4735		3433	5085	1583	1770	5085	1583
Volume (vph)	245	463	64	33	404	342	715	315	316	118	437	290
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	266	503	70	36	439	372	777	342	343	128	475	315
RTOR Reduction (vph)	0	17	0	0	145	0	0	0	231	0	0	158
Lane Group Flow (vph)	266	556	0	36	666	0	777	342	112	128	475	157
Turn Type	Prot			Prot			Prot		Perm	Prot		Perm
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases									4			8
Actuated Green, G (s)	17.1	33.6		3.3	19.8		24.1	30.2	30.2	9.4	15.5	15.5
Effective Green, g (s)	17.1	33.6		3.3	19.8		24.1	30.2	30.2	9.4	15.5	15.5
Actuated g/C Ratio	0.18	0.36		0.04	0.21		0.26	0.33	0.33	0.10	0.17	0.17
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	327	1813		63	1014		894	1660	517	180	852	265
v/s Ratio Prot	c0.15	0.11		0.02	c0.14		c0.23	0.07		0.07	0.09	
v/s Ratio Perm									0.07			c0.10
v/c Ratio	0.81	0.31		0.57	0.66		0.87	0.21	0.22	0.71	0.56	0.59
Uniform Delay, d1	36.2	21.1		43.9	33.2		32.7	22.5	22.6	40.2	35.4	35.6
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	14.3	0.4		11.9	3.3		9.0	0.1	0.2	12.4	0.8	3.5
Delay (s)	50.4	21.5		55.8	36.6		41.7	22.6	22.8	52.7	36.1	39.1
Level of Service	D	C		E	D		D	C	C	D	D	D
Approach Delay (s)		30.7			37.4			32.8			39.5	
Approach LOS		C			D			C			D	

Intersection Summary			
HCM Average Control Delay	34.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	92.5	Sum of lost time (s)	16.0
Intersection Capacity Utilization	71.2%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00
Frt		1.00	0.93		1.00	0.85
Flt Protected		1.00	1.00		0.95	1.00
Satd. Flow (prot)		1859	1733		1770	1583
Flt Permitted		0.94	1.00		0.95	1.00
Satd. Flow (perm)		1760	1733		1770	1583
Volume (vph)	10	230	180	191	7	35
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	250	196	208	8	38
RTOR Reduction (vph)	0	0	63	0	0	15
Lane Group Flow (vph)	0	261	341	0	8	23
Turn Type	Perm					Perm
Protected Phases		4	8		6	
Permitted Phases	4					6
Actuated Green, G (s)		16.5	16.5		36.3	36.3
Effective Green, g (s)		16.5	16.5		36.3	36.3
Actuated g/C Ratio		0.27	0.27		0.60	0.60
Clearance Time (s)		4.0	4.0		4.0	4.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		478	470		1057	945
v/s Ratio Prot			c0.20		0.00	
v/s Ratio Perm		0.15				c0.01
v/c Ratio		0.55	0.72		0.01	0.02
Uniform Delay, d1		18.9	20.1		5.0	5.0
Progression Factor		1.00	1.00		1.00	1.00
Incremental Delay, d2		1.3	5.5		0.0	0.0
Delay (s)		20.2	25.6		5.0	5.1
Level of Service		C	C		A	A
Approach Delay (s)		20.2	25.6		5.0	
Approach LOS		C	C		A	

Intersection Summary			
HCM Average Control Delay	22.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.24		
Actuated Cycle Length (s)	60.8	Sum of lost time (s)	8.0
Intersection Capacity Utilization	31.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
1: Kunia Loop & Kunia Road

Year 2030 PM

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↰	↱	↑↑	↱		↑↑↑
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0		4.0
Lane Util. Factor	*0.99	1.00	*0.99	1.00		*0.99
Frt	1.00	0.85	1.00	0.85		1.00
Flt Protected	0.95	1.00	1.00	1.00		1.00
Satd. Flow (prot)	3504	1583	3688	1583		5532
Flt Permitted	0.95	1.00	1.00	1.00		1.00
Satd. Flow (perm)	3504	1583	3688	1583		5532
Volume (vph)	634	41	2366	643	0	2415
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	640	41	2390	649	0	2439
RTOR Reduction (vph)	0	7	0	198	0	0
Lane Group Flow (vph)	640	34	2390	451	0	2439
Turn Type		Perm		Perm		
Protected Phases	8		2			6
Permitted Phases		8		2		
Actuated Green, G (s)	22.0	22.0	68.1	68.1		68.1
Effective Green, g (s)	22.0	22.0	68.1	68.1		68.1
Actuated g/C Ratio	0.22	0.22	0.69	0.69		0.69
Clearance Time (s)	4.0	4.0	4.0	4.0		4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0		3.0
Lane Grp Cap (vph)	786	355	2560	1099		3840
v/s Ratio Prot	c0.18		c0.65			0.44
v/s Ratio Perm		0.02		0.28		
v/c Ratio	0.81	0.10	0.93	0.41		0.64
Uniform Delay, d1	36.1	30.2	13.0	6.4		8.2
Progression Factor	1.00	1.00	1.00	1.00		1.00
Incremental Delay, d2	6.5	0.1	7.8	1.1		0.8
Delay (s)	42.6	30.3	20.9	7.5		9.0
Level of Service	D	C	C	A		A
Approach Delay (s)	41.9		18.0			9.0
Approach LOS	D		B			A

Intersection Summary			
HCM Average Control Delay	17.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	98.1	Sum of lost time (s)	8.0
Intersection Capacity Utilization	90.2%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
2: H-1 WB On-Ramp & Kunia Road

Year 2030 PM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations						↱	↰	↑↑↑			↑↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)						4.0	4.0	4.0			4.0	
Lane Util. Factor						1.00	1.00	0.91			0.91	
Frt						0.86	1.00	1.00			0.99	
Flt Protected						1.00	0.95	1.00			1.00	
Satd. Flow (prot)						1611	1770	5085			5016	
Flt Permitted						1.00	0.95	1.00			1.00	
Satd. Flow (perm)						1611	1770	5085			5016	
Volume (vph)	0	0	0	0	0	1230	323	1779	0	0	2774	275
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	0	0	1337	351	1934	0	0	3015	299
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	11	0
Lane Group Flow (vph)	0	0	0	0	0	1337	351	1934	0	0	3303	0
Turn Type						Free	Prot					
Protected Phases							5	2			6	
Permitted Phases						Free						
Actuated Green, G (s)						100.0	22.8	100.0			69.2	
Effective Green, g (s)						100.0	22.8	100.0			69.2	
Actuated g/C Ratio						1.00	0.23	1.00			0.69	
Clearance Time (s)							4.0	4.0			4.0	
Vehicle Extension (s)							3.0	3.0			3.0	
Lane Grp Cap (vph)						1611	404	5085			3471	
v/s Ratio Prot							0.20	0.38			c0.66	
v/s Ratio Perm						c0.83						
v/c Ratio						0.83	0.87	0.38			0.95	
Uniform Delay, d1						0.0	37.2	0.0			13.9	
Progression Factor						1.00	1.08	1.00			1.00	
Incremental Delay, d2						5.1	15.8	0.2			7.6	
Delay (s)						5.1	56.0	0.2			21.5	
Level of Service						A	E	A			C	
Approach Delay (s)		0.0			5.1			8.8			21.5	
Approach LOS		A			A			A			C	

Intersection Summary			
HCM Average Control Delay	14.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	84.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
3: H-1 EB & Kunia Road

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations	↰↰	↱	↑↑↑↑			↑↑↑
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0			4.0
Lane Util. Factor	0.97	1.00	0.86			0.91
Frt	1.00	0.85	1.00			1.00
Flt Protected	0.95	1.00	1.00			1.00
Satd. Flow (prot)	3433	1583	6408			5085
Flt Permitted	0.95	1.00	1.00			1.00
Satd. Flow (perm)	3433	1583	6408			5085
Volume (vph)	455	413	3770	0	0	2102
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	495	449	4098	0	0	2285
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	495	449	4098	0	0	2285
Turn Type		Free				
Protected Phases	4		6			2
Permitted Phases		Free				
Actuated Green, G (s)	18.3	100.0	73.7			73.7
Effective Green, g (s)	18.3	100.0	73.7			73.7
Actuated g/C Ratio	0.18	1.00	0.74			0.74
Clearance Time (s)	4.0		4.0			4.0
Vehicle Extension (s)	3.0		3.0			3.0
Lane Grp Cap (vph)	628	1583	4723			3748
v/s Ratio Prot	c0.14		c0.64			0.45
v/s Ratio Perm		0.28				
v/c Ratio	0.79	0.28	0.87			0.61
Uniform Delay, d1	39.0	0.0	9.6			6.3
Progression Factor	1.00	1.00	0.42			1.00
Incremental Delay, d2	6.5	0.4	2.2			0.7
Delay (s)	45.5	0.4	6.2			7.0
Level of Service	D	A	A			A
Approach Delay (s)	24.1		6.2			7.0
Approach LOS	C		A			A

Intersection Summary			
HCM Average Control Delay	8.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	74.3%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
4: Farrington Hwy & Fort Weaver Road SB Ramp

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↱		↰↰	↑↑↑				↱			↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0				4.0			4.0
Lane Util. Factor		0.91		0.97	0.91				1.00			1.00
Frt		0.97		1.00	1.00				0.86			0.86
Flt Protected		1.00		0.95	1.00				1.00			1.00
Satd. Flow (prot)		4952		3433	5085				1611			1611
Flt Permitted		1.00		0.95	1.00				1.00			1.00
Satd. Flow (perm)		4952		3433	5085				1611			1611
Volume (vph)	0	483	102	622	1345	0	0	0	426	0	0	144
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	525	111	676	1462	0	0	0	463	0	0	157
RTOR Reduction (vph)	0	9	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	627	0	676	1462	0	0	0	463	0	0	157
Turn Type				Prot					Free			Free
Protected Phases		2		1	6							
Permitted Phases									Free			Free
Actuated Green, G (s)		90.7		31.3	130.0				130.0			130.0
Effective Green, g (s)		90.7		31.3	130.0				130.0			130.0
Actuated g/C Ratio		0.70		0.24	1.00				1.00			1.00
Clearance Time (s)		4.0		4.0	4.0							
Vehicle Extension (s)		3.0		3.0	3.0							
Lane Grp Cap (vph)		3455		827	5085				1611			1611
v/s Ratio Prot		0.13		c0.20	c0.29							
v/s Ratio Perm									0.29			0.10
v/c Ratio		0.18		0.82	0.29				0.29			0.10
Uniform Delay, d1		6.8		46.6	0.0				0.0			0.0
Progression Factor		1.00		1.29	1.00				1.00			1.00
Incremental Delay, d2		0.1		3.3	0.1				0.4			0.1
Delay (s)		6.9		63.5	0.1				0.4			0.1
Level of Service		A		E	A				A			A
Approach Delay (s)		6.9			20.1			0.4			0.1	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM Average Control Delay	14.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	36.0%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
5: Farrington Hwy & Fort Weaver Road NB Ramps

Year 2030 PM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↑			↑↑↱				↱			
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0				4.0			
Lane Util. Factor	1.00	0.91			0.91				1.00			
Frt	1.00	1.00			0.94				0.86			
Flt Protected	0.95	1.00			1.00				1.00			
Satd. Flow (prot)	1770	5085			4802				1611			
Flt Permitted	0.95	1.00			1.00				1.00			
Satd. Flow (perm)	1770	5085			4802				1611			
Volume (vph)	129	780	0	0	1968	1164	0	0	428	0	0	0
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	140	848	0	0	2139	1265	0	0	465	0	0	0
RTOR Reduction (vph)	0	0	0	0	47	0	0	0	0	0	0	0
Lane Group Flow (vph)	140	848	0	0	3357	0	0	0	465	0	0	0
Turn Type	Prot								Free			
Protected Phases	5	2			6							
Permitted Phases									Free			
Actuated Green, G (s)	14.4	130.0			107.6				130.0			
Effective Green, g (s)	14.4	130.0			107.6				130.0			
Actuated g/C Ratio	0.11	1.00			0.83				1.00			
Clearance Time (s)	4.0	4.0			4.0							
Vehicle Extension (s)	3.0	3.0			3.0							
Lane Grp Cap (vph)	196	5085			3975				1611			
v/s Ratio Prot	c0.08	0.17			c0.70							
v/s Ratio Perm									0.29			
v/c Ratio	0.71	0.17			0.92dr				0.29			
Uniform Delay, d1	55.8	0.0			6.4				0.0			
Progression Factor	0.93	1.00			1.00				1.00			
Incremental Delay, d2	11.5	0.1			2.4				0.5			
Delay (s)	63.3	0.1			8.8				0.5			
Level of Service	E	A			A				A			
Approach Delay (s)		9.0			8.8			0.5			0.0	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	8.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	77.9%	ICU Level of Service	D
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.
c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
6: Farrington Hwy & Leoku Street

Year 2030 PM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑↑	↱	↰	↑↑↑	↱		↰	↱		↰↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
Lane Util. Factor	*0.99	*0.99	1.00	1.00	*0.99	1.00		1.00	1.00		*0.99	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00		0.96	1.00
Satd. Flow (prot)	3504	5532	1583	1770	5532	1583		1785	1583		3530	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00		0.96	1.00
Satd. Flow (perm)	3504	5532	1583	1770	5532	1583		1785	1583		3530	1583
Volume (vph)	189	903	116	135	2831	515	197	29	130	243	28	99
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	191	912	117	136	2860	520	199	29	131	245	28	100
RTOR Reduction (vph)	0	0	98	0	0	167	0	0	42	0	0	87
Lane Group Flow (vph)	191	912	19	136	2860	353	0	228	89	0	273	13
Turn Type	Prot		Perm	Prot		Perm	Split		Perm	Split		Perm
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			6
Actuated Green, G (s)	9.0	24.7	24.7	73.3	89.0	89.0		20.0	20.0		15.0	15.0
Effective Green, g (s)	9.0	24.7	24.7	73.3	89.0	89.0		20.0	20.0		15.0	15.0
Actuated g/C Ratio	0.06	0.17	0.17	0.49	0.60	0.60		0.13	0.13		0.10	0.10
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	212	917	262	871	3304	946		240	212		355	159
v/s Ratio Prot	c0.05	c0.16		0.08	c0.52			c0.13			c0.08	
v/s Ratio Perm			0.01			0.22			0.06			0.01
v/c Ratio	0.90	0.99	0.07	0.16	0.87	0.37		0.95	0.42		1.38dl	0.08
Uniform Delay, d1	69.6	62.1	52.5	20.8	25.0	15.5		64.0	59.2		65.3	60.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00
Incremental Delay, d2	35.9	28.2	0.1	0.1	2.6	0.2		46.5	6.1		9.6	0.2
Delay (s)	105.5	90.3	52.6	20.9	27.6	15.8		110.5	65.3		75.0	61.0
Level of Service	F	F	D	C	C	B		F	E		E	E
Approach Delay (s)		89.0			25.6			94.0			71.2	
Approach LOS		F			C			F			E	

Intersection Summary			
HCM Average Control Delay	47.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	149.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	90.2%	ICU Level of Service	E
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱		↰	↑	↱	↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		*0.99		1.00	1.00	1.00	1.00	*0.99	1.00	1.00	*0.99	1.00
Frt		0.99		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.96		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		3519		1770	1863	1583	1770	5532	1583	1770	5532	1583
Flt Permitted		0.96		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		3519		1770	1863	1583	1770	5532	1583	1770	5532	1583
Volume (vph)	209	37	13	40	4	180	56	2225	71	173	3239	82
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	227	40	14	43	4	196	61	2418	77	188	3521	89
RTOR Reduction (vph)	0	3	0	0	0	190	0	0	28	0	0	26
Lane Group Flow (vph)	0	278	0	43	4	6	61	2418	49	188	3521	63
Turn Type	Split			Split		Perm	Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases						8			2			6
Actuated Green, G (s)		14.4		4.0	4.0	4.0	5.0	76.0	76.0	18.0	89.0	89.0
Effective Green, g (s)		14.4		4.0	4.0	4.0	5.0	76.0	76.0	18.0	89.0	89.0
Actuated g/C Ratio		0.11		0.03	0.03	0.03	0.04	0.59	0.59	0.14	0.69	0.69
Clearance Time (s)		4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		395		55	58	49	69	3274	937	248	3834	1097
v/s Ratio Prot		c0.08		c0.02	0.00		0.03	c0.44		0.11	c0.64	
v/s Ratio Perm						0.00			0.03			0.04
v/c Ratio		1.14dl		0.78	0.07	0.12	0.88	0.74	0.05	0.76	0.92	0.06
Uniform Delay, d1		54.9		61.8	60.4	60.5	61.4	19.0	11.0	53.1	16.6	6.3
Progression Factor		1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		5.6		50.5	0.5	1.1	69.1	1.5	0.1	12.4	4.7	0.1
Delay (s)		60.6		112.3	60.9	61.6	130.5	20.5	11.1	65.6	21.3	6.4
Level of Service		E		F	E	E	F	C	B	E	C	A
Approach Delay (s)		60.6			70.6			22.9			23.2	
Approach LOS		E			E			C			C	

Intersection Summary			
HCM Average Control Delay	26.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	128.4	Sum of lost time (s)	16.0
Intersection Capacity Utilization	94.2%	ICU Level of Service	F
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑	↱		↰↑	↱	↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	*0.99	1.00	1.00	*0.99	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.97	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1809	1583		1829	1583	1770	5532	1583	1770	5532	1583
Flt Permitted		0.72	1.00		0.47	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		1339	1583		880	1583	1770	5532	1583	1770	5532	1583
Volume (vph)	199	135	372	36	62	46	230	2104	2	135	2959	198
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	201	136	376	36	63	46	232	2125	2	136	2989	200
RTOR Reduction (vph)	0	0	0	0	0	36	0	0	0	0	0	96
Lane Group Flow (vph)	0	337	376	0	99	10	232	2125	2	136	2989	104
Turn Type	Perm		Free	Perm		Perm	Prot		Free	Prot		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		Free	8		8			Free			6
Actuated Green, G (s)		26.0	119.2		26.0	26.0	19.4	69.0	119.2	12.2	61.8	61.8
Effective Green, g (s)		26.0	119.2		26.0	26.0	19.4	69.0	119.2	12.2	61.8	61.8
Actuated g/C Ratio		0.22	1.00		0.22	0.22	0.16	0.58	1.00	0.10	0.52	0.52
Clearance Time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)		292	1583		192	345	288	3202	1583	181	2868	821
v/s Ratio Prot							c0.13	0.38		0.08	c0.54	
v/s Ratio Perm		c0.25	0.24		0.11	0.01			0.00			0.07
v/c Ratio		1.15	0.24		0.52	0.03	0.81	0.66	0.00	0.75	1.04	0.13
Uniform Delay, d1		46.6	0.0		41.1	36.7	48.1	17.2	0.0	52.0	28.7	14.8
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		101.0	0.4		2.3	0.0	15.0	1.1	0.0	16.0	29.1	0.3
Delay (s)		147.6	0.4		43.4	36.7	63.1	18.3	0.0	68.1	57.8	15.1
Level of Service		F	A		D	D	E	B	A	E	E	B
Approach Delay (s)		70.0			41.3			22.7			55.7	
Approach LOS		E			D			C			E	

Intersection Summary			
HCM Average Control Delay	45.0	HCM Level of Service	D
HCM Volume to Capacity ratio	1.03		
Actuated Cycle Length (s)	119.2	Sum of lost time (s)	12.0
Intersection Capacity Utilization	106.6%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
9: Renton Road & Fort Weaver Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*0.99	*0.99	1.00		1.00		1.00	*0.99	1.00	1.00	*0.99	1.00
Frt	1.00	1.00	0.85		0.93		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.95	1.00		1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1752	1760	1583		1731		1770	5532	1583	1770	5532	1583
Flt Permitted	0.95	0.95	1.00		1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1752	1760	1583		1731		1770	5532	1583	1770	5532	1583
Volume (vph)	682	14	43	9	144	160	45	1671	75	425	2480	472
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	689	14	43	9	145	162	45	1688	76	429	2505	477
RTOR Reduction (vph)	0	0	0	0	25	0	0	0	9	0	0	229
Lane Group Flow (vph)	345	358	43	0	291	0	45	1688	67	429	2505	248
Turn Type	Split		Free	Split			Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			Free						2			6
Actuated Green, G (s)	29.0	29.0	150.0		23.0		4.0	49.0	49.0	33.0	78.0	78.0
Effective Green, g (s)	29.0	29.0	150.0		23.0		4.0	49.0	49.0	33.0	78.0	78.0
Actuated g/C Ratio	0.19	0.19	1.00		0.15		0.03	0.33	0.33	0.22	0.52	0.52
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	339	340	1583		265		47	1807	517	389	2877	823
v/s Ratio Prot	0.20	c0.20			c0.17		0.03	c0.31		c0.24	0.45	
v/s Ratio Perm			0.03						0.04			0.16
v/c Ratio	1.02	1.05	0.03		1.10		0.96	0.93	0.13	1.10	0.87	0.30
Uniform Delay, d1	60.5	60.5	0.0		63.5		72.9	48.9	35.5	58.5	31.6	20.5
Progression Factor	1.00	1.00	1.00		1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	53.5	63.4	0.0		83.6		114.0	10.4	0.5	76.3	3.9	0.9
Delay (s)	114.0	123.9	0.0		147.1		186.9	59.4	36.0	134.8	35.5	21.4
Level of Service	F	F	A		F		F	E	D	F	D	C
Approach Delay (s)		112.2			147.1			61.6			46.0	
Approach LOS		F			F			E			D	

Intersection Summary			
HCM Average Control Delay	63.4	HCM Level of Service	E
HCM Volume to Capacity ratio	1.03		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	106.3%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
10: Farrington Hwy & East Old Fort Weaver Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBR	SWL	SWR
Lane Configurations										
Sign Control		Free			Free		Stop		Stop	
Grade		0%			0%		0%		0%	
Volume (veh/h)	0	540	0	0	0	0	0	0	275	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	587	0	0	0	0	0	0	299	0
Pedestrians										
Lane Width (ft)										
Walking Speed (ft/s)										
Percent Blockage										
Right turn flare (veh)										
Median type							None		None	
Median storage veh)										
Upstream signal (ft)					942					
pX, platoon unblocked										
vC, conflicting volume	0			587			736	587	587	0
vC1, stage 1 conf vol										
vC2, stage 2 conf vol										
vCu, unblocked vol	0			587			736	587	587	0
tC, single (s)	4.1			4.1			7.5	6.5	6.5	6.9
tC, 2 stage (s)										
tF (s)	2.2			2.2			3.5	4.0	4.0	3.3
p0 queue free %	100			100			100	100	29	100
cM capacity (veh/h)	1622			984			130	420	420	1084

Direction, Lane #	EB 1	EB 2	SW 1
Volume Total	293	293	299
Volume Left	0	0	0
Volume Right	0	0	0
cSH	1700	1700	420
Volume to Capacity	0.17	0.17	0.71
Queue Length 95th (ft)	0	0	136
Control Delay (s)	0.0	0.0	32.0
Lane LOS			D
Approach Delay (s)	0.0		32.0
Approach LOS			D

Intersection Summary			
Average Delay	10.8		
Intersection Capacity Utilization	36.8%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
11: Farrington Hwy & West Old Fort Weaver Road

Year 2030 PM

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑↱			↑↑	↰	↱
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	535	143	0	1214	75	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	582	155	0	1320	82	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			737		1319	368
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			737		1319	368
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		45	100
cM capacity (veh/h)			865		148	629

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2
Volume Total	388	349	660	660	82	0
Volume Left	0	0	0	0	82	0
Volume Right	0	155	0	0	0	0
cSH	1700	1700	1700	1700	148	1700
Volume to Capacity	0.23	0.21	0.39	0.39	0.55	0.00
Queue Length 95th (ft)	0	0	0	0	69	0
Control Delay (s)	0.0	0.0	0.0	0.0	55.4	0.0
Lane LOS					F	A
Approach Delay (s)	0.0		0.0		55.4	
Approach LOS					F	

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	44.4%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
12: Fort Barrette Road & Farrington Hwy

Year 2030 PM

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰↰	↑↑↱	↱	↰↰	↑↑	↱	↰↰	↑↑	↱	↰	↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	0.91	0.97	0.95	1.00	0.97	0.95	1.00	1.00	0.95	1.00
Frt	1.00	0.96	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3245	1441	3433	3539	1583	3433	3539	1583	1770	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3245	1441	3433	3539	1583	3433	3539	1583	1770	3539	1583
Volume (vph)	478	463	708	355	380	37	658	390	746	157	550	448
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	520	503	770	386	413	40	715	424	811	171	598	487
RTOR Reduction (vph)	0	17	315	0	0	31	0	0	228	0	0	260
Lane Group Flow (vph)	520	687	254	386	413	9	715	424	583	171	598	227
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases			6			2			4			8
Actuated Green, G (s)	31.2	48.1	48.1	23.1	40.0	40.0	41.4	67.8	67.8	20.5	46.9	46.9
Effective Green, g (s)	31.2	48.1	48.1	23.1	40.0	40.0	41.4	67.8	67.8	20.5	46.9	46.9
Actuated g/C Ratio	0.18	0.27	0.27	0.13	0.23	0.23	0.24	0.39	0.39	0.12	0.27	0.27
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	610	889	395	452	807	361	810	1367	612	207	946	423
v/s Ratio Prot	c0.15	c0.21		0.11	0.12		c0.21	0.12		0.10	0.17	
v/s Ratio Perm			0.18			0.01			c0.37			0.14
v/c Ratio	0.85	0.77	0.64	0.85	0.51	0.03	0.88	0.31	0.95	0.83	0.63	0.54
Uniform Delay, d1	69.9	58.7	56.1	74.6	59.2	52.6	64.7	37.5	52.3	75.8	56.7	55.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	11.1	4.2	3.6	14.5	2.3	0.1	11.2	0.1	24.9	22.8	1.4	1.3
Delay (s)	81.0	62.9	59.7	89.1	61.5	52.7	75.9	37.7	77.2	98.5	58.1	56.3
Level of Service	F	E	E	F	E	D	E	D	E	F	E	E
Approach Delay (s)		67.1			73.8			68.1			62.9	
Approach LOS		E			E			E			E	

Intersection Summary			
HCM Average Control Delay	67.5	HCM Level of Service	E
HCM Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	175.5	Sum of lost time (s)	12.0
Intersection Capacity Utilization	85.2%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
13: WB Ramps & North-South Road

Year 2030 PM

Movement	WBL2	WBL	WBR	NBL	NBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰↰		↱				↑↑	↱	↰↰	↑↑	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0				4.0	4.0	4.0	4.0	
Lane Util. Factor	0.97		1.00				0.95	1.00	0.97	0.95	
Frt	1.00		0.85				1.00	0.85	1.00	1.00	
Flt Protected	0.95		1.00				1.00	1.00	0.95	1.00	
Satd. Flow (prot)	3433		1583				3539	1583	3433	3539	
Flt Permitted	0.95		1.00				1.00	1.00	0.95	1.00	
Satd. Flow (perm)	3433		1583				3539	1583	3433	3539	
Volume (vph)	1190	0	412	0	0	0	309	86	144	331	0
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1293	0	448	0	0	0	336	93	157	360	0
RTOR Reduction (vph)	0	0	211	0	0	0	0	67	0	0	0
Lane Group Flow (vph)	1293	0	237	0	0	0	336	26	157	360	0
Turn Type	Prot		custom					Perm	Prot		
Protected Phases	8		8				6		5	2	
Permitted Phases								6			
Actuated Green, G (s)	44.4		44.4				27.6	27.6	16.0	47.6	
Effective Green, g (s)	44.4		44.4				27.6	27.6	16.0	47.6	
Actuated g/C Ratio	0.44		0.44				0.28	0.28	0.16	0.48	
Clearance Time (s)	4.0		4.0				4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0		3.0				3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	1524		703				977	437	549	1685	
v/s Ratio Prot	c0.38		0.15				c0.09		c0.05	0.10	
v/s Ratio Perm								0.02			
v/c Ratio	0.85		0.34				0.34	0.06	0.29	0.21	
Uniform Delay, d1	24.8		18.2				29.0	26.6	37.0	15.3	
Progression Factor	1.00		1.00				1.00	1.00	0.93	0.78	
Incremental Delay, d2	4.6		0.3				1.0	0.3	0.3	0.3	
Delay (s)	29.4		18.5				29.9	26.9	34.8	12.3	
Level of Service	C		B				C	C	C	B	
Approach Delay (s)		26.6		0.0			29.3			19.1	
Approach LOS		C		A			C			B	

Intersection Summary			
HCM Average Control Delay	25.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	61.4%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
14: EB Ramps & North-South Road

Year 2030 PM

Movement	EBL2	EBL	EBR	SBL	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰		↱			↰↰	↑↑			↑↑	↱↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0			4.0	4.0			4.0	4.0
Lane Util. Factor	1.00		1.00			0.97	0.95			0.95	0.88
Frt	1.00		0.85			1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (prot)	1770		1583			3433	3539			3539	2787
Flt Permitted	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (perm)	1770		1583			3433	3539			3539	2787
Volume (vph)	92	0	304	0	0	201	1298	0	0	383	1239
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	100	0	330	0	0	218	1411	0	0	416	1347
RTOR Reduction (vph)	0	0	59	0	0	0	0	0	0	0	532
Lane Group Flow (vph)	100	0	271	0	0	218	1411	0	0	416	815
Turn Type	Prot		custom			Prot					Perm
Protected Phases	4		4			1	6			2	
Permitted Phases											2
Actuated Green, G (s)	19.7		19.7			11.0	72.3			57.3	57.3
Effective Green, g (s)	19.7		19.7			11.0	72.3			57.3	57.3
Actuated g/C Ratio	0.20		0.20			0.11	0.72			0.57	0.57
Clearance Time (s)	4.0		4.0			4.0	4.0			4.0	4.0
Vehicle Extension (s)	3.0		3.0			3.0	3.0			3.0	3.0
Lane Grp Cap (vph)	349		312			378	2559			2028	1597
v/s Ratio Prot	0.06		c0.17			0.06	c0.40			0.12	
v/s Ratio Perm											0.29
v/c Ratio	0.29		0.87			0.58	0.55			0.21	0.51
Uniform Delay, d1	34.2		38.9			42.3	6.4			10.3	12.9
Progression Factor	1.00		1.00			1.26	0.06			1.00	1.00
Incremental Delay, d2	0.5		21.5			1.4	0.6			0.2	1.2
Delay (s)	34.6		60.4			54.5	1.0			10.6	14.1
Level of Service	C		E			D	A			B	B
Approach Delay (s)		54.4		0.0			8.1			13.2	
Approach LOS		D		A			A			B	

Intersection Summary			
HCM Average Control Delay	15.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	61.4%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
15: North-South Road & Farrington Hwy

Year 2030 PM

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰↰	↑↑↑	↱	↰↰	↑↑↑	↱	↰↰	↑↑	↱	↰↰	↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91	1.00	0.97	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5085	1583	3433	3539	1583	3433	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5085	1583	3433	3539	1583	3433	3539	1583
Volume (vph)	153	983	466	245	771	201	313	324	268	297	444	538
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	166	1068	507	266	838	218	340	352	291	323	483	585
RTOR Reduction (vph)	0	0	271	0	0	157	0	0	201	0	0	251
Lane Group Flow (vph)	166	1068	236	266	838	61	340	352	90	323	483	334
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases			6			2			4			8
Actuated Green, G (s)	9.9	24.4	24.4	12.5	27.0	27.0	18.0	29.8	29.8	13.3	25.1	25.1
Effective Green, g (s)	9.9	24.4	24.4	12.5	27.0	27.0	18.0	29.8	29.8	13.3	25.1	25.1
Actuated g/C Ratio	0.10	0.25	0.25	0.13	0.28	0.28	0.19	0.31	0.31	0.14	0.26	0.26
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	354	1292	402	447	1430	445	644	1099	491	476	925	414
v/s Ratio Prot	0.05	c0.21		c0.08	c0.16		c0.10	0.10		c0.09	0.14	
v/s Ratio Perm			0.15			0.04			0.06			c0.21
v/c Ratio	0.47	0.83	0.59	0.60	0.59	0.14	0.53	0.32	0.18	0.68	0.52	0.81
Uniform Delay, d1	40.6	33.8	31.4	39.4	29.7	25.8	35.2	25.3	24.2	39.3	30.3	33.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.0	4.5	2.2	2.1	0.6	0.1	3.1	0.8	0.8	3.8	2.1	15.4
Delay (s)	41.6	38.3	33.6	41.5	30.3	25.9	38.3	26.1	25.0	43.1	32.4	48.6
Level of Service	D	D	C	D	C	C	D	C	C	D	C	D
Approach Delay (s)		37.2			31.8			30.0			41.7	
Approach LOS		D			C			C			D	

Intersection Summary			
HCM Average Control Delay	35.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	96.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	67.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
16: North-South Road & North UH Connector

Year 2030 PM

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰↰	↑↑↑↱	↱	↰↰	↑↑↑↱		↰↰	↑↑↱				
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0		4.0	4.0				
Lane Util. Factor	0.97	*0.99			*0.99		*0.99	0.95				
Frt	1.00	1.00			0.98		1.00	0.94				
Flt Protected	0.95	1.00			1.00		0.95	1.00				
Satd. Flow (prot)	3433	5532			5408		3504	3340				
Flt Permitted	0.95	1.00			1.00		0.95	1.00				
Satd. Flow (perm)	3433	5532			5408		3504	3340				
Volume (vph)	61	1021	0	0	1315	233	196	279	168	0	0	0
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	62	1031	0	0	1328	235	198	282	170	0	0	0
RTOR Reduction (vph)	0	0	0	0	19	0	0	98	0	0	0	0
Lane Group Flow (vph)	62	1031	0	0	1544	0	198	354	0	0	0	0
Turn Type	Prot		Perm	Perm			Split					
Protected Phases	5	2			6		4	4				
Permitted Phases			2	6								
Actuated Green, G (s)	5.9	70.0			60.1		15.4	15.4				
Effective Green, g (s)	5.9	70.0			60.1		15.4	15.4				
Actuated g/C Ratio	0.06	0.75			0.64		0.16	0.16				
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0				
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0				
Lane Grp Cap (vph)	217	4146			3480		578	551				
v/s Ratio Prot	0.02	c0.19			c0.29		0.06	c0.11				
v/s Ratio Perm												
v/c Ratio	0.29	0.25			0.44		0.34	0.64				
Uniform Delay, d1	41.7	3.6			8.3		34.5	36.4				
Progression Factor	1.00	1.00			1.00		1.00	1.00				
Incremental Delay, d2	0.7	0.1			0.4		0.4	2.6				
Delay (s)	42.5	3.7			8.7		34.9	39.0				
Level of Service	D	A			A		C	D				
Approach Delay (s)		5.9			8.7			37.7			0.0	
Approach LOS		A			A			D			A	

Intersection Summary			
HCM Average Control Delay	13.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	93.4	Sum of lost time (s)	12.0
Intersection Capacity Utilization	50.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
17: East-West Rd & North-South Road

Year 2030 PM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↱		↰↰	↑↱		↰↰	↑↑↱		↰↰	↑↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	0.97	0.95		0.97	0.95		0.97	0.91		0.97	0.91	
Frt	1.00	0.93		1.00	0.93		1.00	0.98		1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	3433	3303		3433	3280		3433	4983		3433	4936	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	3433	3303		3433	3280		3433	4983		3433	4936	
Volume (vph)	249	289	232	220	172	164	110	669	104	103	1110	270
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	271	314	252	239	187	178	120	727	113	112	1207	293
RTOR Reduction (vph)	0	150	0	0	149	0	0	19	0	0	34	0
Lane Group Flow (vph)	271	416	0	239	216	0	120	821	0	112	1466	0
Turn Type	Prot			Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases												
Actuated Green, G (s)	12.1	15.3		11.3	14.5		7.0	30.0		16.1	39.1	
Effective Green, g (s)	12.1	15.3		11.3	14.5		7.0	30.0		16.1	39.1	
Actuated g/C Ratio	0.14	0.17		0.13	0.16		0.08	0.34		0.18	0.44	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	468	570		437	536		271	1685		623	2176	
v/s Ratio Prot	c0.08	c0.13		0.07	0.07		c0.03	0.16		0.03	c0.30	
v/s Ratio Perm												
v/c Ratio	0.58	0.73		0.55	0.40		0.44	0.49		0.18	0.67	
Uniform Delay, d1	35.9	34.7		36.3	33.2		39.0	23.3		30.7	19.7	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.7	4.8		1.4	0.5		1.2	1.0		0.6	1.7	
Delay (s)	37.7	39.5		37.7	33.7		40.1	24.3		31.3	21.4	
Level of Service	D	D		D	C		D	C		C	C	
Approach Delay (s)		38.9			35.3			26.2			22.1	
Approach LOS		D			D			C			C	

Intersection Summary			
HCM Average Control Delay	28.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	88.7	Sum of lost time (s)	12.0
Intersection Capacity Utilization	65.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
18: North-South Road & Kapolei Parkway

Year 2030 PM

Movement	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰	↑↑↱		↰	↑↑↱		↰↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.91		1.00	0.91		0.97	0.91	1.00	1.00	0.91	1.00
Frt	1.00	0.96		1.00	0.95		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	4896		1770	4825		3433	5085	1583	1770	5085	1583
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	4896		1770	4825		3433	5085	1583	1770	5085	1583
Volume (vph)	378	469	155	176	914	472	385	643	505	121	568	29
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	411	510	168	191	993	513	418	699	549	132	617	32
RTOR Reduction (vph)	0	40	0	0	65	0	0	0	340	0	0	27
Lane Group Flow (vph)	411	638	0	191	1441	0	418	699	209	132	617	5
Turn Type	Prot			Prot			Prot		Perm	Prot		Perm
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases									4			8
Actuated Green, G (s)	34.0	62.2		19.0	47.2		19.0	25.9	25.9	12.3	19.2	19.2
Effective Green, g (s)	34.0	62.2		19.0	47.2		19.0	25.9	25.9	12.3	19.2	19.2
Actuated g/C Ratio	0.25	0.46		0.14	0.35		0.14	0.19	0.19	0.09	0.14	0.14
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	444	2249		248	1682		482	973	303	161	721	224
v/s Ratio Prot	c0.23	0.13		0.11	c0.30		c0.12	0.14		0.07	c0.12	
v/s Ratio Perm									0.13			0.00
v/c Ratio	0.93	0.28		0.77	0.86		0.87	0.72	0.69	0.82	0.86	0.02
Uniform Delay, d1	49.5	22.8		56.1	41.0		57.0	51.3	51.0	60.5	56.7	50.0
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	25.1	0.3		13.7	5.9		15.1	2.6	6.6	26.7	9.8	0.0
Delay (s)	74.6	23.1		69.8	46.8		72.1	53.9	57.7	87.1	66.5	50.0
Level of Service	E	C		E	D		E	D	E	F	E	D
Approach Delay (s)		42.5			49.4			59.7			69.3	
Approach LOS		D			D			E			E	

Intersection Summary			
HCM Average Control Delay	54.2	HCM Level of Service	D
HCM Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	135.4	Sum of lost time (s)	16.0
Intersection Capacity Utilization	84.5%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00
Frt		1.00	0.94		1.00	0.85
Flt Protected		1.00	1.00		0.95	1.00
Satd. Flow (prot)		1856	1747		1770	1583
Flt Permitted		0.76	1.00		0.95	1.00
Satd. Flow (perm)		1424	1747		1770	1583
Volume (vph)	20	263	265	225	443	75
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	22	286	288	245	482	82
RTOR Reduction (vph)	0	0	44	0	0	37
Lane Group Flow (vph)	0	308	489	0	482	45
Turn Type	Perm					Perm
Protected Phases		4	8		6	
Permitted Phases	4					6
Actuated Green, G (s)		24.3	24.3		38.5	38.5
Effective Green, g (s)		24.3	24.3		38.5	38.5
Actuated g/C Ratio		0.34	0.34		0.54	0.54
Clearance Time (s)		4.0	4.0		4.0	4.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		489	600		963	861
v/s Ratio Prot			c0.28		c0.27	
v/s Ratio Perm		0.22				0.03
v/c Ratio		0.63	0.81		0.50	0.05
Uniform Delay, d1		19.5	21.2		10.1	7.6
Progression Factor		1.00	1.00		1.00	1.00
Incremental Delay, d2		2.5	8.4		1.9	0.1
Delay (s)		22.0	29.6		12.0	7.7
Level of Service		C	C		B	A
Approach Delay (s)		22.0	29.6		11.4	
Approach LOS		C	C		B	

Intersection Summary			
HCM Average Control Delay	20.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	70.8	Sum of lost time (s)	8.0
Intersection Capacity Utilization	61.5%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

APPENDIX A-3

YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO A: WITH TRANSIT CORRIDOR SCENARIO

HCM Signalized Intersection Capacity Analysis
1: Kunia Loop & Kunia Road

2030 + PRO (with Transit Corridor) - AM Peak

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↰	↱	↑↑	↱		↓↓↓
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0		4.0
Lane Util. Factor	0.97	1.00	0.95	1.00		0.91
Frt	1.00	0.85	1.00	0.85		1.00
Flt Protected	0.95	1.00	1.00	1.00		1.00
Satd. Flow (prot)	3433	1583	3539	1583		5085
Flt Permitted	0.95	1.00	1.00	1.00		1.00
Satd. Flow (perm)	3433	1583	3539	1583		5085
Volume (vph)	718	37	1770	492	0	1301
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	725	37	1788	497	0	1314
RTOR Reduction (vph)	0	15	0	174	0	0
Lane Group Flow (vph)	725	22	1788	323	0	1314
Turn Type		Perm		Perm		
Protected Phases	8		2			6
Permitted Phases		8		2		
Actuated Green, G (s)	25.1	25.1	61.2	61.2		61.2
Effective Green, g (s)	25.1	25.1	61.2	61.2		61.2
Actuated g/C Ratio	0.27	0.27	0.65	0.65		0.65
Clearance Time (s)	4.0	4.0	4.0	4.0		4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0		3.0
Lane Grp Cap (vph)	914	421	2297	1027		3300
v/s Ratio Prot	c0.21		c0.51			0.26
v/s Ratio Perm		0.01		0.20		
v/c Ratio	0.79	0.05	0.78	0.31		0.40
Uniform Delay, d1	32.2	25.8	11.7	7.3		7.8
Progression Factor	1.00	1.00	1.00	1.00		1.00
Incremental Delay, d2	4.8	0.1	2.7	0.8		0.4
Delay (s)	37.0	25.8	14.4	8.1		8.2
Level of Service	D	C	B	A		A
Approach Delay (s)	36.4		13.0			8.2
Approach LOS	D		B			A

Intersection Summary			
HCM Average Control Delay	15.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	94.3	Sum of lost time (s)	8.0
Intersection Capacity Utilization	76.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
2: H-1 WB On-Ramp & Kunia Road

2030 + PRO (with Transit Corridor) - AM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations						↱	↰	↑↑↑			↓↓↓↳	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)						4.0	4.0	4.0			4.0	
Lane Util. Factor						1.00	1.00	0.91			0.91	
Frt						0.86	1.00	1.00			0.98	
Flt Protected						1.00	0.95	1.00			1.00	
Satd. Flow (prot)						1611	1770	5085			4960	
Flt Permitted						1.00	0.95	1.00			1.00	
Satd. Flow (perm)						1611	1770	5085			4960	
Volume (vph)	0	0	0	0	0	530	163	1731	0	0	1685	331
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	0	0	576	177	1882	0	0	1832	360
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	15	0
Lane Group Flow (vph)	0	0	0	0	0	576	177	1882	0	0	2177	0
Turn Type						Free	Prot					
Protected Phases							5	2			6	
Permitted Phases						Free						
Actuated Green, G (s)						110.0	15.0	110.0			87.0	
Effective Green, g (s)						110.0	15.0	110.0			87.0	
Actuated g/C Ratio						1.00	0.14	1.00			0.79	
Clearance Time (s)							4.0	4.0			4.0	
Vehicle Extension (s)							3.0	3.0			3.0	
Lane Grp Cap (vph)						1611	241	5085			3923	
v/s Ratio Prot							c0.10	0.37			c0.44	
v/s Ratio Perm						0.36						
v/c Ratio						0.36	0.73	0.37			0.55	
Uniform Delay, d1						0.0	45.6	0.0			4.3	
Progression Factor						1.00	1.06	1.00			1.00	
Incremental Delay, d2						0.6	9.7	0.2			0.6	
Delay (s)						0.6	58.3	0.2			4.9	
Level of Service						A	E	A			A	
Approach Delay (s)		0.0			0.6			5.2			4.9	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	4.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	55.6%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations	↰↰	↱	↑↑↑↑			↑↑↑
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0			4.0
Lane Util. Factor	0.97	1.00	0.86			0.91
Frt	1.00	0.85	1.00			1.00
Flt Protected	0.95	1.00	1.00			1.00
Satd. Flow (prot)	3433	1583	6408			5085
Flt Permitted	0.95	1.00	1.00			1.00
Satd. Flow (perm)	3433	1583	6408			5085
Volume (vph)	402	358	2072	0	0	1541
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	437	389	2252	0	0	1675
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	437	389	2252	0	0	1675
Turn Type		Free				
Protected Phases	4		6			2
Permitted Phases		Free				
Actuated Green, G (s)	17.3	110.0	84.7			84.7
Effective Green, g (s)	17.3	110.0	84.7			84.7
Actuated g/C Ratio	0.16	1.00	0.77			0.77
Clearance Time (s)	4.0		4.0			4.0
Vehicle Extension (s)	3.0		3.0			3.0
Lane Grp Cap (vph)	540	1583	4934			3915
v/s Ratio Prot	c0.13		c0.35			0.33
v/s Ratio Perm		0.25				
v/c Ratio	0.81	0.25	0.46			0.43
Uniform Delay, d1	44.8	0.0	4.5			4.3
Progression Factor	1.00	1.00	0.80			1.00
Incremental Delay, d2	8.7	0.4	0.3			0.3
Delay (s)	53.5	0.4	3.9			4.7
Level of Service	D	A	A			A
Approach Delay (s)	28.5		3.9			4.7
Approach LOS	C		A			A

Intersection Summary			
HCM Average Control Delay	8.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	49.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↑↱		↰↰	↑↑↑				↱			↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0				4.0			4.0
Lane Util. Factor		0.91		0.97	0.91				1.00			1.00
Frt		0.98		1.00	1.00				0.86			0.86
Flt Protected		1.00		0.95	1.00				1.00			1.00
Satd. Flow (prot)		5001		3433	5085				1611			1611
Flt Permitted		1.00		0.95	1.00				1.00			1.00
Satd. Flow (perm)		5001		3433	5085				1611			1611
Volume (vph)	0	1885	235	496	705	0	0	0	429	0	0	350
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	2049	255	539	766	0	0	0	466	0	0	380
RTOR Reduction (vph)	0	10	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	2294	0	539	766	0	0	0	466	0	0	380
Turn Type				Prot					Free			Free
Protected Phases		2		1	6							
Permitted Phases									Free			Free
Actuated Green, G (s)		79.7		22.3	110.0				110.0			110.0
Effective Green, g (s)		79.7		22.3	110.0				110.0			110.0
Actuated g/C Ratio		0.72		0.20	1.00				1.00			1.00
Clearance Time (s)		4.0		4.0	4.0							
Vehicle Extension (s)		3.0		3.0	3.0							
Lane Grp Cap (vph)		3623		696	5085				1611			1611
v/s Ratio Prot		c0.46		c0.16	0.15							
v/s Ratio Perm									0.29			0.24
v/c Ratio		0.63		0.77	0.15				0.29			0.24
Uniform Delay, d1		7.7		41.5	0.0				0.0			0.0
Progression Factor		0.51		1.44	1.00				1.00			1.00
Incremental Delay, d2		0.6		1.8	0.0				0.5			0.3
Delay (s)		4.6		61.4	0.0				0.5			0.3
Level of Service		A		E	A				A			A
Approach Delay (s)		4.6			25.4			0.5			0.3	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM Average Control Delay	9.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	62.5%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
5: Farrington Hwy & Fort Weaver Road NB Ramps

2030 + PRO (with Transit Corridor) - AM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↑			↑↑↱				↱			
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0				4.0			
Lane Util. Factor	1.00	*0.99			*0.99				1.00			
Frt	1.00	1.00			0.95				0.86			
Flt Protected	0.95	1.00			1.00				1.00			
Satd. Flow (prot)	1770	5532			5266				1611			
Flt Permitted	0.95	1.00			1.00				1.00			
Satd. Flow (perm)	1770	5532			5266				1611			
Volume (vph)	928	1386	0	0	1200	567	0	0	904	0	0	0
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	937	1400	0	0	1212	573	0	0	913	0	0	0
RTOR Reduction (vph)	0	0	0	0	78	0	0	0	0	0	0	0
Lane Group Flow (vph)	937	1400	0	0	1707	0	0	0	913	0	0	0
Turn Type	Prot								Free			
Protected Phases	5	2			6							
Permitted Phases									Free			
Actuated Green, G (s)	67.0	110.0			35.0				110.0			
Effective Green, g (s)	67.0	110.0			35.0				110.0			
Actuated g/C Ratio	0.61	1.00			0.32				1.00			
Clearance Time (s)	4.0	4.0			4.0							
Vehicle Extension (s)	3.0	3.0			3.0							
Lane Grp Cap (vph)	1078	5532			1676				1611			
v/s Ratio Prot	c0.53	0.25			c0.32							
v/s Ratio Perm									0.57			
v/c Ratio	0.87	0.25			1.02				0.57			
Uniform Delay, d1	17.9	0.0			37.5				0.0			
Progression Factor	0.33	1.00			1.00				1.00			
Incremental Delay, d2	6.4	0.1			26.8				1.5			
Delay (s)	12.2	0.1			64.3				1.5			
Level of Service	B	A			E				A			
Approach Delay (s)		5.0			64.3			1.5			0.0	
Approach LOS		A			E			A			A	

Intersection Summary			
HCM Average Control Delay	25.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	93.9%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
6: Farrington Hwy & Leoku Street

2030 + PRO (with Transit Corridor) - AM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑↑	↱	↰	↑↑↑	↱		↰↑	↱		↰↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	1.00	0.91	1.00		1.00	1.00		0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00		0.97	1.00
Satd. Flow (prot)	3433	5085	1583	1770	5085	1583		1780	1583		3424	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00		0.97	1.00
Satd. Flow (perm)	3433	5085	1583	1770	5085	1583		1780	1583		3424	1583
Volume (vph)	144	1990	155	119	1601	156	56	5	48	92	45	113
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	157	2163	168	129	1740	170	61	5	52	100	49	123
RTOR Reduction (vph)	0	0	83	0	0	89	0	0	49	0	0	109
Lane Group Flow (vph)	157	2163	85	129	1740	81	0	66	3	0	149	14
Turn Type	Prot		Perm	Prot		Perm	Split		Perm	Split		Perm
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			6
Actuated Green, G (s)	9.4	36.5	36.5	7.0	34.1	34.1		4.0	4.0		8.4	8.4
Effective Green, g (s)	9.4	36.5	36.5	7.0	34.1	34.1		4.0	4.0		8.4	8.4
Actuated g/C Ratio	0.13	0.51	0.51	0.10	0.47	0.47		0.06	0.06		0.12	0.12
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	449	2581	804	172	2412	751		99	88		400	185
v/s Ratio Prot	0.05	c0.43		c0.07	0.34			c0.04			c0.04	
v/s Ratio Perm			0.05			0.05			0.00			0.01
v/c Ratio	0.35	0.84	0.11	0.75	0.72	0.11		0.67	0.03		0.37	0.08
Uniform Delay, d1	28.5	15.2	9.2	31.6	15.1	10.5		33.3	32.1		29.3	28.3
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00
Incremental Delay, d2	0.5	2.5	0.1	16.7	1.1	0.1		30.3	0.7		0.6	0.2
Delay (s)	28.9	17.7	9.3	48.3	16.2	10.5		63.6	32.8		29.9	28.5
Level of Service	C	B	A	D	B	B		E	C		C	C
Approach Delay (s)		17.8			17.8			50.0			29.3	
Approach LOS		B			B			D			C	

Intersection Summary			
HCM Average Control Delay	19.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	71.9	Sum of lost time (s)	16.0
Intersection Capacity Utilization	66.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
7: Laulaunui Street & Fort Weaver Road

2030 + PRO (with Transit Corridor) - AM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱		↰	↑	↱	↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		*0.99		1.00	1.00	1.00	1.00	*0.99	1.00	1.00	*0.99	1.00
Frt		0.99		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.96		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		3510		1770	1863	1583	1770	5532	1583	1770	5532	1583
Flt Permitted		0.96		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		3510		1770	1863	1583	1770	5532	1583	1770	5532	1583
Volume (vph)	96	24	12	71	4	234	48	3857	52	91	1306	170
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	97	24	12	72	4	236	48	3896	53	92	1319	172
RTOR Reduction (vph)	0	6	0	0	0	102	0	0	10	0	0	52
Lane Group Flow (vph)	0	127	0	72	4	134	48	3896	43	92	1319	120
Turn Type	Split			Split		Perm	Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases						8			2			6
Actuated Green, G (s)		10.6		10.0	10.0	10.0	7.4	101.0	101.0	7.9	101.5	101.5
Effective Green, g (s)		10.6		10.0	10.0	10.0	7.4	101.0	101.0	7.9	101.5	101.5
Actuated g/C Ratio		0.07		0.07	0.07	0.07	0.05	0.69	0.69	0.05	0.70	0.70
Clearance Time (s)		4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		256		122	128	109	90	3840	1099	96	3859	1104
v/s Ratio Prot		c0.04		0.04	0.00		0.03	c0.70		c0.05	0.24	
v/s Ratio Perm						c0.08			0.03			0.08
v/c Ratio		0.50		0.59	0.03	1.23	0.53	1.01	0.04	0.96	0.34	0.11
Uniform Delay, d1		64.9		65.8	63.2	67.8	67.4	22.2	7.0	68.6	8.7	7.2
Progression Factor		1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		1.5		7.4	0.1	161.9	6.0	18.3	0.1	77.4	0.2	0.2
Delay (s)		66.4		73.2	63.3	229.6	73.3	40.5	7.1	146.0	9.0	7.4
Level of Service		E		E	E	F	E	D	A	F	A	A
Approach Delay (s)		66.4			191.4			40.5			16.8	
Approach LOS		E			F			D			B	

Intersection Summary			
HCM Average Control Delay	42.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	145.5	Sum of lost time (s)	16.0
Intersection Capacity Utilization	104.3%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
8: Old Fort Weaver Rd & Fort Weaver Road

2030 + PRO (with Transit Corridor) - AM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑	↱		↰↑	↱	↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	*0.99	1.00	1.00	*0.99	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.96	1.00		1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1782	1583		1862	1583	1770	5532	1583	1770	5532	1583
Flt Permitted		0.43	1.00		0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		803	1583		1846	1583	1770	5532	1583	1770	5532	1583
Volume (vph)	701	73	393	4	344	230	283	3028	1	20	925	444
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	708	74	397	4	347	232	286	3059	1	20	934	448
RTOR Reduction (vph)	0	0	0	0	0	37	0	0	0	0	0	286
Lane Group Flow (vph)	0	782	397	0	351	195	286	3059	1	20	934	162
Turn Type	Perm		Free	Perm		Perm	Prot		Free	Prot		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		Free	8		8			Free			6
Actuated Green, G (s)		75.0	149.2		75.0	75.0	27.1	59.8	149.2	2.4	35.1	35.1
Effective Green, g (s)		75.0	149.2		75.0	75.0	27.1	59.8	149.2	2.4	35.1	35.1
Actuated g/C Ratio		0.50	1.00		0.50	0.50	0.18	0.40	1.00	0.02	0.24	0.24
Clearance Time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)		404	1583		928	796	321	2217	1583	28	1301	372
v/s Ratio Prot							c0.16	c0.55		0.01	0.17	
v/s Ratio Perm		c0.97	0.25		0.19	0.12			0.00			0.10
v/c Ratio		1.94	0.25		0.38	0.25	0.89	1.38	0.00	0.71	0.72	0.44
Uniform Delay, d1		37.1	0.0		22.8	21.0	59.6	44.7	0.0	73.1	52.5	48.6
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		430.1	0.4		0.3	0.2	25.0	173.8	0.0	60.5	3.4	3.7
Delay (s)		467.2	0.4		23.0	21.2	84.6	218.5	0.0	133.6	55.9	52.3
Level of Service		F	A		C	C	F	F	A	F	E	D
Approach Delay (s)		310.0			22.3			207.0			55.9	
Approach LOS		F			C			F			E	

Intersection Summary			
HCM Average Control Delay	176.6	HCM Level of Service	F
HCM Volume to Capacity ratio	1.69		
Actuated Cycle Length (s)	149.2	Sum of lost time (s)	12.0
Intersection Capacity Utilization	136.2%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
9: Renton Road & Fort Weaver Road

2030 + PRO (with Transit Corridor) - AM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*0.99	*0.99	1.00		1.00		1.00	*0.99	1.00	1.00	*0.99	1.00
Frt	1.00	1.00	0.85		0.95		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1752	1766	1583		1766		1770	5532	1583	1770	5532	1583
Flt Permitted	0.95	0.96	1.00		1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1752	1766	1583		1766		1770	5532	1583	1770	5532	1583
Volume (vph)	467	31	36	10	339	213	89	2631	1	248	1028	49
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	472	31	36	10	342	215	90	2658	1	251	1038	49
RTOR Reduction (vph)	0	0	0	0	15	0	0	0	0	0	0	27
Lane Group Flow (vph)	245	258	36	0	552	0	90	2658	1	251	1038	22
Turn Type	Split		Free	Split			Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			Free						2			6
Actuated Green, G (s)	20.0	20.0	150.0		33.0		12.3	65.0	65.0	16.0	68.7	68.7
Effective Green, g (s)	20.0	20.0	150.0		33.0		12.3	65.0	65.0	16.0	68.7	68.7
Actuated g/C Ratio	0.13	0.13	1.00		0.22		0.08	0.43	0.43	0.11	0.46	0.46
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	234	235	1583		389		145	2397	686	189	2534	725
v/s Ratio Prot	0.14	c0.15			c0.31		0.05	c0.48		c0.14	c0.19	
v/s Ratio Perm			0.02						0.00			0.01
v/c Ratio	1.05	1.10	0.02		1.42		0.62	1.11	0.00	1.33	0.41	0.03
Uniform Delay, d1	65.0	65.0	0.0		58.5		66.6	42.5	24.1	67.0	27.1	22.3
Progression Factor	1.00	1.00	1.00		1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	71.7	87.4	0.0		203.3		8.0	55.7	0.0	179.4	0.5	0.1
Delay (s)	136.7	152.4	0.0		261.8		74.6	98.2	24.1	246.4	27.6	22.4
Level of Service	F	F	A		F		E	F	C	F	C	C
Approach Delay (s)		135.1			261.8			97.4			68.5	
Approach LOS		F			F			F			E	

Intersection Summary			
HCM Average Control Delay	111.8	HCM Level of Service	F
HCM Volume to Capacity ratio	1.23		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	123.0%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
10: Farrington Hwy & D Street

2030 + PRO (with Transit Corridor) - AM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	0.91		0.97	0.91			0.95	0.95	0.95	0.95	
Frt	1.00	1.00		1.00	0.98			0.86	0.85	1.00	0.91	
Flt Protected	0.95	1.00		0.95	1.00			1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	5085		3433	4982			1528	1504	1681	1607	
Flt Permitted	0.95	1.00		0.95	1.00			1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	5085		3433	4982			1528	1504	1681	1607	
Volume (vph)	130	1588	0	270	679	106	0	17	347	178	191	304
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	131	1604	0	273	686	107	0	17	351	180	193	307
RTOR Reduction (vph)	0	0	0	0	16	0	0	161	162	0	52	0
Lane Group Flow (vph)	131	1604	0	273	777	0	0	31	14	180	448	0
Turn Type	Prot			Prot					Perm	Split		
Protected Phases	5	2		1	6			8		4	4	
Permitted Phases									8			
Actuated Green, G (s)	12.9	45.0		9.0	41.1			8.5	8.5	31.5	31.5	
Effective Green, g (s)	12.9	45.0		9.0	41.1			8.5	8.5	31.5	31.5	
Actuated g/C Ratio	0.12	0.41		0.08	0.37			0.08	0.08	0.29	0.29	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	208	2080		281	1861			118	116	481	460	
v/s Ratio Prot	0.07	c0.32		c0.08	0.16			c0.02		0.11	c0.28	
v/s Ratio Perm									0.01			
v/c Ratio	0.63	0.77		0.97	0.42			0.26	0.12	0.37	0.97	
Uniform Delay, d1	46.3	28.1		50.4	25.6			47.8	47.3	31.4	38.8	
Progression Factor	0.99	0.50		0.55	0.33			1.00	1.00	1.00	1.00	
Incremental Delay, d2	4.9	2.4		45.4	0.7			1.2	0.5	0.5	34.9	
Delay (s)	50.8	16.5		73.3	9.1			49.0	47.7	31.9	73.8	
Level of Service	D	B		E	A			D	D	C	E	
Approach Delay (s)		19.1			25.5			48.4			62.7	
Approach LOS		B			C			D			E	

Intersection Summary			
HCM Average Control Delay	31.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	79.0%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
11: Farrington Hwy & E Street

2030 + PRO (with Transit Corridor) - AM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0			4.0		4.0	4.0	
Lane Util. Factor	1.00	0.91			0.91			1.00		1.00	1.00	
Frt	1.00	1.00			1.00			1.00		1.00	0.92	
Flt Protected	0.95	1.00			1.00			0.96		0.95	1.00	
Satd. Flow (prot)	1770	5061			5065			1792		1770	1720	
Flt Permitted	0.95	1.00			1.00			0.96		0.95	1.00	
Satd. Flow (perm)	1770	5061			5065			1792		1770	1720	
Volume (vph)	49	1600	52	0	957	26	202	68	5	113	47	49
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	49	1616	53	0	967	26	204	69	5	114	47	49
RTOR Reduction (vph)	0	2	0	0	2	0	0	1	0	0	36	0
Lane Group Flow (vph)	49	1667	0	0	991	0	0	277	0	114	60	0
Turn Type	Prot						Split			Split		
Protected Phases	5	2			6		8	8		4	4	
Permitted Phases												
Actuated Green, G (s)	7.2	64.3			53.1			21.5		12.2	12.2	
Effective Green, g (s)	7.2	64.3			53.1			21.5		12.2	12.2	
Actuated g/C Ratio	0.07	0.58			0.48			0.20		0.11	0.11	
Clearance Time (s)	4.0	4.0			4.0			4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0			3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)	116	2958			2445			350		196	191	
v/s Ratio Prot	0.03	c0.33			0.20			c0.15		c0.06	0.04	
v/s Ratio Perm												
v/c Ratio	0.42	0.56			0.41			0.79		0.58	0.32	
Uniform Delay, d1	49.4	14.2			18.3			42.1		46.5	45.1	
Progression Factor	0.72	0.65			0.62			1.00		1.00	1.00	
Incremental Delay, d2	1.9	0.6			0.4			11.6		4.3	1.0	
Delay (s)	37.7	9.8			11.8			53.7		50.8	46.0	
Level of Service	D	A			B			D		D	D	
Approach Delay (s)		10.6			11.8			53.7			48.6	
Approach LOS		B			B			D			D	

Intersection Summary			
HCM Average Control Delay	17.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	60.5%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
12: Fort Barrette Road & Farrington Hwy

2030 + PRO (with Transit Corridor) - AM Peak

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	0.91	0.97	0.95	1.00	0.97	0.95	1.00	1.00	0.95	1.00
Frt	1.00	0.96	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3250	1441	3433	3539	1583	3433	3539	1583	1770	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3250	1441	3433	3539	1583	3433	3539	1583	1770	3539	1583
Volume (vph)	377	707	798	572	578	159	338	438	485	78	739	704
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	381	714	806	578	584	161	341	442	490	79	746	711
RTOR Reduction (vph)	0	17	131	0	0	94	0	0	253	0	0	254
Lane Group Flow (vph)	381	970	402	578	584	67	341	442	237	79	746	457
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases			6			2			4			8
Actuated Green, G (s)	26.7	66.7	66.7	35.9	75.9	75.9	21.4	68.4	68.4	13.6	60.6	60.6
Effective Green, g (s)	26.7	66.7	66.7	35.9	75.9	75.9	21.4	68.4	68.4	13.6	60.6	60.6
Actuated g/C Ratio	0.13	0.33	0.33	0.18	0.38	0.38	0.11	0.34	0.34	0.07	0.30	0.30
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	457	1081	479	614	1339	599	366	1207	540	120	1069	478
v/s Ratio Prot	0.11	c0.30		c0.17	0.17		c0.10	0.12		0.04	0.21	
v/s Ratio Perm			0.28			0.04			0.15			c0.29
v/c Ratio	0.83	0.90	0.84	0.94	0.44	0.11	0.93	0.37	0.44	0.66	0.70	0.96
Uniform Delay, d1	84.8	63.7	62.0	81.3	46.4	40.5	88.9	49.8	51.2	91.2	61.9	68.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	12.3	9.9	12.2	22.8	1.0	0.4	30.1	0.2	0.6	12.3	2.0	30.0
Delay (s)	97.1	73.5	74.2	104.1	47.5	40.8	119.0	50.0	51.8	103.5	63.9	98.6
Level of Service	F	E	E	F	D	D	F	D	D	F	E	F
Approach Delay (s)		78.5			71.4			69.2			82.0	
Approach LOS		E			E			E			F	

Intersection Summary			
HCM Average Control Delay	75.9	HCM Level of Service	E
HCM Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	200.6	Sum of lost time (s)	16.0
Intersection Capacity Utilization	87.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL2	WBL	WBR	NBL	NBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰↰		↱				↑↑	↱	↰↰	↑↑	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0				4.0	4.0	4.0	4.0	
Lane Util. Factor	*0.99		1.00				*0.99	1.00	0.97	*0.99	
Frt	1.00		0.85				1.00	0.85	1.00	1.00	
Flt Protected	0.95		1.00				1.00	1.00	0.95	1.00	
Satd. Flow (prot)	3504		1583				3688	1583	3433	3688	
Flt Permitted	0.95		1.00				1.00	1.00	0.95	1.00	
Satd. Flow (perm)	3504		1583				3688	1583	3433	3688	
Volume (vph)	1338	0	115	0	0	0	1099	248	518	222	0
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	1352	0	116	0	0	0	1110	251	523	224	0
RTOR Reduction (vph)	0	0	71	0	0	0	0	168	0	0	0
Lane Group Flow (vph)	1352	0	45	0	0	0	1110	83	523	224	0
Turn Type	Prot		custom					Perm	Prot		
Protected Phases	8		8				6		5	2	
Permitted Phases								6			
Actuated Green, G (s)	39.0		39.0				33.0	33.0	16.0	53.0	
Effective Green, g (s)	39.0		39.0				33.0	33.0	16.0	53.0	
Actuated g/C Ratio	0.39		0.39				0.33	0.33	0.16	0.53	
Clearance Time (s)	4.0		4.0				4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0		3.0				3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	1367		617				1217	522	549	1955	
v/s Ratio Prot	c0.39		0.03				c0.30		c0.15	0.06	
v/s Ratio Perm								0.05			
v/c Ratio	0.99		0.07				0.91	0.16	0.95	0.11	
Uniform Delay, d1	30.3		19.2				32.1	23.7	41.6	11.8	
Progression Factor	1.00		1.00				1.00	1.00	0.62	0.04	
Incremental Delay, d2	21.5		0.1				11.8	0.6	22.9	0.1	
Delay (s)	51.8		19.2				43.9	24.3	48.9	0.6	
Level of Service	D		B				D	C	D	A	
Approach Delay (s)		49.2		0.0			40.3			34.4	
Approach LOS		D		A			D			C	

Intersection Summary			
HCM Average Control Delay	42.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	91.0%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL2	EBL	EBR	SBL	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰		↱			↰↰	↑↑			↑↑	↱↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0			4.0	4.0			4.0	4.0
Lane Util. Factor	1.00		1.00			0.97	*0.99			*0.99	*0.99
Frt	1.00		0.85			1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (prot)	1770		1583			3433	3688			3688	3135
Flt Permitted	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (perm)	1770		1583			3433	3688			3688	3135
Volume (vph)	51	0	633	0	0	802	1634	0	0	689	2305
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	52	0	639	0	0	810	1651	0	0	696	2328
RTOR Reduction (vph)	0	0	23	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	52	0	616	0	0	810	1651	0	0	696	2328
Turn Type	Prot		custom			Prot					Free
Protected Phases	4		4			1	6			2	
Permitted Phases											Free
Actuated Green, G (s)	29.0		29.0			30.4	63.0			28.6	100.0
Effective Green, g (s)	29.0		29.0			30.4	63.0			28.6	100.0
Actuated g/C Ratio	0.29		0.29			0.30	0.63			0.29	1.00
Clearance Time (s)	4.0		4.0			4.0	4.0			4.0	
Vehicle Extension (s)	3.0		3.0			3.0	3.0			3.0	
Lane Grp Cap (vph)	513		459			1044	2323			1055	3135
v/s Ratio Prot	0.03		c0.39			0.24	0.45			0.19	
v/s Ratio Perm											c0.74
v/c Ratio	0.10		1.34			0.78	0.71			0.66	0.74
Uniform Delay, d1	26.0		35.5			31.7	12.4			31.4	0.0
Progression Factor	1.00		1.00			1.15	0.90			1.00	1.00
Incremental Delay, d2	0.1		168.3			1.2	0.6			3.2	1.6
Delay (s)	26.1		203.8			37.7	11.7			34.7	1.6
Level of Service	C		F			D	B			C	A
Approach Delay (s)		190.4		0.0			20.3			9.2	
Approach LOS		F		A			C			A	

Intersection Summary			
HCM Average Control Delay	33.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	91.0%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
15: North-South Road & Farrington Hwy

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰↰	↑↑↑	↱	↰↰	↑↑↑	↱	↰↰	↑↑	↱	↰↰	↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*0.99	*0.99	1.00	*0.99	*0.99	1.00	*0.99	*0.99	1.00	*0.99	*0.99	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3504	5532	1583	3504	5532	1583	3504	3688	1583	3504	3688	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3504	5532	1583	3504	5532	1583	3504	3688	1583	3504	3688	1583
Volume (vph)	514	1147	563	459	1739	344	542	393	224	172	483	713
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	519	1159	569	464	1757	347	547	397	226	174	488	720
RTOR Reduction (vph)	0	0	224	0	0	154	0	0	150	0	0	227
Lane Group Flow (vph)	519	1159	345	464	1757	193	547	397	76	174	488	493
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases			6			2			4			8
Actuated Green, G (s)	25.3	47.1	47.1	23.2	45.0	45.0	26.0	49.9	49.9	12.2	36.1	36.1
Effective Green, g (s)	25.3	47.1	47.1	23.2	45.0	45.0	26.0	49.9	49.9	12.2	36.1	36.1
Actuated g/C Ratio	0.17	0.32	0.32	0.16	0.30	0.30	0.18	0.34	0.34	0.08	0.24	0.24
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	597	1756	502	548	1677	480	614	1240	532	288	897	385
v/s Ratio Prot	c0.15	0.21		0.13	c0.32		c0.16	0.11		0.05	0.13	
v/s Ratio Perm			0.22			0.12			0.05			c0.31
v/c Ratio	0.87	0.66	0.69	0.85	1.05	0.40	0.89	0.32	0.14	0.60	0.54	1.28
Uniform Delay, d1	59.9	43.7	44.2	60.9	51.7	41.0	59.8	36.6	34.3	65.8	49.0	56.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	12.8	0.9	3.9	11.6	35.7	0.6	17.6	0.7	0.6	3.6	2.4	144.8
Delay (s)	72.7	44.7	48.1	72.4	87.4	41.6	77.4	37.3	34.9	69.3	51.3	201.0
Level of Service	E	D	D	E	F	D	E	D	C	E	D	F
Approach Delay (s)		52.0			78.5			55.6			131.6	
Approach LOS		D			E			E			F	

Intersection Summary			
HCM Average Control Delay	76.7	HCM Level of Service	E
HCM Volume to Capacity ratio	1.04		
Actuated Cycle Length (s)	148.4	Sum of lost time (s)	16.0
Intersection Capacity Utilization	103.2%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
16: North-South Road & North UH Connector

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰↰	↑↑↱	↱	↰↰	↑↑↱		↰↰	↑↱		↰↰	↑	↱↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	0.86	0.86	0.97	0.91		0.97	0.95		0.97	1.00	0.88
Frt	1.00	1.00	0.85	1.00	0.98		1.00	0.98		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	3433	4806	1362	3433	4987		3433	3461		3433	1863	2787
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	3433	4806	1362	3433	4987		3433	3461		3433	1863	2787
Volume (vph)	51	2024	224	471	934	138	217	161	28	353	103	300
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	52	2044	226	476	943	139	219	163	28	357	104	303
RTOR Reduction (vph)	0	0	105	0	14	0	0	15	0	0	0	70
Lane Group Flow (vph)	52	2044	121	476	1068	0	219	176	0	357	104	233
Turn Type	Prot		Perm	Prot			Prot			Prot		pm+ov
Protected Phases	5	2		1	6		7	4		3	8	1
Permitted Phases			2									8
Actuated Green, G (s)	4.4	39.8	39.8	14.0	49.4		14.0	11.2		13.1	10.3	24.3
Effective Green, g (s)	4.4	39.8	39.8	14.0	49.4		14.0	11.2		13.1	10.3	24.3
Actuated g/C Ratio	0.05	0.42	0.42	0.15	0.52		0.15	0.12		0.14	0.11	0.26
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	161	2033	576	511	2618		511	412		478	204	838
v/s Ratio Prot	0.02	c0.43		c0.14	0.21		0.06	0.05		c0.10	c0.06	0.04
v/s Ratio Perm			0.09									0.04
v/c Ratio	0.32	1.01	0.21	0.93	0.41		0.43	0.43		0.75	0.51	0.28
Uniform Delay, d1	43.4	27.2	17.2	39.6	13.5		36.4	38.5		38.9	39.5	27.9
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	1.2	21.3	0.8	23.9	0.5		0.6	0.7		6.3	2.0	0.2
Delay (s)	44.6	48.4	18.0	63.5	14.0		37.0	39.2		45.2	41.5	28.1
Level of Service	D	D	B	E	B		D	D		D	D	C
Approach Delay (s)		45.4			29.1			38.0			37.9	
Approach LOS		D			C			D			D	

Intersection Summary			
HCM Average Control Delay	38.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	94.1	Sum of lost time (s)	16.0
Intersection Capacity Utilization	83.0%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
17: East-West Rd. & North-South Road

2030 + PRO (with Transit Corridor) - AM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↱		↰↰	↑↱		↰↰	↑↑↱		↰↰	↑↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	0.97	0.95		0.97	0.95		0.97	0.91		0.97	0.91	
Frt	1.00	0.95		1.00	0.87		1.00	0.98		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	3433	3362		3433	3066		3433	4990		3433	4969	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	3433	3362		3433	3066		3433	4990		3433	4969	
Volume (vph)	243	224	112	239	75	614	207	1442	206	189	954	172
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	245	226	113	241	76	620	209	1457	208	191	964	174
RTOR Reduction (vph)	0	54	0	0	206	0	0	17	0	0	21	0
Lane Group Flow (vph)	245	285	0	241	490	0	209	1648	0	191	1117	0
Turn Type	Prot			Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases												
Actuated Green, G (s)	12.4	20.5		12.2	20.3		11.2	37.2		16.1	42.1	
Effective Green, g (s)	12.4	20.5		12.2	20.3		11.2	37.2		16.1	42.1	
Actuated g/C Ratio	0.12	0.20		0.12	0.20		0.11	0.36		0.16	0.41	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	417	676		411	610		377	1820		542	2051	
v/s Ratio Prot	c0.07	0.08		0.07	c0.16		c0.06	c0.33		0.06	c0.22	
v/s Ratio Perm												
v/c Ratio	0.59	0.42		0.59	1.19dr		0.55	0.91		0.35	0.54	
Uniform Delay, d1	42.4	35.6		42.5	38.9		43.0	30.7		38.3	22.7	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	2.1	0.4		2.1	7.6		1.8	8.0		1.8	1.0	
Delay (s)	44.5	36.0		44.6	46.5		44.8	38.7		40.1	23.7	
Level of Service	D	D		D	D		D	D		D	C	
Approach Delay (s)		39.6			46.0			39.4			26.1	
Approach LOS		D			D			D			C	

Intersection Summary			
HCM Average Control Delay	37.0	HCM Level of Service	D
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	102.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	80.1%	ICU Level of Service	D
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.
c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
18: North-South Road & Kapolei Parkway

2030 + PRO (with Transit Corridor) - AM Peak

Movement	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰	↑↑↱		↰	↑↑↱		↰↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	*0.99		1.00	*0.99		*0.99	*0.99	1.00	1.00	*0.99	1.00
Frt	1.00	0.98		1.00	0.92		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	5440		1770	5082		3504	5532	1583	1770	5532	1583
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	5440		1770	5082		3504	5532	1583	1770	5532	1583
Volume (vph)	245	517	64	222	496	588	855	315	316	118	637	483
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	247	522	65	224	501	594	864	318	319	119	643	488
RTOR Reduction (vph)	0	17	0	0	211	0	0	0	195	0	0	249
Lane Group Flow (vph)	247	570	0	224	884	0	864	318	124	119	643	239
Turn Type	Prot			Prot			Prot		Perm	Prot		Perm
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases									4			8
Actuated Green, G (s)	15.2	17.8		14.6	17.2		26.4	36.7	36.7	9.4	19.7	19.7
Effective Green, g (s)	15.2	17.8		14.6	17.2		26.4	36.7	36.7	9.4	19.7	19.7
Actuated g/C Ratio	0.16	0.19		0.15	0.18		0.28	0.39	0.39	0.10	0.21	0.21
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	285	1025		273	925		979	2148	615	176	1153	330
v/s Ratio Prot	c0.14	0.10		0.13	c0.17		c0.25	0.06		0.07	0.12	
v/s Ratio Perm									0.08			c0.15
v/c Ratio	0.87	0.56		0.82	1.19dr		0.88	0.15	0.20	0.68	0.56	0.73
Uniform Delay, d1	38.7	34.8		38.7	38.3		32.6	18.8	19.2	41.1	33.5	34.9
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	23.0	2.2		17.6	20.6		9.5	0.0	0.2	9.8	0.6	7.7
Delay (s)	61.7	36.9		56.3	58.9		42.0	18.8	19.3	50.9	34.1	42.6
Level of Service	E	D		E	E		D	B	B	D	C	D
Approach Delay (s)		44.3			58.5			32.3			39.0	
Approach LOS		D			E			C			D	

Intersection Summary			
HCM Average Control Delay	43.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	94.5	Sum of lost time (s)	16.0
Intersection Capacity Utilization	86.4%	ICU Level of Service	E
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.
c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
19: East-West Rd. & Old Fort Weaver Rd

2030 + PRO (with Transit Corridor) - AM Peak

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	0.97	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1863	3539	1583	3433	1583
Flt Permitted	0.58	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1080	1863	3539	1583	3433	1583
Volume (vph)	21	765	277	795	402	45
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	21	773	280	803	406	45
RTOR Reduction (vph)	0	0	0	407	0	28
Lane Group Flow (vph)	21	773	280	396	406	17
Turn Type	Perm			Perm		Perm
Protected Phases		4	8		6	
Permitted Phases	4			8		6
Actuated Green, G (s)	29.8	29.8	29.8	29.8	22.7	22.7
Effective Green, g (s)	29.8	29.8	29.8	29.8	22.7	22.7
Actuated g/C Ratio	0.49	0.49	0.49	0.49	0.38	0.38
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	532	918	1743	780	1288	594
v/s Ratio Prot		c0.41	0.08		c0.12	
v/s Ratio Perm	0.02			0.25		0.01
v/c Ratio	0.04	0.84	0.16	0.51	0.32	0.03
Uniform Delay, d1	7.9	13.3	8.5	10.4	13.4	11.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.0	7.1	0.0	0.5	0.6	0.1
Delay (s)	8.0	20.4	8.5	10.9	14.0	12.0
Level of Service	A	C	A	B	B	B
Approach Delay (s)		20.1	10.3		13.8	
Approach LOS		C	B		B	

Intersection Summary			
HCM Average Control Delay	14.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	60.5	Sum of lost time (s)	8.0
Intersection Capacity Utilization	59.2%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
20: Farrington Hwy & B Street

2030 + PRO (with Transit Corridor) - AM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3539	1583	3433	3539	1583	1770	1863	1583	3433	1863	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3539	1583	3433	3539	1583	1770	1863	1583	3433	1863	1583
Volume (vph)	206	1094	186	119	866	83	47	137	121	331	223	198
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	224	1189	202	129	941	90	51	149	132	360	242	215
RTOR Reduction (vph)	0	0	94	0	0	58	0	0	14	0	0	63
Lane Group Flow (vph)	224	1189	108	129	941	32	51	149	118	360	242	152
Turn Type	Prot		pm+ov	Prot		Perm	Prot		pm+ov	Prot		pm+ov
Protected Phases	5	2	3	1	6		7	4	5	3	8	1
Permitted Phases			2			6			4			8
Actuated Green, G (s)	11.2	35.9	49.1	8.4	33.1	33.1	4.4	18.2	29.4	13.2	27.0	35.4
Effective Green, g (s)	11.2	35.9	49.1	8.4	33.1	33.1	4.4	18.2	29.4	13.2	27.0	35.4
Actuated g/C Ratio	0.12	0.39	0.54	0.09	0.36	0.36	0.05	0.20	0.32	0.14	0.29	0.39
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	419	1385	917	314	1277	571	85	370	577	494	549	680
v/s Ratio Prot	c0.07	c0.34	0.02	0.04	0.27		0.03	0.08	0.02	c0.10	c0.13	0.02
v/s Ratio Perm			0.05			0.02			0.05			0.08
v/c Ratio	0.53	0.86	0.12	0.41	0.74	0.06	0.60	0.40	0.20	0.73	0.44	0.22
Uniform Delay, d1	37.8	25.6	10.6	39.3	25.5	19.1	42.8	32.0	22.6	37.5	26.2	18.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.3	5.5	0.1	0.9	2.3	0.0	11.4	3.2	0.2	5.3	2.6	0.2
Delay (s)	39.1	31.1	10.6	40.2	27.8	19.2	54.1	35.3	22.8	42.9	28.8	19.1
Level of Service	D	C	B	D	C	B	D	D	C	D	C	B
Approach Delay (s)		29.6			28.5			33.2			32.4	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	30.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	91.7	Sum of lost time (s)	12.0
Intersection Capacity Utilization	63.6%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
21: East-West Rd. & A Street

2030 + PRO (with Transit Corridor) - AM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	1.00	0.85	1.00	0.85		1.00	0.88	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1842		1770	1863	1583	1770	1591		1770	1630	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	1842		1770	1863	1583	1770	1591		1770	1630	
Volume (vph)	86	324	26	31	625	27	26	4	135	43	7	37
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	93	352	28	34	679	29	28	4	147	47	8	40
RTOR Reduction (vph)	0	2	0	0	0	14	0	132	0	0	36	0
Lane Group Flow (vph)	93	378	0	34	679	15	28	19	0	47	12	0
Turn Type	Prot			Prot		Perm	Split			Split		
Protected Phases	5	2		1	6		4	4		8	8	
Permitted Phases						6						
Actuated Green, G (s)	7.3	39.6		2.1	34.4	34.4	7.5	7.5		7.6	7.6	
Effective Green, g (s)	7.3	39.6		2.1	34.4	34.4	7.5	7.5		7.6	7.6	
Actuated g/C Ratio	0.10	0.54		0.03	0.47	0.47	0.10	0.10		0.10	0.10	
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	177	1002		51	880	748	182	164		185	170	
v/s Ratio Prot	c0.05	0.21		0.02	c0.36		c0.02	0.01		c0.03	0.01	
v/s Ratio Perm						0.01						
v/c Ratio	0.53	0.38		0.67	0.77	0.02	0.15	0.12		0.25	0.07	
Uniform Delay, d1	31.1	9.5		35.0	15.9	10.2	29.8	29.6		30.0	29.4	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	2.8	0.2		28.3	4.2	0.0	0.4	0.3		0.7	0.2	
Delay (s)	33.9	9.8		63.3	20.2	10.2	30.2	30.0		30.7	29.6	
Level of Service	C	A		E	C	B	C	C		C	C	
Approach Delay (s)		14.5			21.8			30.0			30.2	
Approach LOS		B			C			C			C	

Intersection Summary			
HCM Average Control Delay	21.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	72.8	Sum of lost time (s)	16.0
Intersection Capacity Utilization	62.9%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
22: Farrington Hwy & 2nd Avenue

2030 + PRO (with Transit Corridor) - AM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.91		0.97	0.95	1.00	1.00	0.95	0.88	0.97	0.95	1.00
Frt	1.00	0.99		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	5043		3433	3539	1583	1770	3539	2787	3433	3539	1583
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	5043		3433	3539	1583	1770	3539	2787	3433	3539	1583
Volume (vph)	166	1029	61	223	746	239	95	391	446	225	259	133
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	180	1118	66	242	811	260	103	425	485	245	282	145
RTOR Reduction (vph)	0	6	0	0	0	188	0	0	20	0	0	96
Lane Group Flow (vph)	180	1178	0	242	811	72	103	425	465	245	282	49
Turn Type	Prot			Prot		Perm	Prot		pm+ov	Prot		Perm
Protected Phases	5	2		1	6		3	8	1	7	4	
Permitted Phases						6			8			4
Actuated Green, G (s)	15.7	34.0		12.0	30.3	30.3	10.5	36.0	48.0	12.0	37.5	37.5
Effective Green, g (s)	15.7	34.0		12.0	30.3	30.3	10.5	36.0	48.0	12.0	37.5	37.5
Actuated g/C Ratio	0.14	0.31		0.11	0.28	0.28	0.10	0.33	0.44	0.11	0.34	0.34
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	253	1559		375	975	436	169	1158	1317	375	1206	540
v/s Ratio Prot	0.10	c0.23		0.07	c0.23		c0.06	c0.12	0.04	c0.07	0.08	
v/s Ratio Perm						0.05			0.13			0.03
v/c Ratio	0.71	0.76		0.65	0.83	0.16	0.61	0.37	0.35	0.65	0.23	0.09
Uniform Delay, d1	45.0	34.3		47.0	37.5	30.2	47.8	28.3	20.7	47.0	26.0	24.7
Progression Factor	1.00	1.00		0.72	0.65	0.35	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	9.1	3.5		3.5	7.6	0.7	6.1	0.9	0.2	4.1	0.5	0.3
Delay (s)	54.1	37.7		37.2	32.0	11.3	53.9	29.2	20.8	51.1	26.4	25.0
Level of Service	D	D		D	C	B	D	C	C	D	C	C
Approach Delay (s)		39.9			28.9			27.7			35.1	
Approach LOS		D			C			C			D	

Intersection Summary			
HCM Average Control Delay	33.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	60.4%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations			↑↑↑↱			↑↑↑↑
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	0	0	1679	234	0	4777
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	1825	254	0	5192
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)			870			
pX, platoon unblocked						
vC, conflicting volume	3250	583			2079	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	3250	583			2079	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	7	455			263	

Direction, Lane #	SE 1	SE 2	SE 3	SE 4	NW 1	NW 2	NW 3	NW 4
Volume Total	521	521	521	515	1298	1298	1298	1298
Volume Left	0	0	0	0	0	0	0	0
Volume Right	0	0	0	254	0	0	0	0
cSH	1700	1700	1700	1700	1700	1700	1700	1700
Volume to Capacity	0.31	0.31	0.31	0.30	0.76	0.76	0.76	0.76
Queue Length 95th (ft)	0	0	0	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane LOS								
Approach Delay (s)	0.0				0.0			
Approach LOS								

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	72.6%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations		↱	↑↑↑↱			↑↑↑↑
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	0	7	1593	86	0	4777
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	8	1732	93	0	5192
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)			1234			
pX, platoon unblocked						
vC, conflicting volume	3076	480			1825	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	3076	480			1825	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	99			100	
cM capacity (veh/h)	9	532			331	

Direction, Lane #	EB 1	SE 1	SE 2	SE 3	SE 4	NW 1	NW 2	NW 3	NW 4
Volume Total	8	495	495	495	341	1298	1298	1298	1298
Volume Left	0	0	0	0	0	0	0	0	0
Volume Right	8	0	0	0	93	0	0	0	0
cSH	532	1700	1700	1700	1700	1700	1700	1700	1700
Volume to Capacity	0.01	0.29	0.29	0.29	0.20	0.76	0.76	0.76	0.76
Queue Length 95th (ft)	1	0	0	0	0	0	0	0	0
Control Delay (s)	11.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane LOS	B								
Approach Delay (s)	11.9	0.0				0.0			
Approach LOS	B								

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	72.6%	ICU Level of Service	C
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
25: East-West Rd. & B Street

2030 + PRO (with Transit Corridor) - AM Peak

Movement	EBL	EBT	WBT	WBR	SEL	SER
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1863	1863	1583	1770	1583
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1863	1863	1583	1770	1583
Volume (vph)	153	234	314	85	643	369
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	166	254	341	92	699	401
RTOR Reduction (vph)	0	0	0	68	0	179
Lane Group Flow (vph)	166	254	341	24	699	222
Turn Type	Prot			Prot		Prot
Protected Phases	5	2	6	6	4	4
Permitted Phases						
Actuated Green, G (s)	9.5	30.4	16.9	16.9	27.6	27.6
Effective Green, g (s)	9.5	30.4	16.9	16.9	27.6	27.6
Actuated g/C Ratio	0.14	0.46	0.26	0.26	0.42	0.42
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	255	858	477	405	740	662
v/s Ratio Prot	c0.09	0.14	c0.18	0.01	c0.40	0.14
v/s Ratio Perm						
v/c Ratio	0.65	0.30	0.71	0.06	0.94	0.34
Uniform Delay, d1	26.7	11.1	22.4	18.5	18.5	13.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	5.8	0.2	5.0	0.1	22.0	1.4
Delay (s)	32.5	11.3	27.4	18.6	40.5	14.4
Level of Service	C	B	C	B	D	B
Approach Delay (s)		19.7	25.5		31.0	
Approach LOS		B	C		C	

Intersection Summary			
HCM Average Control Delay	27.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	66.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	70.6%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
26: Farrington Hwy &

2030 + PRO (with Transit Corridor) - AM Peak

Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	*0.99	*0.99	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3688	3688	1583
Flt Permitted	0.95	1.00	0.25	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	466	3688	3688	1583
Volume (vph)	100	233	46	1060	1373	132
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	101	235	46	1071	1387	133
RTOR Reduction (vph)	0	5	0	0	0	80
Lane Group Flow (vph)	101	230	46	1071	1387	53
Turn Type		Perm	Perm			Perm
Protected Phases	6			4	8	
Permitted Phases		6	4			8
Actuated Green, G (s)	16.0	16.0	16.0	16.0	16.0	16.0
Effective Green, g (s)	16.0	16.0	16.0	16.0	16.0	16.0
Actuated g/C Ratio	0.40	0.40	0.40	0.40	0.40	0.40
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	708	633	186	1475	1475	633
v/s Ratio Prot	0.06			0.29	c0.38	
v/s Ratio Perm		c0.15	0.10			0.03
v/c Ratio	0.14	0.36	0.25	0.73	0.94	0.08
Uniform Delay, d1	7.6	8.4	8.0	10.1	11.5	7.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.4	1.6	3.2	3.2	13.0	0.3
Delay (s)	8.1	10.0	11.1	13.3	24.5	7.7
Level of Service	A	B	B	B	C	A
Approach Delay (s)	9.4			13.2	23.0	
Approach LOS	A			B	C	

Intersection Summary			
HCM Average Control Delay	17.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	40.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	59.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
1: Kunia Loop & Kunia Road

2030 + PRO (With Transit Corridor) - PM Peak

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↰	↱	↑↑	↱		↑↑↑
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0		4.0
Lane Util. Factor	*0.99	1.00	*0.99	1.00		*0.99
Frt	1.00	0.85	1.00	0.85		1.00
Flt Protected	0.95	1.00	1.00	1.00		1.00
Satd. Flow (prot)	3504	1583	3688	1583		5532
Flt Permitted	0.95	1.00	1.00	1.00		1.00
Satd. Flow (perm)	3504	1583	3688	1583		5532
Volume (vph)	882	41	2658	907	0	2752
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	891	41	2685	916	0	2780
RTOR Reduction (vph)	0	4	0	206	0	0
Lane Group Flow (vph)	891	37	2685	710	0	2780
Turn Type		Perm		Perm		
Protected Phases	8		2			6
Permitted Phases		8		2		
Actuated Green, G (s)	31.0	31.0	91.0	91.0		91.0
Effective Green, g (s)	31.0	31.0	91.0	91.0		91.0
Actuated g/C Ratio	0.24	0.24	0.70	0.70		0.70
Clearance Time (s)	4.0	4.0	4.0	4.0		4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0		3.0
Lane Grp Cap (vph)	836	377	2582	1108		3872
v/s Ratio Prot	c0.25		c0.73			0.50
v/s Ratio Perm		0.02		0.45		
v/c Ratio	1.07	0.10	1.04	0.64		0.72
Uniform Delay, d1	49.5	38.6	19.5	10.6		11.8
Progression Factor	1.00	1.00	1.00	1.00		1.00
Incremental Delay, d2	50.2	0.1	29.1	2.9		1.2
Delay (s)	99.7	38.7	48.6	13.5		12.9
Level of Service	F	D	D	B		B
Approach Delay (s)	97.0		39.7			12.9
Approach LOS	F		D			B

Intersection Summary			
HCM Average Control Delay	36.8	HCM Level of Service	D
HCM Volume to Capacity ratio	1.05		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	105.3%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
2: H-1 WB On-Ramp & Kunia Road

2030 + PRO (With Transit Corridor) - PM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations						↱	↰	↑↑↑			↑↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)						4.0	4.0	4.0			4.0	
Lane Util. Factor						1.00	1.00	*0.99			*0.99	
Frt						0.86	1.00	1.00			0.99	
Flt Protected						1.00	0.95	1.00			1.00	
Satd. Flow (prot)						1611	1770	5532			5455	
Flt Permitted						1.00	0.95	1.00			1.00	
Satd. Flow (perm)						1611	1770	5532			5455	
Volume (vph)	0	0	0	0	0	1230	423	2335	0	0	3295	339
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	0	0	0	0	0	1242	427	2359	0	0	3328	342
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	20	0
Lane Group Flow (vph)	0	0	0	0	0	1242	427	2359	0	0	3650	0
Turn Type						Free	Prot					
Protected Phases							5	2			6	
Permitted Phases						Free						
Actuated Green, G (s)						70.0	15.0	70.0			47.0	
Effective Green, g (s)						70.0	15.0	70.0			47.0	
Actuated g/C Ratio						1.00	0.21	1.00			0.67	
Clearance Time (s)							4.0	4.0			4.0	
Vehicle Extension (s)							3.0	3.0			3.0	
Lane Grp Cap (vph)						1611	379	5532			3663	
v/s Ratio Prot							c0.24	0.43			c0.67	
v/s Ratio Perm						0.77						
v/c Ratio						0.77	1.13	0.43			1.00	
Uniform Delay, d1						0.0	27.5	0.0			11.4	
Progression Factor						1.00	0.90	1.00			1.00	
Incremental Delay, d2						3.6	79.1	0.2			14.1	
Delay (s)						3.6	103.8	0.2			25.5	
Level of Service						A	F	A			C	
Approach Delay (s)		0.0			3.6			16.1			25.5	
Approach LOS		A			A			B			C	

Intersection Summary			
HCM Average Control Delay	18.6	HCM Level of Service	B
HCM Volume to Capacity ratio	1.03		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	101.3%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
3: H-1 EB & Kunia Road

2030 + PRO (With Transit Corridor) - PM Peak

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations	↰↰	↱	↑↑↑↑			↑↑↑
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0			4.0
Lane Util. Factor	*0.99	1.00	*0.99			*0.99
Frt	1.00	0.85	1.00			1.00
Flt Protected	0.95	1.00	1.00			1.00
Satd. Flow (prot)	3504	1583	7376			5532
Flt Permitted	0.95	1.00	1.00			1.00
Satd. Flow (perm)	3504	1583	7376			5532
Volume (vph)	527	578	4322	0	0	2231
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	573	628	4698	0	0	2425
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	573	628	4698	0	0	2425
Turn Type		Free				
Protected Phases	4		6			2
Permitted Phases		Free				
Actuated Green, G (s)	16.0	70.0	46.0			46.0
Effective Green, g (s)	16.0	70.0	46.0			46.0
Actuated g/C Ratio	0.23	1.00	0.66			0.66
Clearance Time (s)	4.0		4.0			4.0
Vehicle Extension (s)	3.0		3.0			3.0
Lane Grp Cap (vph)	801	1583	4847			3635
v/s Ratio Prot	c0.16		c0.64			0.44
v/s Ratio Perm		0.40				
v/c Ratio	0.72	0.40	0.97			0.67
Uniform Delay, d1	24.9	0.0	11.3			7.3
Progression Factor	1.00	1.00	0.49			1.00
Incremental Delay, d2	3.1	0.7	6.7			1.0
Delay (s)	28.0	0.7	12.2			8.3
Level of Service	C	A	B			A
Approach Delay (s)	13.7		12.2			8.3
Approach LOS	B		B			A

Intersection Summary			
HCM Average Control Delay	11.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	130.8%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
4: Farrington Hwy & Fort Weaver Road SB Ramp

2030 + PRO (With Transit Corridor) - PM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↑↱		↰↰	↑↑↑				↱			↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0				4.0			4.0
Lane Util. Factor		0.91		0.97	0.91				1.00			1.00
Frt		0.97		1.00	1.00				0.86			0.86
Flt Protected		1.00		0.95	1.00				1.00			1.00
Satd. Flow (prot)		4947		3433	5085				1611			1611
Flt Permitted		1.00		0.95	1.00				1.00			1.00
Satd. Flow (perm)		4947		3433	5085				1611			1611
Volume (vph)	0	1884	416	774	1938	0	0	0	439	0	0	729
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	2048	452	841	2107	0	0	0	477	0	0	792
RTOR Reduction (vph)	0	19	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	2481	0	841	2107	0	0	0	477	0	0	792
Turn Type				Prot					Free			Free
Protected Phases		2		1	6							
Permitted Phases									Free			Free
Actuated Green, G (s)		81.8		40.2	130.0				130.0			130.0
Effective Green, g (s)		81.8		40.2	130.0				130.0			130.0
Actuated g/C Ratio		0.63		0.31	1.00				1.00			1.00
Clearance Time (s)		4.0		4.0	4.0							
Vehicle Extension (s)		3.0		3.0	3.0							
Lane Grp Cap (vph)		3113		1062	5085				1611			1611
v/s Ratio Prot		c0.50		c0.24	0.41							
v/s Ratio Perm									0.30			0.49
v/c Ratio		0.80		0.79	0.41				0.30			0.49
Uniform Delay, d1		17.9		41.1	0.0				0.0			0.0
Progression Factor		0.22		1.53	1.00				1.00			1.00
Incremental Delay, d2		1.4		0.4	0.0				0.5			1.1
Delay (s)		5.3		63.0	0.0				0.5			1.1
Level of Service		A		E	A				A			A
Approach Delay (s)		5.3			18.0			0.5			1.1	
Approach LOS		A			B			A			A	

Intersection Summary			
HCM Average Control Delay	10.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	74.4%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
5: Farrington Hwy & Fort Weaver Road NB Ramps

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↑			↑↑↱				↱			
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0				4.0			
Lane Util. Factor	1.00	*0.99			*0.99				1.00			
Frt	1.00	1.00			0.95				0.86			
Flt Protected	0.95	1.00			1.00				1.00			
Satd. Flow (prot)	1770	5532			5283				1611			
Flt Permitted	0.95	1.00			1.00				1.00			
Satd. Flow (perm)	1770	5532			5283				1611			
Volume (vph)	1027	1297	0	0	2713	1164	0	0	638	0	0	0
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	1037	1310	0	0	2740	1176	0	0	644	0	0	0
RTOR Reduction (vph)	0	0	0	0	14	0	0	0	0	0	0	0
Lane Group Flow (vph)	1037	1310	0	0	3902	0	0	0	644	0	0	0
Turn Type	Prot								Free			
Protected Phases	5	2			6							
Permitted Phases									Free			
Actuated Green, G (s)	51.0	130.0			71.0				130.0			
Effective Green, g (s)	51.0	130.0			71.0				130.0			
Actuated g/C Ratio	0.39	1.00			0.55				1.00			
Clearance Time (s)	4.0	4.0			4.0							
Vehicle Extension (s)	3.0	3.0			3.0							
Lane Grp Cap (vph)	694	5532			2885				1611			
v/s Ratio Prot	c0.59	0.24			c0.74							
v/s Ratio Perm									0.40			
v/c Ratio	1.49	0.24			1.35				0.40			
Uniform Delay, d1	39.5	0.0			29.5				0.0			
Progression Factor	0.50	1.00			0.41				1.00			
Incremental Delay, d2	227.7	0.1			158.8				0.7			
Delay (s)	247.4	0.1			171.1				0.7			
Level of Service	F	A			F				A			
Approach Delay (s)		109.4			171.1			0.7			0.0	
Approach LOS		F			F			A			A	

Intersection Summary			
HCM Average Control Delay	134.2	HCM Level of Service	F
HCM Volume to Capacity ratio	1.41		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	142.0%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
6: Farrington Hwy & Leoku Street

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑↑	↱	↰	↑↑↑	↱		↰↑	↱		↰↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
Lane Util. Factor	*0.99	*0.99	1.00	1.00	*0.99	1.00		1.00	1.00		*0.99	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00		0.96	1.00
Satd. Flow (prot)	3504	5532	1583	1770	5532	1583		1785	1583		3530	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00		0.96	1.00
Satd. Flow (perm)	3504	5532	1583	1770	5532	1583		1785	1583		3530	1583
Volume (vph)	282	1537	116	135	3481	515	197	29	130	243	28	194
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	285	1553	117	136	3516	520	199	29	131	245	28	196
RTOR Reduction (vph)	0	0	56	0	0	158	0	0	47	0	0	106
Lane Group Flow (vph)	285	1553	61	136	3516	362	0	228	84	0	273	90
Turn Type	Prot		Perm	Prot		Perm	Split		Perm	Split		Perm
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			6
Actuated Green, G (s)	10.6	67.6	67.6	18.0	75.0	75.0		14.0	14.0		14.4	14.4
Effective Green, g (s)	10.6	67.6	67.6	18.0	75.0	75.0		14.0	14.0		14.4	14.4
Actuated g/C Ratio	0.08	0.52	0.52	0.14	0.58	0.58		0.11	0.11		0.11	0.11
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	286	2877	823	245	3192	913		192	170		391	175
v/s Ratio Prot	c0.08	0.28		0.08	c0.64			c0.13			c0.08	
v/s Ratio Perm			0.04			0.23			0.05			0.06
v/c Ratio	1.00	0.54	0.07	0.56	1.10	0.40		1.19	0.49		1.26dl	0.52
Uniform Delay, d1	59.7	20.8	15.6	52.3	27.5	15.1		58.0	54.7		55.7	54.5
Progression Factor	0.93	0.85	0.51	1.00	1.00	1.00		1.00	1.00		1.00	1.00
Incremental Delay, d2	51.2	0.7	0.2	2.7	51.1	1.3		124.6	9.8		5.4	2.6
Delay (s)	106.9	18.5	8.0	55.0	78.6	16.4		182.6	64.5		61.1	57.1
Level of Service	F	B	A	D	E	B		F	E		E	E
Approach Delay (s)		30.8			70.1			139.5			59.4	
Approach LOS		C			E			F			E	

Intersection Summary			
HCM Average Control Delay	61.9	HCM Level of Service	E
HCM Volume to Capacity ratio	1.05		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	105.4%	ICU Level of Service	G
Analysis Period (min)	15		
dl Defacto Left Lane. Recode with 1 though lane as a left lane.			
c Critical Lane Group			

7: Laulaunui Street & Fort Weaver Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱		↰	↑	↱	↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		*0.99		1.00	1.00	1.00	1.00	*0.99	1.00	1.00	*0.99	1.00
Frt		0.99		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.96		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		3518		1770	1863	1583	1770	5532	1583	1770	5532	1583
Flt Permitted		0.96		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		3518		1770	1863	1583	1770	5532	1583	1770	5532	1583
Volume (vph)	209	37	13	61	4	229	56	2756	89	228	4188	82
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	211	37	13	62	4	231	57	2784	90	230	4230	83
RTOR Reduction (vph)	0	3	0	0	0	196	0	0	25	0	0	18
Lane Group Flow (vph)	0	258	0	62	4	35	57	2784	65	230	4230	65
Turn Type	Split			Split		Perm	Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases						8			2			6
Actuated Green, G (s)		14.8		5.0	5.0	5.0	4.0	91.0	91.0	22.0	109.0	109.0
Effective Green, g (s)		14.8		5.0	5.0	5.0	4.0	91.0	91.0	22.0	109.0	109.0
Actuated g/C Ratio		0.10		0.03	0.03	0.03	0.03	0.61	0.61	0.15	0.73	0.73
Clearance Time (s)		4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		350		59	63	53	48	3383	968	262	4052	1160
v/s Ratio Prot		c0.07		c0.04	0.00		c0.03	0.50		0.13	c0.76	
v/s Ratio Perm						0.02			0.04			0.04
v/c Ratio		1.19dl		1.05	0.06	0.66	1.19	0.82	0.07	0.88	1.04	0.06
Uniform Delay, d1		65.1		71.9	69.6	71.1	72.4	22.6	11.7	62.1	19.9	5.6
Progression Factor		1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		7.9		132.1	0.4	25.7	189.9	2.4	0.1	26.4	27.4	0.1
Delay (s)		73.0		204.0	70.1	96.7	262.3	25.0	11.8	88.5	47.3	5.6
Level of Service		E		F	E	F	F	C	B	F	D	A
Approach Delay (s)		73.0			118.7			29.2			48.6	
Approach LOS		E			F			C			D	

Intersection Summary			
HCM Average Control Delay	44.9	HCM Level of Service	D
HCM Volume to Capacity ratio	1.01		
Actuated Cycle Length (s)	148.8	Sum of lost time (s)	16.0
Intersection Capacity Utilization	112.5%	ICU Level of Service	H
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

8: Old Fort Weaver Rd & Fort Weaver Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑	↱		↰↑	↱	↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	*0.99	1.00	1.00	*0.99	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.96	1.00		0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1792	1583		1849	1583	1770	5532	1583	1770	5532	1583
Flt Permitted		0.53	1.00		0.29	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		995	1583		537	1583	1770	5532	1583	1770	5532	1583
Volume (vph)	731	189	418	37	214	48	539	2120	3	190	3187	884
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	738	191	422	37	216	48	544	2141	3	192	3219	893
RTOR Reduction (vph)	0	0	0	0	0	26	0	0	0	0	0	330
Lane Group Flow (vph)	0	929	422	0	253	22	544	2141	3	192	3219	563
Turn Type	Perm		Free	Perm		Perm	Prot		Free	Prot		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		Free	8		8			Free			6
Actuated Green, G (s)		59.0	130.0		59.0	59.0	17.0	52.0	130.0	7.0	42.0	42.0
Effective Green, g (s)		59.0	130.0		59.0	59.0	17.0	52.0	130.0	7.0	42.0	42.0
Actuated g/C Ratio		0.45	1.00		0.45	0.45	0.13	0.40	1.00	0.05	0.32	0.32
Clearance Time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)		452	1583		244	718	231	2213	1583	95	1787	511
v/s Ratio Prot							c0.31	0.39		0.11	c0.58	
v/s Ratio Perm		c0.93	0.27		0.47	0.01			0.00			0.36
v/c Ratio		2.06	0.27		1.04	0.03	2.35	0.97	0.00	2.02	1.80	1.10
Uniform Delay, d1		35.5	0.0		35.5	19.7	56.5	38.2	0.0	61.5	44.0	44.0
Progression Factor		0.91	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		481.4	0.3		67.6	0.0	623.0	12.9	0.0	494.3	362.9	70.8
Delay (s)		513.6	0.3		103.1	19.7	679.5	51.0	0.0	555.8	406.9	114.8
Level of Service		F	A		F	B	F	D	A	F	F	F
Approach Delay (s)		353.3			89.8			178.2			352.9	
Approach LOS		F			F			F			F	

Intersection Summary			
HCM Average Control Delay	289.5	HCM Level of Service	F
HCM Volume to Capacity ratio	2.01		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	168.5%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↰↑	↱		✥		↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*0.99	*0.99	1.00		1.00		1.00	*0.99	1.00	1.00	*0.99	1.00
Frt	1.00	1.00	0.85		0.91		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.95	1.00		1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1752	1761	1583		1694		1770	5532	1583	1770	5532	1583
Flt Permitted	0.95	0.95	1.00		1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1752	1761	1583		1694		1770	5532	1583	1770	5532	1583
Volume (vph)	723	22	43	9	151	320	45	2086	75	506	3054	518
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	730	22	43	9	153	323	45	2107	76	511	3085	523
RTOR Reduction (vph)	0	0	0	0	48	0	0	0	8	0	0	205
Lane Group Flow (vph)	366	386	43	0	437	0	45	2107	68	511	3085	318
Turn Type	Split		Free	Split			Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			Free						2			6
Actuated Green, G (s)	28.0	28.0	150.0		26.0		4.0	50.0	50.0	30.0	76.0	76.0
Effective Green, g (s)	28.0	28.0	150.0		26.0		4.0	50.0	50.0	30.0	76.0	76.0
Actuated g/C Ratio	0.19	0.19	1.00		0.17		0.03	0.33	0.33	0.20	0.51	0.51
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	327	329	1583		294		47	1844	528	354	2803	802
v/s Ratio Prot	0.21	c0.22			c0.26		0.03	0.38		c0.29	c0.56	
v/s Ratio Perm			0.03						0.04			0.20
v/c Ratio	1.12	1.17	0.03		1.49		0.96	1.14	0.13	1.44	1.10	0.40
Uniform Delay, d1	61.0	61.0	0.0		62.0		72.9	50.0	34.8	60.0	37.0	22.8
Progression Factor	1.00	1.00	1.00		1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	85.9	105.4	0.0		236.3		114.0	71.2	0.5	214.9	51.5	1.5
Delay (s)	146.9	166.4	0.0		298.3		186.9	121.2	35.3	274.9	88.5	24.3
Level of Service	F	F	A		F		F	F	D	F	F	C
Approach Delay (s)		148.4			298.3			119.6			103.4	
Approach LOS		F			F			F			F	

Intersection Summary			
HCM Average Control Delay	125.3	HCM Level of Service	F
HCM Volume to Capacity ratio	1.25		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	130.4%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↑		↰↰	↑↑↑↱			↑↱	↱	↰	✥	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	*0.99		*0.99	*0.99			*0.99	*0.99	*0.99	*0.99	
Frt	1.00	1.00		1.00	1.00			1.00	0.85	1.00	0.92	
Flt Protected	0.95	1.00		0.95	1.00			1.00	1.00	0.95	0.98	
Satd. Flow (prot)	1770	5532		3504	5506			1844	1567	1752	1660	
Flt Permitted	0.95	1.00		0.95	1.00			1.00	1.00	0.95	0.98	
Satd. Flow (perm)	1770	5532		3504	5506			1844	1567	1752	1660	
Volume (vph)	108	2029	0	408	2186	73	0	79	45	226	9	92
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	117	2205	0	443	2376	79	0	86	49	246	10	100
RTOR Reduction (vph)	0	0	0	0	3	0	0	0	45	0	33	0
Lane Group Flow (vph)	117	2205	0	443	2452	0	0	86	4	173	150	0
Turn Type	Prot			Prot					Perm	Split		
Protected Phases	5	2		1	6			8		4	4	
Permitted Phases									8			
Actuated Green, G (s)	12.7	66.8		20.1	74.2			11.3	11.3	15.8	15.8	
Effective Green, g (s)	12.7	66.8		20.1	74.2			11.3	11.3	15.8	15.8	
Actuated g/C Ratio	0.10	0.51		0.15	0.57			0.09	0.09	0.12	0.12	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	173	2843		542	3143			160	136	213	202	
v/s Ratio Prot	0.07	c0.40		0.13	c0.45			c0.05		c0.10	0.09	
v/s Ratio Perm									0.00			
v/c Ratio	0.68	0.78		0.82	0.78			0.54	0.03	0.81	0.74	
Uniform Delay, d1	56.7	25.5		53.2	21.6			56.8	54.3	55.7	55.1	
Progression Factor	0.99	0.62		0.63	0.29			1.00	1.00	1.00	1.00	
Incremental Delay, d2	6.5	1.4		8.6	1.8			3.4	0.1	20.5	13.6	
Delay (s)	62.3	17.3		42.3	8.0			60.3	54.4	76.1	68.7	
Level of Service	E	B		D	A			E	D	E	E	
Approach Delay (s)		19.5			13.3			58.2			72.3	
Approach LOS		B			B			E			E	

Intersection Summary			
HCM Average Control Delay	20.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	76.8%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
11: Farrington Hwy & E Street

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↱			↑↑↱			✥		↰	↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0			4.0		4.0	4.0	
Lane Util. Factor	1.00	*0.99			*0.99			1.00		1.00	1.00	
Frt	1.00	0.98			1.00			1.00		1.00	0.94	
Flt Protected	0.95	1.00			1.00			0.97		0.95	1.00	
Satd. Flow (prot)	1770	5421			5518			1803		1770	1744	
Flt Permitted	0.95	1.00			1.00			0.97		0.95	1.00	
Satd. Flow (perm)	1770	5421			5518			1803		1770	1744	
Volume (vph)	75	1950	303	0	2238	40	179	106	5	182	125	93
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	82	2120	329	0	2433	43	195	115	5	198	136	101
RTOR Reduction (vph)	0	18	0	0	1	0	0	1	0	0	21	0
Lane Group Flow (vph)	82	2431	0	0	2475	0	0	314	0	198	216	0
Turn Type	Prot						Split			Split		
Protected Phases	5	2			6		8	8		4	4	
Permitted Phases												
Actuated Green, G (s)	7.0	78.0			67.0			23.0		17.0	17.0	
Effective Green, g (s)	7.0	78.0			67.0			23.0		17.0	17.0	
Actuated g/C Ratio	0.05	0.60			0.52			0.18		0.13	0.13	
Clearance Time (s)	4.0	4.0			4.0			4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0			3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)	95	3253			2844			319		231	228	
v/s Ratio Prot	0.05	c0.45			c0.45			c0.17		0.11	c0.12	
v/s Ratio Perm												
v/c Ratio	0.86	0.75			0.87			0.98		0.86	0.95	
Uniform Delay, d1	61.0	18.9			27.7			53.3		55.3	56.1	
Progression Factor	0.86	0.76			0.41			1.00		1.00	1.00	
Incremental Delay, d2	30.4	0.8			2.4			45.9		25.5	44.7	
Delay (s)	83.1	15.2			13.8			99.2		80.8	100.8	
Level of Service	F	B			B			F		F	F	
Approach Delay (s)		17.4			13.8			99.2			91.7	
Approach LOS		B			B			F			F	

Intersection Summary			
HCM Average Control Delay	25.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	89.7%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
12: Fort Barrette Road & Farrington Hwy

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰↰	↑↱	↱	↰↰	↑↑	↱	↰↰	↑↑	↱	↰	↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*0.99	*0.99	*0.99	*0.99	*0.99	1.00	*0.99	*0.99	1.00	1.00	*0.99	1.00
Frt	1.00	0.96	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3504	3540	1567	3504	3688	1583	3504	3688	1583	1770	3688	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3504	3540	1567	3504	3688	1583	3504	3688	1583	1770	3688	1583
Volume (vph)	493	482	722	355	404	111	677	654	746	225	961	763
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	498	487	729	359	408	112	684	661	754	227	971	771
RTOR Reduction (vph)	0	19	309	0	0	94	0	0	217	0	0	189
Lane Group Flow (vph)	498	647	241	359	408	18	684	661	537	227	971	582
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases			6			2			4			8
Actuated Green, G (s)	30.4	39.8	39.8	21.4	30.8	30.8	42.5	88.8	88.8	28.6	74.9	74.9
Effective Green, g (s)	30.4	39.8	39.8	21.4	30.8	30.8	42.5	88.8	88.8	28.6	74.9	74.9
Actuated g/C Ratio	0.16	0.20	0.20	0.11	0.16	0.16	0.22	0.46	0.46	0.15	0.38	0.38
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	547	724	320	385	584	251	765	1683	722	260	1419	609
v/s Ratio Prot	c0.14	c0.18		0.10	0.11		c0.20	0.18		0.13	0.26	
v/s Ratio Perm			0.15			0.01			0.34			c0.37
v/c Ratio	0.91	0.89	0.75	0.93	0.70	0.07	0.89	0.39	0.74	0.87	0.68	0.96
Uniform Delay, d1	80.8	75.3	72.8	85.9	77.5	69.7	73.9	35.0	43.5	81.2	50.0	58.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	19.3	13.4	9.6	29.2	6.8	0.5	12.9	0.2	4.1	25.9	1.4	25.7
Delay (s)	100.1	88.8	82.3	115.1	84.3	70.3	86.8	35.2	47.7	107.2	51.4	83.9
Level of Service	F	F	F	F	F	E	F	D	D	F	D	F
Approach Delay (s)		90.0			95.1			56.5			70.5	
Approach LOS		F			F			E			E	

Intersection Summary			
HCM Average Control Delay	74.4	HCM Level of Service	E
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	194.6	Sum of lost time (s)	12.0
Intersection Capacity Utilization	90.4%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL2	WBL	WBR	NBL	NBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰↰		↱				↑↑	↱	↰↰	↑↑	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0				4.0	4.0	4.0	4.0	
Lane Util. Factor	*0.99		1.00				*0.99	1.00	0.97	*0.99	
Frt	1.00		0.85				1.00	0.85	1.00	1.00	
Flt Protected	0.95		1.00				1.00	1.00	0.95	1.00	
Satd. Flow (prot)	3504		1583				3688	1583	3433	3688	
Flt Permitted	0.95		1.00				1.00	1.00	0.95	1.00	
Satd. Flow (perm)	3504		1583				3688	1583	3433	3688	
Volume (vph)	1986	0	412	0	0	0	469	86	302	514	0
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	2006	0	416	0	0	0	474	87	305	519	0
RTOR Reduction (vph)	0	0	63	0	0	0	0	70	0	0	0
Lane Group Flow (vph)	2006	0	353	0	0	0	474	17	305	519	0
Turn Type	Prot		custom					Perm	Prot		
Protected Phases	8		8				6		5	2	
Permitted Phases								6			
Actuated Green, G (s)	82.8		82.8				28.1	28.1	17.1	49.2	
Effective Green, g (s)	82.8		82.8				28.1	28.1	17.1	49.2	
Actuated g/C Ratio	0.59		0.59				0.20	0.20	0.12	0.35	
Clearance Time (s)	4.0		4.0				4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0		3.0				3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	2072		936				740	318	419	1296	
v/s Ratio Prot	c0.57		0.22				c0.13		c0.09	0.14	
v/s Ratio Perm								0.01			
v/c Ratio	0.97		0.38				0.64	0.05	0.73	0.40	
Uniform Delay, d1	27.3		15.0				51.3	45.2	59.2	34.3	
Progression Factor	1.00		1.00				1.00	1.00	0.60	0.84	
Incremental Delay, d2	13.0		0.3				4.2	0.3	5.6	0.8	
Delay (s)	40.3		15.3				55.5	45.5	41.2	29.5	
Level of Service	D		B				E	D	D	C	
Approach Delay (s)		36.0		0.0			54.0			33.8	
Approach LOS		D		A			D			C	

Intersection Summary			
HCM Average Control Delay	38.2	HCM Level of Service	D
HCM Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	107.3%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL2	EBL	EBR	SBL	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰		↱			↰↰	↑↑			↑↑	↱↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0			4.0	4.0			4.0	4.0
Lane Util. Factor	1.00		1.00			0.97	*0.99			*0.99	*0.99
Frt	1.00		0.85			1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (prot)	1770		1583			3433	3688			3688	3135
Flt Permitted	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (perm)	1770		1583			3433	3688			3688	3135
Volume (vph)	92	0	952	0	0	206	2248	0	0	724	2003
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	93	0	962	0	0	208	2271	0	0	731	2023
RTOR Reduction (vph)	0	0	1	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	93	0	961	0	0	208	2271	0	0	731	2023
Turn Type	Prot		custom			Prot					Free
Protected Phases	4		4			1	6			2	
Permitted Phases											Free
Actuated Green, G (s)	63.0		63.0			12.7	69.0			52.3	140.0
Effective Green, g (s)	63.0		63.0			12.7	69.0			52.3	140.0
Actuated g/C Ratio	0.45		0.45			0.09	0.49			0.37	1.00
Clearance Time (s)	4.0		4.0			4.0	4.0			4.0	
Vehicle Extension (s)	3.0		3.0			3.0	3.0			3.0	
Lane Grp Cap (vph)	797		712			311	1818			1378	3135
v/s Ratio Prot	0.05		c0.61			0.06	c0.62			0.20	
v/s Ratio Perm											0.65
v/c Ratio	0.12		1.35			0.67	1.25			0.53	0.65
Uniform Delay, d1	22.3		38.5			61.6	35.5			34.3	0.0
Progression Factor	1.00		1.00			1.12	0.61			1.00	1.00
Incremental Delay, d2	0.1		166.5			2.2	114.1			1.5	1.0
Delay (s)	22.4		205.0			71.5	135.6			35.7	1.0
Level of Service	C		F			E	F			D	A
Approach Delay (s)		188.9		0.0			130.3			10.2	
Approach LOS		F		A			F			B	

Intersection Summary			
HCM Average Control Delay	87.5	HCM Level of Service	F
HCM Volume to Capacity ratio	1.30		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	107.3%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
15: North-South Road & Farrington Hwy

2030 + PRO (With Transit Corridor) - PM Peak

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*0.99	*0.99		*0.99	*0.99	1.00	*0.99	*0.99	1.00	*0.99	*0.99	1.00
Frt	1.00	0.96		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3504	5328		3504	5532	1583	3504	3688	1583	3504	3688	1583
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3504	5328		3504	5532	1583	3504	3688	1583	3504	3688	1583
Volume (vph)	717	1856	607	876	1562	386	407	740	537	529	847	758
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	724	1875	613	885	1578	390	411	747	542	534	856	766
RTOR Reduction (vph)	0	45	0	0	0	190	0	0	284	0	0	265
Lane Group Flow (vph)	724	2443	0	885	1578	200	411	747	258	534	856	501
Turn Type	Prot			Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases						2			4			8
Actuated Green, G (s)	25.0	40.0		27.0	42.0	42.0	17.0	30.0	30.0	17.0	30.0	30.0
Effective Green, g (s)	25.0	40.0		27.0	42.0	42.0	17.0	30.0	30.0	17.0	30.0	30.0
Actuated g/C Ratio	0.19	0.31		0.21	0.32	0.32	0.13	0.23	0.23	0.13	0.23	0.23
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	674	1639		728	1787	511	458	851	365	458	851	365
v/s Ratio Prot	0.21	c0.46		c0.25	0.29		0.12	c0.20		0.15	0.23	
v/s Ratio Perm						0.13			0.16			c0.32
v/c Ratio	1.07	1.49		1.22	0.88	0.39	0.90	0.88	0.71	1.17	1.01	1.37
Uniform Delay, d1	52.5	45.0		51.5	41.7	34.1	55.6	48.2	46.0	56.5	50.0	50.0
Progression Factor	1.00	1.00		0.63	0.56	0.21	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	56.3	224.0		102.9	3.2	1.0	23.0	12.4	11.0	96.1	32.3	183.8
Delay (s)	108.8	269.0		135.2	26.7	8.0	78.6	60.6	57.0	152.6	82.3	233.8
Level of Service	F	F		F	C	A	E	E	E	F	F	F
Approach Delay (s)		232.9			57.8			63.8			153.5	
Approach LOS		F			E			E			F	

Intersection Summary			
HCM Average Control Delay	136.3	HCM Level of Service	F
HCM Volume to Capacity ratio	1.28		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	123.3%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
16: North-South Road & North UH Connector

2030 + PRO (With Transit Corridor) - PM Peak

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	*0.99	0.86	*0.99	*0.99	1.00	*0.99	*0.99		*0.99	1.00	*0.99
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.94		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	3433	5532	1362	3504	5532	1583	3504	3466		3504	1863	3135
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	3433	5532	1362	3504	5532	1583	3504	3466		3504	1863	3135
Volume (vph)	73	1834	457	642	1906	374	273	421	282	374	117	717
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	74	1853	462	648	1925	378	276	425	285	378	118	724
RTOR Reduction (vph)	0	0	215	0	0	173	0	90	0	0	0	26
Lane Group Flow (vph)	74	1853	247	648	1925	205	276	620	0	378	118	698
Turn Type	Prot		Perm	Prot		pm+ov	Prot			Prot		pm+ov
Protected Phases	5	2		1	6	7	7	4		3	8	1
Permitted Phases			2			6						8
Actuated Green, G (s)	5.6	40.3	40.3	20.8	55.5	70.5	15.0	27.8		25.1	37.9	58.7
Effective Green, g (s)	5.6	40.3	40.3	20.8	55.5	70.5	15.0	27.8		25.1	37.9	58.7
Actuated g/C Ratio	0.04	0.31	0.31	0.16	0.43	0.54	0.12	0.21		0.19	0.29	0.45
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	148	1715	422	561	2362	858	404	741		677	543	1416
v/s Ratio Prot	0.02	c0.33		c0.18	0.35	0.03	0.08	c0.18		c0.11	0.06	0.08
v/s Ratio Perm			0.18			0.10						0.14
v/c Ratio	0.50	1.08	0.59	1.16	0.81	0.24	0.68	0.84		0.56	0.22	0.49
Uniform Delay, d1	60.8	44.9	37.8	54.6	32.7	15.6	55.2	48.9		47.4	34.8	25.2
Progression Factor	1.00	1.00	1.00	0.70	0.40	0.30	1.00	1.00		0.52	0.46	0.40
Incremental Delay, d2	2.6	47.1	5.9	71.9	0.3	0.0	4.7	8.2		0.3	0.1	0.1
Delay (s)	63.5	91.9	43.7	110.1	13.5	4.7	59.9	57.1		24.9	16.2	10.2
Level of Service	E	F	D	F	B	A	E	E		C	B	B
Approach Delay (s)		81.7			33.6			57.9			15.4	
Approach LOS		F			C			E			B	

Intersection Summary			
HCM Average Control Delay	49.0	HCM Level of Service	D
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	101.8%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
17: East-West Rd & North-South Road

2030 + PRO (With Transit Corridor) - PM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↱		↰↰	↑↱		↰↰	↑↑↱		↰↰	↑↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	*0.99	0.95		0.97	*0.99		*0.99	*0.99		*0.99	*0.99	
Frt	1.00	0.94		1.00	0.89		1.00	0.98		1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	3504	3313		3433	3283		3504	5405		3504	5358	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	3504	3313		3433	3283		3504	5405		3504	5358	
Volume (vph)	308	312	232	361	192	525	110	1530	277	504	1626	432
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	311	315	234	365	194	530	111	1545	280	509	1642	436
RTOR Reduction (vph)	0	81	0	0	163	0	0	24	0	0	39	0
Lane Group Flow (vph)	311	468	0	365	561	0	111	1801	0	509	2039	0
Turn Type	Prot			Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases												
Actuated Green, G (s)	14.4	20.6		17.2	23.4		5.0	45.1		17.0	57.1	
Effective Green, g (s)	14.4	20.6		17.2	23.4		5.0	45.1		17.0	57.1	
Actuated g/C Ratio	0.12	0.18		0.15	0.20		0.04	0.39		0.15	0.49	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	435	589		509	663		151	2103		514	2640	
v/s Ratio Prot	0.09	0.14		c0.11	c0.17		0.03	c0.33		c0.15	0.38	
v/s Ratio Perm												
v/c Ratio	0.71	0.79		0.72	1.11dr		0.74	0.86		0.99	0.77	
Uniform Delay, d1	48.8	45.6		47.0	44.5		54.8	32.4		49.4	24.1	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	5.5	7.3		4.8	9.8		16.9	4.7		37.4	2.3	
Delay (s)	54.3	52.9		51.8	54.3		71.7	37.2		86.7	26.3	
Level of Service	D	D		D	D		E	D		F	C	
Approach Delay (s)		53.4			53.5			39.2			38.2	
Approach LOS		D			D			D			D	

Intersection Summary			
HCM Average Control Delay	43.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	115.9	Sum of lost time (s)	16.0
Intersection Capacity Utilization	94.5%	ICU Level of Service	F
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
18: North-South Road & Kapolei Parkway

2030 + PRO (With Transit Corridor) - PM Peak

Movement	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰	↑↑↱		↰	↑↑↱		↰↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	*0.99		1.00	*0.99		*0.99	*0.99	1.00	1.00	*0.99	1.00
Frt	1.00	0.98		1.00	0.94		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	5407		1770	5184		3504	5532	1583	1770	5532	1583
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	5407		1770	5184		3504	5532	1583	1770	5532	1583
Volume (vph)	378	875	155	494	1001	725	704	643	505	121	568	339
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	382	884	157	499	1011	732	711	649	510	122	574	342
RTOR Reduction (vph)	0	26	0	0	118	0	0	0	297	0	0	292
Lane Group Flow (vph)	382	1015	0	499	1625	0	711	649	213	122	574	50
Turn Type	Prot			Prot			Prot		Perm	Prot		Perm
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases									4			8
Actuated Green, G (s)	20.0	25.0		31.0	36.0		21.0	26.5	26.5	10.4	15.9	15.9
Effective Green, g (s)	20.0	25.0		31.0	36.0		21.0	26.5	26.5	10.4	15.9	15.9
Actuated g/C Ratio	0.18	0.23		0.28	0.33		0.19	0.24	0.24	0.10	0.15	0.15
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	325	1241		504	1714		676	1346	385	169	808	231
v/s Ratio Prot	c0.22	0.19		c0.28	c0.31		c0.20	0.12		0.07	c0.10	
v/s Ratio Perm									0.13			0.03
v/c Ratio	1.18	0.82		0.99	1.15dr		1.05	0.48	0.55	0.72	0.71	0.22
Uniform Delay, d1	44.5	39.8		38.8	35.5		44.0	35.3	36.0	47.8	44.3	41.0
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	106.4	6.1		37.4	12.5		49.0	0.3	1.7	14.1	3.0	0.5
Delay (s)	150.9	45.8		76.2	48.0		93.0	35.6	37.7	62.0	47.3	41.5
Level of Service	F	D		E	D		F	D	D	E	D	D
Approach Delay (s)		74.0			54.3			58.0			47.1	
Approach LOS		E			D			E			D	

Intersection Summary			
HCM Average Control Delay	58.5	HCM Level of Service	E
HCM Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	108.9	Sum of lost time (s)	12.0
Intersection Capacity Utilization	100.9%	ICU Level of Service	G
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
19: East-West Rd & Old Fort Weaver Rd

2030 + PRO (With Transit Corridor) - PM Peak

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↰	↑	↑↑	↱	↰↰	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	0.97	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1863	3539	1583	3433	1583
Flt Permitted	0.29	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	546	1863	3539	1583	3433	1583
Volume (vph)	37	533	689	948	805	93
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	37	538	696	958	813	94
RTOR Reduction (vph)	0	0	0	0	0	48
Lane Group Flow (vph)	37	538	696	958	813	46
Turn Type	Perm			pm+ov		Perm
Protected Phases		4	8	6	6	
Permitted Phases	4			8		6
Actuated Green, G (s)	58.7	58.7	58.7	122.0	63.3	63.3
Effective Green, g (s)	58.7	58.7	58.7	122.0	63.3	63.3
Actuated g/C Ratio	0.45	0.45	0.45	0.94	0.49	0.49
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	247	841	1598	1583	1672	771
v/s Ratio Prot		0.29	0.20	c0.29	0.24	
v/s Ratio Perm	0.07			0.31		0.03
v/c Ratio	0.15	0.64	0.44	0.61	0.49	0.06
Uniform Delay, d1	21.0	27.5	24.3	0.6	22.4	17.6
Progression Factor	0.27	0.25	0.89	1.00	1.19	1.75
Incremental Delay, d2	0.2	1.3	0.0	0.1	0.4	0.1
Delay (s)	5.8	8.1	21.7	0.6	27.0	30.8
Level of Service	A	A	C	A	C	C
Approach Delay (s)		8.0	9.5		27.4	
Approach LOS		A	A		C	

Intersection Summary			
HCM Average Control Delay	14.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	0.0
Intersection Capacity Utilization	68.7%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
20: Farrington Hwy & B Street

2030 + PRO (With Transit Corridor) - PM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰↰	↑↑	↱	↰↰	↑↑	↱	↰	↑	↱	↰↰	↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	*0.99	1.00	0.97	*0.99	1.00	1.00	1.00	1.00	*0.99	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3688	1583	3433	3688	1583	1770	1863	1583	3504	1863	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3688	1583	3433	3688	1583	1770	1863	1583	3504	1863	1583
Volume (vph)	221	1384	344	375	1728	74	146	282	195	264	143	171
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	223	1398	347	379	1745	75	147	285	197	267	144	173
RTOR Reduction (vph)	0	0	46	0	0	27	0	0	5	0	0	23
Lane Group Flow (vph)	223	1398	301	379	1745	48	147	285	192	267	144	150
Turn Type	Prot		pm+ov	Prot		Perm	Prot		pm+ov	Prot		pm+ov
Protected Phases	5	2	3	1	6		7	4	5	3	8	1
Permitted Phases			2			6			4			8
Actuated Green, G (s)	12.7	51.0	61.0	17.9	56.2	56.2	11.0	18.0	30.7	10.0	17.0	34.9
Effective Green, g (s)	12.7	51.0	61.0	17.9	56.2	56.2	11.0	18.0	30.7	10.0	17.0	34.9
Actuated g/C Ratio	0.11	0.45	0.54	0.16	0.50	0.50	0.10	0.16	0.27	0.09	0.15	0.31
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	386	1666	855	544	1836	788	172	297	430	310	281	545
v/s Ratio Prot	0.06	0.38	0.03	c0.11	c0.47		0.08	c0.15	0.05	c0.08	0.08	0.04
v/s Ratio Perm			0.16			0.03			0.07			0.05
v/c Ratio	0.58	0.84	0.35	0.70	0.95	0.06	0.85	0.96	0.45	0.86	0.51	0.28
Uniform Delay, d1	47.6	27.3	14.7	44.9	27.0	14.7	50.2	47.1	34.1	50.8	44.1	29.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	2.1	5.3	0.3	3.9	12.2	0.1	31.5	40.8	0.7	20.9	1.6	0.3
Delay (s)	49.6	32.6	15.0	48.8	39.2	14.8	81.7	87.9	34.8	71.7	45.7	29.7
Level of Service	D	C	B	D	D	B	F	F	C	E	D	C
Approach Delay (s)		31.4			40.0			69.8			52.9	
Approach LOS		C			D			E			D	

Intersection Summary			
HCM Average Control Delay	41.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	112.9	Sum of lost time (s)	12.0
Intersection Capacity Utilization	89.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
21: East-West Rd & A Street

2030 + PRO (With Transit Corridor) - PM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	1.00	0.85	1.00	0.85		1.00	0.88	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1841		1770	1863	1583	1770	1585		1770	1631	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	1841		1770	1863	1583	1770	1585		1770	1631	
Volume (vph)	164	661	55	34	683	513	12	1	135	44	6	31
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	178	718	60	37	742	558	13	1	147	48	7	34
RTOR Reduction (vph)	0	2	0	0	0	174	0	138	0	0	32	0
Lane Group Flow (vph)	178	776	0	37	742	384	13	10	0	48	9	0
Turn Type	Prot			Prot		Perm	Split			Split		
Protected Phases	5	2		1	6		4	4		8	8	
Permitted Phases						6						
Actuated Green, G (s)	19.9	92.7		4.8	77.6	77.6	7.7	7.7		8.8	8.8	
Effective Green, g (s)	19.9	92.7		4.8	77.6	77.6	7.7	7.7		8.8	8.8	
Actuated g/C Ratio	0.15	0.71		0.04	0.60	0.60	0.06	0.06		0.07	0.07	
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	271	1313		65	1112	945	105	94		120	110	
v/s Ratio Prot	c0.10	0.42		0.02	c0.40		c0.01	0.01		c0.03	0.01	
v/s Ratio Perm						0.24						
v/c Ratio	0.66	0.59		0.57	0.67	0.41	0.12	0.10		0.40	0.08	
Uniform Delay, d1	51.8	9.3		61.6	17.6	13.9	58.0	57.9		58.1	56.8	
Progression Factor	1.00	1.00		0.97	0.49	0.09	1.00	1.00		1.00	1.00	
Incremental Delay, d2	5.6	2.0		5.2	1.5	0.6	0.5	0.5		2.2	0.3	
Delay (s)	57.5	11.2		64.9	10.0	1.8	58.5	58.4		60.3	57.2	
Level of Service	E	B		E	B	A	E	E		E	E	
Approach Delay (s)		19.8			8.1			58.4			58.8	
Approach LOS		B			A			E			E	

Intersection Summary			
HCM Average Control Delay	17.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	70.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
22: Farrington Hwy & 2nd Avenue

2030 + PRO (With Transit Corridor) - PM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.91		0.97	0.95	1.00	1.00	0.95	0.88	0.97	0.95	1.00
Frt	1.00	0.99		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	5021		3433	3539	1583	1770	3539	2787	3433	3539	1583
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	5021		3433	3539	1583	1770	3539	2787	3433	3539	1583
Volume (vph)	180	1404	130	555	1708	237	103	297	410	515	356	308
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	196	1526	141	603	1857	258	112	323	446	560	387	335
RTOR Reduction (vph)	0	8	0	0	0	81	0	0	6	0	0	181
Lane Group Flow (vph)	196	1659	0	603	1857	177	112	323	440	560	387	154
Turn Type	Prot			Prot		Perm	Prot		pm+ov	Prot		Perm
Protected Phases	5	2		1	6		3	8	1	7	4	
Permitted Phases						6			8			4
Actuated Green, G (s)	15.0	46.0		23.0	54.0	54.0	11.0	23.0	46.0	22.0	34.0	34.0
Effective Green, g (s)	15.0	46.0		23.0	54.0	54.0	11.0	23.0	46.0	22.0	34.0	34.0
Actuated g/C Ratio	0.12	0.35		0.18	0.42	0.42	0.08	0.18	0.35	0.17	0.26	0.26
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	204	1777		607	1470	658	150	626	986	581	926	414
v/s Ratio Prot	0.11	c0.33		0.18	c0.52		c0.06	c0.09	0.08	c0.16	0.11	
v/s Ratio Perm						0.11			0.08			0.10
v/c Ratio	0.96	0.93		0.99	1.26	0.27	0.75	0.52	0.45	0.96	0.42	0.37
Uniform Delay, d1	57.2	40.5		53.4	38.0	25.0	58.1	48.5	32.2	53.6	39.8	39.3
Progression Factor	1.00	1.00		0.53	0.35	0.05	0.76	0.71	0.66	1.01	0.90	0.84
Incremental Delay, d2	51.6	10.5		22.7	121.0	0.4	13.8	2.2	0.2	15.5	0.5	1.0
Delay (s)	108.8	51.0		51.1	134.5	1.7	57.7	36.5	21.5	69.6	36.5	33.9
Level of Service	F	D		D	F	A	E	D	C	E	D	C
Approach Delay (s)		57.1			103.4			31.6			50.3	
Approach LOS		E			F			C			D	

Intersection Summary			
HCM Average Control Delay	71.1	HCM Level of Service	E
HCM Volume to Capacity ratio	1.07		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	93.4%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
23: 2nd Avenue & Kunia Road

2030 + PRO (With Transit Corridor) - PM Peak

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations			↑↑↑↱			↑↑↑↑
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	0	0	4551	349	0	4748
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	4947	379	0	5161
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)			868			
pX, platoon unblocked	0.39	0.39			0.39	
vC, conflicting volume	6427	1426			5326	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	10281	0			7432	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	0	419			1	

Direction, Lane #	SE 1	SE 2	SE 3	SE 4	NW 1	NW 2	NW 3	NW 4
Volume Total	1413	1413	1413	1086	1290	1290	1290	1290
Volume Left	0	0	0	0	0	0	0	0
Volume Right	0	0	0	379	0	0	0	0
cSH	1700	1700	1700	1700	1700	1700	1700	1700
Volume to Capacity	0.83	0.83	0.83	0.64	0.76	0.76	0.76	0.76
Queue Length 95th (ft)	0	0	0	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane LOS								
Approach Delay (s)	0.0				0.0			
Approach LOS								

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	75.1%	ICU Level of Service	D
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
24: 3rd Avenue & Kunia Road

2030 + PRO (With Transit Corridor) - PM Peak

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations			↑↑↑↱			↑↑↑↑
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	0	0	4433	118	0	4297
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	4818	128	0	4671
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)			1232			
pX, platoon unblocked	0.42	0.42			0.42	
vC, conflicting volume	6050	1269			4947	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	8872	0			6250	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	0	456			2	

Direction, Lane #	SE 1	SE 2	SE 3	SE 4	NW 1	NW 2	NW 3	NW 4
Volume Total	1377	1377	1377	817	1168	1168	1168	1168
Volume Left	0	0	0	0	0	0	0	0
Volume Right	0	0	0	128	0	0	0	0
cSH	1700	1700	1700	1700	1700	1700	1700	1700
Volume to Capacity	0.81	0.81	0.81	0.48	0.69	0.69	0.69	0.69
Queue Length 95th (ft)	0	0	0	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane LOS								
Approach Delay (s)	0.0				0.0			
Approach LOS								

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	69.5%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↰	↑	↑	↱	↰	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1863	1863	1583	1770	1583
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1863	1863	1583	1770	1583
Volume (vph)	414	290	644	95	337	588
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	450	315	700	103	366	639
RTOR Reduction (vph)	0	0	0	44	0	398
Lane Group Flow (vph)	450	315	700	59	366	241
Turn Type	Prot			Prot		Prot
Protected Phases	5	2	6	6	4	4
Permitted Phases						
Actuated Green, G (s)	34.7	94.0	55.3	55.3	28.0	28.0
Effective Green, g (s)	34.7	94.0	55.3	55.3	28.0	28.0
Actuated g/C Ratio	0.27	0.72	0.43	0.43	0.22	0.22
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	472	1347	792	673	381	341
v/s Ratio Prot	c0.25	0.17	c0.38	0.04	c0.21	0.15
v/s Ratio Perm						
v/c Ratio	0.95	0.23	0.88	0.09	0.96	0.71
Uniform Delay, d1	46.9	6.0	34.4	22.3	50.5	47.2
Progression Factor	0.81	1.74	0.36	0.15	1.00	1.00
Incremental Delay, d2	26.4	0.3	13.0	0.2	37.2	11.7
Delay (s)	64.3	10.8	25.4	3.7	87.6	58.9
Level of Service	E	B	C	A	F	E
Approach Delay (s)		42.3	22.7		69.4	
Approach LOS		D	C		E	

Intersection Summary			
HCM Average Control Delay	46.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	85.5%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations	↰	↱	↰	↑↑	↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	*0.99	*0.99	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3688	3688	1583
Flt Permitted	0.95	1.00	0.05	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	98	3688	3688	1583
Volume (vph)	199	173	94	1485	2229	137
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	201	175	95	1500	2252	138
RTOR Reduction (vph)	0	16	0	0	0	33
Lane Group Flow (vph)	201	159	95	1500	2252	105
Turn Type		Perm	Perm			Perm
Protected Phases	6			4	8	
Permitted Phases		6	4			8
Actuated Green, G (s)	16.0	16.0	76.0	76.0	76.0	76.0
Effective Green, g (s)	16.0	16.0	76.0	76.0	76.0	76.0
Actuated g/C Ratio	0.16	0.16	0.76	0.76	0.76	0.76
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	283	253	74	2803	2803	1203
v/s Ratio Prot	c0.11			0.41	0.61	
v/s Ratio Perm		0.10	c0.97			0.07
v/c Ratio	0.71	0.63	1.28	0.54	0.80	0.09
Uniform Delay, d1	39.8	39.2	12.0	4.9	7.4	3.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	14.1	11.3	198.5	0.7	2.6	0.1
Delay (s)	53.9	50.5	210.5	5.6	9.9	3.2
Level of Service	D	D	F	A	A	A
Approach Delay (s)	52.3			17.8	9.6	
Approach LOS	D			B	A	

Intersection Summary			
HCM Average Control Delay	16.3	HCM Level of Service	B
HCM Volume to Capacity ratio	1.18		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	87.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

APPENDIX A-4

YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO B: WITHOUT TRANSIT CORRIDOR SCENARIO

HCM Signalized Intersection Capacity Analysis
1: Kunia Loop & Kunia Road

2030 + PRO (W/O Transit Corridor) - PM Peak

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↰	↱	↑↑	↱		↓↓
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0		4.0
Lane Util. Factor	0.97	1.00	0.95	1.00		0.95
Frt	1.00	0.85	1.00	0.85		1.00
Flt Protected	0.95	1.00	1.00	1.00		1.00
Satd. Flow (prot)	3433	1583	3539	1583		3539
Flt Permitted	0.95	1.00	1.00	1.00		1.00
Satd. Flow (perm)	3433	1583	3539	1583		3539
Volume (vph)	915	41	1730	948	0	2297
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	995	45	1880	1030	0	2497
RTOR Reduction (vph)	0	18	0	317	0	0
Lane Group Flow (vph)	995	27	1880	713	0	2497
Turn Type		Perm		Perm		
Protected Phases	8		2			6
Permitted Phases		8		2		
Actuated Green, G (s)	35.0	35.0	87.0	87.0		87.0
Effective Green, g (s)	35.0	35.0	87.0	87.0		87.0
Actuated g/C Ratio	0.27	0.27	0.67	0.67		0.67
Clearance Time (s)	4.0	4.0	4.0	4.0		4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0		3.0
Lane Grp Cap (vph)	924	426	2368	1059		2368
v/s Ratio Prot	c0.29		0.53			c0.71
v/s Ratio Perm		0.02		0.45		
v/c Ratio	1.08	0.06	0.79	0.67		1.05
Uniform Delay, d1	47.5	35.3	15.2	12.9		21.5
Progression Factor	1.00	1.00	1.00	1.00		1.00
Incremental Delay, d2	52.5	0.1	2.8	3.4		34.9
Delay (s)	100.0	35.4	18.0	16.4		56.4
Level of Service	F	D	B	B		E
Approach Delay (s)	97.2		17.4			56.4
Approach LOS	F		B			E

Intersection Summary			
HCM Average Control Delay	45.4	HCM Level of Service	D
HCM Volume to Capacity ratio	1.06		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	96.3%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
2: H-1 WB On-Ramp & Kunia Road

2030 + PRO (W/O Transit Corridor) - PM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations						↱	↰	↑↑			↑↑↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)						4.0	4.0	4.0			4.0	
Lane Util. Factor						1.00	1.00	0.95			0.91	
Frt						0.86	1.00	1.00			0.99	
Flt Protected						1.00	0.95	1.00			1.00	
Satd. Flow (prot)						1611	1770	3539			5016	
Flt Permitted						1.00	0.95	1.00			1.00	
Satd. Flow (perm)						1611	1770	3539			5016	
Volume (vph)	0	0	0	0	0	303	367	2420	0	0	2922	290
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	0	0	329	399	2630	0	0	3176	315
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	8	0
Lane Group Flow (vph)	0	0	0	0	0	329	399	2630	0	0	3483	0
Turn Type						Free	Prot					
Protected Phases							5	2			6	
Permitted Phases						Free						
Actuated Green, G (s)						150.0	34.6	150.0			107.4	
Effective Green, g (s)						150.0	34.6	150.0			107.4	
Actuated g/C Ratio						1.00	0.23	1.00			0.72	
Clearance Time (s)							4.0	4.0			4.0	
Vehicle Extension (s)							3.0	3.0			3.0	
Lane Grp Cap (vph)						1611	408	3539			3591	
v/s Ratio Prot							c0.23	0.74			c0.69	
v/s Ratio Perm						0.20						
v/c Ratio						0.20	0.98	0.74			0.97	
Uniform Delay, d1						0.0	57.3	0.0			19.8	
Progression Factor						1.00	1.12	1.00			1.00	
Incremental Delay, d2						0.3	28.5	0.9			9.5	
Delay (s)						0.3	92.5	0.9			29.3	
Level of Service						A	F	A			C	
Approach Delay (s)		0.0			0.3			12.9			29.3	
Approach LOS		A			A			B			C	

Intersection Summary			
HCM Average Control Delay	20.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	89.9%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
1: Kunia Loop & Kunia Road

2030 + PRO (without Transit Corridor) - AM Peak

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↰	↱	↑↑	↱		↑↑↑
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0		4.0
Lane Util. Factor	0.97	1.00	0.95	1.00		0.91
Frt	1.00	0.85	1.00	0.85		1.00
Flt Protected	0.95	1.00	1.00	1.00		1.00
Satd. Flow (prot)	3433	1583	3539	1583		5085
Flt Permitted	0.95	1.00	1.00	1.00		1.00
Satd. Flow (perm)	3433	1583	3539	1583		5085
Volume (vph)	724	37	1781	498	0	1309
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	787	40	1936	541	0	1423
RTOR Reduction (vph)	0	10	0	196	0	0
Lane Group Flow (vph)	787	30	1936	345	0	1423
Turn Type		Perm		Perm		
Protected Phases	8		2			6
Permitted Phases		8		2		
Actuated Green, G (s)	26.8	26.8	61.1	61.1		61.1
Effective Green, g (s)	26.8	26.8	61.1	61.1		61.1
Actuated g/C Ratio	0.28	0.28	0.64	0.64		0.64
Clearance Time (s)	4.0	4.0	4.0	4.0		4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0		3.0
Lane Grp Cap (vph)	959	442	2255	1009		3240
v/s Ratio Prot	c0.23		c0.55			0.28
v/s Ratio Perm		0.02		0.22		
v/c Ratio	0.82	0.07	0.86	0.34		0.44
Uniform Delay, d1	32.3	25.4	13.9	8.1		8.8
Progression Factor	1.00	1.00	1.00	1.00		1.00
Incremental Delay, d2	5.7	0.1	4.5	0.9		0.4
Delay (s)	38.0	25.4	18.5	9.0		9.2
Level of Service	D	C	B	A		A
Approach Delay (s)	37.4		16.4			9.2
Approach LOS	D		B			A

Intersection Summary			
HCM Average Control Delay	17.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	95.9	Sum of lost time (s)	8.0
Intersection Capacity Utilization	76.6%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
2: H-1 WB On-Ramp & Kunia Road

2030 + PRO (without Transit Corridor) - AM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations						↱	↰	↑↑↑			↑↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)						4.0	4.0	4.0			4.0	
Lane Util. Factor						1.00	1.00	0.91			0.91	
Frt						0.86	1.00	1.00			0.98	
Flt Protected						1.00	0.95	1.00			1.00	
Satd. Flow (prot)						1611	1770	5085			4960	
Flt Permitted						1.00	0.95	1.00			1.00	
Satd. Flow (perm)						1611	1770	5085			4960	
Volume (vph)	0	0	0	0	0	530	165	1748	0	0	1697	333
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	0	0	576	179	1900	0	0	1845	362
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	15	0
Lane Group Flow (vph)	0	0	0	0	0	576	179	1900	0	0	2192	0
Turn Type						Free	Prot					
Protected Phases							5	2			6	
Permitted Phases						Free						
Actuated Green, G (s)						110.0	15.2	110.0			86.8	
Effective Green, g (s)						110.0	15.2	110.0			86.8	
Actuated g/C Ratio						1.00	0.14	1.00			0.79	
Clearance Time (s)							4.0	4.0			4.0	
Vehicle Extension (s)							3.0	3.0			3.0	
Lane Grp Cap (vph)						1611	245	5085			3914	
v/s Ratio Prot							c0.10	0.37			c0.44	
v/s Ratio Perm						0.36						
v/c Ratio						0.36	0.73	0.37			0.56	
Uniform Delay, d1						0.0	45.4	0.0			4.4	
Progression Factor						1.00	1.07	1.00			1.00	
Incremental Delay, d2						0.6	9.5	0.2			0.6	
Delay (s)						0.6	57.9	0.2			5.0	
Level of Service						A	E	A			A	
Approach Delay (s)		0.0			0.6			5.2			5.0	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	4.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	56.0%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
3: H-1 EB & Kunia Road

2030 + PRO (without Transit Corridor) - AM Peak

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations	↰↰	↱	↓↓↓↓			↑↑↑
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0			4.0
Lane Util. Factor	0.97	1.00	0.86			0.91
Frt	1.00	0.85	1.00			1.00
Flt Protected	0.95	1.00	1.00			1.00
Satd. Flow (prot)	3433	1583	6408			5085
Flt Permitted	0.95	1.00	1.00			1.00
Satd. Flow (perm)	3433	1583	6408			5085
Volume (vph)	403	363	2072	0	0	1509
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	438	395	2252	0	0	1640
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	438	395	2252	0	0	1640
Turn Type		Free				
Protected Phases	4		6			2
Permitted Phases		Free				
Actuated Green, G (s)	17.4	110.0	84.6			84.6
Effective Green, g (s)	17.4	110.0	84.6			84.6
Actuated g/C Ratio	0.16	1.00	0.77			0.77
Clearance Time (s)	4.0		4.0			4.0
Vehicle Extension (s)	3.0		3.0			3.0
Lane Grp Cap (vph)	543	1583	4928			3911
v/s Ratio Prot	c0.13		c0.35			0.32
v/s Ratio Perm		0.25				
v/c Ratio	0.81	0.25	0.46			0.42
Uniform Delay, d1	44.7	0.0	4.5			4.3
Progression Factor	1.00	1.00	0.76			1.01
Incremental Delay, d2	8.6	0.4	0.3			0.3
Delay (s)	53.2	0.4	3.7			4.7
Level of Service	D	A	A			A
Approach Delay (s)	28.2		3.7			4.7
Approach LOS	C		A			A

Intersection Summary			
HCM Average Control Delay	8.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	49.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
4: Farrington Hwy & Fort Weaver Road SB Ramp

2030 + PRO (without Transit Corridor) - AM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↱		↰↰	↑↑↑				↱			↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0				4.0			4.0
Lane Util. Factor		0.91		0.97	0.91				1.00			1.00
Frt		0.98		1.00	1.00				0.86			0.86
Flt Protected		1.00		0.95	1.00				1.00			1.00
Satd. Flow (prot)		5006		3433	5085				1611			1611
Flt Permitted		1.00		0.95	1.00				1.00			1.00
Satd. Flow (perm)		5006		3433	5085				1611			1611
Volume (vph)	0	2066	240	498	721	0	0	0	429	0	0	481
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	2246	261	541	784	0	0	0	466	0	0	523
RTOR Reduction (vph)	0	9	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	2498	0	541	784	0	0	0	466	0	0	523
Turn Type				Prot					Free			Free
Protected Phases		2		1	6							
Permitted Phases									Free			Free
Actuated Green, G (s)		79.5		22.5	110.0				110.0			110.0
Effective Green, g (s)		79.5		22.5	110.0				110.0			110.0
Actuated g/C Ratio		0.72		0.20	1.00				1.00			1.00
Clearance Time (s)		4.0		4.0	4.0							
Vehicle Extension (s)		3.0		3.0	3.0							
Lane Grp Cap (vph)		3618		702	5085				1611			1611
v/s Ratio Prot		c0.50		c0.16	0.15							
v/s Ratio Perm									0.29			0.32
v/c Ratio		0.69		0.77	0.15				0.29			0.32
Uniform Delay, d1		8.4		41.3	0.0				0.0			0.0
Progression Factor		0.65		1.45	1.00				1.00			1.00
Incremental Delay, d2		0.8		1.6	0.0				0.5			0.5
Delay (s)		6.3		61.4	0.0				0.5			0.5
Level of Service		A		E	A				A			A
Approach Delay (s)		6.3			25.1			0.5			0.5	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM Average Control Delay	10.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	66.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
5: Farrington Hwy & Fort Weaver Road NB Ramps

2030 + PRO (without Transit Corridor) - AM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↑			↑↑↱				↱			
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0				4.0			
Lane Util. Factor	1.00	*0.99			*0.99				1.00			
Frt	1.00	1.00			0.95				0.86			
Flt Protected	0.95	1.00			1.00				1.00			
Satd. Flow (prot)	1770	5532			5269				1611			
Flt Permitted	0.95	1.00			1.00				1.00			
Satd. Flow (perm)	1770	5532			5269				1611			
Volume (vph)	1165	1330	0	0	1218	567	0	0	911	0	0	0
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	1177	1343	0	0	1230	573	0	0	920	0	0	0
RTOR Reduction (vph)	0	0	0	0	57	0	0	0	0	0	0	0
Lane Group Flow (vph)	1177	1343	0	0	1746	0	0	0	920	0	0	0
Turn Type	Prot								Free			
Protected Phases	5	2			6							
Permitted Phases									Free			
Actuated Green, G (s)	67.0	110.0			35.0				110.0			
Effective Green, g (s)	67.0	110.0			35.0				110.0			
Actuated g/C Ratio	0.61	1.00			0.32				1.00			
Clearance Time (s)	4.0	4.0			4.0							
Vehicle Extension (s)	3.0	3.0			3.0							
Lane Grp Cap (vph)	1078	5532			1677				1611			
v/s Ratio Prot	c0.67	0.24			c0.33							
v/s Ratio Perm									0.57			
v/c Ratio	1.09	0.24			1.04				0.57			
Uniform Delay, d1	21.5	0.0			37.5				0.0			
Progression Factor	0.34	1.00			1.00				1.00			
Incremental Delay, d2	53.4	0.1			33.6				1.5			
Delay (s)	60.7	0.1			71.1				1.5			
Level of Service	E	A			E				A			
Approach Delay (s)		28.4			71.1			1.5			0.0	
Approach LOS		C			E			A			A	

Intersection Summary			
HCM Average Control Delay	38.4	HCM Level of Service	D
HCM Volume to Capacity ratio	1.07		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	107.4%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
6: Farrington Hwy & Leoku Street

2030 + PRO (without Transit Corridor) - AM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑↑	↱	↰	↑↑↑	↱		↰↑	↱		↰↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
Lane Util. Factor	*0.99	*0.99	1.00	1.00	*0.99	1.00		1.00	1.00		*0.99	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00		0.97	1.00
Satd. Flow (prot)	3504	5532	1583	1770	5532	1583		1780	1583		3568	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00		0.97	1.00
Satd. Flow (perm)	3504	5532	1583	1770	5532	1583		1780	1583		3568	1583
Volume (vph)	147	1938	155	119	1619	156	56	5	48	92	45	113
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	160	2107	168	129	1760	170	61	5	52	100	49	123
RTOR Reduction (vph)	0	0	74	0	0	91	0	0	45	0	0	111
Lane Group Flow (vph)	160	2107	94	129	1760	79	0	66	7	0	149	12
Turn Type	Prot		Perm	Prot		Perm	Split		Perm	Split		Perm
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			6
Actuated Green, G (s)	13.7	48.2	48.2	10.2	44.7	44.7		12.8	12.8		9.6	9.6
Effective Green, g (s)	13.7	48.2	48.2	10.2	44.7	44.7		12.8	12.8		9.6	9.6
Actuated g/C Ratio	0.14	0.50	0.50	0.11	0.46	0.46		0.13	0.13		0.10	0.10
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	496	2755	788	187	2555	731		235	209		354	157
v/s Ratio Prot	c0.05	c0.38		c0.07	0.32			c0.04			c0.04	
v/s Ratio Perm			0.06			0.05			0.00			0.01
v/c Ratio	0.32	0.76	0.12	0.69	0.69	0.11		0.28	0.03		0.42	0.08
Uniform Delay, d1	37.4	19.7	13.0	41.8	20.6	14.8		37.9	36.6		41.0	39.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00
Incremental Delay, d2	0.4	1.3	0.1	10.1	0.8	0.1		3.0	0.3		0.8	0.2
Delay (s)	37.8	21.0	13.0	51.9	21.3	14.8		40.8	36.9		41.8	39.8
Level of Service	D	C	B	D	C	B		D	D		D	D
Approach Delay (s)		21.6			22.7			39.1			40.9	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM Average Control Delay	23.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	96.8	Sum of lost time (s)	20.0
Intersection Capacity Utilization	65.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
7: Laulaunui Street & Fort Weaver Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↑↱		↰	↑	↱	↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		*0.99		1.00	1.00	1.00	1.00	*0.99	1.00	1.00	*0.99	1.00
Frt		0.99		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.96		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		3510		1770	1863	1583	1770	5532	1583	1770	5532	1583
Flt Permitted		0.96		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		3510		1770	1863	1583	1770	5532	1583	1770	5532	1583
Volume (vph)	96	24	12	72	4	235	48	4056	53	92	1419	170
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	97	24	12	73	4	237	48	4097	54	93	1433	172
RTOR Reduction (vph)	0	6	0	0	0	102	0	0	10	0	0	52
Lane Group Flow (vph)	0	127	0	73	4	135	48	4097	44	93	1433	120
Turn Type	Split			Split		Perm	Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases						8			2			6
Actuated Green, G (s)		10.6		10.0	10.0	10.0	7.4	101.0	101.0	7.9	101.5	101.5
Effective Green, g (s)		10.6		10.0	10.0	10.0	7.4	101.0	101.0	7.9	101.5	101.5
Actuated g/C Ratio		0.07		0.07	0.07	0.07	0.05	0.69	0.69	0.05	0.70	0.70
Clearance Time (s)		4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		256		122	128	109	90	3840	1099	96	3859	1104
v/s Ratio Prot		c0.04		0.04	0.00		0.03	c0.74		c0.05	0.26	
v/s Ratio Perm						c0.09			0.03			0.08
v/c Ratio		0.50		0.60	0.03	1.24	0.53	1.07	0.04	0.97	0.37	0.11
Uniform Delay, d1		64.9		65.8	63.2	67.8	67.4	22.2	7.0	68.7	9.0	7.2
Progression Factor		1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		1.5		7.7	0.1	165.3	6.0	36.3	0.1	80.7	0.3	0.2
Delay (s)		66.4		73.5	63.3	233.0	73.3	58.6	7.1	149.4	9.3	7.4
Level of Service		E		E	E	F	E	E	A	F	A	A
Approach Delay (s)		66.4			193.8			58.1			16.7	
Approach LOS		E			F			E			B	

Intersection Summary			
HCM Average Control Delay	53.9	HCM Level of Service	D
HCM Volume to Capacity ratio	1.03		
Actuated Cycle Length (s)	145.5	Sum of lost time (s)	16.0
Intersection Capacity Utilization	108.2%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
8: Old Fort Weaver Road & Fort Weaver Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑	↱		↰↑	↱	↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	*0.99	1.00	1.00	*0.99	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.96	1.00		1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1785	1583		1862	1583	1770	5532	1583	1770	5532	1583
Flt Permitted		0.32	1.00		0.70	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		596	1583		1311	1583	1770	5532	1583	1770	5532	1583
Volume (vph)	851	126	403	4	484	262	299	3044	1	21	949	532
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	860	127	407	4	489	265	302	3075	1	21	959	537
RTOR Reduction (vph)	0	0	0	0	0	37	0	0	0	0	0	204
Lane Group Flow (vph)	0	987	407	0	493	228	302	3075	1	21	959	333
Turn Type	Perm		Free	Perm		Perm	Prot		Free	Prot		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		Free	8		8			Free			6
Actuated Green, G (s)		75.0	149.6		75.0	75.0	27.9	60.2	149.6	2.4	34.7	34.7
Effective Green, g (s)		75.0	149.6		75.0	75.0	27.9	60.2	149.6	2.4	34.7	34.7
Actuated g/C Ratio		0.50	1.00		0.50	0.50	0.19	0.40	1.00	0.02	0.23	0.23
Clearance Time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)		299	1583		657	794	330	2226	1583	28	1283	367
v/s Ratio Prot							c0.17	c0.56		0.01	0.17	
v/s Ratio Perm		c1.66	0.26		0.38	0.14			0.00			0.21
v/c Ratio		3.30	0.26		0.75	0.29	0.92	1.38	0.00	0.75	0.75	0.91
Uniform Delay, d1		37.3	0.0		29.8	21.7	59.7	44.7	0.0	73.3	53.4	55.9
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		1044.0	0.4		4.8	0.2	28.7	174.5	0.0	71.8	4.0	28.4
Delay (s)		1081.3	0.4		34.6	21.9	88.4	219.2	0.0	145.1	57.4	84.3
Level of Service		F	A		C	C	F	F	A	F	E	F
Approach Delay (s)		765.7			30.2			207.5			68.1	
Approach LOS		F			C			F			E	

Intersection Summary			
HCM Average Control Delay	268.8	HCM Level of Service	F
HCM Volume to Capacity ratio	2.43		
Actuated Cycle Length (s)	149.6	Sum of lost time (s)	12.0
Intersection Capacity Utilization	154.9%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

9: Renton Road & Fort Weaver Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↰↑	↱		↰↑↱		↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*0.99	*0.99	1.00		1.00		1.00	*0.99	1.00	1.00	*0.99	1.00
Frt	1.00	1.00	0.85		0.95		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1752	1766	1583		1765		1770	5532	1583	1770	5532	1583
Flt Permitted	0.95	0.96	1.00		1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1752	1766	1583		1765		1770	5532	1583	1770	5532	1583
Volume (vph)	468	31	36	10	339	217	89	2658	1	251	1023	85
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	473	31	36	10	342	219	90	2685	1	254	1033	86
RTOR Reduction (vph)	0	0	0	0	15	0	0	0	0	0	0	47
Lane Group Flow (vph)	246	258	36	0	556	0	90	2685	1	254	1033	39
Turn Type	Split		Free	Split			Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			Free						2			6
Actuated Green, G (s)	20.0	20.0	150.0		33.0		12.3	65.0	65.0	16.0	68.7	68.7
Effective Green, g (s)	20.0	20.0	150.0		33.0		12.3	65.0	65.0	16.0	68.7	68.7
Actuated g/C Ratio	0.13	0.13	1.00		0.22		0.08	0.43	0.43	0.11	0.46	0.46
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	234	235	1583		388		145	2397	686	189	2534	725
v/s Ratio Prot	0.14	c0.15			c0.32		0.05	c0.49		c0.14	c0.19	
v/s Ratio Perm			0.02						0.00			0.02
v/c Ratio	1.05	1.10	0.02		1.43		0.62	1.12	0.00	1.34	0.41	0.05
Uniform Delay, d1	65.0	65.0	0.0		58.5		66.6	42.5	24.1	67.0	27.1	22.6
Progression Factor	1.00	1.00	1.00		1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	73.0	87.4	0.0		209.3		8.0	60.3	0.0	185.8	0.5	0.1
Delay (s)	138.0	152.4	0.0		267.8		74.6	102.8	24.1	252.8	27.6	22.7
Level of Service	F	F	A		F		E	F	C	F	C	C
Approach Delay (s)		135.6			267.8			101.9			68.9	
Approach LOS		F			F			F			E	

Intersection Summary			
HCM Average Control Delay	114.8	HCM Level of Service	F
HCM Volume to Capacity ratio	1.24		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	124.0%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

10: Farrington Hwy & D Street

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↑		↰↰	↑↑↑↱			↑↱	↱	↰	↰↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	*0.99		*0.99	*0.99			*0.99	*0.99	*0.99	*0.99	
Frt	1.00	1.00		1.00	0.99			0.91	0.85	1.00	0.91	
Flt Protected	0.95	1.00		0.95	1.00			1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	5532		3504	5478			1669	1567	1752	1678	
Flt Permitted	0.95	1.00		0.95	1.00			1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	5532		3504	5478			1669	1567	1752	1678	
Volume (vph)	146	1756	0	240	899	63	0	65	347	205	230	345
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	147	1774	0	242	908	64	0	66	351	207	232	348
RTOR Reduction (vph)	0	0	0	0	8	0	0	59	212	0	49	0
Lane Group Flow (vph)	147	1774	0	242	964	0	0	120	26	207	531	0
Turn Type	Prot			Prot					Perm	Split		
Protected Phases	5	2		1	6			8		4	4	
Permitted Phases									8			
Actuated Green, G (s)	12.1	42.8		7.0	37.7			12.2	12.2	32.0	32.0	
Effective Green, g (s)	12.1	42.8		7.0	37.7			12.2	12.2	32.0	32.0	
Actuated g/C Ratio	0.11	0.39		0.06	0.34			0.11	0.11	0.29	0.29	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	195	2152		223	1877			185	174	510	488	
v/s Ratio Prot	0.08	c0.32		c0.07	0.18			c0.07		0.12	c0.32	
v/s Ratio Perm									0.02			
v/c Ratio	0.75	0.82		1.09	0.51			0.65	0.15	0.41	1.09	
Uniform Delay, d1	47.5	30.2		51.5	28.8			46.9	44.2	31.4	39.0	
Progression Factor	0.72	0.57		0.66	0.52			1.00	1.00	1.00	1.00	
Incremental Delay, d2	10.6	2.6		84.4	1.0			7.9	0.4	0.5	66.8	
Delay (s)	44.7	19.7		118.4	15.9			54.8	44.6	31.9	105.8	
Level of Service	D	B		F	B			D	D	C	F	
Approach Delay (s)		21.6			36.3			49.0			86.3	
Approach LOS		C			D			D			F	

Intersection Summary			
HCM Average Control Delay	40.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	86.9%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
11: Farrington Hwy & E Street

2030 + PRO (without Transit Corridor) - AM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↱			↑↑↱			✥		↰	↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0			4.0		4.0	4.0	
Lane Util. Factor	1.00	*0.99			*0.99			1.00		1.00	1.00	
Frt	1.00	0.99			1.00			1.00		1.00	0.92	
Flt Protected	0.95	1.00			1.00			0.97		0.95	1.00	
Satd. Flow (prot)	1770	5503			5515			1812		1770	1722	
Flt Permitted	0.95	1.00			1.00			0.97		0.95	1.00	
Satd. Flow (perm)	1770	5503			5515			1812		1770	1722	
Volume (vph)	51	1764	64	0	1217	27	218	189	5	133	49	50
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	55	1917	70	0	1323	29	237	205	5	145	53	54
RTOR Reduction (vph)	0	4	0	0	2	0	0	1	0	0	34	0
Lane Group Flow (vph)	55	1983	0	0	1350	0	0	446	0	145	73	0
Turn Type	Prot						Split			Split		
Protected Phases	5	2			6		8	8		4	4	
Permitted Phases												
Actuated Green, G (s)	4.8	54.6			45.8			30.0		13.4	13.4	
Effective Green, g (s)	4.8	54.6			45.8			30.0		13.4	13.4	
Actuated g/C Ratio	0.04	0.50			0.42			0.27		0.12	0.12	
Clearance Time (s)	4.0	4.0			4.0			4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0			3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)	77	2731			2296			494		216	210	
v/s Ratio Prot	0.03	c0.36			0.24			c0.25		c0.08	0.04	
v/s Ratio Perm												
v/c Ratio	0.71	0.73			0.59			0.90		0.67	0.35	
Uniform Delay, d1	51.9	21.8			24.8			38.6		46.2	44.3	
Progression Factor	0.90	0.78			0.63			1.00		1.00	1.00	
Incremental Delay, d2	21.3	1.3			0.9			19.7		7.9	1.0	
Delay (s)	68.0	18.4			16.5			58.3		54.1	45.3	
Level of Service	E	B			B			E		D	D	
Approach Delay (s)		19.7			16.5			58.3			50.4	
Approach LOS		B			B			E			D	

Intersection Summary			
HCM Average Control Delay	24.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	71.2%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
12: Fort Barrette Road & Farrington Hwy

2030 + PRO (without Transit Corridor) - AM Peak

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰↰	↑↱	↱	↰↰	↑↑	↱	↰↰	↑↑	↱	↰	↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*0.99	*0.99	*0.99	*0.99	*0.99	1.00	*0.99	*0.99	1.00	1.00	*0.99	1.00
Frt	1.00	0.96	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3504	3538	1567	3504	3688	1583	3504	3688	1583	1770	3688	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3504	3538	1567	3504	3688	1583	3504	3688	1583	1770	3688	1583
Volume (vph)	377	708	799	572	579	161	338	441	485	80	743	707
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	381	715	807	578	585	163	341	445	490	81	751	714
RTOR Reduction (vph)	0	20	155	0	0	98	0	0	247	0	0	253
Lane Group Flow (vph)	381	951	386	578	585	65	341	445	243	81	751	461
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases			6			2			4			8
Actuated Green, G (s)	26.1	64.0	64.0	34.9	72.8	72.8	21.1	67.2	67.2	13.9	60.0	60.0
Effective Green, g (s)	26.1	64.0	64.0	34.9	72.8	72.8	21.1	67.2	67.2	13.9	60.0	60.0
Actuated g/C Ratio	0.13	0.33	0.33	0.18	0.37	0.37	0.11	0.34	0.34	0.07	0.31	0.31
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	467	1155	512	624	1370	588	377	1264	543	126	1129	485
v/s Ratio Prot	0.11	c0.27		c0.16	0.16		c0.10	0.12		0.05	0.20	
v/s Ratio Perm			0.25			0.04			0.15			c0.29
v/c Ratio	0.82	0.83	0.75	0.93	0.43	0.11	0.90	0.35	0.45	0.64	0.67	0.95
Uniform Delay, d1	82.6	61.0	59.0	79.3	46.0	40.4	86.5	48.1	50.0	88.6	59.2	66.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	10.5	5.3	6.2	19.8	1.0	0.4	24.3	0.2	0.6	10.7	1.5	28.8
Delay (s)	93.2	66.3	65.2	99.1	47.0	40.8	110.7	48.3	50.6	99.3	60.7	95.4
Level of Service	F	E	E	F	D	D	F	D	D	F	E	F
Approach Delay (s)		71.4			68.9			65.9			78.8	
Approach LOS		E			E			E			E	

Intersection Summary			
HCM Average Control Delay	71.6	HCM Level of Service	E
HCM Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	196.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	87.9%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
13: WB Ramps & North-South Road

2030 + PRO (without Transit Corridor) - AM Peak

Movement	WBL2	WBL	WBR	NBL	NBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰↰		↱				↑↑	↱	↰↰	↑↑	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0				4.0	4.0	4.0	4.0	
Lane Util. Factor	*0.99		1.00				*0.99	1.00	0.97	*0.99	
Frt	1.00		0.85				1.00	0.85	1.00	1.00	
Flt Protected	0.95		1.00				1.00	1.00	0.95	1.00	
Satd. Flow (prot)	3504		1583				3688	1583	3433	3688	
Flt Permitted	0.95		1.00				1.00	1.00	0.95	1.00	
Satd. Flow (perm)	3504		1583				3688	1583	3433	3688	
Volume (vph)	1414	0	115	0	0	0	1103	248	585	244	0
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	1428	0	116	0	0	0	1114	251	591	246	0
RTOR Reduction (vph)	0	0	70	0	0	0	0	173	0	0	0
Lane Group Flow (vph)	1428	0	46	0	0	0	1114	78	591	246	0
Turn Type	Prot		custom					Perm	Prot		
Protected Phases	8		8				6		5	2	
Permitted Phases								6			
Actuated Green, G (s)	40.0		40.0				31.0	31.0	17.0	52.0	
Effective Green, g (s)	40.0		40.0				31.0	31.0	17.0	52.0	
Actuated g/C Ratio	0.40		0.40				0.31	0.31	0.17	0.52	
Clearance Time (s)	4.0		4.0				4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0		3.0				3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	1402		633				1143	491	584	1918	
v/s Ratio Prot	c0.41		0.03				c0.30		c0.17	0.07	
v/s Ratio Perm								0.05			
v/c Ratio	1.02		0.07				0.97	0.16	1.01	0.13	
Uniform Delay, d1	30.0		18.5				34.1	25.0	41.5	12.3	
Progression Factor	1.00		1.00				1.00	1.00	0.40	0.48	
Incremental Delay, d2	28.8		0.0				21.2	0.7	34.6	0.1	
Delay (s)	58.8		18.6				55.3	25.7	51.1	6.0	
Level of Service	E		B				E	C	D	A	
Approach Delay (s)		55.8		0.0			49.9			37.9	
Approach LOS		E		A			D			D	

Intersection Summary			
HCM Average Control Delay	49.6	HCM Level of Service	D
HCM Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	96.7%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
14: EB Ramps & North-South Road

2030 + PRO (without Transit Corridor) - AM Peak

Movement	EBL2	EBL	EBR	SBL	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰		↱			↰↰	↑↑			↑↑	↱↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0			4.0	4.0			4.0	4.0
Lane Util. Factor	1.00		1.00			0.97	*0.99			*0.99	*0.99
Frt	1.00		0.85			1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (prot)	1770		1583			3433	3688			3688	3135
Flt Permitted	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (perm)	1770		1583			3433	3688			3688	3135
Volume (vph)	51	0	689	0	0	803	1714	0	0	778	2380
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	52	0	696	0	0	811	1731	0	0	786	2404
RTOR Reduction (vph)	0	0	18	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	52	0	678	0	0	811	1731	0	0	786	2404
Turn Type	Prot		custom			Prot					Free
Protected Phases	4		4			1	6			2	
Permitted Phases											Free
Actuated Green, G (s)	29.0		29.0			29.4	63.0			29.6	100.0
Effective Green, g (s)	29.0		29.0			29.4	63.0			29.6	100.0
Actuated g/C Ratio	0.29		0.29			0.29	0.63			0.30	1.00
Clearance Time (s)	4.0		4.0			4.0	4.0			4.0	
Vehicle Extension (s)	3.0		3.0			3.0	3.0			3.0	
Lane Grp Cap (vph)	513		459			1009	2323			1092	3135
v/s Ratio Prot	0.03		c0.43			0.24	0.47			0.21	
v/s Ratio Perm											c0.77
v/c Ratio	0.10		1.48			0.80	0.75			0.72	0.77
Uniform Delay, d1	26.0		35.5			32.6	12.9			31.5	0.0
Progression Factor	1.00		1.00			0.94	0.29			1.00	1.00
Incremental Delay, d2	0.1		225.8			1.1	0.5			4.1	1.9
Delay (s)	26.1		261.3			31.6	4.3			35.6	1.9
Level of Service	C		F			C	A			D	A
Approach Delay (s)		244.9		0.0			13.0			10.2	
Approach LOS		F		A			B			B	

Intersection Summary			
HCM Average Control Delay	38.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	96.7%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
15: North-South Road & Farrington Hwy

2030 + PRO (without Transit Corridor) - AM Peak

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰↰	↑↑↑	↱	↰↰	↑↑↑	↱	↰↰	↑↑	↱	↰↰	↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*0.99	*0.99	1.00	*0.99	*0.99	1.00	*0.99	*0.99	1.00	*0.99	*0.99	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3504	5532	1583	3504	5532	1583	3504	3688	1583	3504	3688	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3504	5532	1583	3504	5532	1583	3504	3688	1583	3504	3688	1583
Volume (vph)	765	1166	567	463	1804	349	544	404	227	176	488	810
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	773	1178	573	468	1822	353	549	408	229	178	493	818
RTOR Reduction (vph)	0	0	221	0	0	152	0	0	153	0	0	228
Lane Group Flow (vph)	773	1178	352	468	1822	201	549	408	76	178	493	590
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases			6			2			4			8
Actuated Green, G (s)	27.0	48.7	48.7	23.3	45.0	45.0	26.0	49.7	49.7	12.3	36.0	36.0
Effective Green, g (s)	27.0	48.7	48.7	23.3	45.0	45.0	26.0	49.7	49.7	12.3	36.0	36.0
Actuated g/C Ratio	0.18	0.32	0.32	0.16	0.30	0.30	0.17	0.33	0.33	0.08	0.24	0.24
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	631	1796	514	544	1660	475	607	1222	525	287	885	380
v/s Ratio Prot	c0.22	0.21		0.13	c0.33		c0.16	0.11		0.05	0.13	
v/s Ratio Perm			c0.22			0.13			0.05			c0.37
v/c Ratio	1.23	0.66	0.69	0.86	1.10	0.42	0.90	0.33	0.14	0.62	0.56	1.55
Uniform Delay, d1	61.5	43.5	44.0	61.8	52.5	42.1	60.8	37.7	35.2	66.6	50.0	57.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	114.9	0.9	3.8	13.1	53.9	0.6	19.4	0.7	0.6	4.1	2.5	261.3
Delay (s)	176.4	44.3	47.8	74.9	106.4	42.7	80.1	38.4	35.8	70.7	52.5	318.3
Level of Service	F	D	D	E	F	D	F	D	D	E	D	F
Approach Delay (s)		85.6			92.3			57.2			200.7	
Approach LOS		F			F			E			F	

Intersection Summary			
HCM Average Control Delay	105.4	HCM Level of Service	F
HCM Volume to Capacity ratio	1.23		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	110.5%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
16: North-South Road & North UH Connector

2030 + PRO (without Transit Corridor) - AM Peak

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰	↑↑↑↱	↱	↰↰	↑↑↑↱		↰↰	↑↱		↰↰	↑	↱↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	1.00	*0.99	0.86	*0.99	*0.99		*0.99	*0.99		*0.99	1.00	*0.99
Frt	1.00	1.00	0.85	1.00	0.98		1.00	0.98		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1770	5532	1362	3504	5424		3504	3608		3504	1863	3135
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	1770	5532	1362	3504	5424		3504	3608		3504	1863	3135
Volume (vph)	51	2067	233	489	940	141	220	163	28	367	107	329
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	52	2088	235	494	949	142	222	165	28	371	108	332
RTOR Reduction (vph)	0	0	105	0	17	0	0	13	0	0	0	38
Lane Group Flow (vph)	52	2088	130	494	1074	0	222	180	0	371	108	294
Turn Type	Prot		Perm	Prot			Prot			Prot		pm+ov
Protected Phases	5	2		1	6		7	4		3	8	1
Permitted Phases			2									8
Actuated Green, G (s)	6.7	54.9	54.9	17.9	66.1		12.4	11.9		14.0	13.5	31.4
Effective Green, g (s)	6.7	54.9	54.9	17.9	66.1		12.4	11.9		14.0	13.5	31.4
Actuated g/C Ratio	0.06	0.48	0.48	0.16	0.58		0.11	0.10		0.12	0.12	0.27
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	103	2648	652	547	3126		379	374		428	219	968
v/s Ratio Prot	0.03	c0.38		c0.14	0.20		0.06	0.05		c0.11	c0.06	0.05
v/s Ratio Perm			0.10									0.05
v/c Ratio	0.50	0.79	0.20	0.90	0.34		0.59	0.48		0.87	0.49	0.30
Uniform Delay, d1	52.4	25.0	17.2	47.5	12.8		48.7	48.5		49.4	47.4	33.0
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	3.9	2.5	0.7	18.2	0.3		2.3	1.0		16.6	1.7	0.2
Delay (s)	56.2	27.5	17.9	65.7	13.1		51.0	49.5		66.1	49.1	33.2
Level of Service	E	C	B	E	B		D	D		E	D	C
Approach Delay (s)		27.2			29.5			50.3			50.3	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM Average Control Delay	33.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	114.7	Sum of lost time (s)	12.0
Intersection Capacity Utilization	84.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
17: East-West Rd. & North-South Road

2030 + PRO (without Transit Corridor) - AM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↱		↰↰	↑↱		↰↰	↑↑↱		↰↰	↑↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	*0.99	0.95		0.97	*0.99		*0.99	*0.99		*0.99	*0.99	
Frt	1.00	0.95		1.00	0.87		1.00	0.98		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	3504	3363		3433	3217		3504	5428		3504	5407	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	3504	3363		3433	3217		3504	5428		3504	5407	
Volume (vph)	244	225	112	245	113	652	207	1454	209	193	970	173
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	265	245	122	266	123	709	225	1580	227	210	1054	188
RTOR Reduction (vph)	0	51	0	0	196	0	0	19	0	0	25	0
Lane Group Flow (vph)	265	316	0	266	636	0	225	1788	0	210	1217	0
Turn Type	Prot			Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases												
Actuated Green, G (s)	13.0	23.4		13.3	23.7		11.7	37.1		16.0	41.4	
Effective Green, g (s)	13.0	23.4		13.3	23.7		11.7	37.1		16.0	41.4	
Actuated g/C Ratio	0.12	0.22		0.13	0.22		0.11	0.35		0.15	0.39	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	431	744		432	721		387	1903		530	2116	
v/s Ratio Prot	0.08	0.09		c0.08	c0.20		c0.06	c0.33		c0.06	0.23	
v/s Ratio Perm												
v/c Ratio	0.61	0.42		0.62	1.30dr		0.58	0.94		0.40	0.58	
Uniform Delay, d1	44.0	35.4		43.8	39.7		44.7	33.3		40.5	25.3	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	2.6	0.4		2.6	12.3		2.2	10.6		2.2	1.1	
Delay (s)	46.6	35.8		46.4	52.0		46.9	43.9		42.7	26.4	
Level of Service	D	D		D	D		D	D		D	C	
Approach Delay (s)		40.3			50.7			44.2			28.8	
Approach LOS		D			D			D			C	

Intersection Summary

HCM Average Control Delay	40.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	105.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	82.8%	ICU Level of Service	E
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.
c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
18: North-South Road & Kapolei Parkway

2030 + PRO (without Transit Corridor) - AM Peak

Movement	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰	↑↑↱		↰	↑↑↱		↰↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.91		1.00	0.91		0.97	0.91	1.00	1.00	0.91	1.00
Frt	1.00	0.98		1.00	0.92		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	5001		1770	4670		3433	5085	1583	1770	5085	1583
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	5001		1770	4670		3433	5085	1583	1770	5085	1583
Volume (vph)	245	519	64	229	500	597	860	315	316	118	637	491
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	266	564	70	249	543	649	935	342	343	128	692	534
RTOR Reduction (vph)	0	11	0	0	154	0	0	0	213	0	0	230
Lane Group Flow (vph)	266	623	0	249	1038	0	935	342	130	128	692	304
Turn Type	Prot			Prot			Prot		Perm	Prot		Perm
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases									4			8
Actuated Green, G (s)	22.0	33.7		22.3	34.0		39.0	52.6	52.6	14.6	28.2	28.2
Effective Green, g (s)	22.0	33.7		22.3	34.0		39.0	52.6	52.6	14.6	28.2	28.2
Actuated g/C Ratio	0.16	0.24		0.16	0.24		0.28	0.38	0.38	0.10	0.20	0.20
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	280	1211		284	1141		962	1921	598	186	1030	321
v/s Ratio Prot	c0.15	0.12		0.14	c0.22		c0.27	0.07		0.07	0.14	
v/s Ratio Perm									0.08			c0.19
v/c Ratio	0.95	0.51		0.88	1.20dr		0.97	0.18	0.22	0.69	0.67	0.95
Uniform Delay, d1	58.1	45.7		57.1	51.1		49.6	28.9	29.3	60.1	51.2	54.8
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	39.8	1.6		24.7	12.2		22.3	0.0	0.2	10.1	1.7	36.3
Delay (s)	97.9	47.2		81.8	63.3		71.9	28.9	29.5	70.2	53.0	91.1
Level of Service	F	D		F	E		E	C	C	E	D	F
Approach Delay (s)		62.2			66.5			53.8			69.6	
Approach LOS		E			E			D			E	

Intersection Summary

HCM Average Control Delay	62.7	HCM Level of Service	E
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	139.2	Sum of lost time (s)	12.0
Intersection Capacity Utilization	86.8%	ICU Level of Service	E
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.
c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
19: East-West Rd. & Old Fort Weaver Rd

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↰	↑	↑↑	↱	↰↰	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	0.97	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1863	3539	1583	3433	1583
Flt Permitted	0.56	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1046	1863	3539	1583	3433	1583
Volume (vph)	21	893	310	1006	487	45
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	21	902	313	1016	492	45
RTOR Reduction (vph)	0	0	0	461	0	31
Lane Group Flow (vph)	21	902	313	555	492	14
Turn Type	Perm			Perm		Perm
Protected Phases		4	8		6	
Permitted Phases	4			8		6
Actuated Green, G (s)	29.3	29.3	29.3	29.3	16.3	16.3
Effective Green, g (s)	29.3	29.3	29.3	29.3	16.3	16.3
Actuated g/C Ratio	0.55	0.55	0.55	0.55	0.30	0.30
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	572	1018	1935	865	1044	481
v/s Ratio Prot		c0.48	0.09		c0.14	
v/s Ratio Perm	0.02			0.35		0.01
v/c Ratio	0.04	0.89	0.16	0.64	0.47	0.03
Uniform Delay, d1	5.6	10.7	6.0	8.5	15.1	13.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.0	9.4	0.0	1.6	1.5	0.1
Delay (s)	5.6	20.1	6.1	10.1	16.7	13.2
Level of Service	A	C	A	B	B	B
Approach Delay (s)		19.7	9.2		16.4	
Approach LOS		B	A		B	

Intersection Summary			
HCM Average Control Delay	14.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	53.6	Sum of lost time (s)	8.0
Intersection Capacity Utilization	72.3%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
20: Farrington Hwy & B Street

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰↰	↑↑	↱	↰↰	↑↑	↱	↰	↑	↱	↰↰	↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3539	1583	3433	3539	1583	1770	1863	1583	3433	1863	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3539	1583	3433	3539	1583	1770	1863	1583	3433	1863	1583
Volume (vph)	215	1127	203	124	897	87	49	137	126	343	223	206
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	234	1225	221	135	975	95	53	149	137	373	242	224
RTOR Reduction (vph)	0	0	107	0	0	64	0	0	10	0	0	58
Lane Group Flow (vph)	234	1225	114	135	975	31	53	149	127	373	242	166
Turn Type	Prot		pm+ov	Prot		Perm	Prot		pm+ov	Prot		pm+ov
Protected Phases	5	2	3	1	6		7	4	5	3	8	1
Permitted Phases			2			6			4			8
Actuated Green, G (s)	10.4	31.0	41.0	5.0	25.6	25.6	3.5	17.7	28.1	10.0	24.2	29.2
Effective Green, g (s)	10.4	31.0	41.0	5.0	25.6	25.6	3.5	17.7	28.1	10.0	24.2	29.2
Actuated g/C Ratio	0.13	0.39	0.51	0.06	0.32	0.32	0.04	0.22	0.35	0.13	0.30	0.37
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	448	1377	894	215	1137	508	78	414	638	431	566	659
v/s Ratio Prot	c0.07	c0.35	0.02	0.04	0.28		0.03	0.08	0.03	c0.11	c0.13	0.02
v/s Ratio Perm			0.06			0.02			0.05			0.09
v/c Ratio	0.52	0.89	0.13	0.63	0.86	0.06	0.68	0.36	0.20	0.87	0.43	0.25
Uniform Delay, d1	32.3	22.8	10.1	36.4	25.3	18.7	37.5	26.2	18.0	34.2	22.2	17.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.1	7.4	0.1	5.6	6.6	0.0	21.0	2.4	0.2	16.4	2.4	0.2
Delay (s)	33.4	30.2	10.1	42.1	31.9	18.8	58.6	28.6	18.1	50.6	24.6	17.8
Level of Service	C	C	B	D	C	B	E	C	B	D	C	B
Approach Delay (s)		28.0			32.0			29.1			34.3	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	30.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	79.7	Sum of lost time (s)	12.0
Intersection Capacity Utilization	65.0%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
21: East-West Rd. & A Street

2030 + PRO (without Transit Corridor) - AM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	1.00	0.85	1.00	0.86		1.00	0.88	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1842		1770	1863	1583	1770	1597		1770	1630	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	1842		1770	1863	1583	1770	1597		1770	1630	
Volume (vph)	90	328	27	31	700	74	93	7	140	44	7	37
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	98	357	29	34	761	80	101	8	152	48	8	40
RTOR Reduction (vph)	0	2	0	0	0	34	0	134	0	0	36	0
Lane Group Flow (vph)	98	384	0	34	761	46	101	26	0	48	12	0
Turn Type	Prot			Prot		Perm	Split			Split		
Protected Phases	5	2		1	6		4	4		8	8	
Permitted Phases						6						
Actuated Green, G (s)	7.8	44.1		2.2	38.5	38.5	9.7	9.7		7.7	7.7	
Effective Green, g (s)	7.8	44.1		2.2	38.5	38.5	9.7	9.7		7.7	7.7	
Actuated g/C Ratio	0.10	0.55		0.03	0.48	0.48	0.12	0.12		0.10	0.10	
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	173	1019		49	900	765	215	194		171	157	
v/s Ratio Prot	c0.06	0.21		0.02	c0.41		c0.06	0.02		c0.03	0.01	
v/s Ratio Perm						0.03						
v/c Ratio	0.57	0.38		0.69	0.85	0.06	0.47	0.14		0.28	0.08	
Uniform Delay, d1	34.3	10.0		38.4	18.0	11.0	32.6	31.3		33.4	32.8	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	4.2	0.2		34.8	7.4	0.0	1.6	0.3		0.9	0.2	
Delay (s)	38.5	10.3		73.2	25.4	11.0	34.2	31.6		34.3	33.0	
Level of Service	D	B		E	C	B	C	C		C	C	
Approach Delay (s)		16.0			25.9			32.6			33.6	
Approach LOS		B			C			C			C	

Intersection Summary			
HCM Average Control Delay	24.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	79.7	Sum of lost time (s)	16.0
Intersection Capacity Utilization	67.5%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
22: Farrington Hwy & 2nd Avenue

2030 + PRO (without Transit Corridor) - AM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.91		0.97	0.95	1.00	1.00	0.95	0.88	0.97	0.95	1.00
Frt	1.00	0.99		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	5044		3433	3539	1583	1770	3539	2787	3433	3539	1583
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	5044		3433	3539	1583	1770	3539	2787	3433	3539	1583
Volume (vph)	172	1091	63	241	945	299	98	391	547	241	259	138
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	187	1186	68	262	1027	325	107	425	595	262	282	150
RTOR Reduction (vph)	0	6	0	0	0	213	0	0	17	0	0	109
Lane Group Flow (vph)	187	1248	0	262	1027	112	107	425	578	262	282	41
Turn Type	Prot			Prot		Perm	Prot		pm+ov	Prot		Perm
Protected Phases	5	2		1	6		3	8	1	7	4	
Permitted Phases						6			8			4
Actuated Green, G (s)	15.0	40.0		13.0	38.0	38.0	11.0	30.2	43.2	10.8	30.0	30.0
Effective Green, g (s)	15.0	40.0		13.0	38.0	38.0	11.0	30.2	43.2	10.8	30.0	30.0
Actuated g/C Ratio	0.14	0.36		0.12	0.35	0.35	0.10	0.27	0.39	0.10	0.27	0.27
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	241	1834		406	1223	547	177	972	1196	337	965	432
v/s Ratio Prot	0.11	c0.25		0.08	c0.29		0.06	0.12	c0.06	c0.08	0.08	
v/s Ratio Perm						0.07			0.15			0.03
v/c Ratio	0.78	0.68		0.65	0.84	0.21	0.60	0.44	0.48	0.78	0.29	0.09
Uniform Delay, d1	45.9	29.6		46.3	33.2	25.4	47.4	32.9	25.0	48.4	31.6	29.9
Progression Factor	1.00	1.00		0.59	0.64	1.27	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	14.4	2.1		2.8	5.6	0.7	5.7	1.4	0.3	10.8	0.8	0.4
Delay (s)	60.3	31.7		29.8	27.0	32.9	53.1	34.3	25.3	59.2	32.4	30.3
Level of Service	E	C		C	C	C	D	C	C	E	C	C
Approach Delay (s)		35.4			28.6			31.4			42.0	
Approach LOS		D			C			C			D	

Intersection Summary			
HCM Average Control Delay	33.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	66.7%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
23: 2nd Avenue & Kunia Road

2030 + PRO (without Transit Corridor) - AM Peak

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations		↱	↑↑↑↱			↑↑↑↑
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	0	0	1976	301	0	5208
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	2148	327	0	5661
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)			870			
pX, platoon unblocked	0.91	0.91			0.91	
vC, conflicting volume	3727	701			2475	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	3698	358			2317	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	3	578			192	

Direction, Lane #	EB 1	SE 1	SE 2	SE 3	SE 4	NW 1	NW 2	NW 3	NW 4
Volume Total	0	614	614	614	634	1415	1415	1415	1415
Volume Left	0	0	0	0	0	0	0	0	0
Volume Right	0	0	0	0	327	0	0	0	0
cSH	1700	1700	1700	1700	1700	1700	1700	1700	1700
Volume to Capacity	0.00	0.36	0.36	0.36	0.37	0.83	0.83	0.83	0.83
Queue Length 95th (ft)	0	0	0	0	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane LOS	A								
Approach Delay (s)	0.0	0.0				0.0			
Approach LOS	A								

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	78.8%	ICU Level of Service	D
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
24: 3rd Avenue & Kunia Road

2030 + PRO (without Transit Corridor) - AM Peak

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations		↱	↑↑↑↱			↑↑↑↑
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	0	7	1846	129	0	5208
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	8	2007	140	0	5661
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)			1234			
pX, platoon unblocked	0.98	0.98			0.98	
vC, conflicting volume	3492	572			2147	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	3483	510			2113	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	98			100	
cM capacity (veh/h)	5	499			251	

Direction, Lane #	EB 1	SE 1	SE 2	SE 3	SE 4	NW 1	NW 2	NW 3	NW 4
Volume Total	8	573	573	573	427	1415	1415	1415	1415
Volume Left	0	0	0	0	0	0	0	0	0
Volume Right	8	0	0	0	140	0	0	0	0
cSH	499	1700	1700	1700	1700	1700	1700	1700	1700
Volume to Capacity	0.02	0.34	0.34	0.34	0.25	0.83	0.83	0.83	0.83
Queue Length 95th (ft)	1	0	0	0	0	0	0	0	0
Control Delay (s)	12.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane LOS	B								
Approach Delay (s)	12.3	0.0				0.0			
Approach LOS	B								

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	78.8%	ICU Level of Service	D
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
25: East-West Rd. & B Street

2030 + PRO (without Transit Corridor) - AM Peak

Movement	EBL	EBT	WBT	WBR	SEL	SER
Lane Configurations	↰	↑	↑	↱	↰	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1863	1863	1583	1770	1583
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1863	1863	1583	1770	1583
Volume (vph)	156	302	313	86	648	492
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	170	328	340	93	704	535
RTOR Reduction (vph)	0	0	0	71	0	268
Lane Group Flow (vph)	170	328	340	22	704	267
Turn Type	Prot			Prot		Prot
Protected Phases	5	2	6	6	4	4
Permitted Phases						
Actuated Green, G (s)	7.9	26.9	15.0	15.0	28.1	28.1
Effective Green, g (s)	7.9	26.9	15.0	15.0	28.1	28.1
Actuated g/C Ratio	0.13	0.43	0.24	0.24	0.45	0.45
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	222	795	444	377	789	706
v/s Ratio Prot	c0.10	0.18	c0.18	0.01	c0.40	0.17
v/s Ratio Perm						
v/c Ratio	0.77	0.41	0.77	0.06	0.89	0.38
Uniform Delay, d1	26.7	12.6	22.4	18.5	16.1	11.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	14.5	0.3	7.7	0.1	14.5	1.5
Delay (s)	41.2	12.9	30.1	18.6	30.6	13.2
Level of Service	D	B	C	B	C	B
Approach Delay (s)		22.6	27.6		23.1	
Approach LOS		C	C		C	

Intersection Summary			
HCM Average Control Delay	23.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	63.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	71.0%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
26: Farrington Hwy &

2030 + PRO (without Transit Corridor) - AM Peak

Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations	↰	↱	↰	↑↑	↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	*0.99	*0.99	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3688	3688	1583
Flt Permitted	0.95	1.00	0.25	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	466	3688	3688	1583
Volume (vph)	109	234	51	1066	1384	134
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	110	236	52	1077	1398	135
RTOR Reduction (vph)	0	5	0	0	0	81
Lane Group Flow (vph)	110	231	52	1077	1398	54
Turn Type		Perm	Perm			Perm
Protected Phases	6			4	8	
Permitted Phases		6	4			8
Actuated Green, G (s)	16.0	16.0	16.0	16.0	16.0	16.0
Effective Green, g (s)	16.0	16.0	16.0	16.0	16.0	16.0
Actuated g/C Ratio	0.40	0.40	0.40	0.40	0.40	0.40
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	708	633	186	1475	1475	633
v/s Ratio Prot	0.06			0.29	c0.38	
v/s Ratio Perm		c0.15	0.11			0.03
v/c Ratio	0.16	0.36	0.28	0.73	0.95	0.09
Uniform Delay, d1	7.7	8.4	8.1	10.2	11.6	7.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.5	1.6	3.7	3.2	13.9	0.3
Delay (s)	8.1	10.0	11.8	13.4	25.5	7.7
Level of Service	A	B	B	B	C	A
Approach Delay (s)	9.4			13.3	23.9	
Approach LOS	A			B	C	

Intersection Summary			
HCM Average Control Delay	18.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	40.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	59.4%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
1: Kunia Loop & Kunia Road

2030 + PRO (without Transit Corridor) - PM Peak

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↰	↱	↑↑	↱		↑↑↑
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0		4.0
Lane Util. Factor	*0.99	1.00	*0.99	1.00		*0.99
Frt	1.00	0.85	1.00	0.85		1.00
Flt Protected	0.95	1.00	1.00	1.00		1.00
Satd. Flow (prot)	3504	1583	3688	1583		5532
Flt Permitted	0.95	1.00	1.00	1.00		1.00
Satd. Flow (perm)	3504	1583	3688	1583		5532
Volume (vph)	892	41	2670	918	0	2765
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	901	41	2697	927	0	2793
RTOR Reduction (vph)	0	4	0	180	0	0
Lane Group Flow (vph)	901	37	2697	747	0	2793
Turn Type		Perm		Perm		
Protected Phases	8		2			6
Permitted Phases		8		2		
Actuated Green, G (s)	36.0	36.0	106.0	106.0		106.0
Effective Green, g (s)	36.0	36.0	106.0	106.0		106.0
Actuated g/C Ratio	0.24	0.24	0.71	0.71		0.71
Clearance Time (s)	4.0	4.0	4.0	4.0		4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0		3.0
Lane Grp Cap (vph)	841	380	2606	1119		3909
v/s Ratio Prot	c0.26		c0.73			0.50
v/s Ratio Perm		0.02		0.47		
v/c Ratio	1.07	0.10	1.03	0.67		0.71
Uniform Delay, d1	57.0	44.4	22.0	12.2		13.0
Progression Factor	1.00	1.00	1.14	1.31		1.00
Incremental Delay, d2	52.0	0.1	26.1	2.7		1.1
Delay (s)	109.0	44.5	51.2	18.6		14.2
Level of Service	F	D	D	B		B
Approach Delay (s)	106.2		42.9			14.2
Approach LOS	F		D			B

Intersection Summary

HCM Average Control Delay	40.1	HCM Level of Service	D
HCM Volume to Capacity ratio	1.04		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	105.9%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
2: H-1 WB On-Ramp & Kunia Road

2030 + PRO (without Transit Corridor) - PM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations						↱	↰	↑↑↑			↑↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)						4.0	4.0	4.0			4.0	
Lane Util. Factor						1.00	1.00	*0.99			*0.99	
Frt						0.86	1.00	1.00			0.99	
Flt Protected						1.00	0.95	1.00			1.00	
Satd. Flow (prot)						1611	1770	5532			5455	
Flt Permitted						1.00	0.95	1.00			1.00	
Satd. Flow (perm)						1611	1770	5532			5455	
Volume (vph)	0	0	0	0	0	1230	427	2358	0	0	3316	341
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	0	0	0	0	0	1242	431	2382	0	0	3349	344
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	9	0
Lane Group Flow (vph)	0	0	0	0	0	1242	431	2382	0	0	3684	0
Turn Type						Free	Prot					
Protected Phases							5	2			6	
Permitted Phases						Free						
Actuated Green, G (s)						150.0	35.0	150.0			107.0	
Effective Green, g (s)						150.0	35.0	150.0			107.0	
Actuated g/C Ratio						1.00	0.23	1.00			0.71	
Clearance Time (s)							4.0	4.0			4.0	
Vehicle Extension (s)							3.0	3.0			3.0	
Lane Grp Cap (vph)						1611	413	5532			3891	
v/s Ratio Prot							c0.24	0.43			c0.68	
v/s Ratio Perm						0.77						
v/c Ratio						0.77	1.04	0.43			0.95	
Uniform Delay, d1						0.0	57.5	0.0			19.0	
Progression Factor						1.00	0.93	1.00			0.76	
Incremental Delay, d2						3.6	53.4	0.2			4.0	
Delay (s)						3.6	106.9	0.2			18.5	
Level of Service						A	F	A			B	
Approach Delay (s)		0.0			3.6			16.6			18.5	
Approach LOS		A			A			B			B	

Intersection Summary

HCM Average Control Delay	15.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	102.0%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
3: H-1 EB & Kunia Road

2030 + PRO (without Transit Corridor) - PM Peak

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations	↰↰	↱	↑↑↑↑			↑↑↑
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0			4.0
Lane Util. Factor	*0.99	1.00	*0.99			*0.99
Frt	1.00	0.85	1.00			1.00
Flt Protected	0.95	1.00	1.00			1.00
Satd. Flow (prot)	3504	1583	7376			5532
Flt Permitted	0.95	1.00	1.00			1.00
Satd. Flow (perm)	3504	1583	7376			5532
Volume (vph)	530	584	4854	0	0	2355
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	576	635	5276	0	0	2560
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	576	635	5276	0	0	2560
Turn Type		Free				
Protected Phases	4		6			2
Permitted Phases		Free				
Actuated Green, G (s)	29.2	150.0	112.8			112.8
Effective Green, g (s)	29.2	150.0	112.8			112.8
Actuated g/C Ratio	0.19	1.00	0.75			0.75
Clearance Time (s)	4.0		4.0			4.0
Vehicle Extension (s)	3.0		3.0			3.0
Lane Grp Cap (vph)	682	1583	5547			4160
v/s Ratio Prot	c0.16		c0.72			0.46
v/s Ratio Perm		0.40				
v/c Ratio	0.84	0.40	0.95			0.62
Uniform Delay, d1	58.2	0.0	16.2			8.6
Progression Factor	1.00	1.00	1.01			0.97
Incremental Delay, d2	9.4	0.8	5.0			0.6
Delay (s)	67.6	0.8	21.4			8.9
Level of Service	E	A	C			A
Approach Delay (s)	32.6		21.4			8.9
Approach LOS	C		C			A

Intersection Summary			
HCM Average Control Delay	19.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	141.0%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
4: Farrington Hwy & Fort Weaver Road SB Ramp

2030 + PRO (without Transit Corridor) - PM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↱		↰↰	↑↑↑				↱			↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0				4.0			4.0
Lane Util. Factor		*0.99		*0.99	*0.99				1.00			1.00
Frt		0.98		1.00	1.00				0.86			0.86
Flt Protected		1.00		0.95	1.00				1.00			1.00
Satd. Flow (prot)		5402		3504	5532				1611			1611
Flt Permitted		1.00		0.95	1.00				1.00			1.00
Satd. Flow (perm)		5402		3504	5532				1611			1611
Volume (vph)	0	2308	429	779	1962	0	0	0	440	0	0	903
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	0	2331	433	787	1982	0	0	0	444	0	0	912
RTOR Reduction (vph)	0	21	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	2743	0	787	1982	0	0	0	444	0	0	912
Turn Type				Prot					Free			Free
Protected Phases		2		1	6							
Permitted Phases									Free			Free
Actuated Green, G (s)		79.0		63.0	150.0				150.0			150.0
Effective Green, g (s)		79.0		63.0	150.0				150.0			150.0
Actuated g/C Ratio		0.53		0.42	1.00				1.00			1.00
Clearance Time (s)		4.0		4.0	4.0							
Vehicle Extension (s)		3.0		3.0	3.0							
Lane Grp Cap (vph)		2845		1472	5532				1611			1611
v/s Ratio Prot		c0.51		0.22	0.36							
v/s Ratio Perm									0.28			c0.57
v/c Ratio		0.96		0.53	0.36				0.28			0.57
Uniform Delay, d1		34.1		32.5	0.0				0.0			0.0
Progression Factor		0.23		1.00	1.00				1.00			1.00
Incremental Delay, d2		5.7		0.0	0.0				0.4			1.4
Delay (s)		13.5		32.6	0.0				0.4			1.4
Level of Service		B		C	A				A			A
Approach Delay (s)		13.5			9.3			0.4			1.4	
Approach LOS		B			A			A			A	

Intersection Summary			
HCM Average Control Delay	9.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	83.0%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
5: Farrington Hwy & Fort Weaver Road NB Ramps

2030 + PRO (without Transit Corridor) - PM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↑			↑↑↱				↱			
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0				4.0			
Lane Util. Factor	1.00	*0.99			*0.99				1.00			
Frt	1.00	1.00			0.96				0.86			
Flt Protected	0.95	1.00			1.00				1.00			
Satd. Flow (prot)	1770	5532			5285				1611			
Flt Permitted	0.95	1.00			1.00				1.00			
Satd. Flow (perm)	1770	5532			5285				1611			
Volume (vph)	1429	1319	0	0	2743	1164	0	0	647	0	0	0
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	1443	1332	0	0	2771	1176	0	0	654	0	0	0
RTOR Reduction (vph)	0	0	0	0	9	0	0	0	0	0	0	0
Lane Group Flow (vph)	1443	1332	0	0	3938	0	0	0	654	0	0	0
Turn Type	Prot								Free			
Protected Phases	5	2			6							
Permitted Phases									Free			
Actuated Green, G (s)	71.0	150.0			71.0				150.0			
Effective Green, g (s)	71.0	150.0			71.0				150.0			
Actuated g/C Ratio	0.47	1.00			0.47				1.00			
Clearance Time (s)	4.0	4.0			4.0							
Vehicle Extension (s)	3.0	3.0			3.0							
Lane Grp Cap (vph)	838	5532			2502				1611			
v/s Ratio Prot	c0.82	0.24			c0.75							
v/s Ratio Perm									0.41			
v/c Ratio	1.72	0.24			1.57				0.41			
Uniform Delay, d1	39.5	0.0			39.5				0.0			
Progression Factor	0.52	1.00			0.69				1.00			
Incremental Delay, d2	327.4	0.1			258.5				0.8			
Delay (s)	347.9	0.1			285.7				0.8			
Level of Service	F	A			F				A			
Approach Delay (s)		180.9			285.7			0.8			0.0	
Approach LOS		F			F			A			A	

Intersection Summary			
HCM Average Control Delay	221.0	HCM Level of Service	F
HCM Volume to Capacity ratio	1.65		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	164.9%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
6: Farrington Hwy & Leoku Street

2030 + PRO (without Transit Corridor) - PM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑↑	↱	↰	↑↑↑	↱		↰↑	↱		↰↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
Lane Util. Factor	*0.99	*0.99	1.00	1.00	*0.99	1.00		1.00	1.00		*0.99	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00		0.96	1.00
Satd. Flow (prot)	3504	5532	1583	1770	5532	1583		1785	1583		3530	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00		0.96	1.00
Satd. Flow (perm)	3504	5532	1583	1770	5532	1583		1785	1583		3530	1583
Volume (vph)	286	1564	116	135	3511	515	197	29	130	243	28	194
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	289	1580	117	136	3546	520	199	29	131	245	28	196
RTOR Reduction (vph)	0	0	49	0	0	136	0	0	41	0	0	106
Lane Group Flow (vph)	289	1580	68	136	3546	384	0	228	90	0	273	90
Turn Type	Prot		Perm	Prot		Perm	Split		Perm	Split		Perm
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			6
Actuated Green, G (s)	11.9	86.6	86.6	16.3	91.0	91.0		16.0	16.0		15.1	15.1
Effective Green, g (s)	11.9	86.6	86.6	16.3	91.0	91.0		16.0	16.0		15.1	15.1
Actuated g/C Ratio	0.08	0.58	0.58	0.11	0.61	0.61		0.11	0.11		0.10	0.10
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	278	3194	914	192	3356	960		190	169		355	159
v/s Ratio Prot	c0.08	0.29		c0.08	c0.64			c0.13			c0.08	
v/s Ratio Perm			0.04			0.24			0.06			0.06
v/c Ratio	1.04	0.49	0.07	0.71	1.06	0.40		1.20	0.53		1.39dl	0.57
Uniform Delay, d1	69.0	18.8	14.0	64.6	29.5	15.3		67.0	63.5		65.8	64.3
Progression Factor	1.06	1.07	1.44	1.00	1.00	1.00		1.00	1.00		1.00	1.00
Incremental Delay, d2	63.8	0.5	0.2	11.3	33.2	1.2		129.5	11.5		9.6	4.5
Delay (s)	137.1	20.6	20.2	75.9	62.7	16.6		196.5	74.9		75.4	68.9
Level of Service	F	C	C	E	E	B		F	E		E	E
Approach Delay (s)		37.5			57.4			152.1			72.7	
Approach LOS		D			E			F			E	

Intersection Summary			
HCM Average Control Delay	57.6	HCM Level of Service	E
HCM Volume to Capacity ratio	1.01		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	106.1%	ICU Level of Service	G
Analysis Period (min)	15		
dl Defacto Left Lane. Recode with 1 though lane as a left lane.			
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
7: Laulaunui Street & Fort Weaver Road

2030 + PRO (without Transit Corridor) - PM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱		↰	↑	↱	↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		*0.99		1.00	1.00	1.00	1.00	*0.99	1.00	1.00	*0.99	1.00
Frt		0.99		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.96		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		3518		1770	1863	1583	1770	5532	1583	1770	5532	1583
Flt Permitted		0.96		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		3518		1770	1863	1583	1770	5532	1583	1770	5532	1583
Volume (vph)	209	37	13	62	4	231	56	2896	100	231	4375	82
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	211	37	13	63	4	233	57	2925	101	233	4419	83
RTOR Reduction (vph)	0	3	0	0	0	187	0	0	27	0	0	17
Lane Group Flow (vph)	0	258	0	63	4	46	57	2925	74	233	4419	66
Turn Type	Split			Split		Perm	Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases						8			2			6
Actuated Green, G (s)		14.8		5.0	5.0	5.0	4.0	92.0	92.0	21.0	109.0	109.0
Effective Green, g (s)		14.8		5.0	5.0	5.0	4.0	92.0	92.0	21.0	109.0	109.0
Actuated g/C Ratio		0.10		0.03	0.03	0.03	0.03	0.62	0.62	0.14	0.73	0.73
Clearance Time (s)		4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		350		59	63	53	48	3420	979	250	4052	1160
v/s Ratio Prot		c0.07		c0.04	0.00		c0.03	0.53		0.13	c0.80	
v/s Ratio Perm						0.03			0.05			0.04
v/c Ratio		1.19dl		1.07	0.06	0.86	1.19	0.86	0.08	0.93	1.09	0.06
Uniform Delay, d1		65.1		71.9	69.6	71.5	72.4	23.0	11.4	63.2	19.9	5.6
Progression Factor		1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		7.9		137.3	0.4	73.0	189.9	3.0	0.2	38.7	45.5	0.1
Delay (s)		73.0		209.2	70.1	144.6	262.3	26.0	11.5	101.9	65.4	5.6
Level of Service		E		F	E	F	F	C	B	F	E	A
Approach Delay (s)		73.0			157.2			29.9			66.2	
Approach LOS		E			F			C			E	

Intersection Summary			
HCM Average Control Delay	56.3	HCM Level of Service	E
HCM Volume to Capacity ratio	1.05		
Actuated Cycle Length (s)	148.8	Sum of lost time (s)	16.0
Intersection Capacity Utilization	116.1%	ICU Level of Service	H
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
8: Old Fort Weaver Road & Fort Weaver Road

2030 + PRO (without Transit Corridor) - PM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑	↱		↰↑	↱	↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	*0.99	1.00	1.00	*0.99	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.96	1.00		0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1790	1583		1849	1583	1770	5532	1583	1770	5532	1583
Flt Permitted		0.52	1.00		0.26	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		969	1583		493	1583	1770	5532	1583	1770	5532	1583
Volume (vph)	837	200	483	37	219	89	563	2123	3	193	3255	1002
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	845	202	488	37	221	90	569	2144	3	195	3288	1012
RTOR Reduction (vph)	0	0	0	0	0	42	0	0	0	0	0	315
Lane Group Flow (vph)	0	1047	488	0	258	48	569	2144	3	195	3288	697
Turn Type	Perm		Free	Perm		Perm	Prot		Free	Prot		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		Free	8		8			Free			6
Actuated Green, G (s)		68.0	150.0		68.0	68.0	21.0	61.0	150.0	9.0	49.0	49.0
Effective Green, g (s)		68.0	150.0		68.0	68.0	21.0	61.0	150.0	9.0	49.0	49.0
Actuated g/C Ratio		0.45	1.00		0.45	0.45	0.14	0.41	1.00	0.06	0.33	0.33
Clearance Time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)		439	1583		223	718	248	2250	1583	106	1807	517
v/s Ratio Prot							c0.32	0.39		0.11	c0.59	
v/s Ratio Perm		c1.08	0.31		0.52	0.03			0.00			0.44
v/c Ratio		2.38	0.31		1.16	0.07	2.29	0.95	0.00	1.84	1.82	1.35
Uniform Delay, d1		41.0	0.0		41.0	23.1	64.5	43.1	0.0	70.5	50.5	50.5
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		630.2	0.5		109.1	0.0	595.1	10.7	0.0	412.0	371.0	169.1
Delay (s)		671.2	0.5		150.1	23.2	659.6	53.8	0.0	482.5	421.5	219.6
Level of Service		F	A		F	C	F	D	A	F	F	F
Approach Delay (s)		458.0			117.3			180.7			378.7	
Approach LOS		F			F			F			F	

Intersection Summary			
HCM Average Control Delay	322.9	HCM Level of Service	F
HCM Volume to Capacity ratio	2.17		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	177.9%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
9: Renton Road & Fort Weaver Road

2030 + PRO (without Transit Corridor) - PM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↰↑	↱		✥		↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*0.99	*0.99	1.00		1.00		1.00	*0.99	1.00	1.00	*0.99	1.00
Frt	1.00	1.00	0.85		0.91		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1752	1761	1583		1693		1770	5532	1583	1770	5532	1583
Flt Permitted	0.95	0.96	1.00		1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1752	1761	1583		1693		1770	5532	1583	1770	5532	1583
Volume (vph)	725	23	43	9	151	326	45	2103	75	514	3074	519
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	732	23	43	9	153	329	45	2124	76	519	3105	524
RTOR Reduction (vph)	0	0	0	0	49	0	0	0	7	0	0	205
Lane Group Flow (vph)	368	387	43	0	442	0	45	2124	69	519	3105	319
Turn Type	Split		Free	Split			Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			Free						2			6
Actuated Green, G (s)	28.0	28.0	150.0		26.0		4.0	49.0	49.0	31.0	76.0	76.0
Effective Green, g (s)	28.0	28.0	150.0		26.0		4.0	49.0	49.0	31.0	76.0	76.0
Actuated g/C Ratio	0.19	0.19	1.00		0.17		0.03	0.33	0.33	0.21	0.51	0.51
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	327	329	1583		293		47	1807	517	366	2803	802
v/s Ratio Prot	0.21	c0.22			c0.26		0.03	c0.38		c0.29	0.56	
v/s Ratio Perm			0.03						0.04			0.20
v/c Ratio	1.13	1.18	0.03		1.51		0.96	1.18	0.13	1.42	1.11	0.40
Uniform Delay, d1	61.0	61.0	0.0		62.0		72.9	50.5	35.5	59.5	37.0	22.9
Progression Factor	1.00	1.00	1.00		1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	88.1	106.5	0.0		246.1		114.0	85.1	0.5	203.5	54.4	1.5
Delay (s)	149.1	167.5	0.0		308.1		186.9	135.6	36.1	263.0	91.4	24.3
Level of Service	F	F	A		F		F	F	D	F	F	C
Approach Delay (s)		150.0			308.1			133.3			104.4	
Approach LOS		F			F			F			F	

Intersection Summary			
HCM Average Control Delay	130.6	HCM Level of Service	F
HCM Volume to Capacity ratio	1.30		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	131.6%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
10: Farrington Hwy & D Street

2030 + PRO (without Transit Corridor) - PM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↑		↰↰	↑↑↑↱			↑↱	↱	↰	✥	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	*0.99		*0.99	*0.99			*0.99	*0.99	*0.99	*0.99	
Frt	1.00	1.00		1.00	0.99			1.00	0.85	1.00	0.88	
Flt Protected	0.95	1.00		0.95	1.00			1.00	1.00	0.95	0.99	
Satd. Flow (prot)	1770	5532		3504	5473			1844	1567	1752	1614	
Flt Permitted	0.95	1.00		0.95	1.00			1.00	1.00	0.95	0.99	
Satd. Flow (perm)	1770	5532		3504	5473			1844	1567	1752	1614	
Volume (vph)	99	2335	0	425	2265	175	0	179	45	357	7	259
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	100	2359	0	429	2288	177	0	181	45	361	7	262
RTOR Reduction (vph)	0	0	0	0	6	0	0	0	40	0	82	0
Lane Group Flow (vph)	100	2359	0	429	2459	0	0	181	5	291	257	0
Turn Type	Prot			Prot					Perm	Split		
Protected Phases	5	2		1	6			8		4	4	
Permitted Phases									8			
Actuated Green, G (s)	10.0	72.6		19.0	81.6			16.0	16.0	26.4	26.4	
Effective Green, g (s)	10.0	72.6		19.0	81.6			16.0	16.0	26.4	26.4	
Actuated g/C Ratio	0.07	0.48		0.13	0.54			0.11	0.11	0.18	0.18	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	118	2677		444	2977			197	167	308	284	
v/s Ratio Prot	0.06	c0.43		c0.12	0.45			c0.10		c0.17	0.16	
v/s Ratio Perm									0.00			
v/c Ratio	0.85	0.88		0.97	0.83			0.92	0.03	0.94	0.90	
Uniform Delay, d1	69.2	34.8		65.2	28.3			66.4	60.0	61.1	60.6	
Progression Factor	1.03	0.70		0.91	0.77			1.00	1.00	1.00	1.00	
Incremental Delay, d2	26.4	2.8		32.1	2.6			41.5	0.1	36.6	29.6	
Delay (s)	97.6	27.0		91.7	24.4			107.8	60.1	97.7	90.2	
Level of Service	F	C		F	C			F	E	F	F	
Approach Delay (s)		29.9			34.4			98.3			93.6	
Approach LOS		C			C			F			F	

Intersection Summary			
HCM Average Control Delay	40.9	HCM Level of Service	D
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	98.9%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
11: Farrington Hwy & E Street

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↱			↑↑↱			↰↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0			4.0		4.0	4.0	
Lane Util. Factor	1.00	*0.99			*0.99			1.00		1.00	1.00	
Frt	1.00	0.98			1.00			1.00		1.00	0.94	
Flt Protected	0.95	1.00			1.00			0.97		0.95	1.00	
Satd. Flow (prot)	1770	5428			5519			1801		1770	1743	
Flt Permitted	0.95	1.00			1.00			0.97		0.95	1.00	
Satd. Flow (perm)	1770	5428			5519			1801		1770	1743	
Volume (vph)	77	2202	318	0	2482	42	203	110	5	227	130	97
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	78	2224	321	0	2507	42	205	111	5	229	131	98
RTOR Reduction (vph)	0	14	0	0	1	0	0	0	0	0	18	0
Lane Group Flow (vph)	78	2531	0	0	2548	0	0	321	0	229	211	0
Turn Type	Prot						Split			Split		
Protected Phases	5	2			6		8	8		4	4	
Permitted Phases												
Actuated Green, G (s)	7.0	90.2			79.2			27.8		20.0	20.0	
Effective Green, g (s)	7.0	90.2			79.2			27.8		20.0	20.0	
Actuated g/C Ratio	0.05	0.60			0.53			0.19		0.13	0.13	
Clearance Time (s)	4.0	4.0			4.0			4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0			3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)	83	3264			2914			334		236	232	
v/s Ratio Prot	0.04	c0.47			c0.46			c0.18		c0.13	0.12	
v/s Ratio Perm												
v/c Ratio	0.94	0.78			0.87			0.96		0.97	0.91	
Uniform Delay, d1	71.3	22.3			31.0			60.6		64.7	64.1	
Progression Factor	0.73	0.41			0.77			1.00		1.00	1.00	
Incremental Delay, d2	55.9	1.1			2.1			38.8		50.0	35.0	
Delay (s)	107.7	10.2			26.0			99.3		114.7	99.1	
Level of Service	F	B			C			F		F	F	
Approach Delay (s)		13.1			26.0			99.3			106.9	
Approach LOS		B			C			F			F	

Intersection Summary			
HCM Average Control Delay	30.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	96.6%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
12: Fort Barrette Road & Farrington Hwy

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰↰	↑↱	↱	↰↰	↑↑	↱	↰↰	↑↑	↱	↰	↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*0.99	*0.99	*0.99	*0.99	*0.99	1.00	*0.99	*0.99	1.00	1.00	*0.99	1.00
Frt	1.00	0.96	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3504	3533	1567	3504	3688	1583	3504	3688	1583	1770	3688	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3504	3533	1567	3504	3688	1583	3504	3688	1583	1770	3688	1583
Volume (vph)	493	483	724	355	405	113	678	660	746	226	1028	677
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	498	488	731	359	409	114	685	667	754	228	1038	684
RTOR Reduction (vph)	0	21	286	0	0	94	0	0	232	0	0	202
Lane Group Flow (vph)	498	657	255	359	409	20	685	667	522	228	1038	482
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases			6			2			4			8
Actuated Green, G (s)	28.8	38.3	38.3	21.8	31.3	31.3	38.7	74.0	74.0	27.2	62.5	62.5
Effective Green, g (s)	28.8	38.3	38.3	21.8	31.3	31.3	38.7	74.0	74.0	27.2	62.5	62.5
Actuated g/C Ratio	0.16	0.22	0.22	0.12	0.18	0.18	0.22	0.42	0.42	0.15	0.35	0.35
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	569	763	339	431	651	279	765	1539	661	272	1300	558
v/s Ratio Prot	c0.14	c0.19		0.10	0.11		c0.20	0.18		0.13	0.28	
v/s Ratio Perm			0.16			0.01			0.33			c0.30
v/c Ratio	0.88	0.86	0.75	0.83	0.63	0.07	0.90	0.43	0.79	0.84	0.80	0.86
Uniform Delay, d1	72.5	66.9	65.1	76.0	67.6	60.9	67.3	36.7	44.9	72.9	51.7	53.4
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	14.1	9.8	9.1	12.9	4.5	0.5	13.0	0.2	6.2	19.7	3.5	13.1
Delay (s)	86.6	76.7	74.1	88.9	72.2	61.4	80.3	36.9	51.1	92.6	55.2	66.5
Level of Service	F	E	E	F	E	E	F	D	D	F	E	E
Approach Delay (s)		78.8			77.6			56.1			63.6	
Approach LOS		E			E			E			E	

Intersection Summary			
HCM Average Control Delay	67.0	HCM Level of Service	E
HCM Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	177.3	Sum of lost time (s)	12.0
Intersection Capacity Utilization	92.3%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
13: WB Ramps & North-South Road

2030 + PRO (without Transit Corridor) - PM Peak

Movement	WBL2	WBL	WBR	NBL	NBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰↰		↱				↑↑	↱	↰↰	↑↑	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0				4.0	4.0	4.0	4.0	
Lane Util. Factor	*0.99		1.00				*0.99	1.00	0.97	*0.99	
Frt	1.00		0.85				1.00	0.85	1.00	1.00	
Flt Protected	0.95		1.00				1.00	1.00	0.95	1.00	
Satd. Flow (prot)	3504		1583				3688	1583	3433	3688	
Flt Permitted	0.95		1.00				1.00	1.00	0.95	1.00	
Satd. Flow (perm)	3504		1583				3688	1583	3433	3688	
Volume (vph)	2099	0	412	0	0	0	495	86	368	585	0
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	2120	0	416	0	0	0	500	87	372	591	0
RTOR Reduction (vph)	0	0	32	0	0	0	0	73	0	0	0
Lane Group Flow (vph)	2120	0	384	0	0	0	500	14	372	591	0
Turn Type	Prot		custom					Perm	Prot		
Protected Phases	8		8				6		5	2	
Permitted Phases								6			
Actuated Green, G (s)	81.6		81.6				20.5	20.5	15.9	40.4	
Effective Green, g (s)	81.6		81.6				20.5	20.5	15.9	40.4	
Actuated g/C Ratio	0.63		0.63				0.16	0.16	0.12	0.31	
Clearance Time (s)	4.0		4.0				4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0		3.0				3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	2199		994				582	250	420	1146	
v/s Ratio Prot	c0.61		0.24				c0.14		c0.11	0.16	
v/s Ratio Perm								0.01			
v/c Ratio	0.96		0.39				0.86	0.05	0.89	0.52	
Uniform Delay, d1	22.8		11.9				53.3	46.5	56.2	36.8	
Progression Factor	1.00		1.00				1.00	1.00	0.61	0.97	
Incremental Delay, d2	11.9		0.3				15.2	0.4	16.4	1.3	
Delay (s)	34.7		12.1				68.6	46.9	50.9	37.0	
Level of Service	C		B				E	D	D	D	
Approach Delay (s)		31.0		0.0			65.3			42.4	
Approach LOS		C		A			E			D	

Intersection Summary			
HCM Average Control Delay	38.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.94		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	115.9%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
14: EB Ramps & North-South Road

2030 + PRO (without Transit Corridor) - PM Peak

Movement	EBL2	EBL	EBR	SBL	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰		↱			↰↰	↑↑			↑↑	↱↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0			4.0	4.0			4.0	4.0
Lane Util. Factor	1.00		1.00			0.97	*0.99			*0.99	*0.99
Frt	1.00		0.85			1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (prot)	1770		1583			3433	3688			3688	3135
Flt Permitted	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (perm)	1770		1583			3433	3688			3688	3135
Volume (vph)	92	0	1018	0	0	207	2387	0	0	861	2122
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	93	0	1028	0	0	209	2411	0	0	870	2143
RTOR Reduction (vph)	0	0	1	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	93	0	1027	0	0	209	2411	0	0	870	2143
Turn Type	Prot		custom			Prot					Free
Protected Phases	4		4			1	6			2	
Permitted Phases											Free
Actuated Green, G (s)	58.0		58.0			12.6	64.0			47.4	130.0
Effective Green, g (s)	58.0		58.0			12.6	64.0			47.4	130.0
Actuated g/C Ratio	0.45		0.45			0.10	0.49			0.36	1.00
Clearance Time (s)	4.0		4.0			4.0	4.0			4.0	
Vehicle Extension (s)	3.0		3.0			3.0	3.0			3.0	
Lane Grp Cap (vph)	790		706			333	1816			1345	3135
v/s Ratio Prot	0.05		c0.65			0.06	c0.65			0.24	
v/s Ratio Perm											0.68
v/c Ratio	0.12		1.46			0.63	1.33			0.65	0.68
Uniform Delay, d1	21.0		36.0			56.4	33.0			34.3	0.0
Progression Factor	1.00		1.00			1.15	0.70			1.00	1.00
Incremental Delay, d2	0.1		212.7			1.2	148.8			2.4	1.2
Delay (s)	21.1		248.7			66.0	171.9			36.8	1.2
Level of Service	C		F			E	F			D	A
Approach Delay (s)		229.9		0.0			163.5			11.5	
Approach LOS		F		A			F			B	

Intersection Summary			
HCM Average Control Delay	106.7	HCM Level of Service	F
HCM Volume to Capacity ratio	1.39		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	115.9%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰↰	↑↑↑	↱	↰↰	↑↑↑	↱	↰↰	↑↑	↱	↰↰	↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*0.99	*0.99	1.00	*0.99	*0.99	1.00	*0.99	*0.99	1.00	*0.99	*0.99	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3504	5532	1583	3504	5532	1583	3504	3688	1583	3504	3688	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3504	5532	1583	3504	5532	1583	3504	3688	1583	3504	3688	1583
Volume (vph)	815	1917	650	880	1657	393	411	756	542	539	920	915
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	823	1936	657	889	1674	397	415	764	547	544	929	924
RTOR Reduction (vph)	0	0	166	0	0	186	0	0	258	0	0	269
Lane Group Flow (vph)	823	1936	491	889	1674	212	415	764	289	544	929	655
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases			6			2			4			8
Actuated Green, G (s)	30.0	46.0	46.0	29.0	45.0	45.0	18.0	34.0	34.0	25.0	41.0	41.0
Effective Green, g (s)	30.0	46.0	46.0	29.0	45.0	45.0	18.0	34.0	34.0	25.0	41.0	41.0
Actuated g/C Ratio	0.20	0.31	0.31	0.19	0.30	0.30	0.12	0.23	0.23	0.17	0.27	0.27
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	701	1696	485	677	1660	475	420	836	359	584	1008	433
v/s Ratio Prot	0.23	c0.35		c0.25	0.30		0.12	c0.21		0.16	0.25	
v/s Ratio Perm			0.31			0.13			0.18			c0.41
v/c Ratio	1.17	1.14	1.01	1.31	1.01	0.45	0.99	0.91	0.81	0.93	0.92	1.51
Uniform Delay, d1	60.0	52.0	52.0	60.5	52.5	42.4	65.9	56.6	54.9	61.7	52.9	54.5
Progression Factor	1.00	1.00	1.00	0.88	0.97	1.25	1.00	1.00	1.00	0.91	0.90	0.77
Incremental Delay, d2	92.9	71.3	44.2	147.4	19.3	1.8	41.1	16.1	17.4	11.6	7.4	236.0
Delay (s)	152.9	123.3	96.2	200.5	70.3	54.9	106.9	72.7	72.3	67.8	55.0	277.9
Level of Service	F	F	F	F	E	D	F	E	E	E	E	F
Approach Delay (s)		125.2			107.4			80.8			143.8	
Approach LOS		F			F			F			F	

Intersection Summary			
HCM Average Control Delay	117.1	HCM Level of Service	F
HCM Volume to Capacity ratio	1.27		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	112.6%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰↰	↑↑↱	↱	↰↰	↑↑↱		↰↰	↑↱		↰↰	↑	↱↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	*0.99	0.86	*0.99	*0.99		*0.99	*0.99		*0.99	1.00	*0.99
Frt	1.00	1.00	0.85	1.00	0.98		1.00	0.93		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	3433	5532	1362	3504	5397		3504	3445		3504	1863	3135
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	3433	5532	1362	3504	5397		3504	3445		3504	1863	3135
Volume (vph)	73	1846	475	676	1942	380	315	427	334	390	121	770
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	74	1865	480	683	1962	384	318	431	337	394	122	778
RTOR Reduction (vph)	0	0	169	0	18	0	0	87	0	0	0	34
Lane Group Flow (vph)	74	1865	311	683	2328	0	318	681	0	394	122	744
Turn Type	Prot		Perm	Prot			Prot			Prot		pm+ov
Protected Phases	5	2		1	6		7	4		3	8	1
Permitted Phases			2									8
Actuated Green, G (s)	8.0	63.0	63.0	23.0	78.0		33.6	34.0		14.0	14.4	37.4
Effective Green, g (s)	8.0	63.0	63.0	23.0	78.0		33.6	34.0		14.0	14.4	37.4
Actuated g/C Ratio	0.05	0.42	0.42	0.15	0.52		0.22	0.23		0.09	0.10	0.25
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	183	2323	572	537	2806		785	781		327	179	865
v/s Ratio Prot	0.02	0.34		c0.19	c0.43		0.09	c0.20		c0.11	0.07	0.13
v/s Ratio Perm			0.23									0.11
v/c Ratio	0.40	0.80	0.54	1.27	0.83		0.41	0.87		1.20	0.68	0.86
Uniform Delay, d1	68.7	38.1	32.7	63.5	30.4		49.7	55.9		68.0	65.6	53.8
Progression Factor	1.00	1.00	1.00	0.72	0.39		1.00	1.00		0.65	0.65	0.52
Incremental Delay, d2	1.5	3.1	3.7	123.7	0.3		0.3	10.5		95.0	1.0	0.9
Delay (s)	70.2	41.1	36.4	169.4	12.2		50.0	66.5		139.3	43.5	28.9
Level of Service	E	D	D	F	B		D	E		F	D	C
Approach Delay (s)		41.1			47.7			61.6			63.9	
Approach LOS		D			D			E			E	

Intersection Summary			
HCM Average Control Delay	50.3	HCM Level of Service	D
HCM Volume to Capacity ratio	0.94		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	105.5%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
17: East-West Rd. & North-South Road

2030 + PRO (without Transit Corridor) - PM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↱		↰↰	↑↱		↰↰	↑↑↱		↰↰	↑↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	*0.99	0.95		0.97	*0.99		*0.99	*0.99		*0.99	*0.99	
Frt	1.00	0.94		1.00	0.89		1.00	0.98		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	3504	3313		3433	3283		3504	5404		3504	5396	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	3504	3313		3433	3283		3504	5404		3504	5396	
Volume (vph)	310	312	232	367	193	531	110	1553	284	611	1718	337
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	313	315	234	371	195	536	111	1569	287	617	1735	340
RTOR Reduction (vph)	0	94	0	0	237	0	0	23	0	0	25	0
Lane Group Flow (vph)	313	455	0	371	494	0	111	1833	0	617	2050	0
Turn Type	Prot			Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases												
Actuated Green, G (s)	14.9	20.9		16.4	22.4		7.7	48.1		26.0	66.4	
Effective Green, g (s)	14.9	20.9		16.4	22.4		7.7	48.1		26.0	66.4	
Actuated g/C Ratio	0.12	0.16		0.13	0.18		0.06	0.38		0.20	0.52	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	410	543		442	577		212	2040		715	2812	
v/s Ratio Prot	0.09	0.14		c0.11	c0.15		0.03	c0.34		c0.18	0.38	
v/s Ratio Perm												
v/c Ratio	0.76	0.84		0.84	1.05dr		0.52	0.90		0.86	0.73	
Uniform Delay, d1	54.5	51.6		54.2	50.9		58.1	37.4		49.0	23.6	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	8.2	10.8		13.1	12.0		2.3	6.8		13.1	1.7	
Delay (s)	62.7	62.4		67.3	62.9		60.4	44.2		62.1	25.2	
Level of Service	E	E		E	E		E	D		E	C	
Approach Delay (s)		62.5			64.4			45.1			33.7	
Approach LOS		E			E			D			C	

Intersection Summary			
HCM Average Control Delay	45.9	HCM Level of Service	D
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	127.4	Sum of lost time (s)	12.0
Intersection Capacity Utilization	98.4%	ICU Level of Service	F
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.
c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
18: North-South Road & Kapolei Parkway

2030 + PRO (without Transit Corridor) - PM Peak

Movement	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰	↑↑↱		↰	↑↑↱		↰↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	*0.99		1.00	*0.99		*0.99	*0.99	1.00	1.00	*0.99	1.00
Frt	1.00	0.98		1.00	0.94		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	5408		1770	5196		3504	5532	1583	1770	5532	1583
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	5408		1770	5196		3504	5532	1583	1770	5532	1583
Volume (vph)	378	879	155	507	1075	735	716	643	505	121	568	352
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	382	888	157	512	1086	742	723	649	510	122	574	356
RTOR Reduction (vph)	0	19	0	0	82	0	0	0	290	0	0	305
Lane Group Flow (vph)	382	1026	0	512	1746	0	723	649	220	122	574	51
Turn Type	Prot			Prot			Prot		Perm	Prot		Perm
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases									4			8
Actuated Green, G (s)	29.0	37.9		44.1	53.0		29.0	36.4	36.4	13.6	21.0	21.0
Effective Green, g (s)	29.0	37.9		44.1	53.0		29.0	36.4	36.4	13.6	21.0	21.0
Actuated g/C Ratio	0.20	0.26		0.30	0.36		0.20	0.25	0.25	0.09	0.14	0.14
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	347	1385		527	1861		687	1361	389	163	785	225
v/s Ratio Prot	c0.22	0.19		c0.29	c0.34		c0.21	0.12		0.07	c0.10	
v/s Ratio Perm									0.14			0.03
v/c Ratio	1.10	0.74		0.97	1.15dr		1.05	0.48	0.56	0.75	0.73	0.22
Uniform Delay, d1	59.5	50.5		51.3	45.9		59.5	47.7	48.9	65.5	60.8	56.3
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	78.2	3.6		31.8	10.7		48.9	0.3	1.9	17.0	3.5	0.5
Delay (s)	137.7	54.1		83.2	56.6		108.4	47.9	50.7	82.6	64.3	56.8
Level of Service	F	D		F	E		F	D	D	F	E	E
Approach Delay (s)		76.5			62.4			71.9			63.9	
Approach LOS		E			E			E			E	

Intersection Summary			
HCM Average Control Delay	68.3	HCM Level of Service	E
HCM Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	148.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	102.9%	ICU Level of Service	G
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.
c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
19: East-West Rd. & Old Fort Weaver Rd

2030 + PRO (without Transit Corridor) - PM Peak

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↰	↑	↑↑	↱	↰↰	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	0.97	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1863	3539	1583	3433	1583
Flt Permitted	0.25	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	466	1863	3539	1583	3433	1583
Volume (vph)	37	621	829	955	898	94
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	37	627	837	965	907	95
RTOR Reduction (vph)	0	0	0	560	0	55
Lane Group Flow (vph)	37	627	837	405	907	40
Turn Type	Perm			Perm		Perm
Protected Phases		4	8		6	
Permitted Phases	4			8		6
Actuated Green, G (s)	21.0	21.0	21.0	21.0	21.0	21.0
Effective Green, g (s)	21.0	21.0	21.0	21.0	21.0	21.0
Actuated g/C Ratio	0.42	0.42	0.42	0.42	0.42	0.42
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	196	782	1486	665	1442	665
v/s Ratio Prot		c0.34	0.24		c0.26	
v/s Ratio Perm	0.08			0.26		0.03
v/c Ratio	0.19	0.80	0.56	0.61	0.63	0.06
Uniform Delay, d1	9.1	12.7	11.0	11.3	11.4	8.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.5	5.9	0.5	1.6	2.1	0.2
Delay (s)	9.6	18.6	11.5	12.9	13.5	8.8
Level of Service	A	B	B	B	B	A
Approach Delay (s)		18.1	12.3		13.1	
Approach LOS		B	B		B	

Intersection Summary			
HCM Average Control Delay	13.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	50.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	69.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
20: Farrington Hwy & B Street

2030 + PRO (without Transit Corridor) - PM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰↰	↑↑	↱	↰↰	↑↑	↱	↰	↑	↱	↰↰	↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	*0.99	1.00	0.97	*0.99	1.00	1.00	1.00	1.00	*0.99	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3688	1583	3433	3688	1583	1770	1863	1583	3504	1863	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3688	1583	3433	3688	1583	1770	1863	1583	3504	1863	1583
Volume (vph)	229	1443	356	554	1792	80	152	182	307	274	143	178
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	231	1458	360	560	1810	81	154	184	310	277	144	180
RTOR Reduction (vph)	0	0	45	0	0	23	0	0	8	0	0	16
Lane Group Flow (vph)	231	1458	315	560	1810	58	154	184	302	277	144	164
Turn Type	Prot		pm+ov	Prot		Perm	Prot		pm+ov	Prot		pm+ov
Protected Phases	5	2	3	1	6		7	4	5	3	8	1
Permitted Phases			2			6			4			8
Actuated Green, G (s)	24.0	73.3	85.3	31.7	81.0	81.0	13.0	17.0	41.0	12.0	16.0	47.7
Effective Green, g (s)	24.0	73.3	85.3	31.7	81.0	81.0	13.0	17.0	41.0	12.0	16.0	47.7
Actuated g/C Ratio	0.16	0.49	0.57	0.21	0.54	0.54	0.09	0.11	0.27	0.08	0.11	0.32
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	549	1802	942	726	1992	855	153	211	433	280	199	546
v/s Ratio Prot	0.07	c0.40	0.03	0.16	c0.49		c0.09	c0.10	0.11	0.08	0.08	0.06
v/s Ratio Perm			0.17			0.04			0.08			0.04
v/c Ratio	0.42	0.81	0.33	0.77	0.91	0.07	1.01	0.87	0.70	0.99	0.72	0.30
Uniform Delay, d1	56.7	32.4	17.2	55.7	31.2	16.5	68.5	65.4	48.9	68.9	64.9	38.6
Progression Factor	0.82	0.76	0.24	0.99	0.45	0.06	1.00	1.00	1.00	1.00	0.93	1.01
Incremental Delay, d2	0.2	1.5	0.1	2.1	3.3	0.1	74.5	35.8	4.8	44.0	16.3	0.2
Delay (s)	46.7	26.1	4.2	57.4	17.4	1.0	143.0	101.3	53.8	112.7	76.8	39.0
Level of Service	D	C	A	E	B	A	F	F	D	F	E	D
Approach Delay (s)		24.6			26.0			88.5			82.0	
Approach LOS		C			C			F			F	

Intersection Summary			
HCM Average Control Delay	38.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	86.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
21: East-West Rd. & A Street

2030 + PRO (without Transit Corridor) - PM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰	↱		↰	↑	↱	↰	↱		↰	↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	1.00	0.85	1.00	0.86		1.00	0.88	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1844		1770	1863	1583	1770	1599		1770	1631	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	1844		1770	1863	1583	1770	1599		1770	1631	
Volume (vph)	170	768	56	34	689	616	91	8	140	46	6	31
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	185	835	61	37	749	670	99	9	152	50	7	34
RTOR Reduction (vph)	0	2	0	0	0	285	0	136	0	0	31	0
Lane Group Flow (vph)	185	894	0	37	749	385	99	25	0	50	10	0
Turn Type	Prot			Prot		Perm	Split			Split		
Protected Phases	5	2		1	6		4	4		8	8	
Permitted Phases						6						
Actuated Green, G (s)	12.6	59.8		5.3	52.5	52.5	10.7	10.7		8.2	8.2	
Effective Green, g (s)	12.6	59.8		5.3	52.5	52.5	10.7	10.7		8.2	8.2	
Actuated g/C Ratio	0.13	0.60		0.05	0.52	0.52	0.11	0.11		0.08	0.08	
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	223	1103		94	978	831	189	171		145	134	
v/s Ratio Prot	0.10	c0.48		0.02	c0.40		c0.06	0.02		c0.03	0.01	
v/s Ratio Perm						0.24						
v/c Ratio	0.83	0.81		0.39	0.77	0.46	0.52	0.15		0.34	0.07	
Uniform Delay, d1	42.7	15.7		45.8	18.9	14.9	42.2	40.5		43.4	42.4	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	21.8	6.5		2.7	3.6	0.4	2.6	0.4		1.4	0.2	
Delay (s)	64.4	22.2		48.5	22.5	15.3	44.8	40.9		44.8	42.6	
Level of Service	E	C		D	C	B	D	D		D	D	
Approach Delay (s)		29.4			19.9			42.4			43.8	
Approach LOS		C			B			D			D	

Intersection Summary			
HCM Average Control Delay	26.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	72.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
22: Farrington Hwy & 2nd Avenue

2030 + PRO (without Transit Corridor) - PM Peak

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↱		↰↰	↑↑	↱	↰	↑↑	↱↱	↰↰	↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	*0.99		*0.99	*0.99	1.00	1.00	0.95	*0.99	*0.99	0.95	1.00
Frt	1.00	0.99		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	5469		3504	3688	1583	1770	3539	3135	3504	3539	1583
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	5469		3504	3688	1583	1770	3539	3135	3504	3539	1583
Volume (vph)	186	1527	127	690	1836	246	106	297	513	558	356	320
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	188	1542	128	697	1855	248	107	300	518	564	360	323
RTOR Reduction (vph)	0	7	0	0	0	70	0	0	5	0	0	161
Lane Group Flow (vph)	188	1663	0	697	1855	178	107	300	513	564	360	162
Turn Type	Prot			Prot		Perm	Prot		pm+ov	Prot		Perm
Protected Phases	5	2		1	6		3	8	1	7	4	
Permitted Phases						6			8			4
Actuated Green, G (s)	16.0	54.0		34.0	72.0	72.0	11.5	23.0	57.0	23.0	34.5	34.5
Effective Green, g (s)	16.0	54.0		34.0	72.0	72.0	11.5	23.0	57.0	23.0	34.5	34.5
Actuated g/C Ratio	0.11	0.36		0.23	0.48	0.48	0.08	0.15	0.38	0.15	0.23	0.23
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	189	1969		794	1770	760	136	543	1275	537	814	364
v/s Ratio Prot	c0.11	0.30		0.20	c0.50		c0.06	c0.08	0.09	c0.16	0.10	
v/s Ratio Perm						0.11			0.07			0.10
v/c Ratio	0.99	0.84		0.88	1.05	0.23	0.79	0.55	0.40	1.05	0.44	0.45
Uniform Delay, d1	67.0	44.1		56.0	39.0	22.9	68.0	58.7	34.0	63.5	49.5	49.5
Progression Factor	0.79	0.72		0.53	0.31	0.01	1.00	1.00	1.00	0.80	0.76	0.59
Incremental Delay, d2	50.7	3.1		5.2	29.0	0.3	25.2	4.0	0.2	27.8	0.2	0.4
Delay (s)	103.3	34.9		34.8	41.2	0.6	93.3	62.8	34.2	78.6	38.0	29.7
Level of Service	F	C		C	D	A	F	E	C	E	D	C
Approach Delay (s)		41.8			36.0			50.3			54.2	
Approach LOS		D			D			D			D	

Intersection Summary			
HCM Average Control Delay	42.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	98.5%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
23: 2nd Avenue & Kunia Road

2030 + PRO (without Transit Corridor) - PM Peak

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations		↱	↑↑↑↱			↑↑↑↑
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	0	0	4998	440	0	5283
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	5433	478	0	5742
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)			870			
pX, platoon unblocked						
vC, conflicting volume	7107	1597			5911	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	7107	1597			5911	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	0	95			7	

Direction, Lane #	EB 1	SE 1	SE 2	SE 3	SE 4	NW 1	NW 2	NW 3	NW 4
Volume Total	0	1552	1552	1552	1254	1436	1436	1436	1436
Volume Left	0	0	0	0	0	0	0	0	0
Volume Right	0	0	0	0	478	0	0	0	0
cSH	1700	1700	1700	1700	1700	1700	1700	1700	1700
Volume to Capacity	0.00	0.91	0.91	0.91	0.74	0.84	0.84	0.84	0.84
Queue Length 95th (ft)	0	0	0	0	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane LOS	A								
Approach Delay (s)	0.0	0.0				0.0			
Approach LOS	A								

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	83.1%	ICU Level of Service	E
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
24: 3rd Avenue & Kunia Road

2030 + PRO (without Transit Corridor) - PM Peak

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations		↱	↑↑↑↱			↑↑↑↑
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	0	0	4808	189	0	5283
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	5226	205	0	5742
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)			1234			
pX, platoon unblocked						
vC, conflicting volume	6764	1409			5432	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	6764	1409			5432	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	0	128			11	

Direction, Lane #	EB 1	SE 1	SE 2	SE 3	SE 4	NW 1	NW 2	NW 3	NW 4
Volume Total	0	1493	1493	1493	952	1436	1436	1436	1436
Volume Left	0	0	0	0	0	0	0	0	0
Volume Right	0	0	0	0	205	0	0	0	0
cSH	1700	1700	1700	1700	1700	1700	1700	1700	1700
Volume to Capacity	0.00	0.88	0.88	0.88	0.56	0.84	0.84	0.84	0.84
Queue Length 95th (ft)	0	0	0	0	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane LOS	A								
Approach Delay (s)	0.0	0.0				0.0			
Approach LOS	A								

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	79.9%	ICU Level of Service	D
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
25: East-West Rd. & B Street — 2030 + PRO (without Transit Corridor) - PM Peak

Movement	EBL	EBT	WBT	WBR	SEL	SER
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	*0.99	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1863	1863	1583	1752	1583
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1863	1863	1583	1752	1583
Volume (vph)	519	371	763	98	342	533
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	524	375	771	99	345	538
RTOR Reduction (vph)	0	0	0	43	0	407
Lane Group Flow (vph)	524	375	771	56	345	131
Turn Type	Prot			Prot		Prot
Protected Phases	5	2	6	6	4	4
Permitted Phases						
Actuated Green, G (s)	35.0	89.0	50.0	50.0	23.0	23.0
Effective Green, g (s)	35.0	89.0	50.0	50.0	23.0	23.0
Actuated g/C Ratio	0.29	0.74	0.42	0.42	0.19	0.19
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	516	1382	776	660	336	303
v/s Ratio Prot	c0.30	0.20	c0.41	0.04	c0.20	0.08
v/s Ratio Perm						
v/c Ratio	1.02	0.27	0.99	0.09	1.03	0.43
Uniform Delay, d1	42.5	5.0	34.8	21.2	48.5	42.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	43.6	0.5	30.8	0.3	56.1	4.4
Delay (s)	86.1	5.5	65.6	21.4	104.6	47.2
Level of Service	F	A	E	C	F	D
Approach Delay (s)		52.5	60.6		69.6	
Approach LOS		D	E		E	

Intersection Summary			
HCM Average Control Delay	60.8	HCM Level of Service	E
HCM Volume to Capacity ratio	1.01		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	97.9%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
26: Btwn Fort Barret Rd and N/S Rd & Farrington Hwy — 2030 + PRO (without Transit Corridor) - PM Peak

Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	*0.99	*0.99	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3688	3688	1583
Flt Permitted	0.95	1.00	0.05	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	98	3688	3688	1583
Volume (vph)	200	209	96	1497	2295	155
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	202	211	97	1512	2318	157
RTOR Reduction (vph)	0	14	0	0	0	38
Lane Group Flow (vph)	202	197	97	1512	2318	119
Turn Type		Perm	Perm			Perm
Protected Phases	6			4	8	
Permitted Phases		6	4			8
Actuated Green, G (s)	16.0	16.0	76.0	76.0	76.0	76.0
Effective Green, g (s)	16.0	16.0	76.0	76.0	76.0	76.0
Actuated g/C Ratio	0.16	0.16	0.76	0.76	0.76	0.76
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	283	253	74	2803	2803	1203
v/s Ratio Prot	0.11			0.41	0.63	
v/s Ratio Perm		c0.12	c0.99			0.08
v/c Ratio	0.71	0.78	1.31	0.54	0.83	0.10
Uniform Delay, d1	39.8	40.3	12.0	4.9	7.8	3.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	14.3	20.6	208.6	0.2	2.1	0.0
Delay (s)	54.1	60.9	220.6	5.1	9.9	3.2
Level of Service	D	E	F	A	A	A
Approach Delay (s)	57.6			18.1	9.5	
Approach LOS	E			B	A	

Intersection Summary			
HCM Average Control Delay	17.0	HCM Level of Service	B
HCM Volume to Capacity ratio	1.21		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	89.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

APPENDIX A-5

MITIGATIONS

YEAR 2030 PLUS PROJECT CONDITIONS

SCENARIO A: WITH TRANSIT CORRIDOR SCENARIO

HCM Signalized Intersection Capacity Analysis
1: Kunia Loop & Kunia Road
2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↰	↱	↑↑	↱		↑↑↑
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0		4.0
Lane Util. Factor	0.97	1.00	0.95	1.00		0.91
Frt	1.00	0.85	1.00	0.85		1.00
Flt Protected	0.95	1.00	1.00	1.00		1.00
Satd. Flow (prot)	3433	1583	3539	1583		5085
Flt Permitted	0.95	1.00	1.00	1.00		1.00
Satd. Flow (perm)	3433	1583	3539	1583		5085
Volume (vph)	718	37	1770	492	0	1301
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	725	37	1788	497	0	1314
RTOR Reduction (vph)	0	17	0	171	0	0
Lane Group Flow (vph)	725	20	1788	326	0	1314
Turn Type		Perm		Perm		
Protected Phases	8		2			6
Permitted Phases		8		2		
Actuated Green, G (s)	25.0	25.0	63.1	63.1		63.1
Effective Green, g (s)	25.0	25.0	63.1	63.1		63.1
Actuated g/C Ratio	0.26	0.26	0.66	0.66		0.66
Clearance Time (s)	4.0	4.0	4.0	4.0		4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0		3.0
Lane Grp Cap (vph)	893	412	2324	1039		3339
v/s Ratio Prot	c0.21		c0.51			0.26
v/s Ratio Perm		0.01		0.21		
v/c Ratio	0.81	0.05	0.77	0.31		0.39
Uniform Delay, d1	33.3	26.6	11.5	7.1		7.6
Progression Factor	1.00	1.00	1.00	1.00		1.00
Incremental Delay, d2	5.7	0.0	2.5	0.8		0.3
Delay (s)	39.0	26.7	14.0	7.9		8.0
Level of Service	D	C	B	A		A
Approach Delay (s)	38.4		12.7			8.0
Approach LOS	D		B			A

Intersection Summary			
HCM Average Control Delay	15.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	96.1	Sum of lost time (s)	8.0
Intersection Capacity Utilization	76.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
2: H-1 WB On-Ramp & Kunia Road
2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations						↱	↰	↑↑↑			↑↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)						4.0	4.0	4.0			4.0	
Lane Util. Factor						1.00	1.00	0.91			0.91	
Frt						0.86	1.00	1.00			0.98	
Flt Protected						1.00	0.95	1.00			1.00	
Satd. Flow (prot)						1611	1770	5085			4960	
Flt Permitted						1.00	0.95	1.00			1.00	
Satd. Flow (perm)						1611	1770	5085			4960	
Volume (vph)	0	0	0	0	0	530	163	1731	0	0	1685	331
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	0	0	576	177	1882	0	0	1832	360
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	15	0
Lane Group Flow (vph)	0	0	0	0	0	576	177	1882	0	0	2177	0
Turn Type						Free	Prot					
Protected Phases							5	2			6	
Permitted Phases						Free						
Actuated Green, G (s)						110.0	15.0	110.0			87.0	
Effective Green, g (s)						110.0	15.0	110.0			87.0	
Actuated g/C Ratio						1.00	0.14	1.00			0.79	
Clearance Time (s)							4.0	4.0			4.0	
Vehicle Extension (s)							3.0	3.0			3.0	
Lane Grp Cap (vph)						1611	241	5085			3923	
v/s Ratio Prot							c0.10	0.37			c0.44	
v/s Ratio Perm						0.36						
v/c Ratio						0.36	0.73	0.37			0.55	
Uniform Delay, d1						0.0	45.6	0.0			4.3	
Progression Factor						1.00	1.07	1.00			1.00	
Incremental Delay, d2						0.6	9.7	0.2			0.6	
Delay (s)						0.6	58.7	0.2			4.9	
Level of Service						A	E	A			A	
Approach Delay (s)		0.0			0.6			5.2			4.9	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	4.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	55.6%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
3: H-1 EB & Kunia Road

2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations	↰↰	↱	↓↓↓↓			↑↑↑
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0			4.0
Lane Util. Factor	0.97	1.00	0.86			0.91
Frt	1.00	0.85	1.00			1.00
Flt Protected	0.95	1.00	1.00			1.00
Satd. Flow (prot)	3433	1583	6408			5085
Flt Permitted	0.95	1.00	1.00			1.00
Satd. Flow (perm)	3433	1583	6408			5085
Volume (vph)	402	358	2072	0	0	1541
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	437	389	2252	0	0	1675
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	437	389	2252	0	0	1675
Turn Type		Free				
Protected Phases	4		6			2
Permitted Phases		Free				
Actuated Green, G (s)	17.9	110.0	84.1			84.1
Effective Green, g (s)	17.9	110.0	84.1			84.1
Actuated g/C Ratio	0.16	1.00	0.76			0.76
Clearance Time (s)	4.0		4.0			4.0
Vehicle Extension (s)	3.0		3.0			3.0
Lane Grp Cap (vph)	559	1583	4899			3888
v/s Ratio Prot	c0.13		c0.35			0.33
v/s Ratio Perm		0.25				
v/c Ratio	0.78	0.25	0.46			0.43
Uniform Delay, d1	44.2	0.0	4.7			4.5
Progression Factor	1.00	1.00	0.53			0.92
Incremental Delay, d2	7.0	0.4	0.3			0.3
Delay (s)	51.2	0.4	2.8			4.5
Level of Service	D	A	A			A
Approach Delay (s)	27.3		2.8			4.5
Approach LOS	C		A			A

Intersection Summary			
HCM Average Control Delay	7.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	49.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
4: Farrington Hwy & Fort Weaver Road SB Ramp

2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↱		↰↰	↑↑↑				↱			↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0				4.0			4.0
Lane Util. Factor		0.91		0.97	0.91				1.00			1.00
Frt		0.98		1.00	1.00				0.86			0.86
Flt Protected		1.00		0.95	1.00				1.00			1.00
Satd. Flow (prot)		5001		3433	5085				1611			1611
Flt Permitted		1.00		0.95	1.00				1.00			1.00
Satd. Flow (perm)		5001		3433	5085				1611			1611
Volume (vph)	0	1885	235	496	705	0	0	0	429	0	0	350
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	2049	255	539	766	0	0	0	466	0	0	380
RTOR Reduction (vph)	0	10	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	2294	0	539	766	0	0	0	466	0	0	380
Turn Type				Prot					Free			Free
Protected Phases		2		1	6							
Permitted Phases									Free			Free
Actuated Green, G (s)		81.4		20.6	110.0				110.0			110.0
Effective Green, g (s)		81.4		20.6	110.0				110.0			110.0
Actuated g/C Ratio		0.74		0.19	1.00				1.00			1.00
Clearance Time (s)		4.0		4.0	4.0							
Vehicle Extension (s)		3.0		3.0	3.0							
Lane Grp Cap (vph)		3701		643	5085				1611			1611
v/s Ratio Prot		c0.46		c0.16	0.15							
v/s Ratio Perm									0.29			0.24
v/c Ratio		0.62		0.84	0.15				0.29			0.24
Uniform Delay, d1		6.9		43.1	0.0				0.0			0.0
Progression Factor		0.42		0.54	1.00				1.00			1.00
Incremental Delay, d2		0.6		8.6	0.1				0.5			0.3
Delay (s)		3.5		31.8	0.1				0.5			0.3
Level of Service		A		C	A				A			A
Approach Delay (s)		3.5			13.2			0.5			0.3	
Approach LOS		A			B			A			A	

Intersection Summary			
HCM Average Control Delay	5.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	62.5%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
5: Farrington Hwy & Fort Weaver Road NB Ramps
2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑↑			↑↑↑	↱			↱			
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0	4.0			4.0			
Lane Util. Factor	0.97	*0.99			*0.99	1.00			1.00			
Frt	1.00	1.00			1.00	0.85			0.86			
Flt Protected	0.95	1.00			1.00	1.00			1.00			
Satd. Flow (prot)	3433	5532			5532	1583			1611			
Flt Permitted	0.95	1.00			1.00	1.00			1.00			
Satd. Flow (perm)	3433	5532			5532	1583			1611			
Volume (vph)	928	1386	0	0	1200	567	0	0	904	0	0	0
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	937	1400	0	0	1212	573	0	0	913	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	68	0	0	0	0	0	0
Lane Group Flow (vph)	937	1400	0	0	1212	505	0	0	913	0	0	0
Turn Type	Prot					Perm			Free			
Protected Phases	5	2			6							
Permitted Phases						6			Free			
Actuated Green, G (s)	51.1	110.0			50.9	50.9			110.0			
Effective Green, g (s)	51.1	110.0			50.9	50.9			110.0			
Actuated g/C Ratio	0.46	1.00			0.46	0.46			1.00			
Clearance Time (s)	4.0	4.0			4.0	4.0						
Vehicle Extension (s)	3.0	3.0			3.0	3.0						
Lane Grp Cap (vph)	1595	5532			2560	732			1611			
v/s Ratio Prot	0.27	0.25			0.22							
v/s Ratio Perm						c0.32			c0.57			
v/c Ratio	0.59	0.25			0.47	0.69			0.57			
Uniform Delay, d1	21.7	0.0			20.3	23.3			0.0			
Progression Factor	1.07	1.00			1.00	1.00			1.00			
Incremental Delay, d2	0.5	0.1			0.6	5.3			1.5			
Delay (s)	23.7	0.1			21.0	28.6			1.5			
Level of Service	C	A			C	C			A			
Approach Delay (s)		9.5			23.4			1.5			0.0	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM Average Control Delay	13.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	68.2%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
6: Farrington Hwy & Leoku Street
2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑↑	↱	↰	↑↑↑	↱		↰↑	↱		↰↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	1.00	0.91	1.00		1.00	1.00		0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00		0.97	1.00
Satd. Flow (prot)	3433	5085	1583	1770	5085	1583		1780	1583		3424	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00		0.97	1.00
Satd. Flow (perm)	3433	5085	1583	1770	5085	1583		1780	1583		3424	1583
Volume (vph)	144	1990	155	119	1681	156	56	5	48	92	45	33
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	157	2163	168	129	1827	170	61	5	52	100	49	36
RTOR Reduction (vph)	0	0	78	0	0	82	0	0	47	0	0	33
Lane Group Flow (vph)	157	2163	90	129	1827	88	0	66	5	0	149	3
Turn Type	Prot		Perm	Prot		Perm	Split		Perm	Split		Perm
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			6
Actuated Green, G (s)	9.2	44.5	44.5	7.6	42.9	42.9		8.1	8.1		7.0	7.0
Effective Green, g (s)	9.2	44.5	44.5	7.6	42.9	42.9		8.1	8.1		7.0	7.0
Actuated g/C Ratio	0.11	0.53	0.53	0.09	0.52	0.52		0.10	0.10		0.08	0.08
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	380	2720	847	162	2622	816		173	154		288	133
v/s Ratio Prot	0.05	c0.43		c0.07	0.36			c0.04			c0.04	
v/s Ratio Perm			0.06			0.06			0.00			0.00
v/c Ratio	0.41	0.80	0.11	0.80	0.70	0.11		0.38	0.03		0.52	0.02
Uniform Delay, d1	34.5	15.7	9.5	37.0	15.2	10.3		35.2	34.0		36.5	35.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00
Incremental Delay, d2	0.7	1.7	0.1	23.1	0.8	0.1		6.3	0.4		1.6	0.1
Delay (s)	35.2	17.3	9.6	60.1	16.1	10.4		41.5	34.4		38.1	35.0
Level of Service	D	B	A	E	B	B		D	C		D	D
Approach Delay (s)		17.9			18.3			38.4			37.5	
Approach LOS		B			B			D			D	

Intersection Summary			
HCM Average Control Delay	19.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	83.2	Sum of lost time (s)	16.0
Intersection Capacity Utilization	66.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
7: Laulaunui Street & Fort Weaver Road
2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱		↰	↑	↱	↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		*0.99		1.00	1.00	1.00	1.00	*0.99	1.00	1.00	*0.99	1.00
Frt		0.99		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.96		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		3510		1770	1863	1583	1770	5532	1583	1770	5532	1583
Flt Permitted		0.96		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		3510		1770	1863	1583	1770	5532	1583	1770	5532	1583
Volume (vph)	96	24	12	71	4	234	48	3857	52	91	1306	170
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	97	24	12	72	4	236	48	3896	53	92	1319	172
RTOR Reduction (vph)	0	6	0	0	0	110	0	0	10	0	0	53
Lane Group Flow (vph)	0	127	0	72	4	126	48	3896	43	92	1319	119
Turn Type	Split			Split		Perm	Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases						8			2			6
Actuated Green, G (s)		10.6		11.0	11.0	11.0	6.9	99.0	99.0	8.8	100.9	100.9
Effective Green, g (s)		10.6		11.0	11.0	11.0	6.9	99.0	99.0	8.8	100.9	100.9
Actuated g/C Ratio		0.07		0.08	0.08	0.08	0.05	0.68	0.68	0.06	0.69	0.69
Clearance Time (s)		4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		256		134	141	120	84	3767	1078	107	3839	1099
v/s Ratio Prot		c0.04		0.04	0.00		0.03	c0.70		c0.05	0.24	
v/s Ratio Perm						c0.08			0.03			0.08
v/c Ratio		0.50		0.54	0.03	1.05	0.57	1.03	0.04	0.86	0.34	0.11
Uniform Delay, d1		64.8		64.7	62.2	67.2	67.8	23.2	7.6	67.7	8.9	7.4
Progression Factor		1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		1.5		4.1	0.1	96.2	9.1	24.5	0.1	45.5	0.2	0.2
Delay (s)		66.4		68.8	62.3	163.4	76.9	47.7	7.7	113.2	9.2	7.6
Level of Service		E		E	E	F	E	D	A	F	A	A
Approach Delay (s)		66.4			140.3			47.5			15.1	
Approach LOS		E			F			D			B	

Intersection Summary			
HCM Average Control Delay	44.2	HCM Level of Service	D
HCM Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	145.4	Sum of lost time (s)	16.0
Intersection Capacity Utilization	104.3%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
8: Old Fort Weaver Rd & Fort Weaver Road
2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰↰	↑	↱		↰↑	↱	↰↰	↑↑↱		↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	4.0	4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.94	1.00	1.00		0.95	1.00	0.97	*0.99		1.00	*0.99	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00		1.00	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	4990	1863	1583		3537	1583	3433	5532		1770	5532	1583
Flt Permitted	0.95	1.00	1.00		1.00	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	4990	1863	1583		3537	1583	3433	5532		1770	5532	1583
Volume (vph)	701	73	393	4	344	230	283	3028	1	20	925	444
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	708	74	397	4	347	232	286	3059	1	20	934	448
RTOR Reduction (vph)	0	0	0	0	0	57	0	0	0	0	0	246
Lane Group Flow (vph)	708	74	397	0	351	175	286	3060	0	20	934	202
Turn Type	Split		Free	Split		Perm	Prot			Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			Free			8						6
Actuated Green, G (s)	15.9	15.9	100.9		11.0	11.0	12.6	56.4		1.6	45.4	45.4
Effective Green, g (s)	15.9	15.9	100.9		11.0	11.0	12.6	56.4		1.6	45.4	45.4
Actuated g/C Ratio	0.16	0.16	1.00		0.11	0.11	0.12	0.56		0.02	0.45	0.45
Clearance Time (s)	4.0	4.0			4.0	4.0	4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0			3.0	3.0	3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	786	294	1583		386	173	429	3092		28	2489	712
v/s Ratio Prot	c0.14	0.04			0.10		c0.08	c0.55		0.01	0.17	
v/s Ratio Perm			0.25			c0.11						0.13
v/c Ratio	0.90	0.25	0.25		0.91	1.01	0.67	0.99		0.71	0.38	0.28
Uniform Delay, d1	41.7	37.3	0.0		44.5	45.0	42.1	22.0		49.4	18.4	17.5
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	13.4	0.5	0.4		24.5	71.4	3.9	13.9		60.5	0.4	1.0
Delay (s)	55.2	37.7	0.4		69.0	116.4	46.0	35.9		110.0	18.8	18.5
Level of Service	E	D	A		E	F	D	D		F	B	B
Approach Delay (s)		35.6			87.9			36.8			20.0	
Approach LOS		D			F			D			B	

Intersection Summary			
HCM Average Control Delay	37.5	HCM Level of Service	D
HCM Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	100.9	Sum of lost time (s)	16.0
Intersection Capacity Utilization	98.2%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
9: Renton Road & Fort Weaver Road
2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↰↑	↱		↰↑	↱	↰	↑↑↑	↱	↰↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*0.99	*0.99	1.00		1.00	1.00	1.00	*0.99	1.00	0.97	*0.99	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1752	1766	1583		1860	1583	1770	5532	1583	3433	5532	1583
Flt Permitted	0.95	0.96	1.00		1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1752	1766	1583		1860	1583	1770	5532	1583	3433	5532	1583
Volume (vph)	467	31	36	10	339	213	89	2631	1	248	1028	49
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	472	31	36	10	342	215	90	2658	1	251	1038	49
RTOR Reduction (vph)	0	0	0	0	0	112	0	0	0	0	0	26
Lane Group Flow (vph)	245	258	36	0	352	103	90	2658	1	251	1038	23
Turn Type	Split		Free	Split		Perm	Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			Free			8			2			6
Actuated Green, G (s)	16.0	16.0	130.0		23.0	23.0	13.0	64.0	64.0	11.0	62.0	62.0
Effective Green, g (s)	16.0	16.0	130.0		23.0	23.0	13.0	64.0	64.0	11.0	62.0	62.0
Actuated g/C Ratio	0.12	0.12	1.00		0.18	0.18	0.10	0.49	0.49	0.08	0.48	0.48
Clearance Time (s)	4.0	4.0			4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	216	217	1583		329	280	177	2723	779	290	2638	755
v/s Ratio Prot	0.14	c0.15			c0.19		0.05	c0.48		c0.07	0.19	
v/s Ratio Perm			c0.02			0.07			0.00			0.01
v/c Ratio	1.13	1.19	0.02		1.07	0.37	0.51	0.98	0.00	0.87	0.39	0.03
Uniform Delay, d1	57.0	57.0	0.0		53.5	47.1	55.5	32.3	16.8	58.8	21.9	18.1
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	102.1	121.5	0.0		69.4	0.8	2.3	12.5	0.0	22.6	0.4	0.1
Delay (s)	159.1	178.5	0.0		122.9	47.9	57.8	44.7	16.8	81.3	22.3	18.1
Level of Service	F	F	A		F	D	E	D	B	F	C	B
Approach Delay (s)		157.8			94.5			45.2			33.3	
Approach LOS		F			F			D			C	

Intersection Summary			
HCM Average Control Delay	59.2	HCM Level of Service	E
HCM Volume to Capacity ratio	1.01		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	103.4%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
10: Farrington Hwy & D Street
2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↑		↰↰	↑↑↑↱			↑↱	↱	↰	↰↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	0.91		0.97	0.91			0.95	0.95	0.95	0.95	
Frt	1.00	1.00		1.00	0.98			0.86	0.85	1.00	0.91	
Flt Protected	0.95	1.00		0.95	1.00			1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	5085		3433	4982			1528	1504	1681	1607	
Flt Permitted	0.95	1.00		0.95	1.00			1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	5085		3433	4982			1528	1504	1681	1607	
Volume (vph)	130	1588	0	270	679	106	0	17	347	178	191	304
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	131	1604	0	273	686	107	0	17	351	180	193	307
RTOR Reduction (vph)	0	0	0	0	17	0	0	161	162	0	52	0
Lane Group Flow (vph)	131	1604	0	273	776	0	0	31	14	180	448	0
Turn Type	Prot			Prot					Perm	Split		
Protected Phases	5	2		1	6			8		4	4	
Permitted Phases									8			
Actuated Green, G (s)	12.8	45.0		9.0	41.2			8.5	8.5	31.5	31.5	
Effective Green, g (s)	12.8	45.0		9.0	41.2			8.5	8.5	31.5	31.5	
Actuated g/C Ratio	0.12	0.41		0.08	0.37			0.08	0.08	0.29	0.29	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	206	2080		281	1866			118	116	481	460	
v/s Ratio Prot	0.07	c0.32		c0.08	0.16			c0.02		0.11	c0.28	
v/s Ratio Perm									0.01			
v/c Ratio	0.64	0.77		0.97	0.42			0.26	0.12	0.37	0.97	
Uniform Delay, d1	46.4	28.1		50.4	25.5			47.8	47.3	31.4	38.8	
Progression Factor	0.75	0.84		0.79	0.57			1.00	1.00	1.00	1.00	
Incremental Delay, d2	5.4	2.4		45.4	0.7			1.2	0.5	0.5	34.9	
Delay (s)	40.1	26.1		85.3	15.1			49.0	47.7	31.9	73.8	
Level of Service	D	C		F	B			D	D	C	E	
Approach Delay (s)		27.2			33.1			48.4			62.7	
Approach LOS		C			C			D			E	

Intersection Summary			
HCM Average Control Delay	37.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	79.0%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
11: Farrington Hwy & E Street

2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↱			↑↑↱		↰	↱		↰	↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.91			0.91		1.00	1.00		1.00	1.00	
Frt	1.00	1.00			1.00		1.00	0.99		1.00	0.92	
Flt Protected	0.95	1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	5061			5065		1770	1844		1770	1720	
Flt Permitted	0.95	1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	5061			5065		1770	1844		1770	1720	
Volume (vph)	49	1600	52	0	957	26	202	68	5	113	47	49
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	49	1616	53	0	967	26	204	69	5	114	47	49
RTOR Reduction (vph)	0	2	0	0	2	0	0	3	0	0	36	0
Lane Group Flow (vph)	49	1667	0	0	991	0	204	71	0	114	60	0
Turn Type	Prot						Split			Split		
Protected Phases	5	2			6		8	8		4	4	
Permitted Phases												
Actuated Green, G (s)	8.0	68.7			56.7		17.2	17.2		12.1	12.1	
Effective Green, g (s)	8.0	68.7			56.7		17.2	17.2		12.1	12.1	
Actuated g/C Ratio	0.07	0.62			0.52		0.16	0.16		0.11	0.11	
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	129	3161			2611		277	288		195	189	
v/s Ratio Prot	0.03	c0.33			0.20		c0.12	0.04		c0.06	0.03	
v/s Ratio Perm												
v/c Ratio	0.38	0.53			0.38		0.74	0.25		0.58	0.31	
Uniform Delay, d1	48.6	11.6			16.1		44.2	40.7		46.6	45.1	
Progression Factor	1.00	1.00			0.65		1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.9	0.6			0.3		9.8	0.5		4.4	1.0	
Delay (s)	50.5	12.2			10.8		54.0	41.2		51.0	46.1	
Level of Service	D	B			B		D	D		D	D	
Approach Delay (s)		13.3			10.8			50.6			48.7	
Approach LOS		B			B			D			D	

Intersection Summary			
HCM Average Control Delay	18.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	56.6%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
12: Fort Barrette Road & Farrington Hwy

2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰↰	↑↱	↱	↰↰	↑↑	↱	↰↰	↑↑	↱	↰	↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	0.91	0.97	0.95	1.00	0.97	0.95	1.00	1.00	0.95	1.00
Frt	1.00	0.96	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3263	1441	3433	3539	1583	3433	3539	1583	1770	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3263	1441	3433	3539	1583	3433	3539	1583	1770	3539	1583
Volume (vph)	377	707	798	572	578	159	338	438	485	78	739	704
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	381	714	806	578	584	161	341	442	490	79	746	711
RTOR Reduction (vph)	0	21	14	0	0	70	0	0	61	0	0	49
Lane Group Flow (vph)	381	931	554	578	584	91	341	442	429	79	746	662
Turn Type	Prot		pm+ov	Prot		pm+ov	Prot		pm+ov	Prot		pm+ov
Protected Phases	1	6	7	5	2	3	7	4	5	3	8	1
Permitted Phases			6			2			4			8
Actuated Green, G (s)	22.0	44.1	58.2	24.1	46.2	56.3	14.1	36.6	60.7	10.1	32.6	54.6
Effective Green, g (s)	22.0	44.1	58.2	24.1	46.2	56.3	14.1	36.6	60.7	10.1	32.6	54.6
Actuated g/C Ratio	0.17	0.34	0.44	0.18	0.35	0.43	0.11	0.28	0.46	0.08	0.25	0.42
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	577	1099	685	632	1249	729	370	990	782	137	881	709
v/s Ratio Prot	0.11	c0.29	c0.09	0.17	0.17	0.01	0.10	0.12	c0.10	0.04	0.21	c0.16
v/s Ratio Perm			0.30			0.05			0.17			0.26
v/c Ratio	0.66	0.85	0.81	0.91	0.47	0.12	0.92	0.45	0.55	0.58	0.85	0.93
Uniform Delay, d1	51.0	40.3	31.5	52.4	32.8	22.5	57.9	38.8	25.2	58.3	46.8	36.4
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	2.8	6.2	7.0	17.8	1.3	0.1	27.9	0.3	0.8	5.8	7.6	19.3
Delay (s)	53.8	46.5	38.5	70.2	34.1	22.5	85.7	39.1	26.0	64.1	54.3	55.7
Level of Service	D	D	D	E	C	C	F	D	C	E	D	E
Approach Delay (s)		45.5			48.5			46.6			55.5	
Approach LOS		D			D			D			E	

Intersection Summary			
HCM Average Control Delay	48.9	HCM Level of Service	D
HCM Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	130.9	Sum of lost time (s)	12.0
Intersection Capacity Utilization	87.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
13: WB Ramps & North-South Road
2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	WBL2	WBL	WBR	NBL	NBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰↰		↱				↑↑	↱	↰↰	↑↑	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0				4.0	4.0	4.0	4.0	
Lane Util. Factor	*0.99		1.00				*0.99	1.00	0.97	*0.99	
Frt	1.00		0.85				1.00	0.85	1.00	1.00	
Flt Protected	0.95		1.00				1.00	1.00	0.95	1.00	
Satd. Flow (prot)	3504		1583				3688	1583	3433	3688	
Flt Permitted	0.95		1.00				1.00	1.00	0.95	1.00	
Satd. Flow (perm)	3504		1583				3688	1583	3433	3688	
Volume (vph)	1338	0	115	0	0	0	1099	248	518	222	0
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	1352	0	116	0	0	0	1110	251	523	224	0
RTOR Reduction (vph)	0	0	71	0	0	0	0	168	0	0	0
Lane Group Flow (vph)	1352	0	45	0	0	0	1110	83	523	224	0
Turn Type	Prot		custom					Perm	Prot		
Protected Phases	8		8				6		5	2	
Permitted Phases								6			
Actuated Green, G (s)	39.0		39.0				33.0	33.0	16.0	53.0	
Effective Green, g (s)	39.0		39.0				33.0	33.0	16.0	53.0	
Actuated g/C Ratio	0.39		0.39				0.33	0.33	0.16	0.53	
Clearance Time (s)	4.0		4.0				4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0		3.0				3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	1367		617				1217	522	549	1955	
v/s Ratio Prot	c0.39		0.03				c0.30		c0.15	0.06	
v/s Ratio Perm								0.05			
v/c Ratio	0.99		0.07				0.91	0.16	0.95	0.11	
Uniform Delay, d1	30.3		19.2				32.1	23.7	41.6	11.8	
Progression Factor	1.00		1.00				1.00	1.00	0.43	0.67	
Incremental Delay, d2	21.5		0.1				11.8	0.6	24.1	0.1	
Delay (s)	51.8		19.2				43.9	24.3	42.1	8.0	
Level of Service	D		B				D	C	D	A	
Approach Delay (s)		49.2		0.0			40.3			31.9	
Approach LOS		D		A			D			C	

Intersection Summary			
HCM Average Control Delay	42.2	HCM Level of Service	D
HCM Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	74.0%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
14: EB Ramps & North-South Road
2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	EBL2	EBL	EBR	SBL	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰		↱↱			↰↰	↑↑			↑↑	↱↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0			4.0	4.0			4.0	4.0
Lane Util. Factor	1.00		0.88			0.97	*0.99			*0.99	*0.99
Frt	1.00		0.85			1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (prot)	1770		2787			3433	3688			3688	3135
Flt Permitted	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (perm)	1770		2787			3433	3688			3688	3135
Volume (vph)	51	0	633	0	0	802	1634	0	0	689	2305
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	52	0	639	0	0	810	1651	0	0	696	2328
RTOR Reduction (vph)	0	0	36	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	52	0	603	0	0	810	1651	0	0	696	2328
Turn Type	Prot		custom			Prot					Free
Protected Phases	4		4			1	6			2	
Permitted Phases											Free
Actuated Green, G (s)	25.8		25.8			29.7	66.2			32.5	100.0
Effective Green, g (s)	25.8		25.8			29.7	66.2			32.5	100.0
Actuated g/C Ratio	0.26		0.26			0.30	0.66			0.32	1.00
Clearance Time (s)	4.0		4.0			4.0	4.0			4.0	
Vehicle Extension (s)	3.0		3.0			3.0	3.0			3.0	
Lane Grp Cap (vph)	457		719			1020	2441			1199	3135
v/s Ratio Prot	0.03		0.22			0.24	0.45			0.19	
v/s Ratio Perm											c0.74
v/c Ratio	0.11		0.84			0.79	0.68			0.58	0.74
Uniform Delay, d1	28.4		35.1			32.3	10.3			28.1	0.0
Progression Factor	1.00		1.00			1.01	0.49			1.00	1.00
Incremental Delay, d2	0.1		8.5			1.4	0.5			2.1	1.6
Delay (s)	28.5		43.6			34.2	5.5			30.1	1.6
Level of Service	C		D			C	A			C	A
Approach Delay (s)		42.4		0.0			15.0			8.2	
Approach LOS		D		A			B			A	

Intersection Summary			
HCM Average Control Delay	14.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	0.0
Intersection Capacity Utilization	74.0%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
15: North-South Road & Farrington Hwy — 2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*0.99	*0.99	1.00	*0.99	*0.99	1.00	*0.99	*0.99	1.00	*0.99	*0.99	0.88
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3504	5532	1583	5256	5532	1583	3504	3688	1583	3504	3688	2787
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3504	5532	1583	5256	5532	1583	3504	3688	1583	3504	3688	2787
Volume (vph)	514	1147	563	459	1739	344	542	393	224	172	483	713
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	519	1159	569	464	1757	347	547	397	226	174	488	720
RTOR Reduction (vph)	0	0	273	0	0	193	0	0	186	0	0	386
Lane Group Flow (vph)	519	1159	296	464	1757	154	547	397	40	174	488	334
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases			6			2			4			8
Actuated Green, G (s)	20.3	35.5	35.5	26.8	42.0	42.0	22.0	21.0	21.0	20.0	19.0	19.0
Effective Green, g (s)	20.3	35.5	35.5	26.8	42.0	42.0	22.0	21.0	21.0	20.0	19.0	19.0
Actuated g/C Ratio	0.17	0.30	0.30	0.22	0.35	0.35	0.18	0.18	0.18	0.17	0.16	0.16
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	596	1646	471	1181	1948	557	646	649	279	587	587	444
v/s Ratio Prot	c0.15	0.21		0.09	c0.32		c0.16	0.11		0.05	c0.13	
v/s Ratio Perm			0.19			0.10			0.03			0.12
v/c Ratio	0.87	0.70	0.63	0.39	0.90	0.28	0.85	0.61	0.14	0.30	0.83	0.75
Uniform Delay, d1	48.2	37.2	36.2	39.3	36.7	27.7	47.0	45.4	41.5	43.5	48.6	47.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	13.1	1.4	2.6	0.2	6.3	0.3	13.0	4.3	1.1	0.3	12.9	11.2
Delay (s)	61.4	38.6	38.8	39.5	42.9	28.0	60.0	49.7	42.6	43.8	61.5	59.1
Level of Service	E	D	D	D	D	C	E	D	D	D	E	E
Approach Delay (s)		43.9			40.3			53.1			58.0	
Approach LOS		D			D			D			E	

Intersection Summary			
HCM Average Control Delay	46.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	119.3	Sum of lost time (s)	12.0
Intersection Capacity Utilization	90.4%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
16: North-South Road & North UH Connector — 2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	1.00	0.86	0.86	0.97	0.91		0.97	0.95		0.97	1.00	0.88
Frt	1.00	1.00	0.85	1.00	0.98		1.00	0.98		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1770	4806	1362	3433	4987		3433	3461		3433	1863	2787
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	1770	4806	1362	3433	4987		3433	3461		3433	1863	2787
Volume (vph)	51	2024	224	471	934	138	217	161	28	353	103	300
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	52	2044	226	476	943	139	219	163	28	357	104	303
RTOR Reduction (vph)	0	0	105	0	17	0	0	14	0	0	0	70
Lane Group Flow (vph)	52	2044	121	476	1065	0	219	177	0	357	104	233
Turn Type	Prot		Perm	Prot			Prot			Prot		pm+ov
Protected Phases	5	2		1	6		7	4		3	8	1
Permitted Phases			2									8
Actuated Green, G (s)	4.1	40.8	40.8	13.0	49.7		14.0	10.9		13.9	10.8	23.8
Effective Green, g (s)	4.1	40.8	40.8	13.0	49.7		14.0	10.9		13.9	10.8	23.8
Actuated g/C Ratio	0.04	0.43	0.43	0.14	0.53		0.15	0.12		0.15	0.11	0.25
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	77	2073	587	472	2620		508	399		504	213	819
v/s Ratio Prot	0.03	c0.43		c0.14	0.21		0.06	0.05		c0.10	c0.06	0.04
v/s Ratio Perm			0.09									0.04
v/c Ratio	0.68	0.99	0.21	1.01	0.41		0.43	0.44		0.71	0.49	0.28
Uniform Delay, d1	44.6	26.6	16.8	40.8	13.6		36.7	39.0		38.4	39.3	28.5
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	20.9	16.7	0.8	43.6	0.5		0.6	0.8		4.5	1.8	0.2
Delay (s)	65.5	43.3	17.6	84.4	14.0		37.3	39.8		42.9	41.1	28.7
Level of Service	E	D	B	F	B		D	D		D	D	C
Approach Delay (s)		41.3			35.5			38.4			37.1	
Approach LOS		D			D			D			D	

Intersection Summary			
HCM Average Control Delay	38.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	94.6	Sum of lost time (s)	16.0
Intersection Capacity Utilization	83.0%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
17: East-West Rd. & North-South Road

2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↱		↰↰	↑↱		↰↰	↑↑↑	↱	↰↰	↑↑↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	0.97	0.95		0.97	0.95		0.97	0.91	1.00	0.97	0.91	
Frt	1.00	0.95		1.00	0.87		1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	3433	3362		3433	3066		3433	5085	1583	3433	4969	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	3433	3362		3433	3066		3433	5085	1583	3433	4969	
Volume (vph)	243	224	112	239	75	614	207	1442	206	189	954	172
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	245	226	113	241	76	620	209	1457	208	191	964	174
RTOR Reduction (vph)	0	59	0	0	183	0	0	0	129	0	23	0
Lane Group Flow (vph)	245	280	0	241	513	0	209	1457	79	191	1115	0
Turn Type	Prot			Prot			Prot		Perm	Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases									2			
Actuated Green, G (s)	12.6	21.3		11.7	20.4		10.2	40.1	40.1	16.0	45.9	
Effective Green, g (s)	12.6	21.3		11.7	20.4		10.2	40.1	40.1	16.0	45.9	
Actuated g/C Ratio	0.12	0.20		0.11	0.19		0.10	0.38	0.38	0.15	0.44	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	412	681		382	595		333	1940	604	523	2170	
v/s Ratio Prot	c0.07	0.08		0.07	c0.17		c0.06	c0.29		0.06	c0.22	
v/s Ratio Perm									0.05			
v/c Ratio	0.59	0.41		0.63	1.27dr		0.63	0.75	0.13	0.37	0.51	
Uniform Delay, d1	43.8	36.4		44.6	41.0		45.6	28.2	21.2	40.0	21.5	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	2.3	0.4		3.4	12.3		3.7	2.7	0.5	2.0	0.9	
Delay (s)	46.1	36.9		48.0	53.3		49.3	30.9	21.6	42.0	22.4	
Level of Service	D	D		D	D		D	C	C	D	C	
Approach Delay (s)		40.7			51.9			31.9			25.2	
Approach LOS		D			D			C			C	

Intersection Summary			
HCM Average Control Delay	35.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	105.1	Sum of lost time (s)	20.0
Intersection Capacity Utilization	75.5%	ICU Level of Service	D
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
18: North-South Road & Kapolei Parkway

2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰	↑↑↑	↱	↰	↑↑↑	↱	↰↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	*0.99	1.00	1.00	*0.99	1.00	*0.99	*0.99	1.00	1.00	*0.99	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	5532	1583	1770	5532	1583	3504	5532	1583	1770	5532	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	5532	1583	1770	5532	1583	3504	5532	1583	1770	5532	1583
Volume (vph)	245	517	64	222	496	588	855	315	316	118	637	483
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	247	522	65	224	501	594	864	318	319	119	643	488
RTOR Reduction (vph)	0	0	51	0	0	375	0	0	202	0	0	253
Lane Group Flow (vph)	247	522	14	224	501	219	864	318	117	119	643	235
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases			2			6			4			8
Actuated Green, G (s)	15.9	21.2	21.2	14.8	20.1	20.1	25.9	35.4	35.4	9.2	18.7	18.7
Effective Green, g (s)	15.9	21.2	21.2	14.8	20.1	20.1	25.9	35.4	35.4	9.2	18.7	18.7
Actuated g/C Ratio	0.16	0.22	0.22	0.15	0.21	0.21	0.27	0.37	0.37	0.10	0.19	0.19
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	291	1214	347	271	1151	329	939	2027	580	169	1071	306
v/s Ratio Prot	c0.14	0.09		0.13	0.09		c0.25	0.06		0.07	0.12	
v/s Ratio Perm			0.01			c0.14			0.07			c0.15
v/c Ratio	0.85	0.43	0.04	0.83	0.44	0.66	0.92	0.16	0.20	0.70	0.60	0.77
Uniform Delay, d1	39.2	32.5	29.7	39.7	33.3	35.2	34.3	20.6	20.9	42.4	35.5	36.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	20.0	1.1	0.2	18.3	1.2	10.2	13.9	0.0	0.2	12.5	1.0	11.0
Delay (s)	59.2	33.6	29.9	57.9	34.5	45.3	48.2	20.6	21.1	54.9	36.5	47.8
Level of Service	E	C	C	E	C	D	D	C	C	D	D	D
Approach Delay (s)		40.9			43.3			36.6			42.7	
Approach LOS		D			D			D			D	

Intersection Summary			
HCM Average Control Delay	40.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	96.6	Sum of lost time (s)	16.0
Intersection Capacity Utilization	74.3%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
19: East-West Rd. & Old Fort Weaver Rd
2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↰	↑	↑↑	↱	↰↰	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	0.97	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1863	3539	1583	3433	1583
Flt Permitted	0.58	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1080	1863	3539	1583	3433	1583
Volume (vph)	21	765	277	795	402	45
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	21	773	280	803	406	45
RTOR Reduction (vph)	0	0	0	426	0	25
Lane Group Flow (vph)	21	773	280	377	406	20
Turn Type	Perm			Perm		Perm
Protected Phases		4	8		6	
Permitted Phases	4			8		6
Actuated Green, G (s)	39.7	39.7	39.7	39.7	36.8	36.8
Effective Green, g (s)	39.7	39.7	39.7	39.7	36.8	36.8
Actuated g/C Ratio	0.47	0.47	0.47	0.47	0.44	0.44
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	507	875	1663	744	1495	689
v/s Ratio Prot		c0.41	0.08		c0.12	
v/s Ratio Perm	0.02			0.24		0.01
v/c Ratio	0.04	0.88	0.17	0.51	0.27	0.03
Uniform Delay, d1	12.1	20.3	12.9	15.6	15.3	13.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.0	10.5	0.0	0.5	0.4	0.1
Delay (s)	12.1	30.8	12.9	16.1	15.7	13.7
Level of Service	B	C	B	B	B	B
Approach Delay (s)		30.3	15.3		15.5	
Approach LOS		C	B		B	

Intersection Summary			
HCM Average Control Delay	20.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	84.5	Sum of lost time (s)	8.0
Intersection Capacity Utilization	59.2%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
20: Farrington Hwy & B Street
2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰↰	↑↑	↱	↰↰	↑↑	↱	↰	↑	↱	↰↰	↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3539	1583	3433	3539	1583	1770	1863	1583	3433	1863	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3539	1583	3433	3539	1583	1770	1863	1583	3433	1863	1583
Volume (vph)	206	1094	186	119	866	83	47	137	121	331	223	198
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	224	1189	202	129	941	90	51	149	132	360	242	215
RTOR Reduction (vph)	0	0	95	0	0	57	0	0	17	0	0	52
Lane Group Flow (vph)	224	1189	107	129	941	33	51	149	115	360	242	163
Turn Type	Prot		pm+ov	Prot		Perm	Prot		pm+ov	Prot		pm+ov
Protected Phases	5	2	3	1	6		7	4	5	3	8	1
Permitted Phases			2			6			4			8
Actuated Green, G (s)	11.1	35.4	48.2	8.7	33.0	33.0	3.9	18.1	29.2	12.8	27.0	35.7
Effective Green, g (s)	11.1	35.4	48.2	8.7	33.0	33.0	3.9	18.1	29.2	12.8	27.0	35.7
Actuated g/C Ratio	0.12	0.39	0.53	0.10	0.36	0.36	0.04	0.20	0.32	0.14	0.30	0.39
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	419	1377	908	328	1283	574	76	371	578	483	553	691
v/s Ratio Prot	c0.07	c0.34	0.02	0.04	0.27		0.03	0.08	0.02	c0.10	c0.13	0.02
v/s Ratio Perm			0.05			0.02			0.05			0.08
v/c Ratio	0.53	0.86	0.12	0.39	0.73	0.06	0.67	0.40	0.20	0.75	0.44	0.24
Uniform Delay, d1	37.5	25.6	10.7	38.7	25.2	18.9	42.9	31.7	22.4	37.5	25.9	18.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.3	5.9	0.1	0.8	2.2	0.0	20.8	3.2	0.2	6.2	2.5	0.2
Delay (s)	38.8	31.4	10.8	39.5	27.4	18.9	63.8	35.0	22.6	43.7	28.4	18.7
Level of Service	D	C	B	D	C	B	E	C	C	D	C	B
Approach Delay (s)		29.9			28.1			34.5			32.6	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	30.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	91.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	63.6%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
21: East-West Rd. & A Street
2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	1.00	0.85	1.00	0.85		1.00	0.88	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1842		1770	1863	1583	1770	1591		1770	1630	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	1842		1770	1863	1583	1770	1591		1770	1630	
Volume (vph)	86	324	26	31	625	27	26	4	135	43	7	37
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	93	352	28	34	679	29	28	4	147	47	8	40
RTOR Reduction (vph)	0	2	0	0	0	13	0	132	0	0	36	0
Lane Group Flow (vph)	93	378	0	34	679	16	28	19	0	47	12	0
Turn Type	Prot			Prot		Perm	Split			Split		
Protected Phases	5	2		1	6		4	4		8	8	
Permitted Phases						6						
Actuated Green, G (s)	7.6	38.9		3.0	34.3	34.3	7.3	7.3		7.4	7.4	
Effective Green, g (s)	7.6	38.9		3.0	34.3	34.3	7.3	7.3		7.4	7.4	
Actuated g/C Ratio	0.10	0.54		0.04	0.47	0.47	0.10	0.10		0.10	0.10	
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	185	987		73	880	748	178	160		180	166	
v/s Ratio Prot	c0.05	0.21		0.02	c0.36		c0.02	0.01		c0.03	0.01	
v/s Ratio Perm						0.01						
v/c Ratio	0.50	0.38		0.47	0.77	0.02	0.16	0.12		0.26	0.07	
Uniform Delay, d1	30.7	9.8		34.0	15.9	10.2	29.8	29.7		30.1	29.5	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	2.1	0.2		4.6	4.2	0.0	0.4	0.3		0.8	0.2	
Delay (s)	32.9	10.1		38.7	20.1	10.2	30.3	30.0		30.9	29.7	
Level of Service	C	B		D	C	B	C	C		C	C	
Approach Delay (s)		14.6			20.6			30.1			30.3	
Approach LOS		B			C			C			C	

Intersection Summary			
HCM Average Control Delay	20.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	72.6	Sum of lost time (s)	16.0
Intersection Capacity Utilization	62.9%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
22: Farrington Hwy & 2nd Avenue
2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.91		0.97	0.95	1.00	1.00	0.95	0.88	0.97	0.95	1.00
Frt	1.00	0.99		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	5043		3433	3539	1583	1770	3539	2787	3433	3539	1583
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	5043		3433	3539	1583	1770	3539	2787	3433	3539	1583
Volume (vph)	166	1029	61	223	746	239	95	391	446	225	259	133
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	180	1118	66	242	811	260	103	425	485	245	282	145
RTOR Reduction (vph)	0	5	0	0	0	176	0	0	58	0	0	108
Lane Group Flow (vph)	180	1179	0	242	811	84	103	425	427	245	282	37
Turn Type	Prot			Prot		Perm	Prot		pm+ov	Prot		Perm
Protected Phases	5	2		1	6		3	8	1	7	4	
Permitted Phases						6			8			4
Actuated Green, G (s)	26.0	52.8		15.2	42.0	42.0	12.7	27.0	42.2	19.0	33.3	33.3
Effective Green, g (s)	26.0	52.8		15.2	42.0	42.0	12.7	27.0	42.2	19.0	33.3	33.3
Actuated g/C Ratio	0.20	0.41		0.12	0.32	0.32	0.10	0.21	0.32	0.15	0.26	0.26
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	354	2048		401	1143	511	173	735	905	502	907	405
v/s Ratio Prot	0.10	c0.23		0.07	c0.23		0.06	c0.12	0.06	c0.07	0.08	
v/s Ratio Perm						0.05			0.10			0.02
v/c Ratio	0.51	0.58		0.60	0.71	0.16	0.60	0.58	0.47	0.49	0.31	0.09
Uniform Delay, d1	46.3	29.9		54.5	38.6	31.5	56.2	46.4	35.0	51.0	39.1	36.8
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.2	1.2		2.6	3.7	0.7	5.4	3.3	0.4	0.7	0.9	0.4
Delay (s)	47.5	31.1		57.1	42.4	32.1	61.6	49.7	35.4	51.8	40.0	37.3
Level of Service	D	C		E	D	C	E	D	D	D	D	D
Approach Delay (s)		33.3			43.1			44.1			43.7	
Approach LOS		C			D			D			D	

Intersection Summary			
HCM Average Control Delay	40.3	HCM Level of Service	D
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	60.4%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
23: 2nd Avenue & Kunia Road
2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations		↱	↑↑↑↱			↑↑↑↑
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	0	0	1679	234	0	4777
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	1825	254	0	5192
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)			870			
pX, platoon unblocked						
vC, conflicting volume	3250	583			2079	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	3250	583			2079	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	7	455			263	

Direction, Lane #	EB 1	SE 1	SE 2	SE 3	SE 4	NW 1	NW 2	NW 3	NW 4
Volume Total	0	521	521	521	515	1298	1298	1298	1298
Volume Left	0	0	0	0	0	0	0	0	0
Volume Right	0	0	0	0	254	0	0	0	0
cSH	1700	1700	1700	1700	1700	1700	1700	1700	1700
Volume to Capacity	0.00	0.31	0.31	0.31	0.30	0.76	0.76	0.76	0.76
Queue Length 95th (ft)	0	0	0	0	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane LOS	A								
Approach Delay (s)	0.0	0.0				0.0			
Approach LOS	A								

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	72.6%	ICU Level of Service	C
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
24: 3rd Avenue & Kunia Road
2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations		↱	↑↑↑↱			↑↑↑↑
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	0	7	1593	86	0	4777
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	8	1732	93	0	5192
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)			1234			
pX, platoon unblocked						
vC, conflicting volume	3076	480			1825	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	3076	480			1825	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	99			100	
cM capacity (veh/h)	9	532			331	

Direction, Lane #	EB 1	SE 1	SE 2	SE 3	SE 4	NW 1	NW 2	NW 3	NW 4
Volume Total	8	495	495	495	341	1298	1298	1298	1298
Volume Left	0	0	0	0	0	0	0	0	0
Volume Right	8	0	0	0	93	0	0	0	0
cSH	532	1700	1700	1700	1700	1700	1700	1700	1700
Volume to Capacity	0.01	0.29	0.29	0.29	0.20	0.76	0.76	0.76	0.76
Queue Length 95th (ft)	1	0	0	0	0	0	0	0	0
Control Delay (s)	11.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane LOS	B								
Approach Delay (s)	11.9	0.0				0.0			
Approach LOS	B								

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	72.6%	ICU Level of Service	C
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
25: East-West Rd. & B Street
2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	WBT	WBR	SEL	SER
Lane Configurations	↰	↑	↑	↱	↰	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1863	1863	1583	1770	1583
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1863	1863	1583	1770	1583
Volume (vph)	153	234	314	85	643	369
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	166	254	341	92	699	401
RTOR Reduction (vph)	0	0	0	72	0	157
Lane Group Flow (vph)	166	254	341	20	699	244
Turn Type	Prot			Prot		Prot
Protected Phases	5	2	6	6	4	4
Permitted Phases						
Actuated Green, G (s)	15.2	45.1	25.9	25.9	65.5	65.5
Effective Green, g (s)	15.2	45.1	25.9	25.9	65.5	65.5
Actuated g/C Ratio	0.13	0.38	0.22	0.22	0.55	0.55
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	227	708	407	346	978	874
v/s Ratio Prot	c0.09	0.14	c0.18	0.01	c0.40	0.15
v/s Ratio Perm						
v/c Ratio	0.73	0.36	0.84	0.06	0.71	0.28
Uniform Delay, d1	49.7	26.4	44.3	36.7	19.6	14.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	11.5	0.3	14.0	0.1	4.5	0.8
Delay (s)	61.2	26.7	58.3	36.8	24.1	14.9
Level of Service	E	C	E	D	C	B
Approach Delay (s)		40.3	53.7		20.7	
Approach LOS		D	D		C	

Intersection Summary			
HCM Average Control Delay	32.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	118.6	Sum of lost time (s)	12.0
Intersection Capacity Utilization	70.6%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
26: Farrington Hwy &
2030 + PRO (with Transit Corridor) - AM Peak Mitigations

Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations	↰	↱	↰	↑↑	↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	*0.99	*0.99	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3688	3688	1583
Flt Permitted	0.95	1.00	0.13	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	240	3688	3688	1583
Volume (vph)	100	233	46	1060	1373	132
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	101	235	46	1071	1387	133
RTOR Reduction (vph)	0	31	0	0	0	55
Lane Group Flow (vph)	101	204	46	1071	1387	78
Turn Type		Perm	Perm			Perm
Protected Phases	6			4	8	
Permitted Phases		6	4			8
Actuated Green, G (s)	33.0	33.0	59.0	59.0	59.0	59.0
Effective Green, g (s)	33.0	33.0	59.0	59.0	59.0	59.0
Actuated g/C Ratio	0.33	0.33	0.59	0.59	0.59	0.59
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	584	522	142	2176	2176	934
v/s Ratio Prot	0.06			0.29	c0.38	
v/s Ratio Perm		c0.13	0.19			0.05
v/c Ratio	0.17	0.39	0.32	0.49	0.64	0.08
Uniform Delay, d1	23.8	25.8	10.4	11.8	13.5	8.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.6	2.2	6.0	0.8	1.4	0.2
Delay (s)	24.4	28.0	16.3	12.6	14.9	9.0
Level of Service	C	C	B	B	B	A
Approach Delay (s)	26.9			12.8	14.4	
Approach LOS	C			B	B	

Intersection Summary			
HCM Average Control Delay	15.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	59.0%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↰	↱	↑↑	↱		↑↑↑
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0		4.0
Lane Util. Factor	*0.99	1.00	*0.99	1.00		*0.99
Frt	1.00	0.85	1.00	0.85		1.00
Flt Protected	0.95	1.00	1.00	1.00		1.00
Satd. Flow (prot)	3504	1583	3688	1583		5532
Flt Permitted	0.95	1.00	1.00	1.00		1.00
Satd. Flow (perm)	3504	1583	3688	1583		5532
Volume (vph)	882	41	2658	907	0	2752
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	891	41	2685	916	0	2780
RTOR Reduction (vph)	0	4	0	206	0	0
Lane Group Flow (vph)	891	37	2685	710	0	2780
Turn Type		Perm		Perm		
Protected Phases	8		2			6
Permitted Phases		8		2		
Actuated Green, G (s)	32.0	32.0	90.0	90.0		90.0
Effective Green, g (s)	32.0	32.0	90.0	90.0		90.0
Actuated g/C Ratio	0.25	0.25	0.69	0.69		0.69
Clearance Time (s)	4.0	4.0	4.0	4.0		4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0		3.0
Lane Grp Cap (vph)	863	390	2553	1096		3830
v/s Ratio Prot	c0.25		c0.73			0.50
v/s Ratio Perm		0.02		0.45		
v/c Ratio	1.03	0.10	1.05	0.65		0.73
Uniform Delay, d1	49.0	37.8	20.0	11.2		12.4
Progression Factor	1.00	1.00	1.00	1.00		1.00
Incremental Delay, d2	39.3	0.1	33.3	3.0		1.2
Delay (s)	88.3	37.9	53.3	14.1		13.6
Level of Service	F	D	D	B		B
Approach Delay (s)	86.1		43.3			13.6
Approach LOS	F		D			B

Intersection Summary			
HCM Average Control Delay	37.5	HCM Level of Service	D
HCM Volume to Capacity ratio	1.05		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	105.3%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations						↱	↰	↑↑↑			↑↑↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)						4.0	4.0	4.0			4.0	
Lane Util. Factor						1.00	1.00	*0.99			*0.99	
Frt						0.86	1.00	1.00			0.99	
Flt Protected						1.00	0.95	1.00			1.00	
Satd. Flow (prot)						1611	1770	5532			5455	
Flt Permitted						1.00	0.95	1.00			1.00	
Satd. Flow (perm)						1611	1770	5532			5455	
Volume (vph)	0	0	0	0	0	1230	423	2335	0	0	3295	339
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	0	0	0	0	0	1242	427	2359	0	0	3328	342
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	20	0
Lane Group Flow (vph)	0	0	0	0	0	1242	427	2359	0	0	3650	0
Turn Type						Free	Prot					
Protected Phases							5	2			6	
Permitted Phases						Free						
Actuated Green, G (s)						70.0	17.0	70.0			45.0	
Effective Green, g (s)						70.0	17.0	70.0			45.0	
Actuated g/C Ratio						1.00	0.24	1.00			0.64	
Clearance Time (s)							4.0	4.0			4.0	
Vehicle Extension (s)							3.0	3.0			3.0	
Lane Grp Cap (vph)						1611	430	5532			3507	
v/s Ratio Prot							c0.24	0.43			c0.67	
v/s Ratio Perm						0.77						
v/c Ratio						0.77	0.99	0.43			1.04	
Uniform Delay, d1						0.0	26.4	0.0			12.5	
Progression Factor						1.00	0.96	1.00			1.00	
Incremental Delay, d2						3.6	35.1	0.2			27.2	
Delay (s)						3.6	60.5	0.2			39.7	
Level of Service						A	E	A			D	
Approach Delay (s)		0.0			3.6			9.4			39.7	
Approach LOS		A			A			A			D	

Intersection Summary			
HCM Average Control Delay	22.9	HCM Level of Service	C
HCM Volume to Capacity ratio	1.03		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	101.3%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
3: H-1 EB & Kunia Road

2030 + PRO (With Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations	↰↰	↱	↓↓↓↓			↑↑↑
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0			4.0
Lane Util. Factor	*0.99	1.00	*0.99			*0.99
Frt	1.00	0.85	1.00			1.00
Flt Protected	0.95	1.00	1.00			1.00
Satd. Flow (prot)	3504	1583	7376			5532
Flt Permitted	0.95	1.00	1.00			1.00
Satd. Flow (perm)	3504	1583	7376			5532
Volume (vph)	527	578	4322	0	0	2231
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	573	628	4698	0	0	2425
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	573	628	4698	0	0	2425
Turn Type		Free				
Protected Phases	4		6			2
Permitted Phases		Free				
Actuated Green, G (s)	13.7	70.0	48.3			48.3
Effective Green, g (s)	13.7	70.0	48.3			48.3
Actuated g/C Ratio	0.20	1.00	0.69			0.69
Clearance Time (s)	4.0		4.0			4.0
Vehicle Extension (s)	3.0		3.0			3.0
Lane Grp Cap (vph)	686	1583	5089			3817
v/s Ratio Prot	c0.16		c0.64			0.44
v/s Ratio Perm		0.40				
v/c Ratio	0.84	0.40	0.92			0.64
Uniform Delay, d1	27.1	0.0	9.3			6.0
Progression Factor	1.00	1.00	0.37			1.00
Incremental Delay, d2	8.7	0.7	3.2			0.8
Delay (s)	35.7	0.7	6.6			6.8
Level of Service	D	A	A			A
Approach Delay (s)	17.4		6.6			6.8
Approach LOS	B		A			A

Intersection Summary			
HCM Average Control Delay	8.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	130.8%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
4: Farrington Hwy & Fort Weaver Road SB Ramp

2030 + PRO (With Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↱		↰↰	↑↑↑				↱			↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0				4.0			4.0
Lane Util. Factor		0.91		0.97	0.91				1.00			1.00
Frt		0.97		1.00	1.00				0.86			0.86
Flt Protected		1.00		0.95	1.00				1.00			1.00
Satd. Flow (prot)		4947		3433	5085				1611			1611
Flt Permitted		1.00		0.95	1.00				1.00			1.00
Satd. Flow (perm)		4947		3433	5085				1611			1611
Volume (vph)	0	1884	416	774	1938	0	0	0	439	0	0	729
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	2048	452	841	2107	0	0	0	477	0	0	792
RTOR Reduction (vph)	0	15	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	2485	0	841	2107	0	0	0	477	0	0	792
Turn Type				Prot					Free			Free
Protected Phases		2		1	6							
Permitted Phases									Free			Free
Actuated Green, G (s)		78.0		44.0	130.0				130.0			130.0
Effective Green, g (s)		78.0		44.0	130.0				130.0			130.0
Actuated g/C Ratio		0.60		0.34	1.00				1.00			1.00
Clearance Time (s)		4.0		4.0	4.0							
Vehicle Extension (s)		3.0		3.0	3.0							
Lane Grp Cap (vph)		2968		1162	5085				1611			1611
v/s Ratio Prot		c0.50		c0.24	0.41							
v/s Ratio Perm									0.30			0.49
v/c Ratio		0.84		0.72	0.41				0.30			0.49
Uniform Delay, d1		20.9		37.7	0.0				0.0			0.0
Progression Factor		0.33		1.35	1.00				1.00			1.00
Incremental Delay, d2		1.8		1.3	0.1				0.5			1.1
Delay (s)		8.7		52.2	0.1				0.5			1.1
Level of Service		A		D	A				A			A
Approach Delay (s)		8.7			15.0			0.5			1.1	
Approach LOS		A			B			A			A	

Intersection Summary			
HCM Average Control Delay	10.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	74.4%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
5: Farrington Hwy & Fort Weaver Road NB Ramps

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑↑			↑↑↑	↱			↱			
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0	4.0			4.0			
Lane Util. Factor	0.97	*0.99			*0.99	1.00			1.00			
Frt	1.00	1.00			1.00	0.85			0.86			
Flt Protected	0.95	1.00			1.00	1.00			1.00			
Satd. Flow (prot)	3433	5532			5532	1583			1611			
Flt Permitted	0.95	1.00			1.00	1.00			1.00			
Satd. Flow (perm)	3433	5532			5532	1583			1611			
Volume (vph)	1027	1297	0	0	2713	1164	0	0	638	0	0	0
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	1037	1310	0	0	2740	1176	0	0	644	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	16	0	0	0	0	0	0
Lane Group Flow (vph)	1037	1310	0	0	2740	1160	0	0	644	0	0	0
Turn Type	Prot					Perm			Free			
Protected Phases	5	2			6							
Permitted Phases						6			Free			
Actuated Green, G (s)	47.8	130.0			74.2	74.2			130.0			
Effective Green, g (s)	47.8	130.0			74.2	74.2			130.0			
Actuated g/C Ratio	0.37	1.00			0.57	0.57			1.00			
Clearance Time (s)	4.0	4.0			4.0	4.0						
Vehicle Extension (s)	3.0	3.0			3.0	3.0						
Lane Grp Cap (vph)	1262	5532			3157	904			1611			
v/s Ratio Prot	c0.30	0.24			0.50							
v/s Ratio Perm						c0.73			0.40			
v/c Ratio	0.82	0.24			0.87	1.28			0.40			
Uniform Delay, d1	37.2	0.0			23.7	27.9			0.0			
Progression Factor	0.48	1.00			0.69	0.65			1.00			
Incremental Delay, d2	3.0	0.1			0.3	128.1			0.7			
Delay (s)	20.7	0.1			16.7	146.3			0.7			
Level of Service	C	A			B	F			A			
Approach Delay (s)		9.2			55.6			0.7			0.0	
Approach LOS		A			E			A			A	

Intersection Summary			
HCM Average Control Delay	34.7	HCM Level of Service	C
HCM Volume to Capacity ratio	1.10		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	108.0%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
6: Farrington Hwy & Leoku Street

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑↑	↱	↰	↑↑↑	↱		↰	↱		↰↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
Lane Util. Factor	*0.99	*0.99	1.00	1.00	*0.99	1.00		1.00	1.00		*0.99	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00		0.96	1.00
Satd. Flow (prot)	3504	5532	1583	1770	5532	1583		1785	1583		3530	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00		0.96	1.00
Satd. Flow (perm)	3504	5532	1583	1770	5532	1583		1785	1583		3530	1583
Volume (vph)	282	1537	116	135	3576	515	197	29	130	243	28	99
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	285	1553	117	136	3612	520	199	29	131	245	28	100
RTOR Reduction (vph)	0	0	56	0	0	154	0	0	47	0	0	89
Lane Group Flow (vph)	285	1553	61	136	3612	366	0	228	84	0	273	11
Turn Type	Prot		Perm	Prot		Perm	Split		Perm	Split		Perm
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			6
Actuated Green, G (s)	10.6	67.6	67.6	18.0	75.0	75.0		14.0	14.0		14.4	14.4
Effective Green, g (s)	10.6	67.6	67.6	18.0	75.0	75.0		14.0	14.0		14.4	14.4
Actuated g/C Ratio	0.08	0.52	0.52	0.14	0.58	0.58		0.11	0.11		0.11	0.11
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	286	2877	823	245	3192	913		192	170		391	175
v/s Ratio Prot	c0.08	0.28		0.08	c0.65			c0.13			c0.08	
v/s Ratio Perm			0.04			0.23			0.05			0.01
v/c Ratio	1.00	0.54	0.07	0.56	1.13	0.40		1.19	0.49		1.26dl	0.06
Uniform Delay, d1	59.7	20.8	15.6	52.3	27.5	15.1		58.0	54.7		55.7	51.8
Progression Factor	0.86	1.01	1.16	1.00	1.00	1.00		1.00	1.00		1.00	1.00
Incremental Delay, d2	51.2	0.7	0.2	2.7	63.7	1.3		124.6	9.8		5.4	0.2
Delay (s)	102.7	21.8	18.2	55.0	91.2	16.4		182.6	64.5		61.1	51.9
Level of Service	F	C	B	D	F	B		F	E		E	D
Approach Delay (s)		33.4			81.0			139.5			58.6	
Approach LOS		C			F			F			E	

Intersection Summary			
HCM Average Control Delay	69.4	HCM Level of Service	E
HCM Volume to Capacity ratio	1.07		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	107.3%	ICU Level of Service	G
Analysis Period (min)	15		
dl Defacto Left Lane. Recode with 1 though lane as a left lane.			
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
7: Laulaunui Street & Fort Weaver Road
2030 + PRO (With Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱		↰	↑	↱	↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		*0.99		1.00	1.00	1.00	1.00	*0.99	1.00	1.00	*0.99	1.00
Frt		0.99		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.96		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		3518		1770	1863	1583	1770	5532	1583	1770	5532	1583
Flt Permitted		0.96		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		3518		1770	1863	1583	1770	5532	1583	1770	5532	1583
Volume (vph)	209	37	13	61	4	229	56	2756	89	228	4188	82
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	211	37	13	62	4	231	57	2784	90	230	4230	83
RTOR Reduction (vph)	0	3	0	0	0	213	0	0	25	0	0	18
Lane Group Flow (vph)	0	258	0	62	4	18	57	2784	65	230	4230	65
Turn Type	Split			Split		Perm	Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases						8			2			6
Actuated Green, G (s)		14.8		5.0	5.0	5.0	5.0	89.0	89.0	24.0	108.0	108.0
Effective Green, g (s)		14.8		5.0	5.0	5.0	5.0	89.0	89.0	24.0	108.0	108.0
Actuated g/C Ratio		0.10		0.03	0.03	0.03	0.03	0.60	0.60	0.16	0.73	0.73
Clearance Time (s)		4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		350		59	63	53	59	3309	947	285	4015	1149
v/s Ratio Prot		c0.07		c0.04	0.00		0.03	c0.50		0.13	c0.76	
v/s Ratio Perm						0.01			0.04			0.04
v/c Ratio		1.19dl		1.05	0.06	0.35	0.97	0.84	0.07	0.81	1.05	0.06
Uniform Delay, d1		65.1		71.9	69.6	70.3	71.8	24.2	12.5	60.2	20.4	5.8
Progression Factor		1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		7.9		132.1	0.4	3.9	104.1	2.8	0.1	15.3	31.0	0.1
Delay (s)		73.0		204.0	70.1	74.2	175.9	27.0	12.7	75.4	51.4	5.9
Level of Service		E		F	E	E	F	C	B	E	D	A
Approach Delay (s)		73.0			101.3			29.4			51.8	
Approach LOS		E			F			C			D	

Intersection Summary			
HCM Average Control Delay	46.1	HCM Level of Service	D
HCM Volume to Capacity ratio	1.02		
Actuated Cycle Length (s)	148.8	Sum of lost time (s)	16.0
Intersection Capacity Utilization	112.5%	ICU Level of Service	H
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
8: Old Fort Weaver Rd & Fort Weaver Road
2030 + PRO (With Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰↰	↑	↱		↰↑	↱	↰↰	↑↑↑↱		↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	4.0	4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.94	1.00	1.00		0.95	1.00	0.97	*0.99		1.00	*0.99	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00		0.99	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	4990	1863	1583		3514	1583	3433	5531		1770	5532	1583
Flt Permitted	0.95	1.00	1.00		0.99	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	4990	1863	1583		3514	1583	3433	5531		1770	5532	1583
Volume (vph)	731	189	418	37	214	48	539	2120	3	190	3187	884
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	738	191	422	37	216	48	544	2141	3	192	3219	893
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	197
Lane Group Flow (vph)	738	191	422	0	253	48	544	2144	0	192	3219	696
Turn Type	Split		Free	Split		Free	Prot			Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			Free			Free						6
Actuated Green, G (s)	17.0	17.0	130.0		8.0	130.0	18.0	70.5		18.5	71.0	71.0
Effective Green, g (s)	17.0	17.0	130.0		8.0	130.0	18.0	70.5		18.5	71.0	71.0
Actuated g/C Ratio	0.13	0.13	1.00		0.06	1.00	0.14	0.54		0.14	0.55	0.55
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	653	244	1583		216	1583	475	3000		252	3021	865
v/s Ratio Prot	c0.15	0.10			c0.07		c0.16	0.39		0.11	c0.58	
v/s Ratio Perm			0.27			0.03						0.44
v/c Ratio	1.13	0.78	0.27		1.17	0.03	1.15	0.71		0.76	1.07	0.80
Uniform Delay, d1	56.5	54.7	0.0		61.0	0.0	56.0	22.2		53.6	29.5	23.9
Progression Factor	1.07	1.08	1.00		1.00	1.00	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	74.2	12.6	0.3		115.2	0.0	87.6	1.5		12.7	37.2	7.8
Delay (s)	134.6	71.6	0.3		176.2	0.0	143.6	23.7		66.4	66.7	31.7
Level of Service	F	E	A		F	A	F	C		E	E	C
Approach Delay (s)		83.8			148.1			48.0			59.4	
Approach LOS		F			F			D			E	

Intersection Summary			
HCM Average Control Delay	62.8	HCM Level of Service	E
HCM Volume to Capacity ratio	1.10		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	111.2%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
9: Renton Road & Fort Weaver Road

2030 + PRO (With Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↰↑	↱		↰↑	↱	↰	↑↑↑	↱	↰↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*0.99	*0.99	1.00		1.00	1.00	1.00	*0.99	1.00	0.97	*0.99	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.95	1.00		1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1752	1761	1583		1858	1583	1770	5532	1583	3433	5532	1583
Flt Permitted	0.95	0.95	1.00		1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1752	1761	1583		1858	1583	1770	5532	1583	3433	5532	1583
Volume (vph)	723	22	43	9	151	320	45	2086	75	506	3054	518
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	730	22	43	9	153	323	45	2107	76	511	3085	523
RTOR Reduction (vph)	0	0	0	0	0	295	0	0	6	0	0	38
Lane Group Flow (vph)	366	386	43	0	162	28	45	2107	70	511	3085	485
Turn Type	Split		Free	Split		Perm	Prot		pm+ov	Prot		pm+ov
Protected Phases	4	4		8	8		5	2	8	1	6	4
Permitted Phases			Free			8			2			6
Actuated Green, G (s)	20.0	20.0	138.8		12.0	12.0	4.7	66.7	78.7	24.1	86.1	106.1
Effective Green, g (s)	20.0	20.0	138.8		12.0	12.0	4.7	66.7	78.7	24.1	86.1	106.1
Actuated g/C Ratio	0.14	0.14	1.00		0.09	0.09	0.03	0.48	0.57	0.17	0.62	0.76
Clearance Time (s)	4.0	4.0			4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	252	254	1583		161	137	60	2658	898	596	3432	1256
v/s Ratio Prot	0.21	c0.22			c0.09		0.03	0.38	0.01	c0.15	c0.56	0.06
v/s Ratio Perm			0.03			0.02			0.04			0.25
v/c Ratio	1.45	1.52	0.03		1.01	0.20	0.75	0.79	0.08	0.86	0.90	0.39
Uniform Delay, d1	59.4	59.4	0.0		63.4	59.0	66.5	30.2	13.6	55.7	22.6	5.5
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	224.4	253.0	0.0		72.6	0.7	40.4	2.5	0.0	11.7	4.3	0.2
Delay (s)	283.8	312.4	0.0		136.0	59.7	106.9	32.8	13.6	67.4	26.9	5.7
Level of Service	F	F	A		F	E	F	C	B	E	C	A
Approach Delay (s)		282.3			85.2			33.6			29.2	
Approach LOS		F			F			C			C	

Intersection Summary			
HCM Average Control Delay	60.4	HCM Level of Service	E
HCM Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	138.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	104.7%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
10: Farrington Hwy & D Street

2030 + PRO (With Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↑		↰↰	↑↑↑↱			↑↱	↱	↰	↰↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	*0.99		*0.99	*0.99			*0.99	*0.99	*0.99	*0.99	
Frt	1.00	1.00		1.00	1.00			1.00	0.85	1.00	0.92	
Flt Protected	0.95	1.00		0.95	1.00			1.00	1.00	0.95	0.98	
Satd. Flow (prot)	1770	5532		3504	5506			1844	1567	1752	1659	
Flt Permitted	0.95	1.00		0.95	1.00			1.00	1.00	0.95	0.98	
Satd. Flow (perm)	1770	5532		3504	5506			1844	1567	1752	1659	
Volume (vph)	108	2029	0	408	2186	73	0	79	45	226	9	92
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	117	2205	0	443	2376	79	0	86	49	246	10	100
RTOR Reduction (vph)	0	0	0	0	3	0	0	0	45	0	34	0
Lane Group Flow (vph)	117	2205	0	443	2452	0	0	86	4	174	148	0
Turn Type	Prot			Prot					Perm	Split		
Protected Phases	5	2		1	6			8		4	4	
Permitted Phases									8			
Actuated Green, G (s)	12.9	65.4		21.0	73.5			11.3	11.3	16.3	16.3	
Effective Green, g (s)	12.9	65.4		21.0	73.5			11.3	11.3	16.3	16.3	
Actuated g/C Ratio	0.10	0.50		0.16	0.57			0.09	0.09	0.13	0.13	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	176	2783		566	3113			160	136	220	208	
v/s Ratio Prot	0.07	c0.40		0.13	c0.45			c0.05		c0.10	0.09	
v/s Ratio Perm									0.00			
v/c Ratio	0.66	0.79		0.78	0.79			0.54	0.03	0.79	0.71	
Uniform Delay, d1	56.5	26.7		52.3	22.1			56.8	54.3	55.2	54.6	
Progression Factor	0.98	0.71		0.67	0.35			1.00	1.00	1.00	1.00	
Incremental Delay, d2	6.2	1.6		6.4	1.9			3.4	0.1	17.4	10.9	
Delay (s)	61.3	20.5		41.7	9.7			60.3	54.4	72.6	65.5	
Level of Service	E	C		D	A			E	D	E	E	
Approach Delay (s)		22.5			14.6			58.2			69.0	
Approach LOS		C			B			E			E	

Intersection Summary			
HCM Average Control Delay	22.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	76.8%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
11: Farrington Hwy & E Street

2030 + PRO (With Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↑↱			↑↑↑↱		↰	↱		↰	↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	*0.99			*0.99		1.00	1.00		1.00	1.00	
Frt	1.00	0.98			1.00		1.00	0.99		1.00	0.94	
Flt Protected	0.95	1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	5421			5518		1770	1851		1770	1744	
Flt Permitted	0.95	1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	5421			5518		1770	1851		1770	1744	
Volume (vph)	75	1950	303	0	2238	40	179	106	5	182	125	93
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	82	2120	329	0	2433	43	195	115	5	198	136	101
RTOR Reduction (vph)	0	16	0	0	1	0	0	1	0	0	21	0
Lane Group Flow (vph)	82	2433	0	0	2475	0	195	119	0	198	216	0
Turn Type	Prot						Split			Split		
Protected Phases	5	2			6		8	8		4	4	
Permitted Phases												
Actuated Green, G (s)	8.0	81.5			69.5		18.9	18.9		17.6	17.6	
Effective Green, g (s)	8.0	81.5			69.5		18.9	18.9		17.6	17.6	
Actuated g/C Ratio	0.06	0.63			0.53		0.15	0.15		0.14	0.14	
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	109	3399			2950		257	269		240	236	
v/s Ratio Prot	0.05	c0.45			c0.45		c0.11	0.06		0.11	c0.12	
v/s Ratio Perm												
v/c Ratio	0.75	0.72			0.84		0.76	0.44		0.82	0.92	
Uniform Delay, d1	60.0	16.4			25.5		53.4	50.7		54.7	55.5	
Progression Factor	0.87	0.76			0.32		1.00	1.00		1.00	1.00	
Incremental Delay, d2	14.7	0.7			1.8		12.1	1.2		20.1	36.4	
Delay (s)	66.8	13.2			10.0		65.5	51.9		74.8	91.8	
Level of Service	E	B			B		E	D		E	F	
Approach Delay (s)		14.9			10.0			60.3			84.1	
Approach LOS		B			B			E			F	

Intersection Summary			
HCM Average Control Delay	20.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	83.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
12: Fort Barrette Road & Farrington Hwy

2030 + PRO (With Transit Corridor) - PM Peak Mitigations

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰↰	↑↱	↱	↰↰	↑↑	↱	↰↰	↑↑	↱	↰	↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*0.99	*0.99	*0.99	*0.99	*0.99	1.00	*0.99	*0.99	1.00	1.00	*0.99	1.00
Frt	1.00	0.96	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3504	3544	1567	3504	3688	1583	3504	3688	1583	1770	3688	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3504	3544	1567	3504	3688	1583	3504	3688	1583	1770	3688	1583
Volume (vph)	493	482	722	355	404	111	677	654	746	225	961	763
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	498	487	729	359	408	112	684	661	754	227	971	771
RTOR Reduction (vph)	0	32	13	0	0	74	0	0	199	0	0	248
Lane Group Flow (vph)	498	626	545	359	408	38	684	661	555	227	971	523
Turn Type	Prot		pm+ov	Prot		pm+ov	Prot		Perm	Prot		Perm
Protected Phases	1	6	7	5	2	3	7	4		3	8	
Permitted Phases			6			2			4			8
Actuated Green, G (s)	18.0	23.3	48.3	13.7	19.0	35.0	25.0	50.0	50.0	16.0	41.0	41.0
Effective Green, g (s)	18.0	23.3	48.3	13.7	19.0	35.0	25.0	50.0	50.0	16.0	41.0	41.0
Actuated g/C Ratio	0.15	0.20	0.41	0.12	0.16	0.29	0.21	0.42	0.42	0.13	0.34	0.34
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	530	694	636	403	589	519	736	1550	665	238	1271	545
v/s Ratio Prot	0.14	c0.18	0.18	c0.10	0.11	0.01	c0.20	0.18		0.13	0.26	
v/s Ratio Perm			0.17			0.01			0.35			c0.33
v/c Ratio	0.94	0.90	0.86	0.89	0.69	0.07	0.93	0.43	0.83	0.95	0.76	0.96
Uniform Delay, d1	50.0	46.7	32.2	51.9	47.2	30.3	46.1	24.4	30.8	51.1	34.7	38.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	24.6	14.9	11.0	21.0	6.6	0.1	17.9	0.2	8.8	45.2	2.8	28.6
Delay (s)	74.6	61.7	43.2	72.9	53.8	30.4	64.1	24.6	39.6	96.4	37.5	66.8
Level of Service	E	E	D	E	D	C	E	C	D	F	D	E
Approach Delay (s)		59.4			58.6			42.9			55.8	
Approach LOS		E			E			D			E	

Intersection Summary			
HCM Average Control Delay	53.0	HCM Level of Service	D
HCM Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	119.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	90.4%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
13: WB Ramps & North-South Road
2030 + PRO (With Transit Corridor) - PM Peak Mitigations

Movement	WBL2	WBL	WBR	NBL	NBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰↰		↱				↑↑	↱	↰↰	↑↑	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0				4.0	4.0	4.0	4.0	
Lane Util. Factor	*0.99		1.00				*0.99	1.00	0.97	*0.99	
Frt	1.00		0.85				1.00	0.85	1.00	1.00	
Flt Protected	0.95		1.00				1.00	1.00	0.95	1.00	
Satd. Flow (prot)	3504		1583				3688	1583	3433	3688	
Flt Permitted	0.95		1.00				1.00	1.00	0.95	1.00	
Satd. Flow (perm)	3504		1583				3688	1583	3433	3688	
Volume (vph)	1986	0	412	0	0	0	469	86	302	514	0
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	2006	0	416	0	0	0	474	87	305	519	0
RTOR Reduction (vph)	0	0	47	0	0	0	0	71	0	0	0
Lane Group Flow (vph)	2006	0	369	0	0	0	474	16	305	519	0
Turn Type	Prot		custom					Perm	Prot		
Protected Phases	8		8				6		5	2	
Permitted Phases								6			
Actuated Green, G (s)	86.3		86.3				26.0	26.0	15.7	45.7	
Effective Green, g (s)	86.3		86.3				26.0	26.0	15.7	45.7	
Actuated g/C Ratio	0.62		0.62				0.19	0.19	0.11	0.33	
Clearance Time (s)	4.0		4.0				4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0		3.0				3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	2160		976				685	294	385	1204	
v/s Ratio Prot	c0.57		0.23				c0.13		c0.09	0.14	
v/s Ratio Perm								0.01			
v/c Ratio	0.93		0.38				0.69	0.05	0.79	0.43	
Uniform Delay, d1	24.1		13.4				53.3	46.9	60.6	37.0	
Progression Factor	1.00		1.00				1.00	1.00	0.70	1.06	
Incremental Delay, d2	7.6		0.2				5.7	0.4	7.7	0.8	
Delay (s)	31.7		13.7				58.9	47.2	49.8	39.9	
Level of Service	C		B				E	D	D	D	
Approach Delay (s)		28.6		0.0			57.1			43.6	
Approach LOS		C		A			E			D	

Intersection Summary			
HCM Average Control Delay	36.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	81.6%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
14: EB Ramps & North-South Road
2030 + PRO (With Transit Corridor) - PM Peak Mitigations

Movement	EBL2	EBL	EBR	SBL	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰		↱↱			↰↰	↑↑			↑↑	↱↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0			4.0	4.0			4.0	4.0
Lane Util. Factor	1.00		0.88			0.97	*0.99			*0.99	*0.99
Frt	1.00		0.85			1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (prot)	1770		2787			3433	3688			3688	3135
Flt Permitted	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (perm)	1770		2787			3433	3688			3688	3135
Volume (vph)	92	0	952	0	0	206	2248	0	0	724	2003
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	93	0	962	0	0	208	2271	0	0	731	2023
RTOR Reduction (vph)	0	0	4	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	93	0	958	0	0	208	2271	0	0	731	2023
Turn Type	Prot		custom			Prot					Free
Protected Phases	4		4			1	6			2	
Permitted Phases											Free
Actuated Green, G (s)	24.0		24.0			16.0	38.0			18.0	70.0
Effective Green, g (s)	24.0		24.0			16.0	38.0			18.0	70.0
Actuated g/C Ratio	0.34		0.34			0.23	0.54			0.26	1.00
Clearance Time (s)	4.0		4.0			4.0	4.0			4.0	
Vehicle Extension (s)	3.0		3.0			3.0	3.0			3.0	
Lane Grp Cap (vph)	607		956			785	2002			948	3135
v/s Ratio Prot	0.05		c0.34			0.06	c0.62			0.20	
v/s Ratio Perm											0.65
v/c Ratio	0.15		1.00			0.26	1.13			0.77	0.65
Uniform Delay, d1	16.0		23.0			22.2	16.0			24.1	0.0
Progression Factor	1.00		1.00			1.00	1.19			1.00	1.00
Incremental Delay, d2	0.1		29.6			0.1	63.7			6.0	1.0
Delay (s)	16.1		52.6			22.2	82.7			30.1	1.0
Level of Service	B		D			C	F			C	A
Approach Delay (s)		49.4		0.0			77.6			8.8	
Approach LOS		D		A			E			A	

Intersection Summary			
HCM Average Control Delay	42.7	HCM Level of Service	D
HCM Volume to Capacity ratio	1.08		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	81.6%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
15: North-South Road & Farrington Hwy 2030 + PRO (With Transit Corridor) - PM Peak Mitigations

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰↰	↑↑↑	↱	↰↰↰	↑↑↑	↱	↰↰	↑↑	↱	↰↰	↑↑	↱↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*0.99	*0.99	1.00	*0.99	*0.99	1.00	*0.99	*0.99	1.00	*0.99	*0.99	0.88
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3504	5532	1583	5256	5532	1583	3504	3688	1583	3504	3688	2787
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3504	5532	1583	5256	5532	1583	3504	3688	1583	3504	3688	2787
Volume (vph)	717	1856	607	876	1562	386	407	740	537	529	847	758
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	724	1875	613	885	1578	390	411	747	542	534	856	766
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	724	1875	613	885	1578	390	411	747	542	534	856	766
Turn Type	Prot		Free	Prot		Free	Prot		Free	Prot		Free
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases			Free			Free			Free			Free
Actuated Green, G (s)	25.0	41.0	120.0	20.0	36.0	120.0	16.0	25.0	120.0	18.0	27.0	120.0
Effective Green, g (s)	25.0	41.0	120.0	20.0	36.0	120.0	16.0	25.0	120.0	18.0	27.0	120.0
Actuated g/C Ratio	0.21	0.34	1.00	0.17	0.30	1.00	0.13	0.21	1.00	0.15	0.22	1.00
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	730	1890	1583	876	1660	1583	467	768	1583	526	830	2787
v/s Ratio Prot	c0.21	c0.34		0.17	0.29		0.12	0.20		c0.15	c0.23	
v/s Ratio Perm			c0.39			0.25			0.34			0.27
v/c Ratio	0.99	0.99	0.39	1.01	0.95	0.25	0.88	0.97	0.34	1.02	1.03	0.27
Uniform Delay, d1	47.4	39.3	0.0	50.0	41.1	0.0	51.1	47.2	0.0	51.0	46.5	0.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	31.1	18.9	0.7	33.0	13.1	0.4	20.5	26.5	0.6	43.1	39.5	0.2
Delay (s)	78.5	58.2	0.7	83.0	54.3	0.4	71.6	73.6	0.6	94.1	86.0	0.2
Level of Service	E	E	A	F	D	A	E	E	A	F	F	A
Approach Delay (s)		51.8			55.8			49.8			57.6	
Approach LOS		D			E			D			E	

Intersection Summary			
HCM Average Control Delay	53.9	HCM Level of Service	D
HCM Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	101.4%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
16: North-South Road & North UH Connector 2030 + PRO (With Transit Corridor) - PM Peak Mitigations

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰	↑↑↱	↱	↰↰	↑↑↱		↰↰	↑↱		↰↰	↑	↱↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	1.00	*0.99	0.86	*0.99	*0.99		*0.99	*0.99		*0.99	1.00	*0.99
Frt	1.00	1.00	0.85	1.00	0.98		1.00	0.94		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1770	5532	1362	3504	5396		3504	3466		3504	1863	3135
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	1770	5532	1362	3504	5396		3504	3466		3504	1863	3135
Volume (vph)	73	1834	457	642	1906	374	273	421	282	374	117	717
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	74	1853	462	648	1925	378	276	425	285	378	118	724
RTOR Reduction (vph)	0	0	205	0	25	0	0	93	0	0	0	17
Lane Group Flow (vph)	74	1853	257	648	2278	0	276	617	0	378	118	707
Turn Type	Prot		Perm	Prot			Prot			Prot		pm+ov
Protected Phases	5	2		1	6		7	4		3	8	1
Permitted Phases			2									8
Actuated Green, G (s)	8.8	46.8	46.8	26.4	64.4		14.5	24.6		16.2	26.3	52.7
Effective Green, g (s)	8.8	46.8	46.8	26.4	64.4		14.5	24.6		16.2	26.3	52.7
Actuated g/C Ratio	0.07	0.36	0.36	0.20	0.50		0.11	0.19		0.12	0.20	0.41
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	120	1992	490	712	2673		391	656		437	377	1271
v/s Ratio Prot	0.04	c0.33		c0.18	0.42		0.08	c0.18		c0.11	0.06	0.11
v/s Ratio Perm			0.19									0.11
v/c Ratio	0.62	0.93	0.52	0.91	0.85		0.71	0.94		0.86	0.31	0.56
Uniform Delay, d1	59.0	40.0	32.8	50.6	28.6		55.7	52.0		55.8	44.2	29.7
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		0.54	0.48	0.81
Incremental Delay, d2	9.1	9.3	4.0	15.8	3.7		5.7	21.6		7.2	0.2	0.2
Delay (s)	68.0	49.3	36.8	66.4	32.3		61.4	73.6		37.6	21.3	24.3
Level of Service	E	D	D	E	C		E	E		D	C	C
Approach Delay (s)		47.5			39.8			70.2			28.1	
Approach LOS		D			D			E			C	

Intersection Summary			
HCM Average Control Delay	44.3	HCM Level of Service	D
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	101.8%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
17: East-West Rd & North-South Road
2030 + PRO (With Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↱		↰↰	↑↱		↰↰	↑↑↑	↱	↰↰	↑↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	*0.99	0.95		0.97	*0.99		*0.99	*0.99	1.00	*0.99	*0.99	
Frt	1.00	0.94		1.00	0.89		1.00	1.00	0.85	1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	3504	3313		3433	3283		3504	5532	1583	3504	5358	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	3504	3313		3433	3283		3504	5532	1583	3504	5358	
Volume (vph)	308	312	232	361	192	525	110	1530	277	504	1626	432
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	311	315	234	365	194	530	111	1545	280	509	1642	436
RTOR Reduction (vph)	0	102	0	0	197	0	0	0	172	0	39	0
Lane Group Flow (vph)	311	447	0	365	527	0	111	1545	108	509	2039	0
Turn Type	Prot			Prot			Prot		Perm	Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases									2			
Actuated Green, G (s)	14.5	21.3		14.6	21.4		7.7	45.1	45.1	20.0	57.4	
Effective Green, g (s)	14.5	21.3		14.6	21.4		7.7	45.1	45.1	20.0	57.4	
Actuated g/C Ratio	0.12	0.18		0.12	0.18		0.07	0.39	0.39	0.17	0.49	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	434	603		428	600		231	2132	610	599	2629	
v/s Ratio Prot	0.09	0.13		c0.11	c0.16		0.03	0.28		c0.15	c0.38	
v/s Ratio Perm									0.07			
v/c Ratio	0.72	0.74		0.85	1.10dr		0.48	0.72	0.18	0.85	0.78	
Uniform Delay, d1	49.3	45.2		50.1	46.5		52.7	30.7	23.7	47.0	24.5	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	5.6	4.9		15.1	13.7		1.6	2.2	0.6	14.1	2.3	
Delay (s)	54.8	50.1		65.2	60.3		54.3	32.8	24.3	61.1	26.8	
Level of Service	D	D		E	E		D	C	C	E	C	
Approach Delay (s)		51.8			61.9			32.8			33.6	
Approach LOS		D			E			C			C	

Intersection Summary			
HCM Average Control Delay	40.5	HCM Level of Service	D
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	117.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	88.8%	ICU Level of Service	E
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.
c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
18: North-South Road & Kapolei Parkway
2030 + PRO (With Transit Corridor) - PM Peak Mitigations

Movement	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰	↑↑↑	↱	↰	↑↑↑	↱	↰↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	*0.99	1.00	1.00	*0.99	1.00	*0.99	*0.99	1.00	1.00	*0.99	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	5532	1583	1770	5532	1583	3504	5532	1583	1770	5532	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	5532	1583	1770	5532	1583	3504	5532	1583	1770	5532	1583
Volume (vph)	378	875	155	494	1001	725	704	643	505	121	568	339
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	382	884	157	499	1011	732	711	649	510	122	574	342
RTOR Reduction (vph)	0	0	122	0	0	285	0	0	341	0	0	297
Lane Group Flow (vph)	382	884	35	499	1011	447	711	649	169	122	574	45
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases			2			6			4			8
Actuated Green, G (s)	26.9	26.6	26.6	36.3	36.0	36.0	25.0	30.2	30.2	10.6	15.8	15.8
Effective Green, g (s)	26.9	26.6	26.6	36.3	36.0	36.0	25.0	30.2	30.2	10.6	15.8	15.8
Actuated g/C Ratio	0.22	0.22	0.22	0.30	0.30	0.30	0.21	0.25	0.25	0.09	0.13	0.13
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	398	1229	352	537	1664	476	732	1396	399	157	730	209
v/s Ratio Prot	0.22	0.16		c0.28	0.18		c0.20	0.12		0.07	c0.10	
v/s Ratio Perm			0.02			c0.28			0.11			0.03
v/c Ratio	0.96	0.72	0.10	0.93	0.61	0.94	0.97	0.46	0.42	0.78	0.79	0.22
Uniform Delay, d1	45.9	43.1	37.0	40.5	35.8	40.8	47.0	37.9	37.5	53.4	50.3	46.4
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	34.3	3.6	0.6	22.5	1.7	28.7	26.2	0.2	0.7	21.1	5.6	0.5
Delay (s)	80.2	46.7	37.6	62.9	37.5	69.5	73.2	38.2	38.2	74.5	55.9	46.9
Level of Service	F	D	D	E	D	E	E	D	D	E	E	D
Approach Delay (s)		54.7			53.6			51.5			55.1	
Approach LOS		D			D			D			E	

Intersection Summary			
HCM Average Control Delay	53.5	HCM Level of Service	D
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	119.7	Sum of lost time (s)	12.0
Intersection Capacity Utilization	88.7%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
19: East-West Rd & Old Fort Weaver Rd
2030 + PRO (With Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↰	↑	↑↑	↱	↰↰	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	0.97	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1863	3539	1583	3433	1583
Flt Permitted	0.23	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	433	1863	3539	1583	3433	1583
Volume (vph)	37	533	689	948	805	93
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	37	538	696	958	813	94
RTOR Reduction (vph)	0	0	0	0	0	38
Lane Group Flow (vph)	37	538	696	958	813	56
Turn Type	Perm			pm+ov		Perm
Protected Phases		4	8	6	6	
Permitted Phases	4			8		6
Actuated Green, G (s)	44.6	44.6	44.6	122.0	77.4	77.4
Effective Green, g (s)	44.6	44.6	44.6	122.0	77.4	77.4
Actuated g/C Ratio	0.34	0.34	0.34	0.94	0.60	0.60
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	149	639	1214	1583	2044	942
v/s Ratio Prot		c0.29	0.20	c0.36	0.24	
v/s Ratio Perm	0.09			0.24		0.04
v/c Ratio	0.25	0.84	0.57	0.61	0.40	0.06
Uniform Delay, d1	30.7	39.4	34.9	0.6	13.9	11.0
Progression Factor	0.69	0.77	0.81	1.00	0.75	0.43
Incremental Delay, d2	0.7	8.0	0.2	0.2	0.2	0.0
Delay (s)	22.0	38.4	28.5	0.7	10.7	4.8
Level of Service	C	D	C	A	B	A
Approach Delay (s)		37.4	12.4		10.1	
Approach LOS		D	B		B	

Intersection Summary			
HCM Average Control Delay	16.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	68.7%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
20: Farrington Hwy & B Street
2030 + PRO (With Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰↰	↑↑	↱	↰↰	↑↑	↱	↰	↑	↱	↰↰	↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	*0.99	1.00	0.97	*0.99	1.00	1.00	1.00	1.00	*0.99	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3688	1583	3433	3688	1583	1770	1863	1583	3504	1863	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3688	1583	3433	3688	1583	1770	1863	1583	3504	1863	1583
Volume (vph)	221	1384	344	375	1728	74	146	282	195	264	143	171
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	223	1398	347	379	1745	75	147	285	197	267	144	173
RTOR Reduction (vph)	0	0	43	0	0	28	0	0	9	0	0	34
Lane Group Flow (vph)	223	1398	304	379	1745	47	147	285	188	267	144	139
Turn Type	Prot		pm+ov	Prot		Perm	Prot		pm+ov	Prot		pm+ov
Protected Phases	5	2	3	1	6		7	4	5	3	8	1
Permitted Phases			2			6			4			8
Actuated Green, G (s)	9.0	55.5	66.5	15.5	62.0	62.0	17.3	20.7	29.7	11.0	14.4	29.9
Effective Green, g (s)	9.0	55.5	66.5	15.5	62.0	62.0	17.3	20.7	29.7	11.0	14.4	29.9
Actuated g/C Ratio	0.08	0.47	0.56	0.13	0.52	0.52	0.15	0.17	0.25	0.09	0.12	0.25
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	260	1724	887	448	1926	827	258	325	396	325	226	399
v/s Ratio Prot	0.06	0.38	0.03	c0.11	c0.47		0.08	c0.15	0.04	c0.08	0.08	0.05
v/s Ratio Perm			0.16			0.03			0.08			0.04
v/c Ratio	0.86	0.81	0.34	0.85	0.91	0.06	0.57	0.88	0.47	0.82	0.64	0.35
Uniform Delay, d1	54.2	27.1	14.2	50.4	25.7	14.0	47.2	47.8	37.9	52.9	49.7	36.4
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	23.3	4.3	0.2	13.7	7.6	0.1	2.9	22.3	0.9	15.3	5.8	0.5
Delay (s)	77.5	31.4	14.4	64.1	33.3	14.1	50.1	70.0	38.8	68.1	55.4	37.0
Level of Service	E	C	B	E	C	B	D	E	D	E	E	D
Approach Delay (s)		33.6			38.0			55.6			55.8	
Approach LOS		C			D			E			E	

Intersection Summary			
HCM Average Control Delay	40.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	118.7	Sum of lost time (s)	12.0
Intersection Capacity Utilization	89.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
21: East-West Rd & A Street
2030 + PRO (With Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰	↱		↰	↑	↱	↰	↱		↰	↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	1.00	0.85	1.00	0.85		1.00	0.88	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1841		1770	1863	1583	1770	1585		1770	1631	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	1841		1770	1863	1583	1770	1585		1770	1631	
Volume (vph)	164	661	55	34	683	513	12	1	135	44	6	31
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	178	718	60	37	742	558	13	1	147	48	7	34
RTOR Reduction (vph)	0	2	0	0	0	174	0	138	0	0	32	0
Lane Group Flow (vph)	178	776	0	37	742	384	13	10	0	48	9	0
Turn Type	Prot			Prot		Perm	Split			Split		
Protected Phases	5	2		1	6		4	4		8	8	
Permitted Phases						6						
Actuated Green, G (s)	18.4	92.7		4.8	79.1	79.1	7.7	7.7		8.8	8.8	
Effective Green, g (s)	18.4	92.7		4.8	79.1	79.1	7.7	7.7		8.8	8.8	
Actuated g/C Ratio	0.14	0.71		0.04	0.61	0.61	0.06	0.06		0.07	0.07	
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	251	1313		65	1134	963	105	94		120	110	
v/s Ratio Prot	c0.10	0.42		0.02	c0.40		c0.01	0.01		c0.03	0.01	
v/s Ratio Perm						0.24						
v/c Ratio	0.71	0.59		0.57	0.65	0.40	0.12	0.10		0.40	0.08	
Uniform Delay, d1	53.2	9.3		61.6	16.6	13.2	58.0	57.9		58.1	56.8	
Progression Factor	1.00	1.00		0.96	0.35	0.08	1.00	1.00		1.00	1.00	
Incremental Delay, d2	8.8	2.0		4.9	1.3	0.5	0.5	0.5		2.2	0.3	
Delay (s)	62.1	11.2		64.2	7.2	1.6	58.5	58.4		60.3	57.2	
Level of Service	E	B		E	A	A	E	E		E	E	
Approach Delay (s)		20.7			6.4			58.4			58.8	
Approach LOS		C			A			E			E	

Intersection Summary			
HCM Average Control Delay	16.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	70.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
22: Farrington Hwy & 2nd Avenue
2030 + PRO (With Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↱		↰↰	↑↑	↱	↰	↑↑	↱↱	↰↰	↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.91		0.97	0.95	1.00	1.00	0.95	0.88	0.97	0.95	1.00
Frt	1.00	0.99		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	5021		3433	3539	1583	1770	3539	2787	3433	3539	1583
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	5021		3433	3539	1583	1770	3539	2787	3433	3539	1583
Volume (vph)	180	1404	130	555	1708	237	103	297	410	515	356	308
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	196	1526	141	603	1857	258	112	323	446	560	387	335
RTOR Reduction (vph)	0	8	0	0	0	80	0	0	7	0	0	169
Lane Group Flow (vph)	196	1659	0	603	1857	178	112	323	439	560	387	166
Turn Type	Prot			Prot		Perm	Prot		pm+ov	Prot		Perm
Protected Phases	5	2		1	6		3	8	1	7	4	
Permitted Phases						6			8			4
Actuated Green, G (s)	14.0	52.0		26.0	64.0	64.0	11.0	16.0	42.0	20.0	25.0	25.0
Effective Green, g (s)	14.0	52.0		26.0	64.0	64.0	11.0	16.0	42.0	20.0	25.0	25.0
Actuated g/C Ratio	0.11	0.40		0.20	0.49	0.49	0.08	0.12	0.32	0.15	0.19	0.19
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	191	2008		687	1742	779	150	436	900	528	681	304
v/s Ratio Prot	c0.11	0.33		0.18	c0.52		0.06	c0.09	0.10	c0.16	c0.11	
v/s Ratio Perm						0.11			0.06			0.10
v/c Ratio	1.03	0.83		0.88	1.07	0.23	0.75	0.74	0.49	1.06	0.57	0.55
Uniform Delay, d1	58.0	34.9		50.5	33.0	18.9	58.1	55.0	35.3	55.0	47.6	47.4
Progression Factor	1.00	1.00		0.70	0.56	0.10	0.75	0.73	0.71	0.80	0.76	0.64
Incremental Delay, d2	72.1	4.0		6.9	36.7	0.4	13.8	8.1	0.3	42.2	1.3	2.7
Delay (s)	130.1	39.0		42.2	55.0	2.3	57.1	48.2	25.3	86.3	37.6	33.0
Level of Service	F	D		D	E	A	E	D	C	F	D	C
Approach Delay (s)		48.6			47.2			37.7			57.6	
Approach LOS		D			D			D			E	

Intersection Summary			
HCM Average Control Delay	48.3	HCM Level of Service	D
HCM Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	93.4%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
23: 2nd Avenue & Kunia Road
2030 + PRO (With Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations		↱	↑↑↑↱			↑↑↑↑
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	0	0	4551	349	0	4748
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	4947	379	0	5161
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)			868			
pX, platoon unblocked	0.37	0.37			0.37	
vC, conflicting volume	6427	1426			5326	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	10601	0			7607	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	0	399			0	

Direction, Lane #	EB 1	SE 1	SE 2	SE 3	SE 4	NW 1	NW 2	NW 3	NW 4
Volume Total	0	1413	1413	1413	1086	1290	1290	1290	1290
Volume Left	0	0	0	0	0	0	0	0	0
Volume Right	0	0	0	0	379	0	0	0	0
cSH	1700	1700	1700	1700	1700	1700	1700	1700	1700
Volume to Capacity	0.00	0.83	0.83	0.83	0.64	0.76	0.76	0.76	0.76
Queue Length 95th (ft)	0	0	0	0	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane LOS	A								
Approach Delay (s)	0.0	0.0				0.0			
Approach LOS	A								

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	75.1%	ICU Level of Service	D
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
24: 3rd Avenue & Kunia Road
2030 + PRO (With Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations		↱	↑↑↑↱			↑↑↑↑
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	0	0	4433	118	0	4297
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	4818	128	0	4671
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)			1232			
pX, platoon unblocked	0.41	0.41			0.41	
vC, conflicting volume	6050	1269			4947	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	9049	0			6332	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	0	440			2	

Direction, Lane #	EB 1	SE 1	SE 2	SE 3	SE 4	NW 1	NW 2	NW 3	NW 4
Volume Total	0	1377	1377	1377	817	1168	1168	1168	1168
Volume Left	0	0	0	0	0	0	0	0	0
Volume Right	0	0	0	0	128	0	0	0	0
cSH	1700	1700	1700	1700	1700	1700	1700	1700	1700
Volume to Capacity	0.00	0.81	0.81	0.81	0.48	0.69	0.69	0.69	0.69
Queue Length 95th (ft)	0	0	0	0	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane LOS	A								
Approach Delay (s)	0.0	0.0				0.0			
Approach LOS	A								

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	69.5%	ICU Level of Service	C
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
25: East-West Rd & B Street

2030 + PRO (With Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1863	1863	1583	1770	1583
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1863	1863	1583	1770	1583
Volume (vph)	414	290	644	95	337	588
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	450	315	700	103	366	639
RTOR Reduction (vph)	0	0	0	45	0	395
Lane Group Flow (vph)	450	315	700	58	366	244
Turn Type	Prot			Prot		Prot
Protected Phases	5	2	6	6	4	4
Permitted Phases						
Actuated Green, G (s)	36.0	93.0	53.0	53.0	29.0	29.0
Effective Green, g (s)	36.0	93.0	53.0	53.0	29.0	29.0
Actuated g/C Ratio	0.28	0.72	0.41	0.41	0.22	0.22
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	490	1333	760	645	395	353
v/s Ratio Prot	c0.25	0.17	c0.38	0.04	c0.21	0.15
v/s Ratio Perm						
v/c Ratio	0.92	0.24	0.92	0.09	0.93	0.69
Uniform Delay, d1	45.6	6.3	36.5	23.7	49.5	46.4
Progression Factor	0.80	0.66	1.68	2.63	1.00	1.00
Incremental Delay, d2	19.3	0.3	16.5	0.2	30.1	10.6
Delay (s)	55.6	4.6	77.7	62.5	79.6	57.0
Level of Service	E	A	E	E	E	E
Approach Delay (s)		34.6	75.8		65.2	
Approach LOS		C	E		E	

Intersection Summary			
HCM Average Control Delay	59.4	HCM Level of Service	E
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	85.5%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
26: Farrington Hwy &

2030 + PRO (With Transit Corridor) - PM Peak Mitigations

Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	*0.99	*0.99	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3688	3688	1583
Flt Permitted	0.95	1.00	0.05	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	98	3688	3688	1583
Volume (vph)	199	173	94	1485	2229	137
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	201	175	95	1500	2252	138
RTOR Reduction (vph)	0	16	0	0	0	33
Lane Group Flow (vph)	201	159	95	1500	2252	105
Turn Type		Perm	Perm			Perm
Protected Phases	6			4	8	
Permitted Phases		6	4			8
Actuated Green, G (s)	16.0	16.0	76.0	76.0	76.0	76.0
Effective Green, g (s)	16.0	16.0	76.0	76.0	76.0	76.0
Actuated g/C Ratio	0.16	0.16	0.76	0.76	0.76	0.76
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	283	253	74	2803	2803	1203
v/s Ratio Prot	c0.11			0.41	0.61	
v/s Ratio Perm		0.10	c0.97			0.07
v/c Ratio	0.71	0.63	1.28	0.54	0.80	0.09
Uniform Delay, d1	39.8	39.2	12.0	4.9	7.4	3.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	14.1	11.3	198.5	0.7	2.6	0.1
Delay (s)	53.9	50.5	210.5	5.6	9.9	3.2
Level of Service	D	D	F	A	A	A
Approach Delay (s)	52.3			17.8	9.6	
Approach LOS	D			B	A	

Intersection Summary			
HCM Average Control Delay	16.3	HCM Level of Service	B
HCM Volume to Capacity ratio	1.18		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	87.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

APPENDIX A-6

MITIGATIONS
YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO B: WITHOUT TRANSIT CORRIDOR SCENARIO

HCM Signalized Intersection Capacity Analysis
1: Kunia Loop & Kunia Road

2030 + PRO (without Transit Corridor) - AM Peak Mitigations

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↰	↱	↑↑	↱		↑↑↑
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0		4.0
Lane Util. Factor	0.97	1.00	0.95	1.00		0.91
Frt	1.00	0.85	1.00	0.85		1.00
Flt Protected	0.95	1.00	1.00	1.00		1.00
Satd. Flow (prot)	3433	1583	3539	1583		5085
Flt Permitted	0.95	1.00	1.00	1.00		1.00
Satd. Flow (perm)	3433	1583	3539	1583		5085
Volume (vph)	724	37	1781	498	0	1309
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	787	40	1936	541	0	1423
RTOR Reduction (vph)	0	10	0	196	0	0
Lane Group Flow (vph)	787	30	1936	345	0	1423
Turn Type		Perm		Perm		
Protected Phases	8		2			6
Permitted Phases		8		2		
Actuated Green, G (s)	26.8	26.8	61.1	61.1		61.1
Effective Green, g (s)	26.8	26.8	61.1	61.1		61.1
Actuated g/C Ratio	0.28	0.28	0.64	0.64		0.64
Clearance Time (s)	4.0	4.0	4.0	4.0		4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0		3.0
Lane Grp Cap (vph)	959	442	2255	1009		3240
v/s Ratio Prot	c0.23		c0.55			0.28
v/s Ratio Perm		0.02		0.22		
v/c Ratio	0.82	0.07	0.86	0.34		0.44
Uniform Delay, d1	32.3	25.4	13.9	8.1		8.8
Progression Factor	1.00	1.00	1.00	1.00		1.00
Incremental Delay, d2	5.7	0.1	4.5	0.9		0.4
Delay (s)	38.0	25.4	18.5	9.0		9.2
Level of Service	D	C	B	A		A
Approach Delay (s)	37.4		16.4			9.2
Approach LOS	D		B			A

Intersection Summary			
HCM Average Control Delay	17.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	95.9	Sum of lost time (s)	8.0
Intersection Capacity Utilization	76.6%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
2: H-1 WB On-Ramp & Kunia Road

2030 + PRO (without Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations						↱	↰	↑↑↑			↑↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)						4.0	4.0	4.0			4.0	
Lane Util. Factor						1.00	1.00	0.91			0.91	
Frt						0.86	1.00	1.00			0.98	
Flt Protected						1.00	0.95	1.00			1.00	
Satd. Flow (prot)						1611	1770	5085			4960	
Flt Permitted						1.00	0.95	1.00			1.00	
Satd. Flow (perm)						1611	1770	5085			4960	
Volume (vph)	0	0	0	0	0	530	165	1748	0	0	1697	333
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	0	0	576	179	1900	0	0	1845	362
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	15	0
Lane Group Flow (vph)	0	0	0	0	0	576	179	1900	0	0	2192	0
Turn Type						Free	Prot					
Protected Phases							5	2			6	
Permitted Phases						Free						
Actuated Green, G (s)						110.0	15.1	110.0			86.9	
Effective Green, g (s)						110.0	15.1	110.0			86.9	
Actuated g/C Ratio						1.00	0.14	1.00			0.79	
Clearance Time (s)							4.0	4.0			4.0	
Vehicle Extension (s)							3.0	3.0			3.0	
Lane Grp Cap (vph)						1611	243	5085			3918	
v/s Ratio Prot							c0.10	0.37			c0.44	
v/s Ratio Perm						0.36						
v/c Ratio						0.36	0.74	0.37			0.56	
Uniform Delay, d1						0.0	45.5	0.0			4.3	
Progression Factor						1.00	1.07	1.00			1.00	
Incremental Delay, d2						0.6	9.8	0.2			0.6	
Delay (s)						0.6	58.5	0.2			4.9	
Level of Service						A	E	A			A	
Approach Delay (s)		0.0			0.6			5.2			4.9	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	4.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	56.0%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
3: H-1 EB & Kunia Road

2030 + PRO (without Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations	↰↰	↱	↓↓↓↓			↑↑↑
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0			4.0
Lane Util. Factor	0.97	1.00	0.86			0.91
Frt	1.00	0.85	1.00			1.00
Flt Protected	0.95	1.00	1.00			1.00
Satd. Flow (prot)	3433	1583	6408			5085
Flt Permitted	0.95	1.00	1.00			1.00
Satd. Flow (perm)	3433	1583	6408			5085
Volume (vph)	403	363	2072	0	0	1509
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	438	395	2252	0	0	1640
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	438	395	2252	0	0	1640
Turn Type		Free				
Protected Phases	4		6			2
Permitted Phases		Free				
Actuated Green, G (s)	17.4	110.0	84.6			84.6
Effective Green, g (s)	17.4	110.0	84.6			84.6
Actuated g/C Ratio	0.16	1.00	0.77			0.77
Clearance Time (s)	4.0		4.0			4.0
Vehicle Extension (s)	3.0		3.0			3.0
Lane Grp Cap (vph)	543	1583	4928			3911
v/s Ratio Prot	c0.13		c0.35			0.32
v/s Ratio Perm		0.25				
v/c Ratio	0.81	0.25	0.46			0.42
Uniform Delay, d1	44.7	0.0	4.5			4.3
Progression Factor	1.00	1.00	0.76			1.02
Incremental Delay, d2	8.6	0.4	0.3			0.3
Delay (s)	53.2	0.4	3.8			4.8
Level of Service	D	A	A			A
Approach Delay (s)	28.2		3.8			4.8
Approach LOS	C		A			A

Intersection Summary			
HCM Average Control Delay	8.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	49.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
4: Farrington Hwy & Fort Weaver Road SB Ramp

2030 + PRO (without Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↑↱		↰↰	↑↑↑				↱			↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0				4.0			4.0
Lane Util. Factor		0.91		0.97	0.91				1.00			1.00
Frt		0.98		1.00	1.00				0.86			0.86
Flt Protected		1.00		0.95	1.00				1.00			1.00
Satd. Flow (prot)		5006		3433	5085				1611			1611
Flt Permitted		1.00		0.95	1.00				1.00			1.00
Satd. Flow (perm)		5006		3433	5085				1611			1611
Volume (vph)	0	2066	240	498	721	0	0	0	429	0	0	481
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	2246	261	541	784	0	0	0	466	0	0	523
RTOR Reduction (vph)	0	12	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	2495	0	541	784	0	0	0	466	0	0	523
Turn Type				Prot					Free			Free
Protected Phases		2		1	6							
Permitted Phases									Free			Free
Actuated Green, G (s)		71.2		30.8	110.0				110.0			110.0
Effective Green, g (s)		71.2		30.8	110.0				110.0			110.0
Actuated g/C Ratio		0.65		0.28	1.00				1.00			1.00
Clearance Time (s)		4.0		4.0	4.0							
Vehicle Extension (s)		3.0		3.0	3.0							
Lane Grp Cap (vph)		3240		961	5085				1611			1611
v/s Ratio Prot		c0.50		c0.16	0.15							
v/s Ratio Perm									0.29			0.32
v/c Ratio		0.77		0.56	0.15				0.29			0.32
Uniform Delay, d1		13.6		33.8	0.0				0.0			0.0
Progression Factor		0.52		1.90	1.00				1.00			1.00
Incremental Delay, d2		1.3		0.6	0.1				0.5			0.5
Delay (s)		8.3		65.0	0.1				0.5			0.5
Level of Service		A		E	A				A			A
Approach Delay (s)		8.3			26.6			0.5			0.5	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM Average Control Delay	11.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	66.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
5: Farrington Hwy & Fort Weaver Road NB Ramps

2030 + PRO (without Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑↑			↑↑↑	↱			↱			
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0	4.0			4.0			
Lane Util. Factor	0.97	*0.99			*0.99	1.00			1.00			
Frt	1.00	1.00			1.00	0.85			0.86			
Flt Protected	0.95	1.00			1.00	1.00			1.00			
Satd. Flow (prot)	3433	5532			5532	1583			1611			
Flt Permitted	0.95	1.00			1.00	1.00			1.00			
Satd. Flow (perm)	3433	5532			5532	1583			1611			
Volume (vph)	1165	1330	0	0	1218	567	0	0	911	0	0	0
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	1177	1343	0	0	1230	573	0	0	920	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	55	0	0	0	0	0	0
Lane Group Flow (vph)	1177	1343	0	0	1230	518	0	0	920	0	0	0
Turn Type	Prot					Perm			Free			
Protected Phases	5	2			6							
Permitted Phases						6			Free			
Actuated Green, G (s)	64.6	110.0			37.4	37.4			110.0			
Effective Green, g (s)	64.6	110.0			37.4	37.4			110.0			
Actuated g/C Ratio	0.59	1.00			0.34	0.34			1.00			
Clearance Time (s)	4.0	4.0			4.0	4.0						
Vehicle Extension (s)	3.0	3.0			3.0	3.0						
Lane Grp Cap (vph)	2016	5532			1881	538			1611			
v/s Ratio Prot	0.34	0.24			0.22							
v/s Ratio Perm						c0.33			c0.57			
v/c Ratio	0.58	0.24			0.65	0.96			0.57			
Uniform Delay, d1	14.3	0.0			30.8	35.6			0.0			
Progression Factor	0.23	1.00			1.00	1.00			1.00			
Incremental Delay, d2	0.3	0.1			1.8	30.5			1.5			
Delay (s)	3.6	0.1			32.6	66.1			1.5			
Level of Service	A	A			C	E			A			
Approach Delay (s)		1.7			43.2			1.5			0.0	
Approach LOS		A			D			A			A	

Intersection Summary			
HCM Average Control Delay	16.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	75.0%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
6: Farrington Hwy & Leoku Street

2030 + PRO (without Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑↑	↱	↰	↑↑↑	↱		↰↑	↱		↰↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
Lane Util. Factor	*0.99	*0.99	1.00	1.00	*0.99	1.00		1.00	1.00		*0.99	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00		0.97	1.00
Satd. Flow (prot)	3504	5532	1583	1770	5532	1583		1780	1583		3568	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00		0.97	1.00
Satd. Flow (perm)	3504	5532	1583	1770	5532	1583		1780	1583		3568	1583
Volume (vph)	147	1938	155	119	1699	156	56	5	48	92	45	33
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	160	2107	168	129	1847	170	61	5	52	100	49	36
RTOR Reduction (vph)	0	0	75	0	0	92	0	0	49	0	0	33
Lane Group Flow (vph)	160	2107	93	129	1847	78	0	66	3	0	149	3
Turn Type	Prot		Perm	Prot		Perm	Split		Perm	Split		Perm
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			6
Actuated Green, G (s)	17.9	47.9	47.9	9.7	39.7	39.7		5.4	5.4		7.2	7.2
Effective Green, g (s)	17.9	47.9	47.9	9.7	39.7	39.7		5.4	5.4		7.2	7.2
Actuated g/C Ratio	0.21	0.56	0.56	0.11	0.46	0.46		0.06	0.06		0.08	0.08
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	728	3074	880	199	2548	729		112	99		298	132
v/s Ratio Prot	0.05	c0.38		c0.07	c0.33			c0.04			c0.04	
v/s Ratio Perm			0.06			0.05			0.00			0.00
v/c Ratio	0.22	0.69	0.11	0.65	0.72	0.11		0.59	0.03		0.50	0.02
Uniform Delay, d1	28.4	13.7	9.0	36.6	18.8	13.2		39.3	37.9		37.8	36.3
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00
Incremental Delay, d2	0.2	0.6	0.1	7.1	1.0	0.1		20.7	0.6		1.3	0.1
Delay (s)	28.5	14.4	9.1	43.7	19.9	13.3		60.1	38.6		39.1	36.3
Level of Service	C	B	A	D	B	B		E	D		D	D
Approach Delay (s)		15.0			20.8			50.6			38.6	
Approach LOS		B			C			D			D	

Intersection Summary			
HCM Average Control Delay	19.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	86.2	Sum of lost time (s)	16.0
Intersection Capacity Utilization	65.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
7: Laulaunui Street & Fort Weaver Road
2030 + PRO (without Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.91	*0.99		1.00	1.00	1.00	1.00	*0.99	1.00	1.00	*0.99	1.00
Frt	1.00	0.98		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.97		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1610	3509		1770	1863	1583	1770	5532	1583	1770	5532	1583
Flt Permitted	0.95	0.97		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1610	3509		1770	1863	1583	1770	5532	1583	1770	5532	1583
Volume (vph)	96	24	12	72	4	235	48	4056	53	92	1419	170
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	97	24	12	73	4	237	48	4097	54	93	1433	172
RTOR Reduction (vph)	0	10	0	0	0	101	0	0	10	0	0	51
Lane Group Flow (vph)	49	74	0	73	4	136	48	4097	44	93	1433	121
Turn Type	Split			Split		Perm	Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases						8			2			6
Actuated Green, G (s)	9.8	9.8		10.0	10.0	10.0	7.4	101.0	101.0	7.9	101.5	101.5
Effective Green, g (s)	9.8	9.8		10.0	10.0	10.0	7.4	101.0	101.0	7.9	101.5	101.5
Actuated g/C Ratio	0.07	0.07		0.07	0.07	0.07	0.05	0.70	0.70	0.05	0.70	0.70
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	109	238		122	129	109	91	3861	1105	97	3880	1110
v/s Ratio Prot	c0.03	0.02		0.04	0.00		0.03	c0.74		c0.05	0.26	
v/s Ratio Perm						c0.09			0.03			0.08
v/c Ratio	0.45	0.31		0.60	0.03	1.24	0.53	1.06	0.04	0.96	0.37	0.11
Uniform Delay, d1	64.9	64.2		65.4	62.8	67.3	66.9	21.8	6.8	68.2	8.7	7.0
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	2.9	0.7		7.7	0.1	165.4	5.4	34.0	0.1	77.0	0.3	0.2
Delay (s)	67.8	65.0		73.1	62.9	232.8	72.4	55.9	6.9	145.3	9.0	7.2
Level of Service	E	E		E	E	F	E	E	A	F	A	A
Approach Delay (s)		66.0			193.5			55.5			16.3	
Approach LOS		E			F			E			B	

Intersection Summary			
HCM Average Control Delay	52.0	HCM Level of Service	D
HCM Volume to Capacity ratio	1.02		
Actuated Cycle Length (s)	144.7	Sum of lost time (s)	16.0
Intersection Capacity Utilization	106.3%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
8: Old Fort Weaver Road & Fort Weaver Road
2030 + PRO (without Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	4.0	4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.94	1.00	1.00		1.00	1.00	0.97	*0.99		1.00	*0.99	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00		1.00	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	4990	1863	1583		1862	1583	3433	5532		1770	5532	1583
Flt Permitted	0.95	1.00	1.00		1.00	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	4990	1863	1583		1862	1583	3433	5532		1770	5532	1583
Volume (vph)	851	126	403	4	484	262	299	3044	1	21	949	532
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	860	127	407	4	489	265	302	3075	1	21	959	537
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	291
Lane Group Flow (vph)	860	127	407	0	493	265	302	3076	0	21	959	246
Turn Type	Split		Free	Split		Free	Prot			Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			Free			Free						6
Actuated Green, G (s)	31.5	31.5	145.0		14.1	145.0	17.0	81.1		2.3	66.4	66.4
Effective Green, g (s)	31.5	31.5	145.0		14.1	145.0	17.0	81.1		2.3	66.4	66.4
Actuated g/C Ratio	0.22	0.22	1.00		0.10	1.00	0.12	0.56		0.02	0.46	0.46
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	1084	405	1583		181	1583	402	3094		28	2533	725
v/s Ratio Prot	c0.17	0.07			c0.26		c0.09	c0.56		0.01	0.17	
v/s Ratio Perm			0.26			0.17						0.16
v/c Ratio	0.79	0.31	0.26		2.72	0.17	0.75	0.99		0.75	0.38	0.34
Uniform Delay, d1	53.7	47.7	0.0		65.5	0.0	62.0	31.7		71.1	25.8	25.2
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	4.1	0.4	0.4		791.1	0.2	7.7	14.9		71.8	0.4	1.3
Delay (s)	57.7	48.1	0.4		856.5	0.2	69.7	46.6		142.9	26.2	26.5
Level of Service	E	D	A		F	A	E	D		F	C	C
Approach Delay (s)		40.1			557.2			48.7			27.9	
Approach LOS		D			F			D			C	

Intersection Summary			
HCM Average Control Delay	97.2	HCM Level of Service	F
HCM Volume to Capacity ratio	1.14		
Actuated Cycle Length (s)	145.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	117.4%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↰↑	↱		↰↑	↱	↰	↑↑↑	↱	↰↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*0.99	*0.99	1.00		1.00	1.00	1.00	*0.99	1.00	0.97	*0.99	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1752	1766	1583		1860	1583	1770	5532	1583	3433	5532	1583
Flt Permitted	0.95	0.96	1.00		1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1752	1766	1583		1860	1583	1770	5532	1583	3433	5532	1583
Volume (vph)	468	31	36	10	339	217	89	2658	1	251	1023	85
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	473	31	36	10	342	219	90	2685	1	254	1033	86
RTOR Reduction (vph)	0	0	0	0	0	97	0	0	0	0	0	33
Lane Group Flow (vph)	246	258	36	0	352	122	90	2685	1	254	1033	53
Turn Type	Split		Free	Split		Perm	Prot		pm+ov	Prot		pm+ov
Protected Phases	4	4		8	8		5	2	8	1	6	4
Permitted Phases			Free			8			2			6
Actuated Green, G (s)	20.0	20.0	140.0		26.0	26.0	11.6	68.0	94.0	10.0	66.4	86.4
Effective Green, g (s)	20.0	20.0	140.0		26.0	26.0	11.6	68.0	94.0	10.0	66.4	86.4
Actuated g/C Ratio	0.14	0.14	1.00		0.19	0.19	0.08	0.49	0.67	0.07	0.47	0.62
Clearance Time (s)	4.0	4.0			4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	250	252	1583		345	294	147	2687	1063	245	2624	1022
v/s Ratio Prot	0.14	c0.15			c0.19		0.05	c0.49	0.00	c0.07	0.19	0.01
v/s Ratio Perm			c0.02			0.08			0.00			0.03
v/c Ratio	0.98	1.02	0.02		1.02	0.42	0.61	1.00	0.00	1.04	0.39	0.05
Uniform Delay, d1	59.8	60.0	0.0		57.0	50.3	62.0	36.0	7.6	65.0	23.8	10.6
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	52.1	63.0	0.0		53.7	1.0	7.3	17.2	0.0	67.4	0.4	0.0
Delay (s)	111.9	123.0	0.0		110.7	51.2	69.4	53.2	7.6	132.4	24.2	10.6
Level of Service	F	F	A		F	D	E	D	A	F	C	B
Approach Delay (s)		109.7			87.9			53.7			43.4	
Approach LOS		F			F			D			D	

Intersection Summary			
HCM Average Control Delay	60.5	HCM Level of Service	E
HCM Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	104.0%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↑		↰↰	↑↑↑↱			↑↱	↱	↰	↰↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	*0.99		*0.99	*0.99			*0.99	*0.99	*0.99	*0.99	
Frt	1.00	1.00		1.00	0.99			0.91	0.85	1.00	0.91	
Flt Protected	0.95	1.00		0.95	1.00			1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	5532		3504	5478			1669	1567	1752	1678	
Flt Permitted	0.95	1.00		0.95	1.00			1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	5532		3504	5478			1669	1567	1752	1678	
Volume (vph)	146	1756	0	240	899	63	0	65	347	205	230	345
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	147	1774	0	242	908	64	0	66	351	207	232	348
RTOR Reduction (vph)	0	0	0	0	8	0	0	59	212	0	49	0
Lane Group Flow (vph)	147	1774	0	242	964	0	0	120	26	207	531	0
Turn Type	Prot			Prot					Perm	Split		
Protected Phases	5	2		1	6			8		4	4	
Permitted Phases									8			
Actuated Green, G (s)	12.0	42.8		7.0	37.8			12.2	12.2	32.0	32.0	
Effective Green, g (s)	12.0	42.8		7.0	37.8			12.2	12.2	32.0	32.0	
Actuated g/C Ratio	0.11	0.39		0.06	0.34			0.11	0.11	0.29	0.29	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	193	2152		223	1882			185	174	510	488	
v/s Ratio Prot	0.08	c0.32		c0.07	0.18			c0.07		0.12	c0.32	
v/s Ratio Perm									0.02			
v/c Ratio	0.76	0.82		1.09	0.51			0.65	0.15	0.41	1.09	
Uniform Delay, d1	47.6	30.2		51.5	28.8			46.9	44.2	31.4	39.0	
Progression Factor	0.74	0.81		0.61	0.39			1.00	1.00	1.00	1.00	
Incremental Delay, d2	13.1	3.0		84.4	1.0			7.9	0.4	0.5	66.8	
Delay (s)	48.2	27.5		115.8	12.2			54.8	44.6	31.9	105.8	
Level of Service	D	C		F	B			D	D	C	F	
Approach Delay (s)		29.1			32.8			49.0			86.3	
Approach LOS		C			C			D			F	

Intersection Summary			
HCM Average Control Delay	42.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	86.9%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
11: Farrington Hwy & E Street

2030 + PRO (without Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↑↱			↑↑↑↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	*0.99			*0.99		1.00	1.00		1.00	1.00	
Frt	1.00	0.99			1.00		1.00	1.00		1.00	0.92	
Flt Protected	0.95	1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	5503			5515		1770	1856		1770	1722	
Flt Permitted	0.95	1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	5503			5515		1770	1856		1770	1722	
Volume (vph)	51	1764	64	0	1217	27	218	189	5	133	49	50
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	55	1917	70	0	1323	29	237	205	5	145	53	54
RTOR Reduction (vph)	0	3	0	0	1	0	0	1	0	0	34	0
Lane Group Flow (vph)	55	1984	0	0	1351	0	237	209	0	145	73	0
Turn Type	Prot						Split			Split		
Protected Phases	5	2			6		8	8		4	4	
Permitted Phases												
Actuated Green, G (s)	4.8	65.4			56.6		19.2	19.2		13.4	13.4	
Effective Green, g (s)	4.8	65.4			56.6		19.2	19.2		13.4	13.4	
Actuated g/C Ratio	0.04	0.59			0.51		0.17	0.17		0.12	0.12	
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	77	3272			2838		309	324		216	210	
v/s Ratio Prot	0.03	c0.36			0.24		c0.13	0.11		c0.08	0.04	
v/s Ratio Perm												
v/c Ratio	0.71	0.61			0.48		0.77	0.65		0.67	0.35	
Uniform Delay, d1	51.9	14.1			17.2		43.3	42.2		46.2	44.3	
Progression Factor	1.00	1.00			0.59		1.00	1.00		1.00	1.00	
Incremental Delay, d2	26.8	0.8			0.4		10.8	4.4		7.9	1.0	
Delay (s)	78.7	15.0			10.6		54.1	46.6		54.1	45.3	
Level of Service	E	B			B		D	D		D	D	
Approach Delay (s)		16.7			10.6			50.6			50.4	
Approach LOS		B			B			D			D	

Intersection Summary			
HCM Average Control Delay	20.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	63.2%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
12: Fort Barrette Road & Farrington Hwy

2030 + PRO (without Transit Corridor) - AM Peak Mitigations

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰↰	↑↑↱	↱	↰↰	↑↑	↱	↰↰	↑↑	↱	↰	↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*0.99	*0.99	*0.99	*0.99	*0.99	1.00	*0.99	*0.99	1.00	1.00	*0.99	1.00
Frt	1.00	0.96	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3504	3539	1567	3504	3688	1583	3504	3688	1583	1770	3688	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3504	3539	1567	3504	3688	1583	3504	3688	1583	1770	3688	1583
Volume (vph)	377	708	799	572	579	161	338	441	485	80	743	707
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	381	715	807	578	585	163	341	445	490	81	751	714
RTOR Reduction (vph)	0	35	160	0	0	112	0	0	276	0	0	257
Lane Group Flow (vph)	381	944	383	578	585	51	341	445	214	81	751	457
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases			6			2			4			8
Actuated Green, G (s)	17.3	34.2	34.2	20.0	36.9	36.9	12.9	39.9	39.9	8.6	35.6	35.6
Effective Green, g (s)	17.3	34.2	34.2	20.0	36.9	36.9	12.9	39.9	39.9	8.6	35.6	35.6
Actuated g/C Ratio	0.15	0.29	0.29	0.17	0.31	0.31	0.11	0.34	0.34	0.07	0.30	0.30
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	511	1020	451	590	1146	492	381	1240	532	128	1106	475
v/s Ratio Prot	0.11	c0.27		c0.16	c0.16		c0.10	0.12		0.05	0.20	
v/s Ratio Perm			0.24			0.03			0.14			c0.29
v/c Ratio	0.75	0.93	0.85	0.98	0.51	0.10	0.90	0.36	0.40	0.63	0.68	0.96
Uniform Delay, d1	48.6	41.0	39.8	49.1	33.5	29.1	52.2	29.7	30.3	53.5	36.5	40.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	5.9	13.6	13.9	31.5	1.6	0.4	22.5	0.2	0.5	9.8	1.7	31.6
Delay (s)	54.4	54.6	53.7	80.6	35.1	29.5	74.7	29.9	30.8	63.3	38.2	72.5
Level of Service	D	D	D	F	D	C	E	C	C	E	D	E
Approach Delay (s)		54.3			54.3			42.2			55.4	
Approach LOS		D			D			D			E	

Intersection Summary			
HCM Average Control Delay	52.0	HCM Level of Service	D
HCM Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	118.7	Sum of lost time (s)	20.0
Intersection Capacity Utilization	87.9%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
13: WB Ramps & North-South Road
2030 + PRO (without Transit Corridor) - AM Peak Mitigations

Movement	WBL2	WBL	WBR	NBL	NBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations											
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0				4.0	4.0	4.0	4.0	
Lane Util. Factor	*0.99		1.00				*0.99	1.00	0.97	*0.99	
Frt	1.00		0.85				1.00	0.85	1.00	1.00	
Flt Protected	0.95		1.00				1.00	1.00	0.95	1.00	
Satd. Flow (prot)	3504		1583				3688	1583	3433	3688	
Flt Permitted	0.95		1.00				1.00	1.00	0.95	1.00	
Satd. Flow (perm)	3504		1583				3688	1583	3433	3688	
Volume (vph)	1414	0	115	0	0	0	1103	248	585	244	0
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	1428	0	116	0	0	0	1114	251	591	246	0
RTOR Reduction (vph)	0	0	70	0	0	0	0	173	0	0	0
Lane Group Flow (vph)	1428	0	46	0	0	0	1114	78	591	246	0
Turn Type	Prot		custom					Perm	Prot		
Protected Phases	8		8				6		5	2	
Permitted Phases								6			
Actuated Green, G (s)	40.0		40.0				31.0	31.0	17.0	52.0	
Effective Green, g (s)	40.0		40.0				31.0	31.0	17.0	52.0	
Actuated g/C Ratio	0.40		0.40				0.31	0.31	0.17	0.52	
Clearance Time (s)	4.0		4.0				4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0		3.0				3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	1402		633				1143	491	584	1918	
v/s Ratio Prot	c0.41		0.03				c0.30		c0.17	0.07	
v/s Ratio Perm								0.05			
v/c Ratio	1.02		0.07				0.97	0.16	1.01	0.13	
Uniform Delay, d1	30.0		18.5				34.1	25.0	41.5	12.3	
Progression Factor	1.00		1.00				1.00	1.00	0.44	0.48	
Incremental Delay, d2	28.8		0.0				21.2	0.7	35.9	0.1	
Delay (s)	58.8		18.6				55.3	25.7	54.1	6.1	
Level of Service	E		B				E	C	D	A	
Approach Delay (s)		55.8		0.0			49.9			40.0	
Approach LOS		E		A			D			D	

Intersection Summary			
HCM Average Control Delay	50.1	HCM Level of Service	D
HCM Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	63.9%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
14: EB Ramps & North-South Road
2030 + PRO (without Transit Corridor) - AM Peak Mitigations

Movement	EBL2	EBL	EBR	SBL	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations											
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0			4.0	4.0			4.0	4.0
Lane Util. Factor	1.00		0.88			0.97	*0.99			*0.99	*0.99
Frt	1.00		0.85			1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (prot)	1770		2787			3433	5532			3688	3135
Flt Permitted	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (perm)	1770		2787			3433	5532			3688	3135
Volume (vph)	51	0	689	0	0	803	1714	0	0	778	2380
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	52	0	696	0	0	811	1731	0	0	786	2404
RTOR Reduction (vph)	0	0	34	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	52	0	662	0	0	811	1731	0	0	786	2404
Turn Type	Prot		custom			Prot					Free
Protected Phases	4					1	6			2	
Permitted Phases			4								Free
Actuated Green, G (s)	26.9		26.9			28.7	65.1			32.4	100.0
Effective Green, g (s)	26.9		26.9			28.7	65.1			32.4	100.0
Actuated g/C Ratio	0.27		0.27			0.29	0.65			0.32	1.00
Clearance Time (s)	4.0		4.0			4.0	4.0			4.0	
Vehicle Extension (s)	3.0		3.0			3.0	3.0			3.0	
Lane Grp Cap (vph)	476		750			985	3601			1195	3135
v/s Ratio Prot	0.03					0.24	0.31			0.21	
v/s Ratio Perm			c0.24								c0.77
v/c Ratio	0.11		0.88			0.82	0.48			0.66	0.77
Uniform Delay, d1	27.5		35.0			33.3	8.9			29.0	0.0
Progression Factor	1.00		1.00			0.97	0.23			1.00	1.00
Incremental Delay, d2	0.1		11.9			1.3	0.1			2.8	1.9
Delay (s)	27.6		47.0			33.5	2.1			31.9	1.9
Level of Service	C		D			C	A			C	A
Approach Delay (s)		45.6		0.0			12.1			9.3	
Approach LOS		D		A			B			A	

Intersection Summary			
HCM Average Control Delay	14.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	63.9%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
15: North-South Road & Farrington Hwy

2030 + PRO (without Transit Corridor) - AM Peak Mitigations

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰↰	↑↑↑	↱↱	↰↰↰	↑↑↑	↱	↰↰	↑↑	↱↱	↰↰	↑↑	↱↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*0.99	*0.99	*0.99	*0.99	*0.99	1.00	*0.99	*0.99	*0.99	*0.99	*0.99	*0.99
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3504	5532	3135	5256	5532	1583	3504	3688	3135	3504	3688	3135
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3504	5532	3135	5256	5532	1583	3504	3688	3135	3504	3688	3135
Volume (vph)	765	1166	567	463	1804	349	544	404	227	176	488	810
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	773	1178	573	468	1822	353	549	408	229	178	493	818
RTOR Reduction (vph)	0	0	0	0	0	207	0	0	0	0	0	542
Lane Group Flow (vph)	773	1178	573	468	1822	146	549	408	229	178	493	276
Turn Type	Prot		Free	Prot		Perm	Prot		Free	Prot		Perm
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases			Free			2			Free			8
Actuated Green, G (s)	24.0	46.4	110.0	14.6	37.0	37.0	17.0	22.2	110.0	10.8	16.0	16.0
Effective Green, g (s)	24.0	46.4	110.0	14.6	37.0	37.0	17.0	22.2	110.0	10.8	16.0	16.0
Actuated g/C Ratio	0.22	0.42	1.00	0.13	0.34	0.34	0.15	0.20	1.00	0.10	0.15	0.15
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	765	2333	3135	698	1861	532	542	744	3135	344	536	456
v/s Ratio Prot	c0.22	0.21		0.09	c0.33		c0.16	0.11		0.05	c0.13	
v/s Ratio Perm			0.18			0.09			0.07			0.09
v/c Ratio	1.01	0.50	0.18	0.67	0.98	0.27	1.01	0.55	0.07	0.52	0.92	0.61
Uniform Delay, d1	43.0	23.4	0.0	45.4	36.1	26.7	46.5	39.4	0.0	47.1	46.4	44.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	35.1	0.2	0.1	2.5	16.0	0.3	41.9	2.9	0.0	1.3	23.4	5.9
Delay (s)	78.1	23.5	0.1	47.9	52.1	27.0	88.4	42.3	0.0	48.4	69.7	49.9
Level of Service	E	C	A	D	D	C	F	D	A	D	E	D
Approach Delay (s)		34.9			48.0			55.5			56.3	
Approach LOS		C			D			E			E	

Intersection Summary			
HCM Average Control Delay	46.5	HCM Level of Service	D
HCM Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	99.0%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
16: North-South Road & North UH Connector

2030 + PRO (without Transit Corridor) - AM Peak Mitigations

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰	↑↑↑↱	↱	↰↰	↑↑↑↱		↰↰	↑↱		↰↰	↑	↱↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	1.00	*0.99	0.86	*0.99	*0.99		*0.99	*0.99		*0.99	1.00	*0.99
Frt	1.00	1.00	0.85	1.00	0.98		1.00	0.98		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1770	5532	1362	3504	5424		3504	3608		3504	1863	3135
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	1770	5532	1362	3504	5424		3504	3608		3504	1863	3135
Volume (vph)	51	2067	233	489	940	141	220	163	28	367	107	329
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	52	2088	235	494	949	142	222	165	28	371	108	332
RTOR Reduction (vph)	0	0	105	0	17	0	0	13	0	0	0	38
Lane Group Flow (vph)	52	2088	130	494	1074	0	222	180	0	371	108	294
Turn Type	Prot		Perm	Prot			Prot			Prot		pm+ov
Protected Phases	5	2		1	6		7	4		3	8	1
Permitted Phases			2									8
Actuated Green, G (s)	6.7	54.9	54.9	17.9	66.1		12.4	11.9		14.0	13.5	31.4
Effective Green, g (s)	6.7	54.9	54.9	17.9	66.1		12.4	11.9		14.0	13.5	31.4
Actuated g/C Ratio	0.06	0.48	0.48	0.16	0.58		0.11	0.10		0.12	0.12	0.27
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	103	2648	652	547	3126		379	374		428	219	968
v/s Ratio Prot	0.03	c0.38		c0.14	0.20		0.06	0.05		c0.11	c0.06	0.05
v/s Ratio Perm			0.10									0.05
v/c Ratio	0.50	0.79	0.20	0.90	0.34		0.59	0.48		0.87	0.49	0.30
Uniform Delay, d1	52.4	25.0	17.2	47.5	12.8		48.7	48.5		49.4	47.4	33.0
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	3.9	2.5	0.7	18.2	0.3		2.3	1.0		16.6	1.7	0.2
Delay (s)	56.2	27.5	17.9	65.7	13.1		51.0	49.5		66.1	49.1	33.2
Level of Service	E	C	B	E	B		D	D		E	D	C
Approach Delay (s)		27.2			29.5			50.3			50.3	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM Average Control Delay	33.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	114.7	Sum of lost time (s)	12.0
Intersection Capacity Utilization	84.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
17: East-West Rd. & North-South Road
2030 + PRO (without Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↱		↰↰	↑↱		↰↰	↑↑↱		↰↰	↑↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	*0.99	0.95		0.97	*0.99		*0.99	*0.99		*0.99	*0.99	
Frt	1.00	0.95		1.00	0.87		1.00	0.98		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	3504	3363		3433	3217		3504	5428		3504	5407	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	3504	3363		3433	3217		3504	5428		3504	5407	
Volume (vph)	244	225	112	245	113	652	207	1454	209	193	970	173
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	265	245	122	266	123	709	225	1580	227	210	1054	188
RTOR Reduction (vph)	0	57	0	0	177	0	0	19	0	0	26	0
Lane Group Flow (vph)	265	310	0	266	655	0	225	1788	0	210	1216	0
Turn Type	Prot			Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases												
Actuated Green, G (s)	13.0	24.1		12.5	23.6		11.0	38.0		16.0	43.0	
Effective Green, g (s)	13.0	24.1		12.5	23.6		11.0	38.0		16.0	43.0	
Actuated g/C Ratio	0.12	0.23		0.12	0.22		0.10	0.36		0.15	0.40	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	427	760		403	712		362	1935		526	2181	
v/s Ratio Prot	0.08	0.09		c0.08	c0.20		c0.06	c0.33		c0.06	0.22	
v/s Ratio Perm												
v/c Ratio	0.62	0.41		0.66	1.36dr		0.62	0.92		0.40	0.56	
Uniform Delay, d1	44.5	35.2		45.0	40.6		45.8	32.9		41.0	24.5	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	2.8	0.4		4.0	17.2		3.3	9.0		2.3	1.0	
Delay (s)	47.3	35.5		49.0	57.8		49.1	41.9		43.2	25.5	
Level of Service	D	D		D	E		D	D		D	C	
Approach Delay (s)		40.4			55.7			42.7			28.1	
Approach LOS		D			E			D			C	

Intersection Summary			
HCM Average Control Delay	41.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	106.6	Sum of lost time (s)	16.0
Intersection Capacity Utilization	82.8%	ICU Level of Service	E
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
18: North-South Road & Kapolei Parkway
2030 + PRO (without Transit Corridor) - AM Peak Mitigations

Movement	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰	↑↑↱		↰↰	↑↑↑	↱	↰↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.91		0.97	0.91	1.00	0.97	0.91	1.00	1.00	0.91	1.00
Frt	1.00	0.98		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	5001		3433	5085	1583	3433	5085	1583	1770	5085	1583
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	5001		3433	5085	1583	3433	5085	1583	1770	5085	1583
Volume (vph)	245	519	64	229	500	597	860	315	316	118	637	491
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	266	564	70	249	543	649	935	342	343	128	692	534
RTOR Reduction (vph)	0	15	0	0	0	396	0	0	215	0	0	203
Lane Group Flow (vph)	266	619	0	249	543	253	935	342	128	128	692	331
Turn Type	Prot			Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases						6			4			8
Actuated Green, G (s)	16.0	23.8		11.2	19.0	19.0	28.0	37.4	37.4	11.6	21.0	21.0
Effective Green, g (s)	16.0	23.8		11.2	19.0	19.0	28.0	37.4	37.4	11.6	21.0	21.0
Actuated g/C Ratio	0.16	0.24		0.11	0.19	0.19	0.28	0.37	0.37	0.12	0.21	0.21
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	283	1190		384	966	301	961	1902	592	205	1068	332
v/s Ratio Prot	c0.15	0.12		0.07	0.11		c0.27	0.07		0.07	0.14	
v/s Ratio Perm						c0.16			0.08			c0.21
v/c Ratio	0.94	0.52		0.65	0.56	0.84	0.97	0.18	0.22	0.62	0.65	1.00
Uniform Delay, d1	41.5	33.1		42.5	36.7	39.0	35.6	21.0	21.3	42.1	36.1	39.5
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	37.2	1.6		3.7	2.4	23.7	22.5	0.0	0.2	5.8	1.4	48.2
Delay (s)	78.7	34.8		46.3	39.1	62.7	58.1	21.1	21.5	47.9	37.5	87.7
Level of Service	E	C		D	D	E	E	C	C	D	D	F
Approach Delay (s)		47.8			51.0			42.6			58.3	
Approach LOS		D			D			D			E	

Intersection Summary			
HCM Average Control Delay	49.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.94		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	76.4%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
19: East-West Rd. & Old Fort Weaver Rd
2030 + PRO (without Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↰	↑	↑↑	↱	↰↰	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	0.97	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1863	3539	1583	3433	1583
Flt Permitted	0.56	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1046	1863	3539	1583	3433	1583
Volume (vph)	21	893	310	1006	487	45
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	21	902	313	1016	492	45
RTOR Reduction (vph)	0	0	0	467	0	29
Lane Group Flow (vph)	21	902	313	549	492	16
Turn Type	Perm			Perm		Perm
Protected Phases		4	8		6	
Permitted Phases	4			8		6
Actuated Green, G (s)	45.8	45.8	45.8	45.8	31.0	31.0
Effective Green, g (s)	45.8	45.8	45.8	45.8	31.0	31.0
Actuated g/C Ratio	0.54	0.54	0.54	0.54	0.37	0.37
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	565	1006	1911	855	1255	579
v/s Ratio Prot		c0.48	0.09		c0.14	
v/s Ratio Perm	0.02			0.35		0.01
v/c Ratio	0.04	0.90	0.16	0.64	0.39	0.03
Uniform Delay, d1	9.2	17.4	9.8	13.7	19.9	17.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.0	10.4	0.0	1.7	0.9	0.1
Delay (s)	9.2	27.8	9.9	15.4	20.8	17.3
Level of Service	A	C	A	B	C	B
Approach Delay (s)		27.4	14.1		20.5	
Approach LOS		C	B		C	

Intersection Summary			
HCM Average Control Delay	19.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	84.8	Sum of lost time (s)	8.0
Intersection Capacity Utilization	72.3%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
20: Farrington Hwy & B Street
2030 + PRO (without Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰↰	↑↑	↱	↰↰	↑↑	↱	↰	↑	↱	↰↰	↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3539	1583	3433	3539	1583	1770	1863	1583	3433	1863	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3539	1583	3433	3539	1583	1770	1863	1583	3433	1863	1583
Volume (vph)	215	1127	203	124	897	87	49	137	126	343	223	206
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	234	1225	221	135	975	95	53	149	137	373	242	224
RTOR Reduction (vph)	0	0	102	0	0	60	0	0	12	0	0	60
Lane Group Flow (vph)	234	1225	119	135	975	35	53	149	125	373	242	164
Turn Type	Prot		pm+ov	Prot		Perm	Prot		pm+ov	Prot		pm+ov
Protected Phases	5	2	3	1	6		7	4	5	3	8	1
Permitted Phases			2			6			4			8
Actuated Green, G (s)	11.5	36.7	50.1	8.6	33.8	33.8	4.4	18.1	29.6	13.4	27.1	35.7
Effective Green, g (s)	11.5	36.7	50.1	8.6	33.8	33.8	4.4	18.1	29.6	13.4	27.1	35.7
Actuated g/C Ratio	0.12	0.40	0.54	0.09	0.36	0.36	0.05	0.20	0.32	0.14	0.29	0.38
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	425	1400	923	318	1289	577	84	363	573	496	544	677
v/s Ratio Prot	c0.07	c0.35	0.02	0.04	0.28		0.03	0.08	0.03	c0.11	c0.13	0.02
v/s Ratio Perm			0.06			0.02			0.05			0.08
v/c Ratio	0.55	0.88	0.13	0.42	0.76	0.06	0.63	0.41	0.22	0.75	0.44	0.24
Uniform Delay, d1	38.2	25.9	10.6	39.8	25.9	19.2	43.4	32.7	23.1	38.1	26.7	19.4
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.5	6.4	0.1	0.9	2.6	0.0	14.4	3.4	0.2	6.4	2.6	0.2
Delay (s)	39.8	32.3	10.6	40.7	28.5	19.2	57.8	36.1	23.3	44.5	29.4	19.6
Level of Service	D	C	B	D	C	B	E	D	C	D	C	B
Approach Delay (s)		30.5			29.1			34.3			33.5	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	31.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	92.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	65.0%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
21: East-West Rd. & A Street

2030 + PRO (without Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰	↱		↰	↑	↱	↰	↱		↰	↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	1.00	0.85	1.00	0.86		1.00	0.88	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1842		1770	1863	1583	1770	1597		1770	1630	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	1842		1770	1863	1583	1770	1597		1770	1630	
Volume (vph)	90	328	27	31	700	74	93	7	140	44	7	37
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	98	357	29	34	761	80	101	8	152	48	8	40
RTOR Reduction (vph)	0	2	0	0	0	39	0	133	0	0	36	0
Lane Group Flow (vph)	98	384	0	34	761	41	101	27	0	48	12	0
Turn Type	Prot			Prot		Perm	Split			Split		
Protected Phases	5	2		1	6		4	4		8	8	
Permitted Phases						6						
Actuated Green, G (s)	5.0	41.3		2.2	38.5	38.5	9.5	9.5		7.5	7.5	
Effective Green, g (s)	5.0	41.3		2.2	38.5	38.5	9.5	9.5		7.5	7.5	
Actuated g/C Ratio	0.07	0.54		0.03	0.50	0.50	0.12	0.12		0.10	0.10	
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	116	994		51	938	797	220	198		174	160	
v/s Ratio Prot	c0.06	c0.21		0.02	c0.41		c0.06	0.02		c0.03	0.01	
v/s Ratio Perm						0.03						
v/c Ratio	0.84	0.39		0.67	0.81	0.05	0.46	0.14		0.28	0.07	
Uniform Delay, d1	35.4	10.2		36.8	16.0	9.7	31.1	29.8		32.0	31.3	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	40.0	0.3		28.3	5.4	0.0	1.5	0.3		0.9	0.2	
Delay (s)	75.3	10.5		65.1	21.3	9.7	32.6	30.2		32.8	31.5	
Level of Service	E	B		E	C	A	C	C		C	C	
Approach Delay (s)		23.6			22.0			31.1			32.2	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	24.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	76.5	Sum of lost time (s)	20.0
Intersection Capacity Utilization	67.5%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
22: Farrington Hwy & 2nd Avenue

2030 + PRO (without Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↱		↰↰	↑↑	↱	↰	↑↑	↱↱	↰↰	↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.91		0.97	0.95	1.00	1.00	0.95	0.88	0.97	0.95	1.00
Frt	1.00	0.99		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	5044		3433	3539	1583	1770	3539	2787	3433	3539	1583
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	5044		3433	3539	1583	1770	3539	2787	3433	3539	1583
Volume (vph)	172	1091	63	241	945	299	98	391	547	241	259	138
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	187	1186	68	262	1027	325	107	425	595	262	282	150
RTOR Reduction (vph)	0	4	0	0	0	159	0	0	47	0	0	115
Lane Group Flow (vph)	187	1250	0	262	1027	166	107	425	548	262	282	35
Turn Type	Prot			Prot		Perm	Prot		pm+ov	Prot		Perm
Protected Phases	5	2		1	6		3	8	1	7	4	
Permitted Phases						6			8			4
Actuated Green, G (s)	29.0	67.1		17.9	56.0	56.0	14.1	28.0	45.9	21.0	34.9	34.9
Effective Green, g (s)	29.0	67.1		17.9	56.0	56.0	14.1	28.0	45.9	21.0	34.9	34.9
Actuated g/C Ratio	0.19	0.45		0.12	0.37	0.37	0.09	0.19	0.31	0.14	0.23	0.23
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	342	2256		410	1321	591	166	661	853	481	823	368
v/s Ratio Prot	0.11	c0.25		0.08	c0.29		0.06	c0.12	0.08	c0.08	0.08	
v/s Ratio Perm						0.11			0.12			0.02
v/c Ratio	0.55	0.55		0.64	0.78	0.28	0.64	0.64	0.64	0.54	0.34	0.09
Uniform Delay, d1	54.6	30.5		63.0	41.5	32.9	65.5	56.4	45.0	60.0	48.0	45.2
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.8	1.0		3.3	4.6	1.2	8.3	4.8	1.7	1.3	1.1	0.5
Delay (s)	56.4	31.4		66.2	46.1	34.1	73.8	61.1	46.6	61.3	49.1	45.7
Level of Service	E	C		E	D	C	E	E	D	E	D	D
Approach Delay (s)		34.7			46.9			54.7			53.0	
Approach LOS		C			D			D			D	

Intersection Summary			
HCM Average Control Delay	46.0	HCM Level of Service	D
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	66.7%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
23: 2nd Avenue & Kunia Road
2030 + PRO (without Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations		↱	↑↑↑↱			↑↑↑↑
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	0	0	1976	301	0	5208
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	2148	327	0	5661
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)			870			
pX, platoon unblocked	0.91	0.91			0.91	
vC, conflicting volume	3727	701			2475	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	3698	358			2317	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	3	578			192	

Direction, Lane #	EB 1	SE 1	SE 2	SE 3	SE 4	NW 1	NW 2	NW 3	NW 4
Volume Total	0	614	614	614	634	1415	1415	1415	1415
Volume Left	0	0	0	0	0	0	0	0	0
Volume Right	0	0	0	0	327	0	0	0	0
cSH	1700	1700	1700	1700	1700	1700	1700	1700	1700
Volume to Capacity	0.00	0.36	0.36	0.36	0.37	0.83	0.83	0.83	0.83
Queue Length 95th (ft)	0	0	0	0	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane LOS	A								
Approach Delay (s)	0.0	0.0				0.0			
Approach LOS	A								

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	78.8%	ICU Level of Service	D
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
24: 3rd Avenue & Kunia Road
2030 + PRO (without Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations		↱	↑↑↑↱			↑↑↑↑
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	0	7	1846	129	0	5208
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	8	2007	140	0	5661
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)			1234			
pX, platoon unblocked	0.98	0.98			0.98	
vC, conflicting volume	3492	572			2147	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	3483	510			2113	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	98			100	
cM capacity (veh/h)	5	499			251	

Direction, Lane #	EB 1	SE 1	SE 2	SE 3	SE 4	NW 1	NW 2	NW 3	NW 4
Volume Total	8	573	573	573	427	1415	1415	1415	1415
Volume Left	0	0	0	0	0	0	0	0	0
Volume Right	8	0	0	0	140	0	0	0	0
cSH	499	1700	1700	1700	1700	1700	1700	1700	1700
Volume to Capacity	0.02	0.34	0.34	0.34	0.25	0.83	0.83	0.83	0.83
Queue Length 95th (ft)	1	0	0	0	0	0	0	0	0
Control Delay (s)	12.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane LOS	B								
Approach Delay (s)	12.3	0.0				0.0			
Approach LOS	B								

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	78.8%	ICU Level of Service	D
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
25: East-West Rd. & B Street
2030 + PRO (without Transit Corridor) - AM Peak Mitigations

Movement	EBL	EBT	WBT	WBR	SEL	SER
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1863	1863	1583	1770	1583
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1863	1863	1583	1770	1583
Volume (vph)	156	302	313	86	648	492
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	170	328	340	93	704	535
RTOR Reduction (vph)	0	0	0	73	0	208
Lane Group Flow (vph)	170	328	340	20	704	327
Turn Type	Prot			Prot		Prot
Protected Phases	5	2	6	6	4	4
Permitted Phases						
Actuated Green, G (s)	15.4	45.3	25.9	25.9	65.5	65.5
Effective Green, g (s)	15.4	45.3	25.9	25.9	65.5	65.5
Actuated g/C Ratio	0.13	0.38	0.22	0.22	0.55	0.55
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	229	710	406	345	976	873
v/s Ratio Prot	c0.10	0.18	c0.18	0.01	c0.40	0.21
v/s Ratio Perm						
v/c Ratio	0.74	0.46	0.84	0.06	0.72	0.37
Uniform Delay, d1	49.8	27.6	44.4	36.8	19.9	15.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	12.2	0.5	14.0	0.1	4.6	1.2
Delay (s)	62.0	28.1	58.4	36.9	24.5	16.3
Level of Service	E	C	E	D	C	B
Approach Delay (s)		39.7	53.8		20.9	
Approach LOS		D	D		C	

Intersection Summary			
HCM Average Control Delay	31.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	118.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	71.0%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
26: Farrington Hwy &
2030 + PRO (without Transit Corridor) - AM Peak Mitigations

Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	*0.99	*0.99	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3688	3688	1583
Flt Permitted	0.95	1.00	0.13	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	235	3688	3688	1583
Volume (vph)	109	234	51	1066	1384	134
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	110	236	52	1077	1398	135
RTOR Reduction (vph)	0	30	0	0	0	55
Lane Group Flow (vph)	110	206	52	1077	1398	80
Turn Type		Perm	Perm			Perm
Protected Phases	6			4	8	
Permitted Phases		6	4			8
Actuated Green, G (s)	33.0	33.0	59.0	59.0	59.0	59.0
Effective Green, g (s)	33.0	33.0	59.0	59.0	59.0	59.0
Actuated g/C Ratio	0.33	0.33	0.59	0.59	0.59	0.59
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	584	522	139	2176	2176	934
v/s Ratio Prot	0.06			0.29	c0.38	
v/s Ratio Perm		c0.13	0.22			0.05
v/c Ratio	0.19	0.39	0.37	0.49	0.64	0.09
Uniform Delay, d1	23.9	25.8	10.8	11.9	13.5	8.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.7	2.2	7.5	0.8	1.5	0.2
Delay (s)	24.6	28.0	18.3	12.7	15.0	9.0
Level of Service	C	C	B	B	B	A
Approach Delay (s)	27.0			12.9	14.5	
Approach LOS	C			B	B	

Intersection Summary			
HCM Average Control Delay	15.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	59.4%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
1: Kunia Loop & Kunia Road
2030 + PRO (without Transit Corridor) - PM Peak Mitigations

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↰	↱	↑↑	↱		↑↑↑
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0		4.0
Lane Util. Factor	*0.99	1.00	*0.99	1.00		*0.99
Frt	1.00	0.85	1.00	0.85		1.00
Flt Protected	0.95	1.00	1.00	1.00		1.00
Satd. Flow (prot)	3504	1583	3688	1583		5532
Flt Permitted	0.95	1.00	1.00	1.00		1.00
Satd. Flow (perm)	3504	1583	3688	1583		5532
Volume (vph)	892	41	2670	918	0	2765
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	901	41	2697	927	0	2793
RTOR Reduction (vph)	0	4	0	180	0	0
Lane Group Flow (vph)	901	37	2697	747	0	2793
Turn Type		Perm		Perm		
Protected Phases	8		2			6
Permitted Phases		8		2		
Actuated Green, G (s)	37.0	37.0	105.0	105.0		105.0
Effective Green, g (s)	37.0	37.0	105.0	105.0		105.0
Actuated g/C Ratio	0.25	0.25	0.70	0.70		0.70
Clearance Time (s)	4.0	4.0	4.0	4.0		4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0		3.0
Lane Grp Cap (vph)	864	390	2582	1108		3872
v/s Ratio Prot	c0.26		c0.73			0.50
v/s Ratio Perm		0.02		0.47		
v/c Ratio	1.04	0.10	1.04	0.67		0.72
Uniform Delay, d1	56.5	43.6	22.5	12.8		13.6
Progression Factor	1.00	1.00	1.14	1.39		1.00
Incremental Delay, d2	42.4	0.1	29.5	2.8		1.2
Delay (s)	98.9	43.7	55.2	20.5		14.8
Level of Service	F	D	E	C		B
Approach Delay (s)	96.5		46.3			14.8
Approach LOS	F		D			B

Intersection Summary			
HCM Average Control Delay	40.8	HCM Level of Service	D
HCM Volume to Capacity ratio	1.04		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	105.9%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
2: H-1 WB On-Ramp & Kunia Road
2030 + PRO (without Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations						↱	↰	↑↑↑			↑↑↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)						4.0	4.0	4.0			4.0	
Lane Util. Factor						1.00	1.00	*0.99			*0.99	
Frt						0.86	1.00	1.00			0.99	
Flt Protected						1.00	0.95	1.00			1.00	
Satd. Flow (prot)						1611	1770	5532			5455	
Flt Permitted						1.00	0.95	1.00			1.00	
Satd. Flow (perm)						1611	1770	5532			5455	
Volume (vph)	0	0	0	0	0	1230	427	2358	0	0	3316	341
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	0	0	0	0	0	1242	431	2382	0	0	3349	344
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	9	0
Lane Group Flow (vph)	0	0	0	0	0	1242	431	2382	0	0	3684	0
Turn Type						Free	Prot					
Protected Phases							5	2			6	
Permitted Phases						Free						
Actuated Green, G (s)						150.0	37.3	150.0			104.7	
Effective Green, g (s)						150.0	37.3	150.0			104.7	
Actuated g/C Ratio						1.00	0.25	1.00			0.70	
Clearance Time (s)							4.0	4.0			4.0	
Vehicle Extension (s)							3.0	3.0			3.0	
Lane Grp Cap (vph)						1611	440	5532			3808	
v/s Ratio Prot							c0.24	0.43			c0.68	
v/s Ratio Perm						0.77						
v/c Ratio						0.77	0.98	0.43			0.97	
Uniform Delay, d1						0.0	56.0	0.0			21.1	
Progression Factor						1.00	1.02	1.00			0.57	
Incremental Delay, d2						3.6	34.6	0.2			5.8	
Delay (s)						3.6	91.7	0.2			17.7	
Level of Service						A	F	A			B	
Approach Delay (s)		0.0			3.6			14.2			17.7	
Approach LOS		A			A			B			B	

Intersection Summary			
HCM Average Control Delay	14.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	102.0%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
3: H-1 EB & Kunia Road

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations	↰↰	↱	↑↑↑↑			↑↑↑
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0			4.0
Lane Util. Factor	*0.99	1.00	*0.99			*0.99
Frt	1.00	0.85	1.00			1.00
Flt Protected	0.95	1.00	1.00			1.00
Satd. Flow (prot)	3504	1583	7376			5532
Flt Permitted	0.95	1.00	1.00			1.00
Satd. Flow (perm)	3504	1583	7376			5532
Volume (vph)	530	584	4854	0	0	2355
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	576	635	5276	0	0	2560
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	576	635	5276	0	0	2560
Turn Type		Free				
Protected Phases	4		6			2
Permitted Phases		Free				
Actuated Green, G (s)	27.1	150.0	114.9			114.9
Effective Green, g (s)	27.1	150.0	114.9			114.9
Actuated g/C Ratio	0.18	1.00	0.77			0.77
Clearance Time (s)	4.0		4.0			4.0
Vehicle Extension (s)	3.0		3.0			3.0
Lane Grp Cap (vph)	633	1583	5650			4238
v/s Ratio Prot	c0.16		c0.72			0.46
v/s Ratio Perm		0.40				
v/c Ratio	0.91	0.40	0.93			0.60
Uniform Delay, d1	60.3	0.0	14.4			7.6
Progression Factor	1.00	1.00	0.85			0.86
Incremental Delay, d2	17.0	0.8	3.9			0.6
Delay (s)	77.3	0.8	16.1			7.2
Level of Service	E	A	B			A
Approach Delay (s)	37.1		16.1			7.2
Approach LOS	D		B			A

Intersection Summary			
HCM Average Control Delay	16.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	141.0%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
4: Farrington Hwy & Fort Weaver Road SB Ramp

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↑↱		↰↰	↑↑↑				↱			↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0				4.0			4.0
Lane Util. Factor		*0.99		*0.99	*0.99				1.00			1.00
Frt		0.98		1.00	1.00				0.86			0.86
Flt Protected		1.00		0.95	1.00				1.00			1.00
Satd. Flow (prot)		5402		3504	5532				1611			1611
Flt Permitted		1.00		0.95	1.00				1.00			1.00
Satd. Flow (perm)		5402		3504	5532				1611			1611
Volume (vph)	0	2308	429	779	1962	0	0	0	440	0	0	903
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	0	2331	433	787	1982	0	0	0	444	0	0	912
RTOR Reduction (vph)	0	18	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	2746	0	787	1982	0	0	0	444	0	0	912
Turn Type				Prot					Free			Free
Protected Phases		2		1	6							
Permitted Phases									Free			Free
Actuated Green, G (s)		92.0		50.0	150.0				150.0			150.0
Effective Green, g (s)		92.0		50.0	150.0				150.0			150.0
Actuated g/C Ratio		0.61		0.33	1.00				1.00			1.00
Clearance Time (s)		4.0		4.0	4.0							
Vehicle Extension (s)		3.0		3.0	3.0							
Lane Grp Cap (vph)		3313		1168	5532				1611			1611
v/s Ratio Prot		c0.51		c0.22	0.36							
v/s Ratio Perm									0.28			0.57
v/c Ratio		0.83		0.67	0.36				0.28			0.57
Uniform Delay, d1		22.8		43.0	0.0				0.0			0.0
Progression Factor		0.26		1.14	1.00				1.00			1.00
Incremental Delay, d2		1.1		0.8	0.1				0.4			1.4
Delay (s)		7.1		49.8	0.1				0.4			1.4
Level of Service		A		D	A				A			A
Approach Delay (s)		7.1			14.2			0.4			1.4	
Approach LOS		A			B			A			A	

Intersection Summary			
HCM Average Control Delay	8.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	83.0%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
5: Farrington Hwy & Fort Weaver Road NB Ramps
2030 + PRO (without Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑↑			↑↑↑	↱			↱			
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0	4.0			4.0			
Lane Util. Factor	0.97	*0.99			*0.99	1.00			1.00			
Frt	1.00	1.00			1.00	0.85			0.86			
Flt Protected	0.95	1.00			1.00	1.00			1.00			
Satd. Flow (prot)	3433	5532			5532	1583			1611			
Flt Permitted	0.95	1.00			1.00	1.00			1.00			
Satd. Flow (perm)	3433	5532			5532	1583			1611			
Volume (vph)	1429	1319	0	0	2743	1164	0	0	647	0	0	0
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	1443	1332	0	0	2771	1176	0	0	654	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	1	0	0	0	0	0	0
Lane Group Flow (vph)	1443	1332	0	0	2771	1175	0	0	654	0	0	0
Turn Type	Prot					Perm			Free			
Protected Phases	5	2			6							
Permitted Phases						6			Free			
Actuated Green, G (s)	51.0	150.0			91.0	91.0			150.0			
Effective Green, g (s)	51.0	150.0			91.0	91.0			150.0			
Actuated g/C Ratio	0.34	1.00			0.61	0.61			1.00			
Clearance Time (s)	4.0	4.0			4.0	4.0						
Vehicle Extension (s)	3.0	3.0			3.0	3.0						
Lane Grp Cap (vph)	1167	5532			3356	960			1611			
v/s Ratio Prot	c0.42	0.24			0.50							
v/s Ratio Perm						c0.74			0.41			
v/c Ratio	1.24	0.24			0.83	1.22			0.41			
Uniform Delay, d1	49.5	0.0			23.2	29.5			0.0			
Progression Factor	0.59	1.00			0.32	0.31			1.00			
Incremental Delay, d2	111.5	0.1			0.2	101.6			0.8			
Delay (s)	140.5	0.1			7.6	110.7			0.8			
Level of Service	F	A			A	F			A			
Approach Delay (s)		73.1			38.3			0.8			0.0	
Approach LOS		E			D			A			A	

Intersection Summary			
HCM Average Control Delay	48.1	HCM Level of Service	D
HCM Volume to Capacity ratio	1.23		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	119.5%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
6: Farrington Hwy & Leoku Street
2030 + PRO (without Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑↑	↱	↰	↑↑↑	↱		↰↑	↱		↰↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
Lane Util. Factor	*0.99	*0.99	1.00	1.00	*0.99	1.00		1.00	1.00		*0.99	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00		0.96	1.00
Satd. Flow (prot)	3504	5532	1583	1770	5532	1583		1785	1583		3530	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00		0.96	1.00
Satd. Flow (perm)	3504	5532	1583	1770	5532	1583		1785	1583		3530	1583
Volume (vph)	286	1564	116	135	3606	515	197	29	130	243	28	99
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	289	1580	117	136	3642	520	199	29	131	245	28	100
RTOR Reduction (vph)	0	0	50	0	0	132	0	0	42	0	0	87
Lane Group Flow (vph)	289	1580	67	136	3642	388	0	228	89	0	273	13
Turn Type	Prot		Perm	Prot		Perm	Split		Perm	Split		Perm
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			6
Actuated Green, G (s)	11.9	85.8	85.8	16.1	90.0	90.0		17.0	17.0		15.1	15.1
Effective Green, g (s)	11.9	85.8	85.8	16.1	90.0	90.0		17.0	17.0		15.1	15.1
Actuated g/C Ratio	0.08	0.57	0.57	0.11	0.60	0.60		0.11	0.11		0.10	0.10
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	278	3164	905	190	3319	950		202	179		355	159
v/s Ratio Prot	c0.08	0.29		c0.08	c0.66			c0.13			c0.08	
v/s Ratio Perm			0.04			0.24			0.06			0.01
v/c Ratio	1.04	0.50	0.07	0.72	1.10	0.41		1.13	0.50		1.39dl	0.08
Uniform Delay, d1	69.0	19.2	14.3	64.7	30.0	15.9		66.5	62.5		65.8	61.2
Progression Factor	0.97	1.38	2.12	1.00	1.00	1.00		1.00	1.00		1.00	1.00
Incremental Delay, d2	63.8	0.5	0.2	12.1	49.2	1.3		102.2	9.6		9.6	0.2
Delay (s)	130.7	27.0	30.6	76.8	79.2	17.2		168.7	72.1		75.4	61.4
Level of Service	F	C	C	E	E	B		F	E		E	E
Approach Delay (s)		42.3			71.6			133.5			71.6	
Approach LOS		D			E			F			E	

Intersection Summary			
HCM Average Control Delay	66.5	HCM Level of Service	E
HCM Volume to Capacity ratio	1.03		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	108.0%	ICU Level of Service	G
Analysis Period (min)	15		
dl Defacto Left Lane. Recode with 1 though lane as a left lane.			
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
7: Laulaunui Street & Fort Weaver Road
2030 + PRO (without Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↰↑↱		↰	↑	↱	↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.91	*0.99		1.00	1.00	1.00	1.00	*0.99	1.00	1.00	*0.99	1.00
Frt	1.00	0.99		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.97		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1610	3523		1770	1863	1583	1770	5532	1583	1770	5532	1583
Flt Permitted	0.95	0.97		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1610	3523		1770	1863	1583	1770	5532	1583	1770	5532	1583
Volume (vph)	209	37	13	62	4	231	56	2896	100	231	4375	82
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	211	37	13	63	4	233	57	2925	101	233	4419	83
RTOR Reduction (vph)	0	5	0	0	0	213	0	0	27	0	0	17
Lane Group Flow (vph)	106	150	0	63	4	20	57	2925	74	233	4419	66
Turn Type	Split			Split		Perm	Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases						8			2			6
Actuated Green, G (s)	13.7	13.7		5.0	5.0	5.0	5.0	89.0	89.0	24.0	108.0	108.0
Effective Green, g (s)	13.7	13.7		5.0	5.0	5.0	5.0	89.0	89.0	24.0	108.0	108.0
Actuated g/C Ratio	0.09	0.09		0.03	0.03	0.03	0.03	0.60	0.60	0.16	0.73	0.73
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	149	327		60	63	54	60	3333	954	288	4045	1158
v/s Ratio Prot	c0.07	0.04		c0.04	0.00		0.03	c0.53		0.13	c0.80	
v/s Ratio Perm						0.01			0.05			0.04
v/c Ratio	0.71	0.46		1.05	0.06	0.38	0.95	0.88	0.08	0.81	1.09	0.06
Uniform Delay, d1	65.1	63.5		71.3	69.1	69.8	71.2	24.8	12.2	59.6	19.8	5.6
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	14.8	1.0		130.8	0.4	4.4	97.0	3.6	0.2	15.3	46.3	0.1
Delay (s)	79.9	64.5		202.2	69.5	74.2	168.2	28.4	12.4	74.9	66.2	5.7
Level of Service	E	E		F	E	E	F	C	B	E	E	A
Approach Delay (s)		70.8			101.0			30.4			65.5	
Approach LOS		E			F			C			E	

Intersection Summary			
HCM Average Control Delay	54.1	HCM Level of Service	D
HCM Volume to Capacity ratio	1.05		
Actuated Cycle Length (s)	147.7	Sum of lost time (s)	16.0
Intersection Capacity Utilization	110.3%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
8: Old Fort Weaver Rd & Fort Weaver Road
2030 + PRO (without Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰↰	↑	↱		↰↑	↱	↰↰	↑↑↑↱		↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	4.0	4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.94	1.00	1.00		1.00	1.00	0.97	*0.99		1.00	*0.99	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00		0.99	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	4990	1863	1583		1849	1583	3433	5531		1770	5532	1583
Flt Permitted	0.95	1.00	1.00		0.99	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	4990	1863	1583		1849	1583	3433	5531		1770	5532	1583
Volume (vph)	837	200	483	37	219	89	563	2123	3	193	3255	1002
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	845	202	488	37	221	90	569	2144	3	195	3288	1012
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	2
Lane Group Flow (vph)	845	202	488	0	258	90	569	2147	0	195	3288	1010
Turn Type	Split		Free	Split		Free	Prot			Prot		pm+ov
Protected Phases	4	4		8	8		5	2		1	6	4
Permitted Phases			Free			Free						6
Actuated Green, G (s)	22.0	22.0	150.0		9.0	150.0	22.0	82.4		20.6	81.0	103.0
Effective Green, g (s)	22.0	22.0	150.0		9.0	150.0	22.0	82.4		20.6	81.0	103.0
Actuated g/C Ratio	0.15	0.15	1.00		0.06	1.00	0.15	0.55		0.14	0.54	0.69
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	732	273	1583		111	1583	504	3038		243	2987	1129
v/s Ratio Prot	c0.17	0.11			c0.14		c0.17	0.39		0.11	c0.59	0.13
v/s Ratio Perm			c0.31			0.06						0.51
v/c Ratio	1.15	0.74	0.31		2.32	0.06	1.13	0.71		0.80	1.10	0.89
Uniform Delay, d1	64.0	61.3	0.0		70.5	0.0	64.0	24.9		62.7	34.5	19.1
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	84.6	10.1	0.5		623.2	0.1	80.6	1.4		17.2	51.2	9.3
Delay (s)	148.6	71.3	0.5		693.7	0.1	144.6	26.3		79.9	85.7	28.4
Level of Service	F	E	A		F	A	F	C		E	F	C
Approach Delay (s)		91.3			514.3			51.1			72.5	
Approach LOS		F			F			D			E	

Intersection Summary			
HCM Average Control Delay	86.2	HCM Level of Service	F
HCM Volume to Capacity ratio	1.20		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	121.8%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
9: Renton Road & Fort Weaver Road
2030 + PRO (without Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↰↑	↱		↰↑	↱	↰	↑↑↑	↱	↰↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*0.99	*0.99	1.00		1.00	1.00	1.00	*0.99	1.00	0.97	*0.99	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1752	1761	1583		1858	1583	1770	5532	1583	3433	5532	1583
Flt Permitted	0.95	0.96	1.00		1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1752	1761	1583		1858	1583	1770	5532	1583	3433	5532	1583
Volume (vph)	725	23	43	9	151	326	45	2103	75	514	3074	519
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	732	23	43	9	153	329	45	2124	76	519	3105	524
RTOR Reduction (vph)	0	0	0	0	0	225	0	0	11	0	0	230
Lane Group Flow (vph)	368	387	43	0	162	104	45	2124	65	519	3105	294
Turn Type	Split		Free	Split		Perm	Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			Free			8			2			6
Actuated Green, G (s)	16.0	16.0	100.8		9.0	9.0	3.2	43.0	43.0	16.8	56.6	56.6
Effective Green, g (s)	16.0	16.0	100.8		9.0	9.0	3.2	43.0	43.0	16.8	56.6	56.6
Actuated g/C Ratio	0.16	0.16	1.00		0.09	0.09	0.03	0.43	0.43	0.17	0.56	0.56
Clearance Time (s)	4.0	4.0			4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	278	280	1583		166	141	56	2360	675	572	3106	889
v/s Ratio Prot	0.21	c0.22			c0.09		0.03	c0.38		0.15	c0.56	
v/s Ratio Perm			0.03			0.07			0.04			0.19
v/c Ratio	1.32	1.38	0.03		0.98	0.74	0.80	0.90	0.10	0.91	1.00	0.33
Uniform Delay, d1	42.4	42.4	0.0		45.8	44.8	48.5	26.9	17.3	41.2	22.1	11.9
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	168.6	192.7	0.0		62.1	18.1	55.1	6.1	0.3	18.1	16.1	1.0
Delay (s)	211.0	235.1	0.0		107.9	62.9	103.6	32.9	17.6	59.3	38.2	12.9
Level of Service	F	F	A		F	E	F	C	B	E	D	B
Approach Delay (s)		211.3			77.7			33.8			37.6	
Approach LOS		F			E			C			D	

Intersection Summary			
HCM Average Control Delay	57.1	HCM Level of Service	E
HCM Volume to Capacity ratio	1.08		
Actuated Cycle Length (s)	100.8	Sum of lost time (s)	16.0
Intersection Capacity Utilization	105.2%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
10: Farrington Hwy & D Street
2030 + PRO (without Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↑		↰↰	↑↑↑↱			↑↱	↱	↰	↰↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	*0.99		*0.99	*0.99			*0.99	*0.99	*0.99	*0.99	
Frt	1.00	1.00		1.00	0.99			1.00	0.85	1.00	0.88	
Flt Protected	0.95	1.00		0.95	1.00			1.00	1.00	0.95	0.99	
Satd. Flow (prot)	1770	5532		3504	5473			1844	1567	1752	1613	
Flt Permitted	0.95	1.00		0.95	1.00			1.00	1.00	0.95	0.99	
Satd. Flow (perm)	1770	5532		3504	5473			1844	1567	1752	1613	
Volume (vph)	99	2335	0	425	2265	175	0	179	45	357	7	259
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	100	2359	0	429	2288	177	0	181	45	361	7	262
RTOR Reduction (vph)	0	0	0	0	6	0	0	0	40	0	84	0
Lane Group Flow (vph)	100	2359	0	429	2459	0	0	181	5	293	253	0
Turn Type	Prot			Prot					Perm	Split		
Protected Phases	5	2		1	6			8		4	4	
Permitted Phases									8			
Actuated Green, G (s)	10.7	69.8		20.0	79.1			17.2	17.2	27.0	27.0	
Effective Green, g (s)	10.7	69.8		20.0	79.1			17.2	17.2	27.0	27.0	
Actuated g/C Ratio	0.07	0.47		0.13	0.53			0.11	0.11	0.18	0.18	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	126	2574		467	2886			211	180	315	290	
v/s Ratio Prot	0.06	c0.43		0.12	c0.45			c0.10		c0.17	0.16	
v/s Ratio Perm									0.00			
v/c Ratio	0.79	0.92		0.92	0.85			0.86	0.03	0.93	0.87	
Uniform Delay, d1	68.6	37.4		64.2	30.4			65.2	59.0	60.6	59.8	
Progression Factor	1.05	0.65		0.78	0.55			1.00	1.00	1.00	1.00	
Incremental Delay, d2	19.2	4.4		21.6	3.2			27.4	0.1	33.0	23.6	
Delay (s)	91.3	28.8		71.7	19.8			92.6	59.0	93.5	83.4	
Level of Service	F	C		E	B			F	E	F	F	
Approach Delay (s)		31.4			27.5			85.9			88.1	
Approach LOS		C			C			F			F	

Intersection Summary			
HCM Average Control Delay	37.3	HCM Level of Service	D
HCM Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	98.9%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
11: Farrington Hwy & E Street
2030 + PRO (without Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	*0.99			*0.99		1.00	1.00		1.00	1.00	
Frt	1.00	0.98			1.00		1.00	0.99		1.00	0.94	
Flt Protected	0.95	1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	5428			5519		1770	1851		1770	1743	
Flt Permitted	0.95	1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	5428			5519		1770	1851		1770	1743	
Volume (vph)	77	2202	318	0	2482	42	203	110	5	227	130	97
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	78	2224	321	0	2507	42	205	111	5	229	131	98
RTOR Reduction (vph)	0	13	0	0	1	0	0	1	0	0	18	0
Lane Group Flow (vph)	78	2532	0	0	2548	0	205	115	0	229	211	0
Turn Type	Prot						Split			Split		
Protected Phases	5	2			6		8	8		4	4	
Permitted Phases												
Actuated Green, G (s)	8.0	94.5			82.5		22.2	22.2		21.3	21.3	
Effective Green, g (s)	8.0	94.5			82.5		22.2	22.2		21.3	21.3	
Actuated g/C Ratio	0.05	0.63			0.55		0.15	0.15		0.14	0.14	
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	94	3420			3035		262	274		251	248	
v/s Ratio Prot	0.04	c0.47			c0.46		c0.12	0.06		c0.13	0.12	
v/s Ratio Perm												
v/c Ratio	0.83	0.74			0.84		0.78	0.42		0.91	0.85	
Uniform Delay, d1	70.3	19.2			28.2		61.6	58.1		63.4	62.8	
Progression Factor	0.75	0.55			0.65		1.00	1.00		1.00	1.00	
Incremental Delay, d2	27.8	0.8			1.5		14.1	1.0		34.2	23.3	
Delay (s)	80.6	11.4			19.8		75.7	59.1		97.6	86.1	
Level of Service	F	B			B		E	E		F	F	
Approach Delay (s)		13.5			19.8			69.7			91.9	
Approach LOS		B			B			E			F	

Intersection Summary			
HCM Average Control Delay	25.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	90.5%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
12: Fort Barrette Road & Farrington Hwy
2030 + PRO (without Transit Corridor) - PM Peak Mitigations

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*0.99	*0.99	*0.99	*0.99	*0.99	1.00	*0.99	*0.99	1.00	1.00	*0.99	1.00
Frt	1.00	0.95	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3504	3507	1567	3504	3688	1583	3504	3688	1583	1770	3688	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3504	3507	1567	3504	3688	1583	3504	3688	1583	1770	3688	1583
Volume (vph)	493	483	724	355	405	113	678	660	746	226	1028	677
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	498	488	731	359	409	114	685	667	754	228	1038	684
RTOR Reduction (vph)	0	55	251	0	0	94	0	0	206	0	0	221
Lane Group Flow (vph)	498	670	243	359	409	20	685	667	548	228	1038	463
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases			6			2			4			8
Actuated Green, G (s)	19.1	26.2	26.2	13.0	20.1	20.1	24.4	45.2	45.2	16.6	37.4	37.4
Effective Green, g (s)	19.1	26.2	26.2	13.0	20.1	20.1	24.4	45.2	45.2	16.6	37.4	37.4
Actuated g/C Ratio	0.16	0.22	0.22	0.11	0.17	0.17	0.21	0.39	0.39	0.14	0.32	0.32
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	572	785	351	389	634	272	731	1425	612	251	1179	506
v/s Ratio Prot	c0.14	c0.19		0.10	0.11		c0.20	0.18		0.13	0.28	
v/s Ratio Perm			0.16			0.01			c0.35			0.29
v/c Ratio	0.87	0.85	0.69	0.92	0.65	0.07	0.94	0.47	0.90	0.91	0.88	0.91
Uniform Delay, d1	47.7	43.6	41.7	51.5	45.1	40.6	45.5	26.9	33.7	49.5	37.7	38.3
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	13.6	8.9	5.8	27.1	5.0	0.5	19.3	0.2	15.6	33.1	7.9	21.1
Delay (s)	61.3	52.5	47.5	78.6	50.1	41.1	64.9	27.1	49.2	82.6	45.6	59.4
Level of Service	E	D	D	E	D	D	E	C	D	F	D	E
Approach Delay (s)		53.6			60.6			47.3			54.7	
Approach LOS		D			E			D			D	

Intersection Summary			
HCM Average Control Delay	52.9	HCM Level of Service	D
HCM Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	117.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	92.3%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
13: WB Ramps & North-South Road

2030 + PRO (without Transit Corridor) - PM Peak Mitigations

Movement	WBL2	WBL	WBR	NBL	NBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰↰		↱				↑↑	↱	↰↰	↑↑	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0				4.0	4.0	4.0	4.0	
Lane Util. Factor	*0.99		1.00				*0.99	1.00	0.97	*0.99	
Frt	1.00		0.85				1.00	0.85	1.00	1.00	
Flt Protected	0.95		1.00				1.00	1.00	0.95	1.00	
Satd. Flow (prot)	3504		1583				3688	1583	3433	3688	
Flt Permitted	0.95		1.00				1.00	1.00	0.95	1.00	
Satd. Flow (perm)	3504		1583				3688	1583	3433	3688	
Volume (vph)	2099	0	412	0	0	0	495	86	368	585	0
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	2120	0	416	0	0	0	500	87	372	591	0
RTOR Reduction (vph)	0	0	57	0	0	0	0	70	0	0	0
Lane Group Flow (vph)	2120	0	359	0	0	0	500	17	372	591	0
Turn Type	Prot		custom					Perm	Prot		
Protected Phases	8		8				6		5	2	
Permitted Phases								6			
Actuated Green, G (s)	74.0		74.0				25.1	25.1	18.9	48.0	
Effective Green, g (s)	74.0		74.0				25.1	25.1	18.9	48.0	
Actuated g/C Ratio	0.57		0.57				0.19	0.19	0.15	0.37	
Clearance Time (s)	4.0		4.0				4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0		3.0				3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	1995		901				712	306	499	1362	
v/s Ratio Prot	c0.61		0.23				c0.14		c0.11	0.16	
v/s Ratio Perm								0.01			
v/c Ratio	1.06		0.40				0.70	0.05	0.75	0.43	
Uniform Delay, d1	28.0		15.6				49.0	42.8	53.2	30.8	
Progression Factor	1.00		1.00				1.00	1.00	1.00	1.00	
Incremental Delay, d2	39.2		0.3				5.7	0.3	6.0	1.0	
Delay (s)	67.2		15.9				54.7	43.1	59.2	31.8	
Level of Service	E		B				D	D	E	C	
Approach Delay (s)		58.8		0.0			53.0			42.4	
Approach LOS		E		A			D			D	

Intersection Summary			
HCM Average Control Delay	54.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.94		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	88.4%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
14: EB Ramps & North-South Road

2030 + PRO (without Transit Corridor) - PM Peak Mitigations

Movement	EBL2	EBL	EBR	SBL	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰		↱↱			↰↰	↑↑↑			↑↑	↱↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0			4.0	4.0			4.0	4.0
Lane Util. Factor	1.00		0.88			0.97	*0.99			*0.99	*0.99
Frt	1.00		0.85			1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (prot)	1770		2787			3433	5532			3688	3135
Flt Permitted	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (perm)	1770		2787			3433	5532			3688	3135
Volume (vph)	92	0	1018	0	0	207	2387	0	0	861	2122
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	93	0	1028	0	0	209	2411	0	0	870	2143
RTOR Reduction (vph)	0	0	3	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	93	0	1025	0	0	209	2411	0	0	870	2143
Turn Type	Prot		custom			Prot					Free
Protected Phases	4		4			1	6			2	
Permitted Phases											Free
Actuated Green, G (s)	23.0		23.0			9.3	39.0			25.7	70.0
Effective Green, g (s)	23.0		23.0			9.3	39.0			25.7	70.0
Actuated g/C Ratio	0.33		0.33			0.13	0.56			0.37	1.00
Clearance Time (s)	4.0		4.0			4.0	4.0			4.0	
Vehicle Extension (s)	3.0		3.0			3.0	3.0			3.0	
Lane Grp Cap (vph)	582		916			456	3082			1354	3135
v/s Ratio Prot	0.05		c0.37			0.06	c0.44			0.24	
v/s Ratio Perm											c0.68
v/c Ratio	0.16		1.12			0.46	0.78			0.64	0.68
Uniform Delay, d1	16.7		23.5			28.0	12.2			18.3	0.0
Progression Factor	1.00		1.00			1.00	1.00			0.67	1.00
Incremental Delay, d2	0.1		68.2			0.7	2.1			0.9	0.5
Delay (s)	16.8		91.7			28.8	14.2			13.2	0.5
Level of Service	B		F			C	B			B	A
Approach Delay (s)		85.5		0.0			15.4			4.1	
Approach LOS		F		A			B			A	

Intersection Summary			
HCM Average Control Delay	22.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	88.4%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
15: North-South Road & Farrington Hwy — 2030 + PRO (without Transit Corridor) - PM Peak Mitigations

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰↰	↑↑↑	↱↱	↰↰↰	↑↑↑	↱	↰↰	↑↑	↱↱	↰↰	↑↑	↱↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*0.99	*0.99	0.88	*0.99	*0.99	1.00	*0.99	*0.99	0.88	*0.99	*0.99	0.88
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3504	5532	2787	5256	5532	1583	3504	3688	2787	3504	3688	2787
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3504	5532	2787	5256	5532	1583	3504	3688	2787	3504	3688	2787
Volume (vph)	815	1917	650	880	1657	393	411	756	542	539	920	915
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	823	1936	657	889	1674	397	415	764	547	544	929	924
RTOR Reduction (vph)	0	0	0	0	0	163	0	0	0	0	0	522
Lane Group Flow (vph)	823	1936	657	889	1674	234	415	764	547	544	929	402
Turn Type	Prot		Free	Prot		Perm	Prot		Free	Prot		Perm
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases			Free			2			Free			8
Actuated Green, G (s)	33.0	48.0	140.0	29.0	44.0	44.0	16.0	27.0	140.0	20.0	31.0	31.0
Effective Green, g (s)	33.0	48.0	140.0	29.0	44.0	44.0	16.0	27.0	140.0	20.0	31.0	31.0
Actuated g/C Ratio	0.24	0.34	1.00	0.21	0.31	0.31	0.11	0.19	1.00	0.14	0.22	0.22
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	826	1897	2787	1089	1739	498	400	711	2787	501	817	617
v/s Ratio Prot	c0.23	c0.35		0.17	0.30		0.12	0.21		c0.16	c0.25	
v/s Ratio Perm			0.24			0.15			0.20			0.14
v/c Ratio	1.00	1.02	0.24	0.82	0.96	0.47	1.04	1.07	0.20	1.09	1.14	0.65
Uniform Delay, d1	53.4	46.0	0.0	53.0	47.2	38.6	62.0	56.5	0.0	60.0	54.5	49.6
Progression Factor	1.03	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	19.8	19.3	0.1	4.8	14.4	3.2	55.0	55.6	0.2	65.4	76.4	5.3
Delay (s)	75.1	60.6	0.1	57.8	61.6	41.8	117.0	112.1	0.2	125.4	130.9	54.8
Level of Service	E	E	A	E	E	D	F	F	A	F	F	D
Approach Delay (s)		52.4			57.8			77.8			100.4	
Approach LOS		D			E			E			F	

Intersection Summary			
HCM Average Control Delay	69.1	HCM Level of Service	E
HCM Volume to Capacity ratio	1.08		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	105.8%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
16: North-South Road & North UH Connector — 2030 + PRO (without Transit Corridor) - PM Peak Mitigations

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰	↑↑↑↱	↱	↰↰	↑↑↑↱		↰↰	↑↑↱		↰↰	↑	↱↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	1.00	*0.99	0.86	*0.99	*0.99		*0.99	*0.99		*0.99	1.00	*0.99
Frt	1.00	1.00	0.85	1.00	0.98		1.00	0.93		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1770	5532	1362	3504	5397		3504	3445		3504	1863	3135
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	1770	5532	1362	3504	5397		3504	3445		3504	1863	3135
Volume (vph)	73	1846	475	676	1942	380	315	427	334	390	121	770
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	74	1865	480	683	1962	384	318	431	337	394	122	778
RTOR Reduction (vph)	0	0	189	0	22	0	0	95	0	0	0	14
Lane Group Flow (vph)	74	1865	291	683	2324	0	318	673	0	394	122	764
Turn Type	Prot		Perm	Prot			Prot			Prot		pm+ov
Protected Phases	5	2		1	6		7	4		3	8	1
Permitted Phases			2									8
Actuated Green, G (s)	12.0	54.4	54.4	31.0	73.4		17.8	30.6		18.0	30.8	61.8
Effective Green, g (s)	12.0	54.4	54.4	31.0	73.4		17.8	30.6		18.0	30.8	61.8
Actuated g/C Ratio	0.08	0.36	0.36	0.21	0.49		0.12	0.20		0.12	0.21	0.41
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	142	2006	494	724	2641		416	703		420	383	1292
v/s Ratio Prot	0.04	c0.34		c0.19	0.43		0.09	c0.20		c0.11	0.07	0.12
v/s Ratio Perm			0.21									0.12
v/c Ratio	0.52	0.93	0.59	0.94	0.88		0.76	0.96		0.94	0.32	0.59
Uniform Delay, d1	66.2	46.0	38.8	58.6	34.3		64.1	59.1		65.4	50.7	34.3
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		0.70	0.97	0.59
Incremental Delay, d2	3.4	9.2	5.1	20.7	4.6		8.1	23.7		4.5	0.0	0.1
Delay (s)	69.7	55.2	43.9	79.3	38.9		72.2	82.8		50.2	49.1	20.3
Level of Service	E	E	D	E	D		E	F		D	D	C
Approach Delay (s)		53.4			48.0			79.7			32.1	
Approach LOS		D			D			E			C	

Intersection Summary			
HCM Average Control Delay	51.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.94		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	105.5%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
17: East-West Rd. & North-South Road — 2030 + PRO (without Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↱		↰↰	↑↱		↰↰	↑↑↱		↰↰	↑↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	*0.99	0.95		0.97	*0.99		*0.99	*0.99		*0.99	*0.99	
Frt	1.00	0.94		1.00	0.89		1.00	0.98		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	3504	3313		3433	3283		3504	5404		3504	5396	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	3504	3313		3433	3283		3504	5404		3504	5396	
Volume (vph)	310	312	232	367	193	531	110	1553	284	611	1718	337
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	313	315	234	371	195	536	111	1569	287	617	1735	340
RTOR Reduction (vph)	0	98	0	0	224	0	0	28	0	0	31	0
Lane Group Flow (vph)	313	451	0	371	507	0	111	1828	0	617	2045	0
Turn Type	Prot			Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases												
Actuated Green, G (s)	14.1	20.0		12.0	17.9		6.9	40.0		20.0	53.1	
Effective Green, g (s)	14.1	20.0		12.0	17.9		6.9	40.0		20.0	53.1	
Actuated g/C Ratio	0.13	0.19		0.11	0.17		0.06	0.37		0.19	0.49	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	457	614		381	544		224	2001		649	2653	
v/s Ratio Prot	0.09	0.14		c0.11	c0.15		0.03	c0.34		c0.18	0.38	
v/s Ratio Perm												
v/c Ratio	0.68	0.73		0.97	1.11dr		0.50	0.91		0.95	0.77	
Uniform Delay, d1	44.8	41.5		47.8	44.4		48.9	32.4		43.5	22.5	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	4.2	4.6		38.9	22.9		1.7	7.9		25.1	2.2	
Delay (s)	49.1	46.1		86.7	67.3		50.6	40.3		68.6	24.7	
Level of Service	D	D		F	E		D	D		E	C	
Approach Delay (s)		47.1			73.9			40.9			34.8	
Approach LOS		D			E			D			C	

Intersection Summary			
HCM Average Control Delay	44.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	108.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	98.4%	ICU Level of Service	F
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.
c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
18: North-South Road & Kapolei Parkway — 2030 + PRO (without Transit Corridor) - PM Peak Mitigations

Movement	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰	↑↑↱		↰↰	↑↑↑	↱	↰↰	↑↑↑	↱	↰	↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	*0.99		0.97	*0.99	1.00	*0.99	*0.99	1.00	1.00	*0.99	1.00
Frt	1.00	0.98		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	5408		3433	5532	1583	3504	5532	1583	1770	5532	1583
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	5408		3433	5532	1583	3504	5532	1583	1770	5532	1583
Volume (vph)	378	879	155	507	1075	735	716	643	505	121	568	352
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	382	888	157	512	1086	742	723	649	510	122	574	356
RTOR Reduction (vph)	0	21	0	0	0	304	0	0	304	0	0	297
Lane Group Flow (vph)	382	1024	0	512	1086	438	723	649	206	122	574	59
Turn Type	Prot			Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases						6			4			8
Actuated Green, G (s)	29.3	45.9		23.4	40.0	40.0	27.9	32.4	32.4	11.5	16.0	16.0
Effective Green, g (s)	29.3	45.9		23.4	40.0	40.0	27.9	32.4	32.4	11.5	16.0	16.0
Actuated g/C Ratio	0.23	0.36		0.18	0.31	0.31	0.22	0.25	0.25	0.09	0.12	0.12
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	401	1921		622	1713	490	757	1387	397	158	685	196
v/s Ratio Prot	c0.22	0.19		0.15	0.20		c0.21	0.12		0.07	c0.10	
v/s Ratio Perm						c0.28			0.13			0.04
v/c Ratio	0.95	0.53		0.82	0.63	0.89	0.96	0.47	0.52	0.77	0.84	0.30
Uniform Delay, d1	49.3	33.1		50.9	38.3	42.6	50.0	41.1	41.7	57.6	55.3	51.5
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	32.7	1.1		8.7	1.8	21.4	22.2	0.3	1.1	20.5	8.8	0.9
Delay (s)	82.0	34.2		59.6	40.1	64.0	72.2	41.3	42.8	78.1	64.2	52.4
Level of Service	F	C		E	D	E	E	D	D	E	E	D
Approach Delay (s)		47.0			51.9			53.6			61.8	
Approach LOS		D			D			D			E	

Intersection Summary			
HCM Average Control Delay	52.9	HCM Level of Service	D
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	129.2	Sum of lost time (s)	16.0
Intersection Capacity Utilization	87.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
19: East-West Rd. & Old Fort Weaver Rd — 2030 + PRO (without Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↰	↑	↑↑	↱	↰↰	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	0.97	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1863	3539	1583	3433	1583
Flt Permitted	0.19	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	351	1863	3539	1583	3433	1583
Volume (vph)	37	621	829	955	898	94
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	37	627	837	965	907	95
RTOR Reduction (vph)	0	0	0	595	0	42
Lane Group Flow (vph)	37	627	837	370	907	53
Turn Type	Perm			Perm		Perm
Protected Phases		4	8		6	
Permitted Phases	4			8		6
Actuated Green, G (s)	49.9	49.9	49.9	49.9	72.1	72.1
Effective Green, g (s)	49.9	49.9	49.9	49.9	72.1	72.1
Actuated g/C Ratio	0.38	0.38	0.38	0.38	0.55	0.55
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	135	715	1358	608	1904	878
v/s Ratio Prot		c0.34	0.24		c0.26	
v/s Ratio Perm	0.11			0.23		0.03
v/c Ratio	0.27	0.88	0.62	0.61	0.48	0.06
Uniform Delay, d1	27.6	37.2	32.3	32.2	17.5	13.3
Progression Factor	1.22	1.20	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.9	9.4	0.8	1.7	0.9	0.1
Delay (s)	34.5	54.1	33.2	33.9	18.4	13.5
Level of Service	C	D	C	C	B	B
Approach Delay (s)		53.0	33.6		17.9	
Approach LOS		D	C		B	

Intersection Summary			
HCM Average Control Delay	32.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	69.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
20: Farrington Hwy & B Street — 2030 + PRO (without Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰↰	↑↑	↱	↰↰	↑↑	↱	↰	↑	↱	↰↰	↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	*0.99	1.00	0.97	*0.99	1.00	1.00	1.00	1.00	*0.99	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3688	1583	3433	3688	1583	1770	1863	1583	3504	1863	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3688	1583	3433	3688	1583	1770	1863	1583	3504	1863	1583
Volume (vph)	229	1443	356	554	1792	80	152	182	307	274	143	178
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	231	1458	360	560	1810	81	154	184	310	277	144	180
RTOR Reduction (vph)	0	0	46	0	0	23	0	0	5	0	0	16
Lane Group Flow (vph)	231	1458	314	560	1810	58	154	184	305	277	144	164
Turn Type	Prot		pm+ov	Prot		Perm	Prot		pm+ov	Prot		pm+ov
Protected Phases	5	2	3	1	6		7	4	5	3	8	1
Permitted Phases			2			6			4			8
Actuated Green, G (s)	31.0	72.8	84.8	32.2	74.0	74.0	13.0	17.0	48.0	12.0	16.0	48.2
Effective Green, g (s)	31.0	72.8	84.8	32.2	74.0	74.0	13.0	17.0	48.0	12.0	16.0	48.2
Actuated g/C Ratio	0.21	0.49	0.57	0.21	0.49	0.49	0.09	0.11	0.32	0.08	0.11	0.32
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	709	1790	937	737	1819	781	153	211	507	280	199	551
v/s Ratio Prot	0.07	c0.40	0.03	0.16	c0.49		c0.09	c0.10	0.12	0.08	0.08	0.06
v/s Ratio Perm			0.17			0.04			0.07			0.04
v/c Ratio	0.33	0.81	0.34	0.76	1.00	0.07	1.01	0.87	0.60	0.99	0.72	0.30
Uniform Delay, d1	50.6	32.9	17.5	55.3	37.8	20.0	68.5	65.4	43.0	68.9	64.9	38.2
Progression Factor	1.00	1.00	1.00	0.95	0.48	0.09	1.00	1.00	1.00	1.00	0.91	0.96
Incremental Delay, d2	0.3	4.2	0.2	1.8	12.2	0.1	74.5	35.8	2.0	44.0	16.3	0.2
Delay (s)	50.9	37.1	17.7	54.2	30.4	1.9	143.0	101.3	45.0	113.2	75.5	37.0
Level of Service	D	D	B	D	C	A	F	F	D	F	E	D
Approach Delay (s)		35.2			34.9			84.3			81.4	
Approach LOS		D			C			F			F	

Intersection Summary			
HCM Average Control Delay	45.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	86.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
21: East-West Rd. & A Street — 2030 + PRO (without Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	↰	↑↱		↰	↑	↱	↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	1.00	0.85	1.00	0.86		1.00	0.88	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1844		1770	1863	1583	1770	1599		1770	1631	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	1844		1770	1863	1583	1770	1599		1770	1631	
Volume (vph)	170	768	56	34	689	616	91	8	140	46	6	31
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	185	835	61	37	749	670	99	9	152	50	7	34
RTOR Reduction (vph)	0	1	0	0	0	240	0	139	0	0	32	0
Lane Group Flow (vph)	185	895	0	37	749	430	99	22	0	50	9	0
Turn Type	Prot			Prot		Perm	Split			Split		
Protected Phases	5	2		1	6		4	4		8	8	
Permitted Phases						6						
Actuated Green, G (s)	34.6	105.3		6.2	76.9	76.9	13.0	13.0		9.5	9.5	
Effective Green, g (s)	34.6	105.3		6.2	76.9	76.9	13.0	13.0		9.5	9.5	
Actuated g/C Ratio	0.23	0.70		0.04	0.51	0.51	0.09	0.09		0.06	0.06	
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	408	1294		73	955	812	153	139		112	103	
v/s Ratio Prot	c0.10	c0.49		0.02	c0.40		c0.06	0.01		c0.03	0.01	
v/s Ratio Perm						0.27						
v/c Ratio	0.45	0.69		0.51	0.78	0.53	0.65	0.16		0.45	0.09	
Uniform Delay, d1	49.6	12.9		70.4	29.8	24.5	66.3	63.4		67.7	66.2	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.8	3.0		5.4	4.3	0.6	9.1	0.5		2.8	0.4	
Delay (s)	50.4	16.0		75.8	34.1	25.1	75.3	64.0		70.5	66.5	
Level of Service	D	B		E	C	C	E	E		E	E	
Approach Delay (s)		21.9			31.0			68.3			68.7	
Approach LOS		C			C			E			E	

Intersection Summary			
HCM Average Control Delay	32.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	72.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
22: Farrington Hwy & 2nd Avenue — 2030 + PRO (without Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↱		↰↰	↑↑	↱	↰	↑↑	↱↱	↰↰	↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	*0.99		*0.99	*0.99	1.00	1.00	0.95	*0.99	*0.99	0.95	1.00
Frt	1.00	0.99		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	5469		3504	3688	1583	1770	3539	3135	3504	3539	1583
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	5469		3504	3688	1583	1770	3539	3135	3504	3539	1583
Volume (vph)	186	1527	127	690	1836	246	106	297	513	558	356	320
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	188	1542	128	697	1855	248	107	300	518	564	360	323
RTOR Reduction (vph)	0	7	0	0	0	70	0	0	5	0	0	161
Lane Group Flow (vph)	188	1663	0	697	1855	178	107	300	513	564	360	162
Turn Type	Prot			Prot		Perm	Prot		pm+ov	Prot		Perm
Protected Phases	5	2		1	6		3	8	1	7	4	
Permitted Phases						6			8			4
Actuated Green, G (s)	16.0	54.0		34.0	72.0	72.0	11.5	23.0	57.0	23.0	34.5	34.5
Effective Green, g (s)	16.0	54.0		34.0	72.0	72.0	11.5	23.0	57.0	23.0	34.5	34.5
Actuated g/C Ratio	0.11	0.36		0.23	0.48	0.48	0.08	0.15	0.38	0.15	0.23	0.23
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	189	1969		794	1770	760	136	543	1275	537	814	364
v/s Ratio Prot	c0.11	0.30		0.20	c0.50		c0.06	c0.08	0.09	c0.16	0.10	
v/s Ratio Perm						0.11			0.07			0.10
v/c Ratio	0.99	0.84		0.88	1.05	0.23	0.79	0.55	0.40	1.05	0.44	0.45
Uniform Delay, d1	67.0	44.1		56.0	39.0	22.9	68.0	58.7	34.0	63.5	49.5	49.5
Progression Factor	0.77	0.76		0.69	0.56	0.13	1.00	1.00	1.00	0.78	0.74	0.63
Incremental Delay, d2	50.5	3.0		6.0	29.9	0.4	25.2	4.0	0.2	27.8	0.2	0.4
Delay (s)	101.8	36.6		44.4	51.8	3.3	93.3	62.8	34.2	77.4	36.6	31.4
Level of Service	F	D		D	D	A	F	E	C	E	D	C
Approach Delay (s)		43.2			45.7			50.3			53.7	
Approach LOS		D			D			D			D	

Intersection Summary			
HCM Average Control Delay	47.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	98.5%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
23: 2nd Avenue & Kunia Road
2030 + PRO (without Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations		↗	↑↑↑↱			↑↑↑↑
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	0	0	4998	440	0	5283
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	5433	478	0	5742
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)			870			
pX, platoon unblocked						
vC, conflicting volume	7107	1597			5911	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	7107	1597			5911	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	0	95			7	

Direction, Lane #	EB 1	SE 1	SE 2	SE 3	SE 4	NW 1	NW 2	NW 3	NW 4
Volume Total	0	1552	1552	1552	1254	1436	1436	1436	1436
Volume Left	0	0	0	0	0	0	0	0	0
Volume Right	0	0	0	0	478	0	0	0	0
cSH	1700	1700	1700	1700	1700	1700	1700	1700	1700
Volume to Capacity	0.00	0.91	0.91	0.91	0.74	0.84	0.84	0.84	0.84
Queue Length 95th (ft)	0	0	0	0	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane LOS	A								
Approach Delay (s)	0.0	0.0				0.0			
Approach LOS	A								

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	83.1%	ICU Level of Service	E
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
24: 3rd Avenue & Kunia Road
2030 + PRO (without Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations		↗	↑↑↑↱			↑↑↑↑
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	0	14	4808	189	0	5283
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	15	5226	205	0	5742
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)			1234			
pX, platoon unblocked						
vC, conflicting volume	6764	1409			5432	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	6764	1409			5432	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	88			100	
cM capacity (veh/h)	0	128			11	

Direction, Lane #	EB 1	SE 1	SE 2	SE 3	SE 4	NW 1	NW 2	NW 3	NW 4
Volume Total	15	1493	1493	1493	952	1436	1436	1436	1436
Volume Left	0	0	0	0	0	0	0	0	0
Volume Right	15	0	0	0	205	0	0	0	0
cSH	128	1700	1700	1700	1700	1700	1700	1700	1700
Volume to Capacity	0.12	0.88	0.88	0.88	0.56	0.84	0.84	0.84	0.84
Queue Length 95th (ft)	10	0	0	0	0	0	0	0	0
Control Delay (s)	36.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane LOS	E								
Approach Delay (s)	36.9	0.0				0.0			
Approach LOS	E								

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	82.8%	ICU Level of Service	E
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
25: East-West Rd. & B Street
2030 + PRO (without Transit Corridor) - PM Peak Mitigations

Movement	EBL	EBT	WBT	WBR	SEL	SER
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	*0.99	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1863	1863	1583	1752	1583
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1863	1863	1583	1752	1583
Volume (vph)	519	371	763	98	342	533
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	524	375	771	99	345	538
RTOR Reduction (vph)	0	0	0	39	0	406
Lane Group Flow (vph)	524	375	771	60	345	132
Turn Type	Prot			Prot		Prot
Protected Phases	5	2	6	6	4	4
Permitted Phases						
Actuated Green, G (s)	38.0	97.0	55.0	55.0	25.0	25.0
Effective Green, g (s)	38.0	97.0	55.0	55.0	25.0	25.0
Actuated g/C Ratio	0.29	0.75	0.42	0.42	0.19	0.19
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	517	1390	788	670	337	304
v/s Ratio Prot	c0.30	0.20	c0.41	0.04	c0.20	0.08
v/s Ratio Perm						
v/c Ratio	1.01	0.27	0.98	0.09	1.02	0.43
Uniform Delay, d1	46.0	5.2	36.9	22.5	52.5	46.3
Progression Factor	1.00	1.00	1.29	2.07	1.00	1.00
Incremental Delay, d2	43.0	0.5	24.5	0.2	55.2	4.5
Delay (s)	89.0	5.7	72.1	46.8	107.7	50.7
Level of Service	F	A	E	D	F	D
Approach Delay (s)		54.3	69.2		73.0	
Approach LOS		D	E		E	

Intersection Summary			
HCM Average Control Delay	65.4	HCM Level of Service	E
HCM Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	97.9%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
26: Btwn Fort Barret Rd and N/S Rd & Farrington Hwy
2030 + PRO (without Transit Corridor) - PM Peak Mitigations

Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	*0.99	*0.99	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3688	3688	1583
Flt Permitted	0.95	1.00	0.05	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	98	3688	3688	1583
Volume (vph)	200	209	96	1497	2295	155
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	202	211	97	1512	2318	157
RTOR Reduction (vph)	0	14	0	0	0	38
Lane Group Flow (vph)	202	197	97	1512	2318	119
Turn Type		Perm	Perm			Perm
Protected Phases	6			4	8	
Permitted Phases		6	4			8
Actuated Green, G (s)	16.0	16.0	76.0	76.0	76.0	76.0
Effective Green, g (s)	16.0	16.0	76.0	76.0	76.0	76.0
Actuated g/C Ratio	0.16	0.16	0.76	0.76	0.76	0.76
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	283	253	74	2803	2803	1203
v/s Ratio Prot	0.11			0.41	0.63	
v/s Ratio Perm		c0.12	c0.99			0.08
v/c Ratio	0.71	0.78	1.31	0.54	0.83	0.10
Uniform Delay, d1	39.8	40.3	12.0	4.9	7.8	3.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	14.3	20.6	208.6	0.2	2.1	0.0
Delay (s)	54.1	60.9	220.6	5.1	9.9	3.2
Level of Service	D	E	F	A	A	A
Approach Delay (s)	57.6			18.1	9.5	
Approach LOS	E			B	A	

Intersection Summary			
HCM Average Control Delay	17.0	HCM Level of Service	B
HCM Volume to Capacity ratio	1.21		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	89.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

APPENDIX B

REEWAY SEGMENT LOS ANALYSIS

APPENDIX B-1

EXISTING CONDITIONS

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	BPK
Agency or Company:	Wilbur Smith Associates
Date Performed:	7/13/2006
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**S/O Makakilo Drive**
Jurisdiction:	Kapolei
Analysis Year:	**Existing (Year 2005)**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	1582	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	439	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	603	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	603	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	57.0	mi/h
Number of lanes, N	3	
Density, D	10.6	pc/mi/ln
Level of service, LOS	**A**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	BPK
Agency or Company:	Wilbur Smith Associates
Date Performed:	7/13/2006
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**W/O Kunia Rd**
Jurisdiction:	Kapolei
Analysis Year:	**Existing (Year 2005)**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	3808	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1058	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1451	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1451	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	57.0	mi/h
Number of lanes, N	3	
Density, D	25.5	pc/mi/ln
Level of service, LOS	**C**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	BPK
Agency or Company:	Wilbur Smith Associates
Date Performed:	7/13/2006
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**W/O Paiwa St**
Jurisdiction:	Kapolei
Analysis Year:	**Existing (Year 2005)**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	7067	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1963	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2020	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2020	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S	56.6	mi/h
Number of lanes, N	4	
Density, D	35.7	pc/mi/ln
Level of service, LOS	**E**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	BPK
Agency or Company:	Wilbur Smith Associates
Date Performed:	7/13/2006
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**E/O Kamehameha Hwy**
Jurisdiction:	Kapolei
Analysis Year:	**Existing (Year 2005)**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	4468	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1241	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1703	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	60.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	1703	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	59.9	mi/h
Number of lanes, N	3	
Density, D	28.4	pc/mi/ln
Level of service, LOS	**D**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	
Agency or Company:	Wilbur Smith Associates
Date Performed:	11/16/06
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H2 NB**
From/To:	**At Ka Uka Blvd**
Jurisdiction:	Kapolei
Analysis Year:	**Existing (Year 2004)**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	1777	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	494	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	677	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	677	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	57.0	mi/h
Number of lanes, N	3	
Density, D	11.9	pc/mi/ln
Level of service, LOS	**B**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	BPK
Agency or Company:	Wilbur Smith Associates
Date Performed:	7/13/2006
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 WB**
From/To:	**S/O Makakilo Drive**
Jurisdiction:	Kapolei
Analysis Year:	**Existing (Year 2005)**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	1482	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	412	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	565	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	565	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	57.0	mi/h
Number of lanes, N	3	
Density, D	9.9	pc/mi/ln
Level of service, LOS	**A**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst: BPK
Agency or Company: Wilbur Smith Associates
Date Performed: 7/13/2006
Analysis Time Period: **AM Peak**
Freeway/Direction: **H1 WB**
From/To: **W/O Kunia Rd**
Jurisdiction: Kapolei
Analysis Year: **Existing (Year 2005)**
Description: East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	3331	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	925	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1269	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1269	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	57.0	mi/h
Number of lanes, N	3	
Density, D	22.3	pc/mi/ln
Level of service, LOS	**C**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst: BPK
Agency or Company: Wilbur Smith Associates
Date Performed: 7/13/2006
Analysis Time Period: **AM Peak**
Freeway/Direction: **H1 WB**
From/To: **W/O Paiwa St**
Jurisdiction: Kapolei
Analysis Year: **Existing (Year 2005)**
Description: East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	4366	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1213	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1248	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1248	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S	58.5	mi/h
Number of lanes, N	4	
Density, D	21.3	pc/mi/ln
Level of service, LOS	**C**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	BPK
Agency or Company:	Wilbur Smith Associates
Date Performed:	7/13/2006
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 WB**
From/To:	**E/O Kamehameha Hwy**
Jurisdiction:	Kapolei
Analysis Year:	**Existing (Year 2005)**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	3069	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	853	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1170	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1170	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	57.0	mi/h
Number of lanes, N	3	
Density, D	20.5	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	BPK
Agency or Company:	Wilbur Smith Associates
Date Performed:	
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H2 SB**
From/To:	**At Ka Uka Blvd**
Jurisdiction:	Kapolei
Analysis Year:	**Existing (Year 2004)**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	4078	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1133	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1554	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1554	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	57.0	mi/h
Number of lanes, N	3	
Density, D	27.3	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	BPK
Agency or Company:	Wilbur Smith Associates
Date Performed:	7/13/2006
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**S/O Makakilo Drive**
Jurisdiction:	Kapolei
Analysis Year:	**Existing (Year 2005)**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	1762	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	489	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	672	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	672	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	57.0	mi/h
Number of lanes, N	3	
Density, D	11.8	pc/mi/ln
Level of service, LOS	**B**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	BPK
Agency or Company:	Wilbur Smith Associates
Date Performed:	7/13/2006
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**W/O Kunia Rd**
Jurisdiction:	Kapolei
Analysis Year:	**Existing (Year 2005)**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	4077	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1133	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1554	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1554	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	57.0	mi/h
Number of lanes, N	3	
Density, D	27.3	pc/mi/ln
Level of service, LOS	**D**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst: BPK
Agency or Company: Wilbur Smith Associates
Date Performed: 7/13/2006
Analysis Time Period: **PM Peak**
Freeway/Direction: **H1 EB**
From/To: **W/O Paiwa St**
Jurisdiction: Kapolei
Analysis Year: **Existing (Year 2005)**
Description: East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	4446	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1235	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1271	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1271	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S	58.5	mi/h
Number of lanes, N	4	
Density, D	21.7	pc/mi/ln
Level of service, LOS	**C**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst: BPK
Agency or Company: Wilbur Smith Associates
Date Performed: 7/13/2006
Analysis Time Period: **PM Peak**
Freeway/Direction: **H1 EB**
From/To: **E/O Kamehameha Hwy**
Jurisdiction: Kapolei
Analysis Year: **Existing (Year 2005)**
Description: East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	2652	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	737	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1011	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1011	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	57.0	mi/h
Number of lanes, N	3	
Density, D	17.7	pc/mi/ln
Level of service, LOS	**B**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	BPK
Agency or Company:	Wilbur Smith Associates
Date Performed:	
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H2 NB**
From/To:	**At Ka Uka Blvd**
Jurisdiction:	Kapolei
Analysis Year:	**Existing (Year 2004)**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	3196	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	888	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1218	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1218	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	57.0	mi/h
Number of lanes, N	3	
Density, D	21.4	pc/mi/ln
Level of service, LOS	**C**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	BPK
Agency or Company:	Wilbur Smith Associates
Date Performed:	7/13/2006
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H1 WB**
From/To:	**S/O Makakilo Drive**
Jurisdiction:	Kapolei
Analysis Year:	**Existing (Year 2005)**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	2223	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	618	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	847	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	847	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	57.0	mi/h
Number of lanes, N	3	
Density, D	14.9	pc/mi/ln
Level of service, LOS	**B**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	BPK
Agency or Company:	Wilbur Smith Associates
Date Performed:	7/13/2006
Analysis Time Period:	PM Peak
Freeway/Direction:	**H1 WB**
From/To:	**W/O Kunia Rd**
Jurisdiction:	Kapolei
Analysis Year:	Existing (Year 2005)
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	4079	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1133	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1555	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	65.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	62.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1555	pc/h/ln
Free-flow speed, FFS	62.0	mi/h
Average passenger-car speed, S	62.0	mi/h
Number of lanes, N	3	
Density, D	25.1	pc/mi/ln
Level of service, LOS	**C**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	BPK
Agency or Company:	Wilbur Smith Associates
Date Performed:	7/13/2006
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H1 WB**
From/To:	**W/O Paiwa St**
Jurisdiction:	Kapolei
Analysis Year:	**Existing (Year 2005)**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	7425	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	2063	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2122	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2122	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S	54.9	mi/h
Number of lanes, N	4	
Density, D	38.6	pc/mi/ln
Level of service, LOS	**E**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	BPK
Agency or Company:	Wilbur Smith Associates
Date Performed:	7/13/2006
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H1 WB**
From/To:	**E/O Kamehameha Hwy**
Jurisdiction:	Kapolei
Analysis Year:	**Existing (Year 2005)**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	5824	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1618	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2220	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2220	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	51.8	mi/h
Number of lanes, N	3	
Density, D	42.8	pc/mi/ln
Level of service, LOS	**E**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	BPK
Agency or Company:	Wilbur Smith Associates
Date Performed:	
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H2 SB**
From/To:	**At Ka Uka Blvd**
Jurisdiction:	Kapolei
Analysis Year:	**Existing (Year 2004)**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	2534	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	704	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	966	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	966	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	57.0	mi/h
Number of lanes, N	3	
Density, D	16.9	pc/mi/ln
Level of service, LOS	**B**	

Overall results are not computed when free-flow speed is less than 55 mph.

APPENDIX B-2
YEAR 2030 CONDITIONS

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	TSO
Agency or Company:	Wilbur Smith Associates
Date Performed:	11/15/06
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**S/O Makakilo Drive**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	5434	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1509	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2071	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2071	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	54.8	mi/h
Number of lanes, N	3	
Density, D	37.8	pc/mi/ln
Level of service, LOS	**E**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	TSO
Agency or Company:	Wilbur Smith Associates
Date Performed:	11/15/06
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**W/O Kunia Rd**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	8197	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	2277	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2343	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2343	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	4	
Density, D		pc/mi/ln
Level of service, LOS	**F**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	2/7/07
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**W/O Paiwa St**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	9906	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	2752	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2265	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	5	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	60.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2265	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	52.2	mi/h
Number of lanes, N	5	
Density, D	43.4	pc/mi/ln
Level of service, LOS	**E**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	TSO
Agency or Company:	Wilbur Smith Associates
Date Performed:	11/15/06
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**E/O Kamehameha Hwy**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	7512	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	2087	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2147	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	60.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	2147	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	55.3	mi/h
Number of lanes, N	4	
Density, D	38.8	pc/mi/ln
Level of service, LOS	**E**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst: TSO
Agency or Company: Wilbur Smith Associates
Date Performed: 11/15/06
Analysis Time Period: **AM Peak**
Freeway/Direction: **H2 NB**
From/To: **At Ka Uka Blvd**
Jurisdiction: Kapolei
Analysis Year: **Year 2030**
Description: East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	3184	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	884	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1213	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1213	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	57.0	mi/h
Number of lanes, N	3	
Density, D	21.3	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst: TSO
Agency or Company: Wilbur Smith Associates
Date Performed: 11/15/06
Analysis Time Period: **AM Peak**
Freeway/Direction: **H1 WB**
From/To: **S/O Makakilo Drive**
Jurisdiction: Kapolei
Analysis Year: **Year 2030**
Description: East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	3259	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	905	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1242	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1242	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	57.0	mi/h
Number of lanes, N	3	
Density, D	21.8	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	TSO
Agency or Company:	Wilbur Smith Associates
Date Performed:	11/15/06
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 WB**
From/To:	**W/O Kunia Rd**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	3735	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1038	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1068	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1068	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S	58.5	mi/h
Number of lanes, N	4	
Density, D	18.3	pc/mi/ln
Level of service, LOS	**C**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	2/7/07
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 WB**
From/To:	**W/O Paiwa St**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	4366	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1213	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	998	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	5	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	60.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	998	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	5	
Density, D	16.6	pc/mi/ln
Level of service, LOS	**B**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	TSO
Agency or Company:	Wilbur Smith Associates
Date Performed:	11/15/06
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 WB**
From/To:	**E/O Kamehameha Hwy**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	3069	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	853	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1170	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1170	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	57.0	mi/h
Number of lanes, N	3	
Density, D	20.5	pc/mi/ln
Level of service, LOS	**C**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	TSO
Agency or Company:	Wilbur Smith Associates
Date Performed:	11/15/06
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H2 SB**
From/To:	**At Ka Uka Blvd**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	6273	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1743	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1793	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1793	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S	58.3	mi/h
Number of lanes, N	4	
Density, D	30.7	pc/mi/ln
Level of service, LOS	**D**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	TSO
Agency or Company:	Wilbur Smith Associates
Date Performed:	11/15/06
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**S/O Makakilo Drive**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	4680	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1300	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1784	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1784	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	56.9	mi/h
Number of lanes, N	3	
Density, D	31.3	pc/mi/ln
Level of service, LOS	**D**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	TSO
Agency or Company:	Wilbur Smith Associates
Date Performed:	11/15/06
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**W/O Kunia Rd**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	5833	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1620	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1667	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1667	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S	58.5	mi/h
Number of lanes, N	4	
Density, D	28.5	pc/mi/ln
Level of service, LOS	**D**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	2/7/07
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**W/O Paiwa St**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	7137	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1983	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1632	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	5	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	60.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1632	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	5	
Density, D	27.2	pc/mi/ln
Level of service, LOS	**D**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	TSO
Agency or Company:	Wilbur Smith Associates
Date Performed:	11/15/06
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**E/O Kamehameha Hwy**
Jurisdiction:	Kapolei
Analysis Year:	
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	4249	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1180	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1619	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1619	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	57.0	mi/h
Number of lanes, N	3	
Density, D	28.4	pc/mi/ln
Level of service, LOS	**D**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

```
Analyst:                TSO
Agency or Company:      Wilbur Smith Associates
Date Performed:         11/15/06
Analysis Time Period:   PM Peak
Freeway/Direction:      H2 NB
From/To:                At Ka Uka Blvd
Jurisdiction:           Kapolei
Analysis Year:          Year 2030
Description:  East Kapolei TIAR
```

Flow Inputs and Adjustments

Volume, V	6220	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1728	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2371	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2371	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	3	
Density, D		pc/mi/ln
Level of service, LOS	**F**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

```
Analyst:                TSO
Agency or Company:      Wilbur Smith Associates
Date Performed:         11/15/06
Analysis Time Period:   PM Peak
Freeway/Direction:      H1 WB
From/To:                S/O Makakilo Drive
Jurisdiction:           Kapolei
Analysis Year:          Year 2030
Description:  East Kapolei TIAR
```

Flow Inputs and Adjustments

Volume, V	6365	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1768	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2426	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2426	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	3	
Density, D		pc/mi/ln
Level of service, LOS	**F**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	TSO
Agency or Company:	Wilbur Smith Associates
Date Performed:	11/15/06
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H1 WB**
From/To:	**W/O Kunia Rd**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	7860	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	2183	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2247	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2247	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S	51.9	mi/h
Number of lanes, N	4	
Density, D	43.3	pc/mi/ln
Level of service, LOS	**E**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	2/7/07
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H1 WB**
From/To:	**W/O Paiwa St**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	7931	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	2203	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1511	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	6	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	60.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1511	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	6	
Density, D	25.2	pc/mi/ln
Level of service, LOS	**C**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	TSO
Agency or Company:	Wilbur Smith Associates
Date Performed:	11/15/06
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H1 WB**
From/To:	**E/O Kamehameha Hwy**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	7766	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	2157	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2220	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2220	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S	52.7	mi/h
Number of lanes, N	4	
Density, D	42.2	pc/mi/ln
Level of service, LOS	**E**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	TSO
Agency or Company:	Wilbur Smith Associates
Date Performed:	11/15/06
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H2 SB**
From/To:	**At Ka Uka Blvd**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	4616	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1282	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1319	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1319	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S	58.5	mi/h
Number of lanes, N	4	
Density, D	22.5	pc/mi/ln
Level of service, LOS	**C**	

Overall results are not computed when free-flow speed is less than 55 mph.

APPENDIX B-3
YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO A: WITH TRANSIT CORRIDOR SCENARIO

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	12/22/06
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**S/O Makakilo Drive**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030 with Reduction
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	5892	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1637	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2246	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2246	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	51.1	mi/h
Number of lanes, N	3	
Density, D	43.9	pc/mi/ln
Level of service, LOS	**E**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	12/22/06
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**W/O Kunia Rd**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030 with Reduction
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	9143	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	2540	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2613	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2613	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	4	
Density, D		pc/mi/ln
Level of service, LOS	**F**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	2/8/07
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**W/O Paiwa St**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030 with Reduction**

Description: East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	11906	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	3307	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2723	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	5	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	60.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2723	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	5	
Density, D		pc/mi/ln
Level of service, LOS	**F**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	12/22/06
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**E/O Kamehameha Hwy**
Jurisdiction:	Kapolei
Analysis Year:	2030 with Transit Reduction

Description: East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	8435	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	2343	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2411	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2411	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	4	
Density, D		pc/mi/ln
Level of service, LOS	**F**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	12/22/06
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H2 NB**
From/To:	**At Ka Uka Blvd**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030 with Reduction
Description: East Kapolei TIAR	

Flow Inputs and Adjustments

Volume, V	3597	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	999	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1371	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1371	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	57.0	mi/h
Number of lanes, N	3	
Density, D	24.1	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	12/22/06
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 WB**
From/To:	**S/O Makakilo Drive**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030 with Reduction
Description: East Kapolei TIAR	

Flow Inputs and Adjustments

Volume, V	3756	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1043	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1431	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1431	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	57.0	mi/h
Number of lanes, N	3	
Density, D	25.1	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	12/22/2006
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 WB**
From/To:	**W/O Kunia Rd**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030 with Reduction
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	4491	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1248	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1284	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1284	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S	58.5	mi/h
Number of lanes, N	4	
Density, D	21.9	pc/mi/ln
Level of service, LOS	**C**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	2/8/07
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 WB**
From/To:	**W/O Paiwa St**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030 with Reduction**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	5858	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1627	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1340	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	5	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	60.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1340	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	5	
Density, D	22.3	pc/mi/ln
Level of service, LOS	**C**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	12/22/06
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 WB**
From/To:	**E/O Kamehameha Hwy**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030 with Reduction
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	3757	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1044	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1432	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1432	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	57.0	mi/h
Number of lanes, N	3	
Density, D	25.1	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	12/22/06
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H2 SB**
From/To:	**At Ka Uka Blvd**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030 with Reduction
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	6581	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1828	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1881	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1881	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S	57.9	mi/h
Number of lanes, N	4	
Density, D	32.5	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	12/22/06
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**S/O Makakilo Drive**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030 with Reduction
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	5334	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1482	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2033	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2033	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	55.3	mi/h
Number of lanes, N	3	
Density, D	36.7	pc/mi/ln
Level of service, LOS	**E**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	12/22/06
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**W/O Kunia Rd**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030 with Reduction
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	6891	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1914	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1970	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1970	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S	57.2	mi/h
Number of lanes, N	4	
Density, D	34.5	pc/mi/ln
Level of service, LOS	**D**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	2/8/07
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**W/O Paiwa St**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030 with Reduction**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	9139	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	2539	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2090	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	5	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	60.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2090	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	56.5	mi/h
Number of lanes, N	5	
Density, D	37.0	pc/mi/ln
Level of service, LOS	**E**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	12/22/06
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**E/O Kamehameha Hwy**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030 with Reduction
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	5173	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1437	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1971	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1971	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	56.0	mi/h
Number of lanes, N	3	
Density, D	35.2	pc/mi/ln
Level of service, LOS	**E**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst: MM
Agency or Company: Wilbur Smith Associates
Date Performed: 12/22/06
Analysis Time Period: **PM Peak**
Freeway/Direction: **H2 NB**
From/To: **At Ka Uka Blvd**
Jurisdiction: Kapolei
Analysis Year: Year 2030 with Reduction
Description: East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	6663	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1851	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2539	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2539	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	3	
Density, D		pc/mi/ln
Level of service, LOS	**F**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst: MM
Agency or Company: Wilbur Smith Associates
Date Performed: 12/22/06
Analysis Time Period: **PM Peak**
Freeway/Direction: **H1 WB**
From/To: **S/O Makakilo Drive**
Jurisdiction: Kapolei
Analysis Year: Year 2030 with Reduction
Description: East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	7022	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1951	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2676	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2676	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	3	
Density, D		pc/mi/ln
Level of service, LOS	**F**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	12/22/06
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H1 WB**
From/To:	**W/O Kunia Rd**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030 with Reduction
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	8875	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	2465	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2537	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2537	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	4	
Density, D		pc/mi/ln
Level of service, LOS	**F**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	2/8/07
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H1 WB**
From/To:	**W/O Paiwa St**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030 with Reduction**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	10131	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	2814	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1931	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	6	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	60.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1931	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	58.7	mi/h
Number of lanes, N	6	
Density, D	32.9	pc/mi/ln
Level of service, LOS	**D**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	12/22/06
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H1 WB**
From/To:	**E/O Kamehameha Hwy**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030 with Reduction
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	8781	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	2439	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2510	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2510	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	4	
Density, D		pc/mi/ln
Level of service, LOS	**F**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	12/22/06
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H2 SB**
From/To:	**At Ka Uka Blvd**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030 with Reduction
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	5070	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1408	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1449	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1449	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S	58.5	mi/h
Number of lanes, N	4	
Density, D	24.8	pc/mi/ln
Level of service, LOS	**C**	

Overall results are not computed when free-flow speed is less than 55 mph.

APPENDIX B-4
YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO B: WITHOUT TRANSIT CORRIDOR SCENARIO

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                  HCS+: Basic Freeway Segments Release 5.2

_________________________Operational Analysis__________________________________

Analyst:                MM
Agency or Company:      Wilbur Smith Associates
Date Performed:         12/22/06
Analysis Time Period:   AM Peak
Freeway/Direction:      H1 EB
From/To:                S/O Makakilo Drive
Jurisdiction:           Kapolei
Analysis Year:          Year 2030 without Reduction
Description:  East Kapolei TIAR

_________________________Flow Inputs and Adjustments__________________________

Volume, V                                     5928          veh/h
Peak-hour factor, PHF                         0.90
Peak 15-min volume, v15                       1647          v
Trucks and buses                              5             %
Recreational vehicles                         2             %
Terrain type:                                 Level
    Grade                                     0.00          %
    Segment length                            0.00          mi
Trucks and buses PCE, ET                      1.5
Recreational vehicle PCE, ER                  1.2
Heavy vehicle adjustment, fHV                 0.972
Driver population factor, fp                  1.00
Flow rate, vp                                 2259          pc/h/ln

_________________________Speed Inputs and Adjustments_________________________

Lane width                                    12.0          ft
Right-shoulder lateral clearance              6.0           ft
Interchange density                           0.50          interchange/mi
Number of lanes, N                            3
Free-flow speed:                              Base
     FFS or BFFS                              60.0          mi/h
Lane width adjustment, fLW                    0.0           mi/h
Lateral clearance adjustment, fLC             0.0           mi/h
Interchange density adjustment, fID           0.0           mi/h
Number of lanes adjustment, fN                3.0           mi/h
Free-flow speed, FFS                          57.0          mi/h
                                              Urban Freeway

_________________________LOS and Performance Measures_________________________

Flow rate, vp                                 2259          pc/h/ln
Free-flow speed, FFS                          57.0          mi/h
Average passenger-car speed, S                50.8          mi/h
Number of lanes, N                            3
Density, D                                    44.5          pc/mi/ln
Level of service, LOS                         E

  Overall results are not computed when free-flow speed is less than 55 mph.
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                  HCS+: Basic Freeway Segments Release 5.2

_________________________Operational Analysis__________________________________

Analyst:                MM
Agency or Company:      Wilbur Smith Associates
Date Performed:         12/22/06
Analysis Time Period:   AM Peak
Freeway/Direction:      H1 EB
From/To:                W/O Kunia Rd
Jurisdiction:           Kapolei
Analysis Year:          Year 2030 without Reduction
Description:  East Kapolei TIAR

_________________________Flow Inputs and Adjustments__________________________

Volume, V                                     9217          veh/h
Peak-hour factor, PHF                         0.90
Peak 15-min volume, v15                       2560          v
Trucks and buses                              5             %
Recreational vehicles                         2             %
Terrain type:                                 Level
    Grade                                     0.00          %
    Segment length                            0.00          mi
Trucks and buses PCE, ET                      1.5
Recreational vehicle PCE, ER                  1.2
Heavy vehicle adjustment, fHV                 0.972
Driver population factor, fp                  1.00
Flow rate, vp                                 2635          pc/h/ln

_________________________Speed Inputs and Adjustments_________________________

Lane width                                    12.0          ft
Right-shoulder lateral clearance              6.0           ft
Interchange density                           0.50          interchange/mi
Number of lanes, N                            4
Free-flow speed:                              Base
     FFS or BFFS                              60.0          mi/h
Lane width adjustment, fLW                    0.0           mi/h
Lateral clearance adjustment, fLC             0.0           mi/h
Interchange density adjustment, fID           0.0           mi/h
Number of lanes adjustment, fN                1.5           mi/h
Free-flow speed, FFS                          58.5          mi/h
                                              Urban Freeway

_________________________LOS and Performance Measures_________________________

Flow rate, vp                                 2635          pc/h/ln
Free-flow speed, FFS                          58.5          mi/h
Average passenger-car speed, S                              mi/h
Number of lanes, N                            4
Density, D                                                  pc/mi/ln
Level of service, LOS                         F

  Overall results are not computed when free-flow speed is less than 55 mph.
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HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	2/8/07
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**W/O Paiwa St**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030 without Reduction**
Description: East Kapolei TIAR	

Flow Inputs and Adjustments

Volume, V	12062	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	3351	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2758	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	5	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	60.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2758	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	5	
Density, D		pc/mi/ln
Level of service, LOS	**F**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	12/22/06
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**E/O Kamehameha Hwy**
Jurisdiction:	Kapolei
Analysis Year:	2030 with Transit Reduction
Description: East Kapolei TIAR	

Flow Inputs and Adjustments

Volume, V	8435	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	2343	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2411	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2411	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	4	
Density, D		pc/mi/ln
Level of service, LOS	**F**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	12/22/06
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H2 NB**
From/To:	**At Ka Uka Blvd**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030 without Reduction
Description: East Kapolei TIAR	

Flow Inputs and Adjustments

Volume, V	3629	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1008	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1383	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1383	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	57.0	mi/h
Number of lanes, N	3	
Density, D	24.3	pc/mi/ln
Level of service, LOS	**C**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	12/22/06
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 WB**
From/To:	**S/O Makakilo Drive**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030 without Reduction
Description: East Kapolei TIAR	

Flow Inputs and Adjustments

Volume, V	3794	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1054	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1446	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1446	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	57.0	mi/h
Number of lanes, N	3	
Density, D	25.4	pc/mi/ln
Level of service, LOS	**C**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	12/22/06
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 WB**
From/To:	**W/O Kunia Rd**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030 without Reduction
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	4549	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1264	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1300	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1300	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S	58.5	mi/h
Number of lanes, N	4	
Density, D	22.2	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	2/8/07
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 WB**
From/To:	**W/O Paiwa St**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030 with Reduction**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	5858	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1627	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1340	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	5	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	60.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1340	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	5	
Density, D	22.3	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	12/22/06
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H1 WB**
From/To:	**E/O Kamehameha Hwy**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030 without Reduction
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	3811	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1059	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1452	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1452	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	57.0	mi/h
Number of lanes, N	3	
Density, D	25.5	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	12/22/06
Analysis Time Period:	**AM Peak**
Freeway/Direction:	**H2 SB**
From/To:	**At Ka Uka Blvd**
Jurisdiction:	Kapolei
Analysis Year:	
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	6605	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1835	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1888	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1888	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S	57.9	mi/h
Number of lanes, N	4	
Density, D	32.6	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	12/22/06
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**S/O Makakilo Drive**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030 without Reduction
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	5392	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1498	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2055	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	57.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2055	pc/h/ln
Free-flow speed, FFS	57.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	3	
Density, D	37.3	pc/mi/ln
Level of service, LOS	**E**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	12/22/06
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H1 EB**
From/To:	**W/O Kunia Rd**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030 without Reduction
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	6985	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1940	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1997	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1997	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S	56.9	mi/h
Number of lanes, N	4	
Density, D	35.1	pc/mi/ln
Level of service, LOS	**E**	

Overall results are not computed when free-flow speed is less than 55 mph.

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                    HCS+: Basic Freeway Segments Release 5.2

_________________________Operational Analysis________________________________

Analyst:                MM
Agency or Company:      Wilbur Smith Associates
Date Performed:         2/8/07
Analysis Time Period:   PM Peak
Freeway/Direction:      H1 EB
From/To:                W/O Paiwa St
Jurisdiction:           Kapolei
Analysis Year:          Year 2030 without Reduction
Description:  East Kapolei TIAR

_________________________Flow Inputs and Adjustments_________________________

Volume, V                                   9309           veh/h
Peak-hour factor, PHF                       0.90
Peak 15-min volume, v15                     2586           v
Trucks and buses                            5              %
Recreational vehicles                       2              %
Terrain type:                               Level
    Grade                                   0.00           %
    Segment length                          0.00           mi
Trucks and buses PCE, ET                    1.5
Recreational vehicle PCE, ER                1.2
Heavy vehicle adjustment, fHV               0.972
Driver population factor, fp                1.00
Flow rate, vp                               2129           pc/h/ln

_________________________Speed Inputs and Adjustments________________________

Lane width                                  12.0           ft
Right-shoulder lateral clearance            6.0            ft
Interchange density                         0.50           interchange/mi
Number of lanes, N                          5
Free-flow speed:                            Base
     FFS or BFFS                            60.0           mi/h
Lane width adjustment, fLW                  0.0            mi/h
Lateral clearance adjustment, fLC           0.0            mi/h
Interchange density adjustment, fID         0.0            mi/h
Number of lanes adjustment, fN              0.0            mi/h
Free-flow speed, FFS                        60.0           mi/h
                                            Urban Freeway

_________________________LOS and Performance Measures________________________

Flow rate, vp                               2129           pc/h/ln
Free-flow speed, FFS                        60.0           mi/h
Average passenger-car speed, S              55.7           mi/h
Number of lanes, N                          5
Density, D                                  38.2           pc/mi/ln
Level of service, LOS                       E

  Overall results are not computed when free-flow speed is less than 55 mph.
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                    HCS+: Basic Freeway Segments Release 5.2

_________________________Operational Analysis________________________________

Analyst:                MM
Agency or Company:      Wilbur Smith Associates
Date Performed:         12/22/06
Analysis Time Period:   PM Peak
Freeway/Direction:      H1 EB
From/To:                E/O Kamehameha Hwy
Jurisdiction:           Kapolei
Analysis Year:          Year 2030 with Reduction
Description:  East Kapolei TIAR

_________________________Flow Inputs and Adjustments_________________________

Volume, V                                   5173           veh/h
Peak-hour factor, PHF                       0.90
Peak 15-min volume, v15                     1437           v
Trucks and buses                            5              %
Recreational vehicles                       2              %
Terrain type:                               Level
    Grade                                   0.00           %
    Segment length                          0.00           mi
Trucks and buses PCE, ET                    1.5
Recreational vehicle PCE, ER                1.2
Heavy vehicle adjustment, fHV               0.972
Driver population factor, fp                1.00
Flow rate, vp                               1971           pc/h/ln

_________________________Speed Inputs and Adjustments________________________

Lane width                                  12.0           ft
Right-shoulder lateral clearance            6.0            ft
Interchange density                         0.50           interchange/mi
Number of lanes, N                          3
Free-flow speed:                            Base
     FFS or BFFS                            60.0           mi/h
Lane width adjustment, fLW                  0.0            mi/h
Lateral clearance adjustment, fLC           0.0            mi/h
Interchange density adjustment, fID         0.0            mi/h
Number of lanes adjustment, fN              3.0            mi/h
Free-flow speed, FFS                        57.0           mi/h
                                            Urban Freeway

_________________________LOS and Performance Measures________________________

Flow rate, vp                               1971           pc/h/ln
Free-flow speed, FFS                        57.0           mi/h
Average passenger-car speed, S              56.0           mi/h
Number of lanes, N                          3
Density, D                                  35.2           pc/mi/ln
Level of service, LOS                       E

  Overall results are not computed when free-flow speed is less than 55 mph.
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HCS+: Basic Freeway Segments Release 5.2

________________________Operational Analysis__________________________

Analyst:                 MM
Agency or Company:       Wilbur Smith Associates
Date Performed:          12/22/06
Analysis Time Period:    PM Peak
Freeway/Direction:       H2 NB
From/To:                 At Ka Uka Blvd
Jurisdiction:            Kapolei
Analysis Year:           Year 2030 without Reduction
Description:  East Kapolei TIAR

________________________Flow Inputs and Adjustments___________________

Volume, V                                  6668          veh/h
Peak-hour factor, PHF                      0.90
Peak 15-min volume, v15                    1852          v
Trucks and buses                           5             %
Recreational vehicles                      2             %
Terrain type:                              Level
    Grade                                  0.00          %
    Segment length                         0.00          mi
Trucks and buses PCE, ET                   1.5
Recreational vehicle PCE, ER               1.2
Heavy vehicle adjustment, fHV              0.972
Driver population factor, fp               1.00
Flow rate, vp                              2541          pc/h/ln

________________________Speed Inputs and Adjustments__________________

Lane width                                 12.0          ft
Right-shoulder lateral clearance           6.0           ft
Interchange density                        0.50          interchange/mi
Number of lanes, N                         3
Free-flow speed:                           Base
     FFS or BFFS                           60.0          mi/h
Lane width adjustment, fLW                 0.0           mi/h
Lateral clearance adjustment, fLC          0.0           mi/h
Interchange density adjustment, fID        0.0           mi/h
Number of lanes adjustment, fN             3.0           mi/h
Free-flow speed, FFS                       57.0          mi/h
                                           Urban Freeway

________________________LOS and Performance Measures__________________

Flow rate, vp                              2541          pc/h/ln
Free-flow speed, FFS                       57.0          mi/h
Average passenger-car speed, S                           mi/h
Number of lanes, N                         3
Density, D                                               pc/mi/ln
Level of service, LOS                      F

  Overall results are not computed when free-flow speed is less than 55 mph.
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HCS+: Basic Freeway Segments Release 5.2

________________________Operational Analysis__________________________

Analyst:                 MM
Agency or Company:       Wilbur Smith Associates
Date Performed:          12/22/06
Analysis Time Period:    PM Peak
Freeway/Direction:       H1 WB
From/To:                 S/O Makakilo Drive
Jurisdiction:            Kapolei
Analysis Year:           Year 2030 without Reduction
Description:  East Kapolei TIAR

________________________Flow Inputs and Adjustments___________________

Volume, V                                  7080          veh/h
Peak-hour factor, PHF                      0.90
Peak 15-min volume, v15                    1967          v
Trucks and buses                           5             %
Recreational vehicles                      2             %
Terrain type:                              Level
    Grade                                  0.00          %
    Segment length                         0.00          mi
Trucks and buses PCE, ET                   1.5
Recreational vehicle PCE, ER               1.2
Heavy vehicle adjustment, fHV              0.972
Driver population factor, fp               1.00
Flow rate, vp                              2698          pc/h/ln

________________________Speed Inputs and Adjustments__________________

Lane width                                 12.0          ft
Right-shoulder lateral clearance           6.0           ft
Interchange density                        0.50          interchange/mi
Number of lanes, N                         3
Free-flow speed:                           Base
     FFS or BFFS                           60.0          mi/h
Lane width adjustment, fLW                 0.0           mi/h
Lateral clearance adjustment, fLC          0.0           mi/h
Interchange density adjustment, fID        0.0           mi/h
Number of lanes adjustment, fN             3.0           mi/h
Free-flow speed, FFS                       57.0          mi/h
                                           Urban Freeway

________________________LOS and Performance Measures__________________

Flow rate, vp                              2698          pc/h/ln
Free-flow speed, FFS                       57.0          mi/h
Average passenger-car speed, S                           mi/h
Number of lanes, N                         3
Density, D                                               pc/mi/ln
Level of service, LOS                      F

  Overall results are not computed when free-flow speed is less than 55 mph.
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HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	12/22/06
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H1 WB**
From/To:	**W/O Kunia Rd**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030 without Reduction
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	8964	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	2490	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2562	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2562	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	4	
Density, D		pc/mi/ln
Level of service, LOS	**F**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	2/8/07
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H1 WB**
From/To:	**W/O Paiwa St**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030 with Reduction**
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	10131	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	2814	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1931	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	6	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	60.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1931	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	58.7	mi/h
Number of lanes, N	6	
Density, D	32.9	pc/mi/ln
Level of service, LOS	**D**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	12/22/06
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H1 WB**
From/To:	**E/O Kamehameha Hwy**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030 without Reduction
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	8867	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	2463	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	2534	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2534	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	4	
Density, D		pc/mi/ln
Level of service, LOS	**F**	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.2

Operational Analysis

Analyst:	MM
Agency or Company:	Wilbur Smith Associates
Date Performed:	12/22/06
Analysis Time Period:	**PM Peak**
Freeway/Direction:	**H2 SB**
From/To:	**At Ka Uka Blvd**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030 without Reduction
Description:	East Kapolei TIAR

Flow Inputs and Adjustments

Volume, V	5108	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1419	v
Trucks and buses	5	%
Recreational vehicles	2	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.972	
Driver population factor, fp	1.00	
Flow rate, vp	1460	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Base	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	58.5	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1460	pc/h/ln
Free-flow speed, FFS	58.5	mi/h
Average passenger-car speed, S	58.5	mi/h
Number of lanes, N	4	
Density, D	25.0	pc/mi/ln
Level of service, LOS	**C**	

Overall results are not computed when free-flow speed is less than 55 mph.

APPENDIX C

RAMP-FREEWAY JUNCTION LOS ANALYSIS

APPENDIX C-1

EXISTING CONDITIONS

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	AM Peak
Freeway/Dir of Travel:	**H1 WB**
Junction:	**F Weaver Rd & H1 Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**Existing**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	57.0	mph
Volume on freeway	5197	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	530	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	5197		530			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1444		147			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	5774		589			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.589 Using Equation 5

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3641 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	5774	6810	No
v_{12}	3641	4400	No
$v_{FO} = v_F - v_R$	5185	6810	No
v_R	589	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 31.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **D**

Speed Estimation

Intermediate speed variable, D_S = 0.481

Space mean speed in ramp influence area, S_R = 49.8 mph

Space mean speed in outer lanes, S_0 = 58.1 mph

Space mean speed for all vehicles, S = 52.6 mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	**AM Peak**
Freeway/Dir of Travel:	**H1 WB**
Junction:	**F Weaver Rd & H1 Loop Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	Existing
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	57.0	mph
Volume on freeway	4667	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	1765	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane	500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	4667		1765			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1296		490			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	5186		1961			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.450 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3412 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	5186	6810	No
v_{12}	3412	4400	No
$v_{FO} = v_F - v_R$	3225	6810	No
v_R	1961	3800	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 20.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **C**

Speed Estimation

Intermediate speed variable,	D_S = 0.604	
Space mean speed in ramp influence area,	S_R = 47.9	mph
Space mean speed in outer lanes,	S_0 = 59.5	mph
Space mean speed for all vehicles,	S = 51.4	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	AM Peak
Freeway/Dir of Travel:	**H-1 WB**
Junction:	**Fort Weaver Rd and H-1 On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**Existing**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	57.0	mph
Volume on freeway	2902	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	429	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2902	429		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	806	119		v
Trucks and buses	0	0		%
Recreational vehicles	0	0		%
Terrain type:	Level	Level		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5		
Recreational vehicle PCE, ER	1.2	1.2		
Heavy vehicle adjustment, fHV	1.000	1.000		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	3224	477		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.591 Using Equation 1

$v_{12} = v_F (P_{FM})$ = 1907 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3701	6810	No
v_{R12}	2384	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 20.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **C**

Speed Estimation

Intermediate speed variable,	M_S = 0.328	
Space mean speed in ramp influence area,	S_R = 52.1	mph
Space mean speed in outer lanes,	S_0 = 54.1	mph
Space mean speed for all vehicles,	S = 52.8	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	AM Peak
Freeway/Dir of Travel:	**H1 EB**
Junction:	**F Weaver Rd & H1 Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**Existing**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	57.0	mph
Volume on freeway	3808	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	756	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	3808		756			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1058		210			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	4231		840			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.616 Using Equation 5

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2927 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4231	6810	No
v_{12}	2927	4400	No
$v_{FO} = v_F - v_R$	3391	6810	No
v_R	840	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 24.9 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **C**

Speed Estimation

Intermediate speed variable,	D_S = 0.504	
Space mean speed in ramp influence area,	S_R = 49.4	mph
Space mean speed in outer lanes,	S_0 = 61.3	mph
Space mean speed for all vehicles,	S = 52.6	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H1 WB**
Junction:	**F Weaver Rd & H1 Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**Existing**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	57.0	mph
Volume on freeway	7368	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	1230	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	7368		1230			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	2047		342			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	8187		1367			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.492 Using Equation 5

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 4725 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	8187	6810	Yes
v_{12}	4725	4400	Yes
$v_{FO} = v_F - v_R$	6820	6810	Yes
v_R	1367	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 40.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **F**

Speed Estimation

Intermediate speed variable,	D_S = 0.551	
Space mean speed in ramp influence area,	S_R = 48.7	mph
Space mean speed in outer lanes,	S_0 = 52.9	mph
Space mean speed for all vehicles,	S = 50.4	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	**PM Peak**
Freeway/Dir of Travel:	**H1 WB**
Junction:	**F Weaver Rd & H1 Loop Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	Existing
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	57.0	mph
Volume on freeway	6138	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	2657	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane	500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6138		2657			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1705		738			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	6820		2952			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.450 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 4693 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6820	6810	Yes
v_{12}	4693	4400	Yes
$v_{FO} = v_F - v_R$	3868	6810	No
v_R	2952	3800	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 31.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **F**

Speed Estimation

Intermediate speed variable,	D_S = 0.694	
Space mean speed in ramp influence area,	S_R = 46.6	mph
Space mean speed in outer lanes,	S_0 = 58.1	mph
Space mean speed for all vehicles,	S = 49.7	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H-1 WB**
Junction:	**Fort Weaver Rd and H-1 On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**Existing**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	57.0	mph
Volume on freeway	3481	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	598	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3481	598		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	967	166		v
Trucks and buses	0	0		%
Recreational vehicles	0	0		%
Terrain type:	Level	Level		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5		
Recreational vehicle PCE, ER	1.2	1.2		
Heavy vehicle adjustment, fHV	1.000	1.000		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	3868	664		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.591 Using Equation 1

$v_{12} = v_F (P_{FM})$ = 2288 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4532	6810	No
v_{R12}	2952	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 25.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **C**

Speed Estimation

Intermediate speed variable,	M_S = 0.361	
Space mean speed in ramp influence area,	S_R = 51.6	mph
Space mean speed in outer lanes,	S_0 = 53.1	mph
Space mean speed for all vehicles,	S = 52.1	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H1 EB**
Junction:	**F Weaver Rd & H1 Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**Existing**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	57.0	mph
Volume on freeway	4077	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	497	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	4077		497			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1133		138			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	4530		552			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.621 Using Equation 5

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3024 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4530	6810	No
v_{12}	3024	4400	No
$v_{FO} = v_F - v_R$	3978	6810	No
v_R	552	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 25.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **C**

Speed Estimation

Intermediate speed variable,	D_S = 0.478	
Space mean speed in ramp influence area,	S_R = 49.8	mph
Space mean speed in outer lanes,	S_0 = 60.6	mph
Space mean speed for all vehicles,	S = 53.0	mph

APPENDIX C-2

YEAR 2030 CONDITIONS

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	AM Peak
Freeway/Dir of Travel:	**H1 WB**
Junction:	**F Weaver Rd & H1 Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	3537	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	280	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	3537		280			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	983		78			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	3930		311			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 1889 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3930	9140	No
v_{12}	1889	4400	No
$v_{FO} = v_F - v_R$	3619	9140	No
v_R	311	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 16.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **B**

Speed Estimation

Intermediate speed variable,	D_S = 0.456	
Space mean speed in ramp influence area,	S_R = 51.0	mph
Space mean speed in outer lanes,	S_0 = 64.1	mph
Space mean speed for all vehicles,	S = 57.0	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	2/7/2007
Analysis time period:	**AM Peak**
Freeway/Dir of Travel:	**H1 WB**
Junction:	F Weaver Rd & H1 Loop Off Ramp
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	3567	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	235	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane	500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	3567		235			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	991		65			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	3963		261			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.260 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 1224 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3963	9140	No
v_{12}	1224	4400	No
$v_{FO} = v_F - v_R$	3702	9140	No
v_R	261	3800	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 1.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **A**

Speed Estimation

Intermediate speed variable,	D_S = 0.451	
Space mean speed in ramp influence area,	S_R = 51.1	mph
Space mean speed in outer lanes,	S_0 = 62.7	mph
Space mean speed for all vehicles,	S = 58.6	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	AM Peak
Freeway/Dir of Travel:	**H-1 WB**
Junction:	**Fort Weaver Rd and H-1 On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	3257	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	478	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	3257		478			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	905		133			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	3619		531			pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.311 Using Equation 4

$v_{12} = v_F (P_{FM})$ = 1124 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4150	9140	No
v_{R12}	1655	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 15.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **B**

Speed Estimation

Intermediate speed variable,	M_S = 0.306	
Space mean speed in ramp influence area,	S_R = 53.4	mph
Space mean speed in outer lanes,	S_0 = 55.8	mph
Space mean speed for all vehicles,	S = 54.8	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	AM Peak
Freeway/Dir of Travel:	**H1 EB**
Junction:	**F Weaver Rd & H1 Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	8197	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	639	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	8197		639			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	2277		178			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	9108		710			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 4372 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	9108	9140	No
v_{12}	4372	4400	No
$v_{FO} = v_F - v_R$	8398	9140	No
v_R	710	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 37.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **E**

Speed Estimation

Intermediate speed variable, D_S = 0.492

Space mean speed in ramp influence area, S_R = 50.4 mph

Space mean speed in outer lanes, S_0 = 58.8 mph

Space mean speed for all vehicles, S = 54.5 mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	2/7/2007
Analysis time period:	**AM Peak**
Freeway/Dir of Travel:	**H-1 EB**
Junction:	Fort Weaver Rd & H-1 On Ramp
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	8333	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-flow speed on ramp	35.0	mph
Volume on ramp	1667	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane	500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	751	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	500	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	8333		1667		751	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	2315		463		209	v
Trucks and buses	0		0		0	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	1.000		1.000		1.000	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	9259		1852		834	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.209 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1935 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	11111	9140	Yes
v_{R12}	3787	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 24.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **F**

Speed Estimation

Intermediate speed variable,	M_S = 0.388	
Space mean speed in ramp influence area,	S_R = 52.1	mph
Space mean speed in outer lanes,	S_0 = 43.8	mph
Space mean speed for all vehicles,	S = 46.3	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	**AM Peak**
Freeway/Dir of Travel:	**H-1 EB**
Junction:	**F Weaver Rd & H-1 Loop On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	7558	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	751	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1807	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	500	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	7558		751		1807	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	2099		209		502	v
Trucks and buses	0		0		0	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	1.000		1.000		1.000	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	8398		834		2008	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.273 Using Equation 4

$v_{12} = v_F (P_{FM})$ = 2291 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	9232	9140	Yes
v_{R12}	3125	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 26.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **F**

Speed Estimation

Intermediate speed variable,	M_S = 0.375	
Space mean speed in ramp influence area,	S_R = 52.3	mph
Space mean speed in outer lanes,	S_0 = 47.5	mph
Space mean speed for all vehicles,	S = 49.0	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	**AM Peak**
Freeway/Dir of Travel:	**H1 WB**
Junction:	**North South Rd & H1 Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	3735	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	927	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	3735		927			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1038		258			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	4150		1030			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2390 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4150	9140	No
v_{12}	2390	4400	No
$v_{FO} = v_F - v_R$	3120	9140	No
v_R	1030	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 20.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **C**

Speed Estimation

Intermediate speed variable,	D_S = 0.521	
Space mean speed in ramp influence area,	S_R = 49.9	mph
Space mean speed in outer lanes,	S_0 = 64.2	mph
Space mean speed for all vehicles,	S = 55.1	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	AM Peak
Freeway/Dir of Travel:	**H-1 WB**
Junction:	**North-South Rd and H-1 On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	2808	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	415	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	2808		415			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	780		115			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	3120		461			pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.319 Using Equation 4

$v_{12} = v_F (P_{FM})$ = 997 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3581	9140	No
v_{R12}	1458	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 13.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **B**

Speed Estimation

Intermediate speed variable,	M_S = 0.303	
Space mean speed in ramp influence area,	S_R = 53.5	mph
Space mean speed in outer lanes,	S_0 = 56.5	mph
Space mean speed for all vehicles,	S = 55.2	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	AM Peak
Freeway/Dir of Travel:	**H1 EB**
Junction:	**North South Rd & H1 Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	5681	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	298	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	5681		298			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1578		83			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	6312		331			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2939 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6312	9140	No
v_{12}	2939	4400	No
$v_{FO} = v_F - v_R$	5981	9140	No
v_R	331	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 25.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **C**

Speed Estimation

Intermediate speed variable,	D_S = 0.458	
Space mean speed in ramp influence area,	S_R = 50.9	mph
Space mean speed in outer lanes,	S_0 = 61.5	mph
Space mean speed for all vehicles,	S = 56.1	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	AM Peak
Freeway/Dir of Travel:	**H-1 EB**
Junction:	**North-South Rd and H-1 On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	5383	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-flow speed on ramp	35.0	mph
Volume on ramp	2814	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane	500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	5383		2814			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1495		782			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	5981		3127			pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.209 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1250 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	9108	9140	No
v_{R12}	4377	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 28.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **D**

Speed Estimation

Intermediate speed variable,	M_S = 0.526	
Space mean speed in ramp influence area,	S_R = 49.8	mph
Space mean speed in outer lanes,	S_0 = 51.6	mph
Space mean speed for all vehicles,	S = 50.7	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H1 WB**
Junction:	**F Weaver Rd & H1 Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	8777	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	303	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	8777		303			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	2438		84			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	9752		337			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 4442 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	9752	9140	Yes
v_{12}	4442	4400	Yes
$v_{FO} = v_F - v_R$	9415	9140	Yes
v_R	337	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 38.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **F**

Speed Estimation

Intermediate speed variable,	D_S = 0.458	
Space mean speed in ramp influence area,	S_R = 50.9	mph
Space mean speed in outer lanes,	S_0 = 57.7	mph
Space mean speed for all vehicles,	S = 54.4	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	2/7/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H1 WB**
Junction:	**F Weaver Rd & H1 Loop Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	8519	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	1126	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane	500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	8519		1126			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	2366		313			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	9466		1251			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.260 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3387 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	9466	9140	Yes
v_{12}	3387	4400	No
$v_{FO} = v_F - v_R$	8215	9140	No
v_R	1251	3800	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 19.9 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **F**

Speed Estimation

Intermediate speed variable,	D_S = 0.541	
Space mean speed in ramp influence area,	S_R = 49.6	mph
Space mean speed in outer lanes,	S_0 = 56.2	mph
Space mean speed for all vehicles,	S = 53.7	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H-1 WB**
Junction:	**Fort Weaver Rd and H-1 On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	7348	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	512	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	7348	512		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	2041	142		v
Trucks and buses	0	0		%
Recreational vehicles	0	0		%
Terrain type:	Level	Level		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5		
Recreational vehicle PCE, ER	1.2	1.2		
Heavy vehicle adjustment, fHV	1.000	1.000		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	8164	569		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.306 Using Equation 4

$v_{12} = v_F (P_{FM})$ = 2498 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	8733	9140	No
v_{R12}	3067	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 26.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **C**

Speed Estimation

Intermediate speed variable,	M_S = 0.370	
Space mean speed in ramp influence area,	S_R = 52.4	mph
Space mean speed in outer lanes,	S_0 = 48.8	mph
Space mean speed for all vehicles,	S = 50.0	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H1 EB**
Junction:	**F Weaver Rd & H1 Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	5833	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	873	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	5833		873			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1620		243			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	6481		970			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3373 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6481	9140	No
v_{12}	3373	4400	No
$v_{FO} = v_F - v_R$	5511	9140	No
v_R	970	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 28.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **D**

Speed Estimation

Intermediate speed variable,	D_S = 0.515	
Space mean speed in ramp influence area,	S_R = 50.0	mph
Space mean speed in outer lanes,	S_0 = 62.0	mph
Space mean speed for all vehicles,	S = 55.1	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	2/7/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H-1 EB**
Junction:	**Fort Weaver Rd and H-1 On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	5881	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-flow speed on ramp	35.0	mph
Volume on ramp	1423	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane	500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	843	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	500	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	5881	1423	843	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	1634	395	234	v
Trucks and buses	0	0	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	6534	1581	937	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.209 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1366 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	8115	9140	No
v_{R12}	2947	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 18.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **B**

Speed Estimation

Intermediate speed variable,	M_S = 0.290	
Space mean speed in ramp influence area,	S_R = 53.7	mph
Space mean speed in outer lanes,	S_0 = 50.3	mph
Space mean speed for all vehicles,	S = 51.5	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	**PM Peak**
Freeway/Dir of Travel:	**H-1 EB**
Junction:	**F Weaver Rd & H-1 Loop On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	4960	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	843	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1313	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	500	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	4960		843		1313	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	1378		234		365	v
Trucks and buses	0		0		0	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	1.000		1.000		1.000	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	5511		937		1459	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.260 Using Equation 4

$v_{12} = v_F (P_{FM})$ = 1433 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	6448	9140	No
v_{R12}	2370	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 20.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **C**

Speed Estimation

Intermediate speed variable,	M_S = 0.328	
Space mean speed in ramp influence area,	S_R = 53.1	mph
Space mean speed in outer lanes,	S_0 = 53.0	mph
Space mean speed for all vehicles,	S = 53.0	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	**PM Peak**
Freeway/Dir of Travel:	**H1 WB**
Junction:	**North South Rd & H1 Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	Year 2030
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	7860	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	1602	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	7860		1602			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	2183		445			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	8733		1780			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 4812 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	8733	9140	No
v_{12}	4812	4400	Yes
$v_{FO} = v_F - v_R$	6953	9140	No
v_R	1780	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 41.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **F**

Speed Estimation

Intermediate speed variable,	D_S = 0.588	
Space mean speed in ramp influence area,	S_R = 48.8	mph
Space mean speed in outer lanes,	S_0 = 60.4	mph
Space mean speed for all vehicles,	S = 53.4	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM	
Agency/Co.:	Wilbur Smith Associates	
Date performed:	1/5/2007	
Analysis time period:	PM Peak	
Freeway/Dir of Travel:	**H-1 WB**	
Junction:	**North-South Rd and H-1 On Ramp**	
Jurisdiction:	Kapolei	
Analysis Year:	**Year 2030**	
Description: East Kapolei TIAR		

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	7860	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	230	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	7860	230		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	2183	64		v
Trucks and buses	0	0		%
Recreational vehicles	0	0		%
Terrain type:	Level	Level		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5		
Recreational vehicle PCE, ER	1.2	1.2		
Heavy vehicle adjustment, fHV	1.000	1.000		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	8733	256		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.345 Using Equation 4

$v_{12} = v_F (P_{FM})$ = 3014 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	8989	9140	No
v_{R12}	3270	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 27.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **C**

Speed Estimation

Intermediate speed variable,	M_S = 0.389	
Space mean speed in ramp influence area,	S_R = 52.1	mph
Space mean speed in outer lanes,	S_0 = 48.6	mph
Space mean speed for all vehicles,	S = 49.8	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H1 EB**
Junction:	**North South Rd & H1 Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	4589	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	396	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	4589		396			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1275		110			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	5099		440			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2471 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	5099	9140	No
v_{12}	2471	4400	No
$v_{FO} = v_F - v_R$	4659	9140	No
v_R	440	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 21.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **C**

Speed Estimation

Intermediate speed variable, D_S = 0.468

Space mean speed in ramp influence area, S_R = 50.8 mph

Space mean speed in outer lanes, S_0 = 62.9 mph

Space mean speed for all vehicles, S = 56.4 mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H-1 EB**
Junction:	**North-South Rd and H-1 On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**Year 2030**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	4193	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-flow speed on ramp	35.0	mph
Volume on ramp	1640	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane	500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4193	1640		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	1165	456		v
Trucks and buses	0	0		%
Recreational vehicles	0	0		%
Terrain type:	Level	Level		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5		
Recreational vehicle PCE, ER	1.2	1.2		
Heavy vehicle adjustment, fHV	1.000	1.000		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	4659	1822		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.209 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 974 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	6481	9140	No
v_{R12}	2796	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 17.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **B**

Speed Estimation

Intermediate speed variable,	M_S = 0.280	
Space mean speed in ramp influence area,	S_R = 53.9	mph
Space mean speed in outer lanes,	S_0 = 53.7	mph
Space mean speed for all vehicles,	S = 53.8	mph

APPENDIX C-3
YEAR 2030 PLUS PROJECT CONDITIONS
SCENARIO A: WITH TRANSIT CORRIDOR SCENARIO

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	AM Peak
Freeway/Dir of Travel:	**H1 WB**
Junction:	**F Weaver Rd & H1 Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030 + Project w Transit Red**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	5299	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	280	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	5299		280			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1472		78			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	5888		311			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2743 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	5888	9140	No
v_{12}	2743	4400	No
$v_{FO} = v_F - v_R$	5577	9140	No
v_R	311	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ = 23.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **C**

Speed Estimation

Intermediate speed variable,	D_S = 0.456	
Space mean speed in ramp influence area,	S_R = 51.0	mph
Space mean speed in outer lanes,	S_0 = 61.9	mph
Space mean speed for all vehicles,	S = 56.3	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	2/8/2007
Analysis time period:	AM Peak
Freeway/Dir of Travel:	**H1 WB**
Junction:	**F Weaver Rd & H1 Loop Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030 + Project w Transit Red**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	4984	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	1078	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane	500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	4984		1078			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1384		299			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	5538		1198			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.260 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2326 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	5538	9140	No
v_{12}	2326	4400	No
$v_{FO} = v_F - v_R$	4340	9140	No
v_R	1198	3800	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 10.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **B**

Speed Estimation

Intermediate speed variable,	D_S = 0.536	
Space mean speed in ramp influence area,	S_R = 49.7	mph
Space mean speed in outer lanes,	S_0 = 61.8	mph
Space mean speed for all vehicles,	S = 56.1	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	AM Peak
Freeway/Dir of Travel:	**H-1 WB**
Junction:	**Fort Weaver Rd and H-1 On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030 + Project w Transit Red**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	3906	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	585	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3906	585		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	1085	163		v
Trucks and buses	0	0		%
Recreational vehicles	0	0		%
Terrain type:	Level	Level		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5		
Recreational vehicle PCE, ER	1.2	1.2		
Heavy vehicle adjustment, fHV	1.000	1.000		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	4340	650		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.296 Using Equation 4

$v_{12} = v_F (P_{FM})$ = 1284 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4990	9140	No
v_{R12}	1934	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 17.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **B**

Speed Estimation

Intermediate speed variable,	M_S = 0.313	
Space mean speed in ramp influence area,	S_R = 53.3	mph
Space mean speed in outer lanes,	S_0 = 54.8	mph
Space mean speed for all vehicles,	S = 54.2	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	AM Peak
Freeway/Dir of Travel:	**H1 EB**
Junction:	**F Weaver Rd & H1 Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030 + Project w Transit Red**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	9143	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	812	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	9143		812			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	2540		226			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	10159		902			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 4938 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	10159	9140	Yes
v_{12}	4938	4400	Yes
$v_{FO} = v_F - v_R$	9257	9140	Yes
v_R	902	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 42.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **F**

Speed Estimation

Intermediate speed variable,	D_S = 0.509	
Space mean speed in ramp influence area,	S_R = 50.1	mph
Space mean speed in outer lanes,	S_0 = 57.9	mph
Space mean speed for all vehicles,	S = 53.8	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst: MM
Agency/Co.: Wilbur Smith Associates
Date performed: 2/8/2007
Analysis time period: AM Peak
Freeway/Dir of Travel: **H-1 EB**
Junction: **Fort Weaver Rd & H-1 On Ramp**
Jurisdiction: Kapolei
Analysis Year: **2030 + Project w Transit Red**
Description: East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	9082	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-flow speed on ramp	35.0	mph
Volume on ramp	2893	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane	500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	751	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	500	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	9082		2893		751	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	2523		804		209	v
Trucks and buses	0		0		0	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	1.000		1.000		1.000	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	10091		3214		834	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.209 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 2109 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	13305	9140	Yes
v_{R12}	5323	4600	Yes

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 36.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **F**

Speed Estimation

Intermediate speed variable,	M_S = 1.015	
Space mean speed in ramp influence area,	S_R = 41.7	mph
Space mean speed in outer lanes,	S_0 = 41.8	mph
Space mean speed for all vehicles,	S = 41.8	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	**AM Peak**
Freeway/Dir of Travel:	**H-1 EB**
Junction:	**F Weaver Rd & H-1 Loop On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	2030 + Project w Transit Red
Description: East Kapolei TIAR	

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	8331	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	751	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	3030	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	500	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	8331		751		3030	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	2314		209		842	v
Trucks and buses	0		0		0	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	1.000		1.000		1.000	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	9257		834		3367	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.273 Using Equation 4

$v_{12} = v_F (P_{FM})$ = 2526 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	10091	9140	Yes
v_{R12}	3360	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 28.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **F**

Speed Estimation

Intermediate speed variable,	M_S = 0.398	
Space mean speed in ramp influence area,	S_R = 51.9	mph
Space mean speed in outer lanes,	S_0 = 45.6	mph
Space mean speed for all vehicles,	S = 47.5	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	AM Peak
Freeway/Dir of Travel:	**H1 WB**
Junction:	**North South Rd & H1 Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030 + Pro with Transit Red.**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	4491	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	1628	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	4491		1628			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1248		452			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	4990		1809			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3196 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4990	9140	No
v_{12}	3196	4400	No
$v_{FO} = v_F - v_R$	3181	9140	No
v_R	1809	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 27.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **C**

Speed Estimation

Intermediate speed variable,	D_S = 0.591	
Space mean speed in ramp influence area,	S_R = 48.8	mph
Space mean speed in outer lanes,	S_0 = 64.2	mph
Space mean speed for all vehicles,	S = 53.4	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	AM Peak
Freeway/Dir of Travel:	**H-1 WB**
Junction:	**North-South Rd and H-1 On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030 + Pro with Transit Red.**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	2863	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	967	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2863	967		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	795	269		v
Trucks and buses	0	0		%
Recreational vehicles	0	0		%
Terrain type:	Level	Level		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5		
Recreational vehicle PCE, ER	1.2	1.2		
Heavy vehicle adjustment, fHV	1.000	1.000		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	3181	1074		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.243 Using Equation 4

$v_{12} = v_F (P_{FM})$ = 772 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4255	9140	No
v_{R12}	1846	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 16.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **B**

Speed Estimation

Intermediate speed variable,	M_S = 0.311	
Space mean speed in ramp influence area,	S_R = 53.4	mph
Space mean speed in outer lanes,	S_0 = 56.0	mph
Space mean speed for all vehicles,	S = 54.8	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	AM Peak
Freeway/Dir of Travel:	**H1 EB**
Junction:	**North South Rd & H1 Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030 + Pro with Transit Red.**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	6081	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	762	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6081		762			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1689		212			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	6757		847			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3424 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6757	9140	No
v_{12}	3424	4400	No
$v_{FO} = v_F - v_R$	5910	9140	No
v_R	847	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 29.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **D**

Speed Estimation

Intermediate speed variable,	D_S = 0.504	
Space mean speed in ramp influence area,	S_R = 50.2	mph
Space mean speed in outer lanes,	S_0 = 61.6	mph
Space mean speed for all vehicles,	S = 55.2	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	AM Peak
Freeway/Dir of Travel:	**H-1 EB**
Junction:	**North-South Rd and H-1 On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030 + Pro with Transit Red.**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	5319	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-flow speed on ramp	35.0	mph
Volume on ramp	3824	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane	500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	5319		3824			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1478		1062			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	5910		4249			pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.209 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1235 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	10159	9140	Yes
v_{R12}	5484	4600	Yes

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 36.9 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **F**

Speed Estimation

Intermediate speed variable,	M_S = 1.155	
Space mean speed in ramp influence area,	S_R = 39.4	mph
Space mean speed in outer lanes,	S_0 = 51.7	mph
Space mean speed for all vehicles,	S = 44.3	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H1 WB**
Junction:	**F Weaver Rd & H1 Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030 + Project w Transit Red**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	10977	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	303	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	10977		303			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	3049		84			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	12197		337			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD} = 5508$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	12197	9140	Yes
v_{12}	5508	4400	Yes
$v_{FO} = v_F - v_R$	11860	9140	Yes
v_R	337	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D = 47.1$ pc/mi/ln

Level of service for ramp-freeway junction areas of influence **F**

Speed Estimation

Intermediate speed variable,	$D_S = 0.458$	
Space mean speed in ramp influence area,	$S_R = 50.9$	mph
Space mean speed in outer lanes,	$S_0 = 55.0$	mph
Space mean speed for all vehicles,	$S = 53.1$	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	2/8/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H1 WB**
Junction:	**F Weaver Rd & H1 Loop Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030 + Project w Transit Red**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	10544	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	2354	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane	500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	10544		2354			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	2929		654			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	11716		2616			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.260 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 4982 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	11716	9140	Yes
v_{12}	4982	4400	Yes
$v_{FO} = v_F - v_R$	9100	9140	No
v_R	2616	3800	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 33.6 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **F**

Speed Estimation

Intermediate speed variable,	D_S = 0.663	
Space mean speed in ramp influence area,	S_R = 47.6	mph
Space mean speed in outer lanes,	S_0 = 54.9	mph
Space mean speed for all vehicles,	S = 51.5	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H-1 WB**
Junction:	**Fort Weaver Rd and H-1 On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030 + Project w Transit Red**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	8190	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	685	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	8190	685		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	2275	190		v
Trucks and buses	0	0		%
Recreational vehicles	0	0		%
Terrain type:	Level	Level		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5		
Recreational vehicle PCE, ER	1.2	1.2		
Heavy vehicle adjustment, fHV	1.000	1.000		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	9100	761		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.282 Using Equation 4

$v_{12} = v_F (P_{FM})$ = 2566 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	9861	9140	Yes
v_{R12}	3327	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 27.9 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **F**

Speed Estimation

Intermediate speed variable,	M_S = 0.395	
Space mean speed in ramp influence area,	S_R = 52.0	mph
Space mean speed in outer lanes,	S_0 = 46.2	mph
Space mean speed for all vehicles,	S = 48.0	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H1 EB**
Junction:	**F Weaver Rd & H1 Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030 + Project w Transit Red**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	6891	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	1121	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6891		1121			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1914		311			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	7657		1246			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 4041 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	7657	9140	No
v_{12}	4041	4400	No
$v_{FO} = v_F - v_R$	6411	9140	No
v_R	1246	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 34.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **D**

Speed Estimation

Intermediate speed variable,	D_S = 0.540	
Space mean speed in ramp influence area,	S_R = 49.6	mph
Space mean speed in outer lanes,	S_0 = 61.0	mph
Space mean speed for all vehicles,	S = 54.4	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	2/8/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H-1 EB**
Junction:	**Fort Weaver Rd and H-1 On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030 + Project w Transit Red**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	6613	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-flow speed on ramp	35.0	mph
Volume on ramp	2615	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane	500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	843	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	500	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6613		2615		843	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	1837		726		234	v
Trucks and buses	0		0		0	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	1.000		1.000		1.000	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	7348		2906		937	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.209 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1536 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	10254	9140	Yes
v_{R12}	4442	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 29.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **F**

Speed Estimation

Intermediate speed variable,	M_S = 0.547	
Space mean speed in ramp influence area,	S_R = 49.5	mph
Space mean speed in outer lanes,	S_0 = 48.3	mph
Space mean speed for all vehicles,	S = 48.8	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	**PM Peak**
Freeway/Dir of Travel:	**H-1 EB**
Junction:	**F Weaver Rd & H-1 Loop On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	2030 + Project w Transit Red

Description: East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	5770	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	843	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	2502	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	500	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	5770	843	2502	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	1603	234	695	v
Trucks and buses	0	0	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	6411	937	2780	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.260 Using Equation 4

$v_{12} = v_F (P_{FM})$ = 1667 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	7348	9140	No
v_{R12}	2604	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 22.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **C**

Speed Estimation

Intermediate speed variable,	M_S = 0.339	
Space mean speed in ramp influence area,	S_R = 52.9	mph
Space mean speed in outer lanes,	S_0 = 51.5	mph
Space mean speed for all vehicles,	S = 52.0	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H1 WB**
Junction:	**North South Rd & H1 Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030 + Pro with Transit Red.**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	8875	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	2511	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	8875		2511			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	2465		698			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	9861		2790			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 5873 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	9861	9140	Yes
v_{12}	5873	4400	Yes
$v_{FO} = v_F - v_R$	7071	9140	No
v_R	2790	2000	Yes

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 50.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **F**

Speed Estimation

Intermediate speed variable,	D_S = 0.679	
Space mean speed in ramp influence area,	S_R = 47.3	mph
Space mean speed in outer lanes,	S_0 = 60.3	mph
Space mean speed for all vehicles,	S = 51.8	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H-1 WB**
Junction:	**North-South Rd and H-1 On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030 + Pro with Transit Red.**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	6364	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	957	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6364		957			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1768		266			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	7071		1063			pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.244 Using Equation 4

$v_{12} = v_F (P_{FM})$ = 1727 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	8134	9140	No
v_{R12}	2790	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 23.6 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **C**

Speed Estimation

Intermediate speed variable,	M_S = 0.349	
Space mean speed in ramp influence area,	S_R = 52.7	mph
Space mean speed in outer lanes,	S_0 = 49.7	mph
Space mean speed for all vehicles,	S = 50.7	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H1 EB**
Junction:	**North South Rd & H1 Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030 + Pro with Transit Red.**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	5405	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	1060	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	5405		1060			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1501		294			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	6006		1178			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3283 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6006	9140	No
v_{12}	3283	4400	No
$v_{FO} = v_F - v_R$	4828	9140	No
v_R	1178	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 28.0- pc/mi/ln

Level of service for ramp-freeway junction areas of influence **C**

Speed Estimation

Intermediate speed variable,	D_S = 0.534	
Space mean speed in ramp influence area,	S_R = 49.7	mph
Space mean speed in outer lanes,	S_0 = 62.8	mph
Space mean speed for all vehicles,	S = 54.9	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H-1 EB**
Junction:	**North-South Rd and H-1 On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030 + Pro with Transit Red.**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	4345	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-flow speed on ramp	35.0	mph
Volume on ramp	2546	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane	500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	4345		2546			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1207		707			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	4828		2829			pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.209 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1009 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	7657	9140	No
v_{R12}	3838	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 24.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **C**

Speed Estimation

Intermediate speed variable,	M_S = 0.397	
Space mean speed in ramp influence area,	S_R = 51.9	mph
Space mean speed in outer lanes,	S_0 = 53.4	mph
Space mean speed for all vehicles,	S = 52.7	mph

APPENDIX C-4

YEAR 2030 PLUS PROJECT CONDITIONS SCENARIO B: WITHOUT TRANSIT CORRIDOR SCENARIO

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst: MM
Agency/Co.: Wilbur Smith Associates
Date performed: 1/5/2007
Analysis time period: AM Peak
Freeway/Dir of Travel: **H1 WB**
Junction: **F Weaver Rd & H1 Off Ramp**
Jurisdiction: Kapolei
Analysis Year: **2030 + Project w/o Transit Red**
Description: East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	5415	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	280	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	5415		280			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1504		78			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	6017		311			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2799 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6017	9140	No
v_{12}	2799	4400	No
$v_{FO} = v_F - v_R$	5706	9140	No
v_R	311	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 23.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **C**

Speed Estimation

Intermediate speed variable, D_S = 0.456

Space mean speed in ramp influence area, S_R = 51.0 mph

Space mean speed in outer lanes, S_0 = 61.8 mph

Space mean speed for all vehicles, S = 56.2 mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst: MM
Agency/Co.: Wilbur Smith Associates
Date performed: 2/8/2007
Analysis time period: AM Peak
Freeway/Dir of Travel: **H1 WB**
Junction: **F Weaver Rd & H1 Loop Off Ramp**
Jurisdiction: Kapolei
Analysis Year: **2030 + Project w/o Transit Red**
Description: East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	5109	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	1153	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane	500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	5109		1153			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1419		320			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	5677		1281			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.260 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2424 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	5677	9140	No
v_{12}	2424	4400	No
$v_{FO} = v_F - v_R$	4396	9140	No
v_R	1281	3800	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 11.6 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **B**

Speed Estimation

Intermediate speed variable,	D_S = 0.543	
Space mean speed in ramp influence area,	S_R = 49.5	mph
Space mean speed in outer lanes,	S_0 = 61.7	mph
Space mean speed for all vehicles,	S = 55.9	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	AM Peak
Freeway/Dir of Travel:	**H-1 WB**
Junction:	**Fort Weaver Rd and H-1 On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030 + Project w/o Transit Red**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	3956	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	593	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3956	593		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	1099	165		v
Trucks and buses	0	0		%
Recreational vehicles	0	0		%
Terrain type:	Level	Level		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5		
Recreational vehicle PCE, ER	1.2	1.2		
Heavy vehicle adjustment, fHV	1.000	1.000		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	4396	659		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.295 Using Equation 4

$v_{12} = v_F (P_{FM})$ = 1296 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	5055	9140	No
v_{R12}	1955	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 17.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **B**

Speed Estimation

Intermediate speed variable,	M_S = 0.314	
Space mean speed in ramp influence area,	S_R = 53.3	mph
Space mean speed in outer lanes,	S_0 = 54.7	mph
Space mean speed for all vehicles,	S = 54.2	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	AM Peak
Freeway/Dir of Travel:	**H1 EB**
Junction:	**F Weaver Rd & H1 Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030 + Project w/o Transit Red**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	9217	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	826	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	9217		826			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	2560		229			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	10241		918			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 4983 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	10241	9140	Yes
v_{12}	4983	4400	Yes
$v_{FO} = v_F - v_R$	9323	9140	Yes
v_R	918	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 42.6 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **F**

Speed Estimation

Intermediate speed variable,	D_S = 0.511	
Space mean speed in ramp influence area,	S_R = 50.1	mph
Space mean speed in outer lanes,	S_0 = 57.8	mph
Space mean speed for all vehicles,	S = 53.8	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	2/8/2007
Analysis time period:	AM Peak
Freeway/Dir of Travel:	**H-1 EB**
Junction:	**Fort Weaver Rd & H-1 On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030 + Project w/o Transit Red**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	9142	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-flow speed on ramp	35.0	mph
Volume on ramp	2999	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane	500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	751	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	500	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	9142	2999	751	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	2539	833	209	v
Trucks and buses	0	0	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	10158	3332	834	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.209 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 2123 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	13490	9140	Yes
v_{R12}	5455	4600	Yes

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 37.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **F**

Speed Estimation

Intermediate speed variable,	M_S = 1.128	
Space mean speed in ramp influence area,	S_R = 39.9	mph
Space mean speed in outer lanes,	S_0 = 41.7	mph
Space mean speed for all vehicles,	S = 40.9	mph

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Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	**AM Peak**
Freeway/Dir of Travel:	**H-1 EB**
Junction:	**F Weaver Rd & H-1 Loop On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	2030 + Project w/o Transit Red
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	8391	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	751	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	3126	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	500	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	8391	751	3126	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	2331	209	868	v
Trucks and buses	0	0	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	9323	834	3473	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.273 Using Equation 4

$v_{12} = v_F (P_{FM})$ = 2544 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	10157	9140	Yes
v_{R12}	3378	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 28.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **F**

Speed Estimation

Intermediate speed variable,	M_S = 0.400	
Space mean speed in ramp influence area,	S_R = 51.9	mph
Space mean speed in outer lanes,	S_0 = 45.4	mph
Space mean speed for all vehicles,	S = 47.4	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	AM Peak
Freeway/Dir of Travel:	**H1 WB**
Junction:	**North South Rd & H1 Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030+ Pro without Transit Red.**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	4549	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	1682	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4549	1682		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	1264	467		v
Trucks and buses	0	0		%
Recreational vehicles	0	0		%
Terrain type:	Level	Level		
Grade	0.00 %	0.00 %	%	
Length	0.00 mi	0.00 mi	mi	
Trucks and buses PCE, ET	1.5	1.5		
Recreational vehicle PCE, ER	1.2	1.2		
Heavy vehicle adjustment, fHV	1.000	1.000		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	5054	1869		pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3258 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	5054	9140	No
v_{12}	3258	4400	No
$v_{FO} = v_F - v_R$	3185	9140	No
v_R	1869	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 27.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **C**

Speed Estimation

Intermediate speed variable,	D_S = 0.596	
Space mean speed in ramp influence area,	S_R = 48.7	mph
Space mean speed in outer lanes,	S_0 = 64.2	mph
Space mean speed for all vehicles,	S = 53.2	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	AM Peak
Freeway/Dir of Travel:	**H-1 WB**
Junction:	**North-South Rd and H-1 On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030+ Pro without Transit Red.**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	2867	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	1010	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2867	1010		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	796	281		v
Trucks and buses	0	0		%
Recreational vehicles	0	0		%
Terrain type:	Level	Level		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5		
Recreational vehicle PCE, ER	1.2	1.2		
Heavy vehicle adjustment, fHV	1.000	1.000		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	3186	1122		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.237 Using Equation 4

$v_{12} = v_F (P_{FM})$ = 755 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4308	9140	No
v_{R12}	1877	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 16.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **B**

Speed Estimation

Intermediate speed variable,	M_S = 0.311	
Space mean speed in ramp influence area,	S_R = 53.4	mph
Space mean speed in outer lanes,	S_0 = 55.9	mph
Space mean speed for all vehicles,	S = 54.8	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	AM Peak
Freeway/Dir of Travel:	**H1 EB**
Junction:	**North South Rd & H1 Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030+ Pro without Transit Red.**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	6309	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	798	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6309		798			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1753		222			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	7010		887			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3557 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	7010	9140	No
v_{12}	3557	4400	No
$v_{FO} = v_F - v_R$	6123	9140	No
v_R	887	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 30.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **D**

Speed Estimation

Intermediate speed variable,	D_S = 0.508	
Space mean speed in ramp influence area,	S_R = 50.1	mph
Space mean speed in outer lanes,	S_0 = 61.3	mph
Space mean speed for all vehicles,	S = 55.1	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	AM Peak
Freeway/Dir of Travel:	**H-1 EB**
Junction:	**North-South Rd and H-1 On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030+ Pro without Transit Red.**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	5511	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-flow speed on ramp	35.0	mph
Volume on ramp	3706	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane	500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	5511		3706			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1531		1029			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	6123		4118			pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.209 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1280 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	10241	9140	Yes
v_{R12}	5398	4600	Yes

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 36.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **F**

Speed Estimation

Intermediate speed variable,	M_S = 1.078	
Space mean speed in ramp influence area,	S_R = 40.7	mph
Space mean speed in outer lanes,	S_0 = 51.2	mph
Space mean speed for all vehicles,	S = 45.1	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H1 WB**
Junction:	**F Weaver Rd & H1 Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030 + Project w/o Transit Red**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	11163	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	303	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	11163		303			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	3101		84			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	12403		337			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 5598 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	12403	9140	Yes
v_{12}	5598	4400	Yes
$v_{FO} = v_F - v_R$	12066	9140	Yes
v_R	337	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 47.9 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **F**

Speed Estimation

Intermediate speed variable,	D_S = 0.458	
Space mean speed in ramp influence area,	S_R = 50.9	mph
Space mean speed in outer lanes,	S_0 = 54.8	mph
Space mean speed for all vehicles,	S = 53.0	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	2/8/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H1 WB**
Junction:	**F Weaver Rd & H1 Loop Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030 + Project w/o Transit Red**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	10757	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	2495	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane	500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	10757		2495			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	2988		693			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	11952		2772			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.260 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 5159 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	11952	9140	Yes
v_{12}	5159	4400	Yes
$v_{FO} = v_F - v_R$	9180	9140	Yes
v_R	2772	3800	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 35.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **F**

Speed Estimation

Intermediate speed variable,	D_S = 0.677	
Space mean speed in ramp influence area,	S_R = 47.3	mph
Space mean speed in outer lanes,	S_0 = 54.8	mph
Space mean speed for all vehicles,	S = 51.3	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H-1 WB**
Junction:	**Fort Weaver Rd and H-1 On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030 + Project w/o Transit Red**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	8262	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	702	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	8262	702		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	2295	195		v
Trucks and buses	0	0		%
Recreational vehicles	0	0		%
Terrain type:	Level	Level		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5		
Recreational vehicle PCE, ER	1.2	1.2		
Heavy vehicle adjustment, fHV	1.000	1.000		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	9180	780		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.280 Using Equation 4

$v_{12} = v_F (P_{FM})$ = 2567 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	9960	9140	Yes
v_{R12}	3347	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 28.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **F**

Speed Estimation

Intermediate speed variable,	M_S = 0.397	
Space mean speed in ramp influence area,	S_R = 52.0	mph
Space mean speed in outer lanes,	S_0 = 45.9	mph
Space mean speed for all vehicles,	S = 47.8	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst: MM
Agency/Co.: Wilbur Smith Associates
Date performed: 1/5/2007
Analysis time period: PM Peak
Freeway/Dir of Travel: **H1 EB**
Junction: **F Weaver Rd & H1 Off Ramp**
Jurisdiction: Kapolei
Analysis Year: **2030 + Project w/o Transit Red**
Description: East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	6985	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	1146	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6985		1146			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1940		318			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	7761		1273			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 4102 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	7761	9140	No
v_{12}	4102	4400	No
$v_{FO} = v_F - v_R$	6488	9140	No
v_R	1273	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 35.0+ pc/mi/ln

Level of service for ramp-freeway junction areas of influence **E**

Speed Estimation

Intermediate speed variable,	D_S = 0.543	
Space mean speed in ramp influence area,	S_R = 49.5	mph
Space mean speed in outer lanes,	S_0 = 60.9	mph
Space mean speed for all vehicles,	S = 54.3	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	2/8/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H-1 EB**
Junction:	**Fort Weaver Rd and H-1 On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030 + Project w/o Transit Red**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	6682	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-flow speed on ramp	35.0	mph
Volume on ramp	2743	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane	500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	843	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	500	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6682		2743		843	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	1856		762		234	v
Trucks and buses	0		0		0	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	1.000		1.000		1.000	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	7424		3048		937	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.209 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1552 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	10472	9140	Yes
v_{R12}	4600	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 30.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **F**

Speed Estimation

Intermediate speed variable,	M_S = 0.604	
Space mean speed in ramp influence area,	S_R = 48.5	mph
Space mean speed in outer lanes,	S_0 = 48.2	mph
Space mean speed for all vehicles,	S = 48.3	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	**PM Peak**
Freeway/Dir of Travel:	**H-1 EB**
Junction:	**F Weaver Rd & H-1 Loop On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	2030 + Project w/o Transit Red
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	5839	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	843	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	2601	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	500	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	5839		843		2601	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	1622		234		723	v
Trucks and buses	0		0		0	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	1.000		1.000		1.000	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	6488		937		2890	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.260 Using Equation 4

$v_{12} = v_F (P_{FM})$ = 1687 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	7425	9140	No
v_{R12}	2624	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 22.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **C**

Speed Estimation

Intermediate speed variable,	M_S = 0.340	
Space mean speed in ramp influence area,	S_R = 52.9	mph
Space mean speed in outer lanes,	S_0 = 51.4	mph
Space mean speed for all vehicles,	S = 51.9	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst: MM
Agency/Co.: Wilbur Smith Associates
Date performed: 1/5/2007
Analysis time period: PM Peak
Freeway/Dir of Travel: **H1 WB**
Junction: **North South Rd & H1 Off Ramp**
Jurisdiction: Kapolei
Analysis Year: **2030+ Pro without Transit Red.**
Description: East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	8964	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	2588	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	8964		2588			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	2490		719			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	9960		2876			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 5965 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	9960	9140	Yes
v_{12}	5965	4400	Yes
$v_{FO} = v_F - v_R$	7084	9140	No
v_R	2876	2000	Yes

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 51.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **F**

Speed Estimation

Intermediate speed variable, D_S = 0.687

Space mean speed in ramp influence area, S_R = 47.2 mph

Space mean speed in outer lanes, S_0 = 60.3 mph

Space mean speed for all vehicles, S = 51.7 mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H-1 WB**
Junction:	**North-South Rd and H-1 On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030+ Pro without Transit Red.**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	6376	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	1020	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	6376	1020		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	1771	283		v
Trucks and buses	0	0		%
Recreational vehicles	0	0		%
Terrain type:	Level	Level		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5		
Recreational vehicle PCE, ER	1.2	1.2		
Heavy vehicle adjustment, fHV	1.000	1.000		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	7084	1133		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.235 Using Equation 4

$v_{12} = v_F (P_{FM})$ = 1668 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	8217	9140	No
v_{R12}	2801	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 23.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **C**

Speed Estimation

Intermediate speed variable,	M_S = 0.350	
Space mean speed in ramp influence area,	S_R = 52.7	mph
Space mean speed in outer lanes,	S_0 = 49.5	mph
Space mean speed for all vehicles,	S = 50.6	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Diverge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H1 EB**
Junction:	**North South Rd & H1 Off Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030+ Pro without Transit Red.**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	5478	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	1116	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	5478		1116			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1522		310			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	6087		1240			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3353 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6087	9140	No
v_{12}	3353	4400	No
$v_{FO} = v_F - v_R$	4847	9140	No
v_R	1240	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 28.6 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **D**

Speed Estimation

Intermediate speed variable,	D_S = 0.540	
Space mean speed in ramp influence area,	S_R = 49.6	mph
Space mean speed in outer lanes,	S_0 = 62.7	mph
Space mean speed for all vehicles,	S = 54.7	mph

HCS+: Ramps and Ramp Junctions Release 5.2

Merge Analysis

Analyst:	MM
Agency/Co.:	Wilbur Smith Associates
Date performed:	1/5/2007
Analysis time period:	PM Peak
Freeway/Dir of Travel:	**H-1 EB**
Junction:	**North-South Rd and H-1 On Ramp**
Jurisdiction:	Kapolei
Analysis Year:	**2030+ Pro without Transit Red.**
Description:	East Kapolei TIAR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	58.5	mph
Volume on freeway	4362	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-flow speed on ramp	35.0	mph
Volume on ramp	2623	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane	500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	4362		2623			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	1212		729			v
Trucks and buses	0		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	1.000		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	4847		2914			pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.209 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1013 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	7761	9140	No
v_{R12}	3927	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 25.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence **C**

Speed Estimation

Intermediate speed variable,	M_S = 0.414	
Space mean speed in ramp influence area,	S_R = 51.7	mph
Space mean speed in outer lanes,	S_0 = 53.4	mph
Space mean speed for all vehicles,	S = 52.5	mph

APPENDIX D

SIGNAL WARRANT ANALYSIS

APPENDIX D-1

YEAR 2030 CONDITIONS

Year 2030 Conditions

#2

Figure 4C-101. Traffic Signal Warrants Worksheet (Sheet 1 of 4)

DIST ____ CD Honolulu RTE ____ KPM ____ CALC: TSO DATE 2/12/07 CHK ____ DATE ____

Major St: Kunia Rd. Critical Approach Speed 40 ~~km/h~~ mph
Minor St: H1 WB Ramps Critical Approach Speed ____ km/h

Critical speed of major street traffic > 64 km/h (40 mph) ☐ or In built up area of isolated community of < 10,000 population ☐ } RURAL (R)
☒ URBAN (U)

WARRANT 3 - Peak Hour — PART A or PART B SATISFIED YES ☒ NO ☐

PART A SATISFIED YES ☐ NO ☐
(All parts 1, 2, and 3 below must be satisfied)

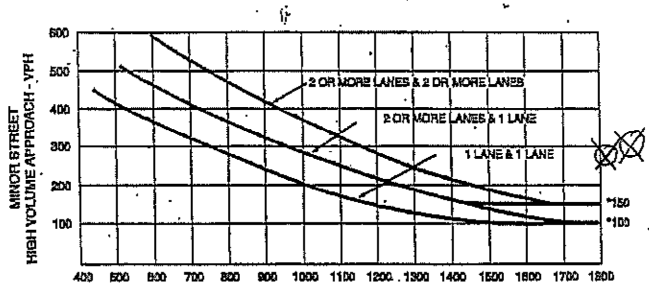
1. The total delay experienced for traffic on one minor street approach controlled by a STOP sign equals or exceeds four vehicle-hours for a one-lane approach and five vehicle-hours for a two-lane approach; AND — Yes ☐ No ☐
2. The volume on the same minor street approach equals or exceeds 100 vph for one moving lane of traffic or 150 vph for two moving lanes; AND — Yes ☐ No ☐
3. The total entering volume serviced during the hour equals or exceeds 800 vph for intersections with four or more approaches or 650 vph for intersections with three approaches. — Yes ☐ No ☐

PART B SATISFIED YES ☒ NO ☐

APPROACH LANES	One	2 or More	AM	PM		Hour
Both Approaches - Major Street		X	3101	4580		
Highest Approaches - Minor Street	X		280	303		

The plotted points for vehicles per hour on major streets (both approaches) and the corresponding per hour higher volume vehicle minor street approach (one direction only) for one hour (any consecutive 15 minute period) fall above the applicable curves in MUTCD Figure 4C-3 or 4C-4.

Figure 4C-3. Warrant 3, Peak Hour



MAJOR STREET—TOTAL OF BOTH APPROACHES—VEHICLES PER HOUR (VPH)

*Note: 150 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor-street approach with one lane.

Year 2030 Conditions

#10

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Figure 4C-101. Traffic Signal Warrants Worksheet (Sheet 1 of 4)

DIST ____ CD Honolulu RTE ____ KPM ____ CALC: TSO DATE 2/12/07 CHK ____ DATE ____

Major St: Farrington Hwy Critical Approach Speed ____ km/h
Minor St: East Old Fort Weaver Rd. Critical Approach Speed ____ km/h

Critical speed of major street traffic > 64 km/h (40 mph) ☐ or In built up area of isolated community of < 10,000 population ☐ } RURAL (R)
☒ URBAN (U)

WARRANT 3 - Peak Hour — PART A or PART B SATISFIED YES ☒ NO ☐

PART A SATISFIED YES ☐ NO ☐
(All parts 1, 2, and 3 below must be satisfied)

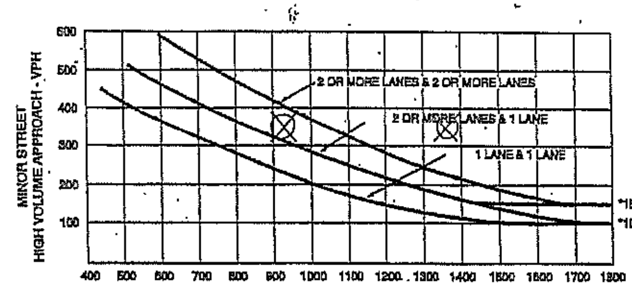
1. The total delay experienced for traffic on one minor street approach controlled by a STOP sign equals or exceeds four vehicle-hours for a one-lane approach and five vehicle-hours for a two-lane approach; AND — Yes ☐ No ☐
2. The volume on the same minor street approach equals or exceeds 100 vph for one moving lane of traffic or 150 vph for two moving lanes; AND — Yes ☐ No ☐
3. The total entering volume serviced during the hour equals or exceeds 800 vph for intersections with four or more approaches or 650 vph for intersections with three approaches. — Yes ☐ No ☐

PART B SATISFIED YES ☒ NO ☐

APPROACH LANES	One	2 or More	AM	PM		Hour
Both Approaches - Major Street		X	928	1358		
Highest Approaches - Minor Street	X		347	354		

The plotted points for vehicles per hour on major streets (both approaches) and the corresponding per hour higher volume vehicle minor street approach (one direction only) for one hour (any consecutive 15 minute period) fall above the applicable curves in MUTCD Figure 4C-3 or 4C-4.

Figure 4C-3. Warrant 3, Peak Hour



MAJOR STREET—TOTAL OF BOTH APPROACHES—VEHICLES PER HOUR (VPH)

*Note: 150 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor-street approach with one lane.

Year 2030 Conditions

#11

Figure 4C-101. Traffic Signal Warrants Worksheet (Sheet 1 of 4)

Honolulu (CO) — DIST / CO / RTE / KPM
CALC: TSO DATE: 2/12/07
CHK ______ DATE ______

Major St: Farrington Hwy
Minor St: West Old Fort Weaver Rd.

Critical Approach Speed: 40 mph
Critical Approach Speed: ______ km/h

Critical speed of major street traffic > 64 km/h (40 mph) ☐ or
In built up area of isolated community of < 10,000 population ☐ } RURAL (R)
☒ URBAN (U)

WARRANT 3 - Peak Hour — PART A or PART B SATISFIED YES ☒ NO ☐

PART A
(All parts 1, 2, and 3 below must be satisfied)
SATISFIED YES ☐ NO ☐

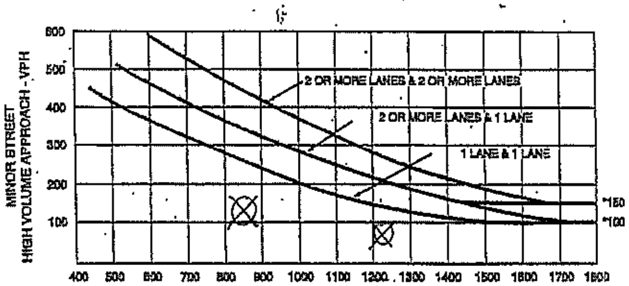
1. The total delay experienced for traffic on one minor street approach controlled by a STOP sign equals or exceeds four vehicle-hours for a one-lane approach and five vehicle-hours for a two-lane approach; AND — Yes ☐ No ☐
2. The volume on the same minor street approach equals or exceeds 100 vph for one moving lane of traffic or 150 vph for two moving lanes; AND — Yes ☐ No ☐
3. The total entering volume serviced during the hour equals or exceeds 800 vph for intersections with four or more approaches or 650 vph for intersections with three approaches. — Yes ☐ No ☐

PART B — SATISFIED YES ☒ NO ☐

APPROACH LANES	One	2 or More	AM	PM		Hour
Both Approaches - Major Street		X	854	1221		
Highest Approaches - Minor Street	X		120	80		

The plotted points for vehicles per hour on major streets (both approaches) and the corresponding per hour higher volume vehicle minor street approach (one direction only) for one hour (any consecutive 15 minute period) fall above the applicable curves in MUTCD Figure 4C-3 or 4C-4.

Figure 4C-3. Warrant 3, Peak Hour



MAJOR STREET—TOTAL OF BOTH APPROACHES—VEHICLES PER HOUR (VPH)

*Note: 150 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor-street approach with one lane.

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Year 2030 Conditions

#19

Figure 4C-101. Traffic Signal Warrants Worksheet (Sheet 1 of 4)

Honolulu (CO) — DIST / CO / RTE / KPM
CALC: TSO DATE: 2/12/07
CHK ______ DATE ______

Major St: East-West Rd.
Minor St: Old Fort Weaver Rd.

Critical Approach Speed: 40 mph
Critical Approach Speed: ______ km/h

Critical speed of major street traffic > 64 km/h (40 mph) ☐ or
In built up area of isolated community of < 10,000 population ☐ } RURAL (R)
☒ URBAN (U)

WARRANT 3 - Peak Hour — PART A or PART B SATISFIED YES ☒ NO ☐

PART A
(All parts 1, 2, and 3 below must be satisfied)
SATISFIED YES ☐ NO ☐

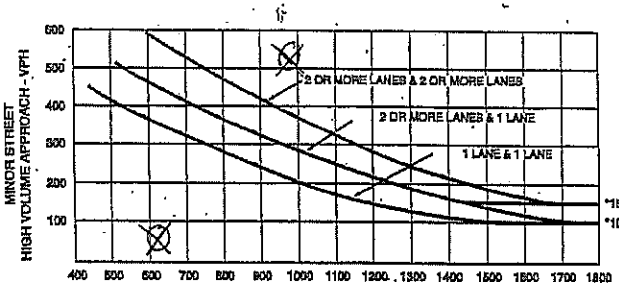
1. The total delay experienced for traffic on one minor street approach controlled by a STOP sign equals or exceeds four vehicle-hours for a one-lane approach and five vehicle-hours for a two-lane approach; AND — Yes ☐ No ☐
2. The volume on the same minor street approach equals or exceeds 100 vph for one moving lane of traffic or 150 vph for two moving lanes; AND — Yes ☐ No ☐
3. The total entering volume serviced during the hour equals or exceeds 800 vph for intersections with four or more approaches or 650 vph for intersections with three approaches. — Yes ☐ No ☐

PART B — SATISFIED YES ☒ NO ☐

APPROACH LANES	One	2 or More	AM	PM		Hour
Both Approaches - Major Street		X	611	973		
Highest Approaches - Minor Street		X	42	518		

The plotted points for vehicles per hour on major streets (both approaches) and the corresponding per hour higher volume vehicle minor street approach (one direction only) for one hour (any consecutive 15 minute period) fall above the applicable curves in MUTCD Figure 4C-3 or 4C-4.

Figure 4C-3. Warrant 3, Peak Hour



MAJOR STREET—TOTAL OF BOTH APPROACHES—VEHICLES PER HOUR (VPH)

*Note: 150 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor-street approach with one lane.

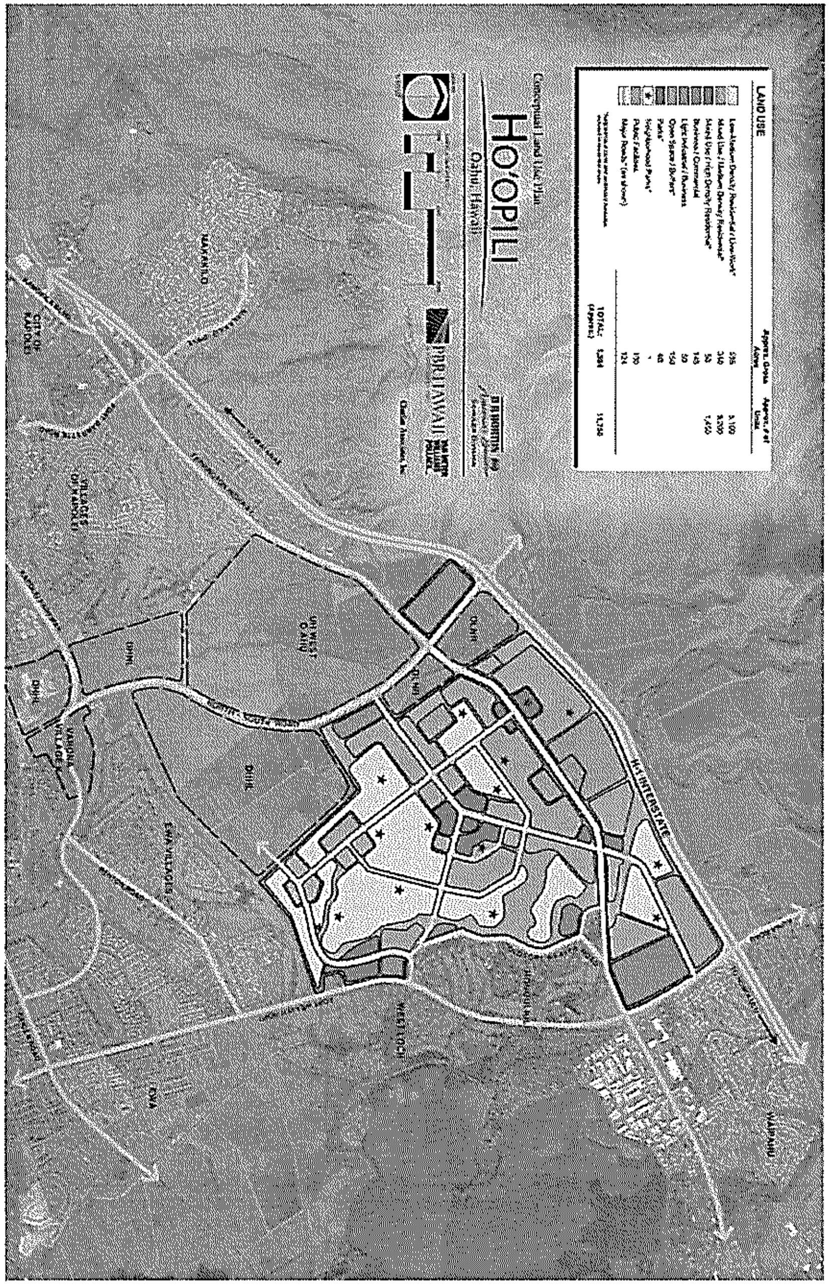
APPENDIX E

HO'OPILI CONCEPTUAL LANDUSE PLAN

APPENDIX E-1

HO'OPILI LAND USE PLAN

OMPO MODEL LAND USE ASSUMPTIONS



IgOMPO TMH
dLdUeMH

The following presents the most recent land use assumptions incorporated in the OMPO model. These same assumptions were used in calculating the travel demand for the proposed Project.

2000 Land Use Model Inputs to the Travel Model

Table 1. Estimated 1994 Base-Year Households

District		Total Households in 1994 Base Year			
No.	Name	Conventional	UrbanSim	Difference	%+/- Diff.
1	Downtown	6,153	6,281	128	2.1%
2	Kakaako	2,853	2,361	(492)	-17.3%
3	Makiki	16,190	15,649	(541)	-3.3%
4	McCully	15,021	15,107	86	0.6%
5	Waikiki	11,663	11,332	(331)	-2.8%
6	Diamond Hd	8,813	9,020	207	2.3%
7	Kaimuki	9,410	9,411	1	0.0%
8	Manoa	5,756	5,894	138	2.4%
9	Nuuanu	10,893	11,330	437	4.0%
10	Kalihi	8,876	8,705	(171)	-1.9%
11	Iwilei	5,163	5,389	226	4.4%
12	Airport PH	5,422	5,850	428	7.9%
13	Salt Lake	13,865	13,370	(495)	-3.6%
14	PC Aiea	22,019	21,959	(60)	-0.3%
15	Waipahu	16,220	15,921	(299)	-1.8%
16	Mililani	23,466	19,597	(3,869)	-16.5%
17	Ewa	17,532	17,541	9	0.0%
18	Waianae	9,787	9,787	(0)	0.0%
19	NorthShore	5,465	5,489	24	0.4%
20	Koolauloa	3,414	3,414	(0)	0.0%
21	Kaneohe	17,886	17,860	(26)	-0.1%
22	Kailua	14,980	14,994	14	0.1%
23	E Honolulu	14,786	14,758	(28)	-0.2%
	Total	265,636	261,019	(4,617)	-1.7%

Table 2. Estimated 2000 Households

District		Total Households				2000-1994 Gain (Loss)	
No.	Name	Conventional	UrbanSim	Difference	%+/- Diff.	Conventional	UrbanSim
1	Downtown	6,635	6,631	(4)	-0.1%	482	350
2	Kakaako	3,077	3,096	19	0.6%	224	735
3	Makiki	17,459	17,394	(65)	-0.4%	1,269	1,745
4	McCully	16,198	16,550	352	2.2%	1,177	1,443
5	Waikiki	12,577	12,059	(518)	-4.1%	914	727
6	Diamond Hd	9,504	9,988	484	5.1%	691	968
7	Kaimuki	10,147	10,970	823	8.1%	737	1,559
8	Manoa	6,207	6,202	(5)	-0.1%	451	308
9	Nuuanu	11,746	12,505	759	6.5%	853	1,175
10	Kalihi	9,572	9,888	316	3.3%	696	1,183
11	Iwilei	5,568	5,850	282	5.1%	405	461
12	Airport PH	5,847	6,211	364	6.2%	425	361
13	Salt Lake	14,951	14,673	(278)	-1.9%	1,086	1,303
14	PC Aiea	23,744	24,502	758	3.2%	1,725	2,543
15	Waipahu	17,491	19,167	1,676	9.6%	1,271	3,246
16	Mililani	25,305	25,000	(305)	-1.2%	1,839	5,403
17	Ewa	18,906	20,117	1,211	6.4%	1,374	2,576
18	Waianae	10,554	9,543	(1,011)	-9.6%	767	(244)
19	NorthShore	5,893	5,033	(860)	-14.6%	428	(456)
20	Koolauloa	3,682	2,651	(1,031)	-28.0%	268	(763)
21	Kaneohe	19,288	18,375	(913)	-4.7%	1,402	515
22	Kailua	16,154	14,678	(1,476)	-9.1%	1,174	(316)
23	E Honolulu	15,945	15,366	(579)	-3.6%	1,159	608
	Total	286,450	286,449	(1)	0.0%	20,814	25,430

Table 3. Estimated 2000 Housing Units

District		Housing Units				% Vacancy	
No.	Name	Conventional	UrbanSim	Difference	%+/- Diff.	Conventional	UrbanSim
1	Downtown	7,121	6,655	(466)	-6.5%	6.8%	0.4%
2	Kakaako	3,970	2,989	(981)	-24.7%	22.5%	-3.6%
3	Makiki	19,044	17,478	(1,566)	-8.2%	8.3%	0.5%
4	McCully	18,242	16,794	(1,448)	-7.9%	11.2%	1.5%
5	Waikiki	20,075	12,225	(7,850)	-39.1%	37.3%	1.4%
6	Diamond Hd	10,296	10,632	336	3.3%	7.7%	6.1%
7	Kaimuki	10,627	11,342	715	6.7%	4.5%	3.3%
8	Manoa	6,513	6,868	355	5.5%	4.7%	9.7%
9	Nuuanu	12,471	12,871	400	3.2%	5.8%	2.8%
10	Kalihi	10,133	10,313	180	1.8%	5.5%	4.1%
11	Iwilei	6,152	5,963	(189)	-3.1%	9.5%	1.9%
12	Airport PH	6,523	6,397	(126)	-1.9%	10.4%	2.9%
13	Salt Lake	16,389	15,175	(1,214)	-7.4%	8.8%	3.3%
14	PC Aiea	24,588	26,009	1,421	5.8%	3.4%	5.8%
15	Waipahu	18,471	20,414	1,943	10.5%	5.3%	6.1%
16	Mililani	27,407	27,550	143	0.5%	7.7%	9.3%
17	Ewa	20,775	22,728	1,953	9.4%	9.0%	11.5%
18	Waianae	12,378	12,096	(282)	-2.3%	14.7%	21.1%
19	NorthShore	6,648	6,913	265	4.0%	11.4%	27.2%
20	Koolauloa	4,473	4,499	26	0.6%	17.7%	41.1%
21	Kaneohe	20,091	20,960	869	4.3%	4.0%	12.3%
22	Kailua	16,873	17,771	898	5.3%	4.3%	17.4%
23	E Honolulu	16,728	18,117	1,389	8.3%	4.7%	15.2%
	Total	315,988	312,759	(3,229)	-1.0%	9.3%	8.4%

Table 4. Estimated 2000 Population Living in Households

District		Population Living in Households				Average Size of Household		
No.	Name	Conventional	UrbanSim	Difference	%+/- Diff.	Conventional	UrbanSim	%+/- Diff.
1	Downtown	13,737	16,469	2,732	19.9%	2.07	2.48	20.0%
2	Kakaako	5,707	8,007	2,300	40.3%	1.85	2.59	39.4%
3	Makiki	33,850	43,321	9,471	28.0%	1.94	2.49	28.5%
4	McCully	31,696	40,684	8,988	28.4%	1.96	2.46	25.6%
5	Waikiki	21,682	28,620	6,938	32.0%	1.72	2.37	37.7%
6	Diamond Hd	25,577	28,543	2,966	11.6%	2.69	2.86	6.2%
7	Kaimuki	28,101	31,602	3,501	12.5%	2.77	2.88	4.0%
8	Manoa	16,646	17,760	1,114	6.7%	2.68	2.86	6.8%
9	Nuuanu	30,828	35,539	4,711	15.3%	2.62	2.84	8.3%
10	Kalihi	37,587	30,835	(6,752)	-18.0%	3.93	3.12	-20.6%
11	Iwilei	20,209	17,485	(2,724)	-13.5%	3.63	2.99	-17.6%
12	Airport PH	19,785	19,018	(767)	-3.9%	3.38	3.06	-9.5%
13	Salt Lake	46,134	45,075	(1,059)	-2.3%	3.09	3.07	-0.4%
14	PC Aiea	71,380	75,325	3,945	5.5%	3.01	3.07	2.3%
15	Waipahu	62,575	61,492	(1,083)	-1.7%	3.58	3.21	-10.3%
16	Mililani	79,488	78,729	(759)	-1.0%	3.14	3.15	0.3%
17	Ewa	68,202	61,355	(6,847)	-10.0%	3.61	3.05	-15.5%
18	Waianae	41,877	30,781	(11,096)	-26.5%	3.97	3.23	-18.7%
19	NorthShore	17,980	17,185	(795)	-4.4%	3.05	3.41	11.9%
20	Koolauloa	13,793	9,267	(4,526)	-32.8%	3.75	3.50	-6.7%
21	Kaneohe	61,371	56,588	(4,783)	-7.8%	3.18	3.08	-3.2%
22	Kailua	51,001	45,302	(5,699)	-11.2%	3.16	3.09	-2.2%
23	E Honolulu	46,005	46,222	217	0.5%	2.89	3.01	4.3%
	Total	845,211	845,204	(7)	0.0%	2.95	2.95	0.0%

Table 5. Estimated 2000 Mean Household Income[2]

District		Mean Household Income		
No.	Name	Conventional	UrbanSim	%+/- Diff.
1	Downtown	$ 29,675	$ 33,664	13.4%
2	Kakaako	$ 19,477	$ 21,067	8.2%
3	Makiki	$ 104,506	$ 112,846	8.0%
4	McCully	$ 81,878	$ 100,865	23.2%
5	Waikiki	$ 69,235	$ 73,445	6.1%
6	Diamond Hd	$ 77,288	$ 80,521	4.2%
7	Kaimuki	$ 80,541	$ 83,835	4.1%
8	Manoa	$ 62,578	$ 55,153	-11.9%
9	Nuuanu	$ 94,869	$ 100,479	5.9%
10	Kalihi	$ 64,537	$ 72,380	12.2%
11	Iwilei	$ 28,152	$ 34,051	21.0%
12	Airport PH	$ 29,833	$ 39,295	31.7%
13	Salt Lake	$ 111,270	$ 109,003	-2.0%
14	PC Aiea	$ 208,921	$ 193,062	-7.6%
15	Waipahu	$ 138,727	$ 139,531	0.6%
16	Mililani	$ 158,351	$ 180,956	14.3%
17	Ewa	$ 141,304	$ 138,487	-2.0%
18	Waianae	$ 60,780	$ 61,647	1.4%
19	NorthShore	$ 38,531	$ 37,337	-3.1%
20	Koolauloa	$ 22,844	$ 21,209	-7.2%
21	Kaneohe	$ 155,974	$ 141,785	-9.1%
22	Kailua	$ 147,219	$ 120,867	-17.9%
23	E Honolulu	$ 181,207	$ 146,494	-19.2%
	Total	$ 48,820	$ 48,566	-0.5%

Table 6. 1994 Base-Year Total Employment

District		Total Employment in 1994 Base Year			
No.	Name	Conventional	UrbanSim	Difference	%+/- Diff.
1	Downtown	61,660	60,580	(1,080)	-1.8%
2	Kakaako	24,666	26,564	1,898	7.7%
3	Makiki	18,996	18,221	(775)	-4.1%
4	McCully	26,627	25,982	(645)	-2.4%
5	Waikiki	34,125	34,190	65	0.2%
6	Diamond Hd	10,646	10,794	148	1.4%
7	Kaimuki	6,585	6,573	(12)	-0.2%
8	Manoa	10,666	10,985	319	3.0%
9	Nuuanu	8,448	8,040	(408)	-4.8%
10	Kalihi	5,025	5,510	485	9.7%
11	Iwilei	34,395	36,751	2,356	6.8%
12	Airport PH	67,626	64,607	(3,019)	-4.5%
13	Salt Lake	26,991	28,991	2,000	7.4%
14	PC Aiea	27,003	25,480	(1,523)	-5.6%
15	Waipahu	13,544	13,588	44	0.3%
16	Mililani	39,936	39,944	8	0.0%
17	Ewa	16,954	17,040	86	0.5%
18	Waianae	6,853	6,829	(24)	-0.3%
19	NorthShore	3,907	3,910	3	0.1%
20	Koolauloa	4,810	4,813	3	0.1%
21	Kaneohe	24,869	23,779	(1,090)	-4.4%
22	Kailua	13,360	14,489	1,129	8.5%
23	E Honolulu	6,132	6,165	33	0.5%
	Total	493,824	493,825	1	0.0%

Table 7. Estimated 2000 Total Employment

District		Total Employment			
No.	Name	Conventional	UrbanSim	Difference	%+/- Diff.
1	Downtown	57,110	61,941	4,831	8.5%
2	Kakaako	24,878	23,128	(1,750)	-7.0%
3	Makiki	21,673	19,188	(2,485)	-11.5%
4	McCully	29,995	26,092	(3,903)	-13.0%
5	Waikiki	36,929	32,147	(4,782)	-12.9%
6	Diamond Hd	11,385	11,778	393	3.5%
7	Kaimuki	8,176	7,611	(565)	-6.9%
8	Manoa	14,468	10,981	(3,487)	-24.1%
9	Nuuanu	11,454	9,039	(2,415)	-21.1%
10	Kalihi	5,877	6,555	678	11.5%
11	Iwilei	39,155	38,949	(206)	-0.5%
12	Airport PH	56,668	56,691	23	0.0%
13	Salt Lake	23,283	29,491	6,208	26.7%
14	PC Aiea	28,159	29,120	961	3.4%
15	Waipahu	15,334	15,644	310	2.0%
16	Mililani	33,399	37,265	3,866	11.6%
17	Ewa	18,473	19,258	785	4.2%
18	Waianae	7,902	7,702	(200)	-2.5%
19	NorthShore	4,629	4,556	(73)	-1.6%
20	Koolauloa	5,934	5,233	(701)	-11.8%
21	Kaneohe	21,972	23,267	1,295	5.9%
22	Kailua	15,660	15,733	73	0.5%
23	E Honolulu	6,794	7,938	1,144	16.8%
	Total	499,307	499,307	-	0.0%

Table 8. Estimated 2000 Accessibilities

District		Access to Employment			Access to Population		
No.	Name	0-Cars	1-Car	2+ Car	0-Cars	1-Car	2+ Car
1	Downtown	0.463	0.882	1.000	0.729	0.845	0.933
2	Kakaako	0.121	0.432	0.892	0.345	0.492	0.895
3	Makiki	0.248	0.423	0.864	0.922	0.974	1.000
4	McCully	0.324	0.397	0.787	0.798	0.848	0.945
5	Waikiki	0.142	0.242	0.706	0.354	0.466	0.825
6	Diamond Hd	0.405	0.438	0.696	1.000	1.000	0.889
7	Kaimuki	0.269	0.330	0.674	0.727	0.775	0.859
8	Manoa	0.335	0.392	0.728	0.620	0.701	0.896
9	Nuuanu	0.301	0.457	0.828	0.783	0.863	0.962
10	Kalihi	0.368	0.429	0.799	0.726	0.799	0.960
11	Iwilei	1.000	1.000	0.941	0.799	0.871	0.989
12	Airport PH	0.467	0.495	0.772	0.277	0.414	0.871
13	Salt Lake	0.291	0.356	0.734	0.308	0.442	0.864
14	PC Alea	0.257	0.315	0.669	0.457	0.555	0.860
15	Waipahu	0.125	0.196	0.560	0.347	0.449	0.773
16	Mililani	0.141	0.201	0.514	0.275	0.367	0.651
17	Ewa	0.050	0.115	0.416	0.118	0.228	0.586
18	Waianae	0.016	0.055	0.225	0.038	0.106	0.328
19	NorthShore	0.030	0.069	0.249	0.051	0.121	0.343
20	Koolauloa	0.009	0.043	0.183	0.016	0.069	0.242
21	Kaneohe	0.111	0.177	0.495	0.329	0.408	0.641
22	Kailua	0.120	0.176	0.455	0.287	0.362	0.589
23	E Honolulu	0.041	0.126	0.505	0.110	0.229	0.621

Table 9. Estimated 2000 Employment in Wholesale/TCPU and Manufacturing Sectors

District		Wholesale/TCPU Employment				Manufacturing Employment			
No.	Name	Conventional	UrbanSim	Difference	%+/- Diff.	Conventional	UrbanSim	Difference	%+/- Diff.
1	Downtown	5,290	5,286	(4)	-0.1%	1,449	4,937	3,488	240.7%
2	Kakaako	4,225	3,962	(263)	-6.2%	2,028	1,139	(889)	-43.8%
3	Makiki	1,187	1,022	(165)	-13.9%	559	319	(240)	-42.9%
4	McCully	2,014	1,829	(185)	-9.2%	1,274	549	(725)	-56.9%
5	Waikiki	902	853	(49)	-5.4%	616	938	322	52.3%
6	Diamond Hd	332	309	(23)	-6.9%	294	130	(164)	-55.8%
7	Kaimuki	239	229	(10)	-4.2%	483	245	(238)	-49.3%
8	Manoa	308	300	(8)	-2.6%	125	81	(44)	-35.2%
9	Nuuanu	167	182	15	9.0%	285	183	(102)	-35.8%
10	Kalihi	116	114	(2)	-1.7%	95	53	(42)	-44.2%
11	Iwilei	5,576	5,424	(152)	-2.7%	7,963	6,077	(1,886)	-23.7%
12	Airport PH	12,198	11,466	(732)	-6.0%	5,289	3,966	(1,323)	-25.0%
13	Salt Lake	527	802	275	52.2%	1,419	2,987	1,568	110.5%
14	PC Aiea	1,467	1,736	269	18.3%	2,849	2,706	(143)	-5.0%
15	Waipahu	738	821	83	11.2%	1,498	1,135	(363)	-24.2%
16	Mililani	1,454	1,684	230	15.8%	570	1,414	844	148.1%
17	Ewa	1,073	1,132	59	5.5%	2,234	1,161	(1,073)	-48.0%
18	Waianae	207	281	74	35.7%	136	207	71	52.2%
19	NorthShore	142	250	108	76.1%	373	278	(95)	-25.5%
20	Koolauloa	242	341	99	40.9%	103	210	107	103.9%
21	Kaneohe	810	989	179	22.1%	427	1,140	713	167.0%
22	Kailua	557	759	202	36.3%	671	902	231	34.4%
23	E Honolulu	437	437	-	0.0%	218	201	(17)	-7.8%
	Total	40,208	40,208	-	0.0%	30,958	30,958	-	0.0%

Table 10. Estimated 2000 Employment in FIRE and Service Sectors

District		Finance, Insur.. Real Est. Employment				Service Employment			
No.	Name	Conventional	UrbanSim	Difference	%+/- Diff.	Conventional	UrbanSim	Difference	%+/- Diff.
1	Downtown	10,207	9,894	(313)	-3.1%	23,941	25,989	2,048	8.6%
2	Kakaako	1,539	1,610	71	4.6%	7,387	6,783	(604)	-8.2%
3	Makiki	1,474	1,340	(134)	-9.1%	13,443	11,658	(1,785)	-13.3%
4	McCully	4,609	3,690	(919)	-19.9%	10,699	9,292	(1,407)	-13.2%
5	Waikiki	1,737	1,571	(166)	-9.6%	9,225	6,689	(2,536)	-27.5%
6	Diamond Hd	666	614	(52)	-7.8%	4,934	4,385	(549)	-11.1%
7	Kaimuki	509	428	(81)	-15.9%	4,349	3,426	(923)	-21.2%
8	Manoa	342	338	(4)	-1.2%	11,785	7,980	(3,805)	-32.3%
9	Nuuanu	528	446	(82)	-15.5%	8,939	6,036	(2,903)	-32.5%
10	Kalihi	277	237	(40)	-14.4%	3,652	3,703	51	1.4%
11	Iwilei	2,499	2,636	137	5.5%	11,581	11,842	261	2.3%
12	Airport PH	1,619	1,678	59	3.6%	9,758	13,930	4,172	42.8%
13	Salt Lake	186	961	775	416.7%	8,548	11,412	2,864	33.5%
14	PC Aiea	1,215	1,477	262	21.6%	9,017	10,551	1,534	17.0%
15	Waipahu	591	653	62	10.5%	5,309	5,468	159	3.0%
16	Mililani	1,223	1,482	259	21.2%	7,978	11,190	3,212	40.3%
17	Ewa	1,018	916	(102)	-10.0%	6,129	7,049	920	15.0%
18	Waianae	291	284	(7)	-2.4%	3,642	3,323	(319)	-8.8%
19	NorthShore	153	154	1	0.7%	1,465	1,468	3	0.2%
20	Koolauloa	228	262	34	14.9%	3,244	2,297	(947)	-29.2%
21	Kaneohe	568	753	185	32.6%	6,750	8,084	1,334	19.8%
22	Kailua	715	813	98	13.7%	7,903	6,738	(1,165)	-14.7%
23	E Honolulu	522	479	(43)	-8.2%	2,799	3,184	385	13.8%
	Total	32,716	32,716	-	0.0%	182,477	182,477	-	0.0%

Table 11. Estimated 2000 Employment in Military and Government Sectors

District		Military Employment				Government Employment			
No.	Name	Conventional	UrbanSim	Difference	%+/- Diff.	Conventional	UrbanSim	Difference	%+/- Diff
1	Downtown	115	135	20	17.4%	9,329	7,626	(1,703)	-18.3%
2	Kakaako	240	314	74	30.8%	1,739	1,982	243	14.0%
3	Makiki	35	134	99	282.9%	1,610	1,384	(226)	-14.0%
4	McCully	30	116	86	286.7%	392	576	184	46.9%
5	Waikiki	148	207	59	39.9%	395	489	94	23.8%
6	Diamond Hd	344	389	45	13.1%	740	1,289	549	74.2%
7	Kaimuki	8	153	145	1812.5%	154	475	321	208.4%
8	Manoa	82	249	167	203.7%	339	468	129	38.1%
9	Nuuanu	36	202	166	461.1%	260	463	203	78.1%
10	Kalihi	4	232	228	5700.0%	391	613	222	56.8%
11	Iwilei	134	295	161	120.1%	1,325	2,012	687	51.8%
12	Airport PH	10,163	9,071	(1,092)	-10.7%	6,363	5,331	(1,032)	-16.2%
13	Salt Lake	6,116	5,661	(455)	-7.4%	3,403	3,371	(32)	-0.9%
14	PC Alea	2,671	2,758	87	3.3%	1,512	1,040	(472)	-31.2%
15	Waipahu	4	364	360	9000.0%	571	717	146	25.6%
16	Mililani	12,230	11,258	(972)	-7.9%	2,586	2,687	101	3.9%
17	Ewa	354	742	388	109.6%	951	1,266	315	33.1%
18	Waianae	47	317	270	574.5%	392	393	1	0.3%
19	NorthShore	126	203	77	61.1%	59	131	72	122.0%
20	Koolauloa	33	60	27	81.8%	134	190	56	41.8%
21	Kaneohe	7,216	6,701	(515)	-7.1%	1,461	1,098	(363)	-24.8%
22	Kailua	288	559	271	94.1%	610	829	219	35.9%
23	E Honolulu	-	304	304	n/a	240	526	286	119.2%
	Total	40,424	40,424	-	0.0%	34,956	34,956	-	0.0%

Table 12. Estimated 2000 Employment in Agriculture and Construction Sectors

District		Agricultural Employment				Construction Employment			
No.	Name	Conventional	UrbanSim	Difference	%+/- Diff.	Conventional	UrbanSim	Difference	%+/- Diff.
1	Downtown	290	168	(122)	-42.1%	846	1,162	316	37.4%
2	Kakaako	221	155	(66)	-29.9%	908	929	21	2.3%
3	Makiki	20	42	22	110.0%	893	765	(128)	-14.3%
4	McCully	141	105	(36)	-25.5%	528	493	(35)	-6.6%
5	Waikiki	94	86	(8)	-8.5%	364	395	31	8.5%
6	Diamond Hd	10	55	45	450.0%	423	383	(40)	-9.5%
7	Kaimuki	53	84	31	58.5%	270	270	-	0.0%
8	Manoa	30	80	50	166.7%	276	245	(31)	-11.2%
9	Nuuanu	17	68	51	300.0%	220	236	16	7.3%
10	Kalihi	37	75	38	102.7%	312	246	(66)	-21.2%
11	Iwilei	287	229	(58)	-20.2%	2,494	2,621	127	5.1%
12	Airport PH	71	280	209	294.4%	1,940	1,906	(34)	-1.8%
13	Salt Lake	-	123	123	n/a	775	860	85	11.0%
14	PC Alea	118	225	107	90.7%	1,339	1,458	119	8.9%
15	Waipahu	66	192	126	190.9%	1,746	1,651	(95)	-5.4%
16	Mililani	667	599	(68)	-10.2%	2,232	2,281	49	2.2%
17	Ewa	245	329	84	34.3%	3,515	3,171	(344)	-9.8%
18	Waianae	665	438	(227)	-34.1%	944	867	(77)	-8.2%
19	NorthShore	462	265	(197)	-42.6%	502	463	(39)	-7.8%
20	Koolauloa	422	237	(185)	-43.8%	189	240	51	27.0%
21	Kaneohe	379	413	34	9.0%	831	723	(108)	-13.0%
22	Kailua	394	339	(55)	-14.0%	758	1,024	266	35.1%
23	E Honolulu	54	156	102	188.9%	794	710	(84)	-10.6%
	Total	4,743	4,743	-	0.0%	23,099	23,099	-	0.0%

Table 13. Estimated 2000 Employment in the Retail Sector

District		Resident-Oriented Retail Employment				Visitor-Oriented Retail Employment			
No.	Name	Conventional	UrbanSim	Difference	%+/- Diff.	Conventional	UrbanSim	Difference	%+/- Diff.
1	Downtown	4,819	6,026	1,207	25.0%	-	-	-	n/a
2	Kakaako	6,213	5,918	(295)	-4.7%	-	-	-	n/a
3	Makiki	2,145	2,181	36	1.7%	-	-	-	n/a
4	McCully	6,634	6,334	(300)	-4.5%	2,049	1,589	(460)	-22.4%
5	Waikiki	-	-	-	n/a	17,740	15,864	(1,876)	-10.6%
6	Diamond Hd	3,019	3,219	200	6.6%	-	-	-	n/a
7	Kaimuki	1,827	1,920	93	5.1%	-	-	-	n/a
8	Manoa	1,019	1,048	29	2.8%	-	-	-	n/a
9	Nuuanu	896	1,067	171	19.1%	-	-	-	n/a
10	Kalihi	855	1,035	180	21.1%	-	-	-	n/a
11	Iwilei	6,613	7,066	453	6.9%	-	-	-	n/a
12	Airport PH	8,209	7,838	(371)	-4.5%	-	-	-	n/a
13	Salt Lake	2,053	3,066	1,013	49.3%	-	-	-	n/a
14	PC Alea	7,115	6,437	(678)	-9.5%	-	-	-	n/a
15	Waipahu	4,370	4,092	(278)	-6.4%	-	-	-	n/a
16	Mililani	3,837	3,997	160	4.2%	-	-	-	n/a
17	Ewa	2,456	2,893	437	17.8%	-	-	-	n/a
18	Waianae	1,344	1,385	41	3.1%	-	-	-	n/a
19	NorthShore	1,130	1,136	6	0.5%	-	-	-	n/a
20	Koolauloa	1,005	1,080	75	7.5%	-	-	-	n/a
21	Kaneohe	3,092	3,005	(87)	-2.8%	-	-	-	n/a
22	Kailua	3,245	3,290	45	1.4%	-	-	-	n/a
23	E Honolulu	1,452	1,651	199	13.7%	-	-	-	n/a
	Total	73,348	75,684	2,336	3.2%	19,789	17,453	(2,336)	-11.8%

Table 14. Estimated 2000 Hotel Rooms and Employment in the Hotel Sector

District		Hotel Rooms		Hotel Employment			
No.	Name	Conventional	UrbanSim	Conventional	UrbanSim	Difference	%+/- Diff.
1	Downtown	26	1,195	824	718	(106)	-12.9%
2	Kakaako	-	561	378	336	(42)	-11.1%
3	Makiki	39	573	307	343	36	11.7%
4	McCully	1,369	2,536	1,625	1,519	(106)	-6.5%
5	Waikiki	24,018	8,443	5,708	5,055	(653)	-11.4%
6	Diamond Hd	368	1,677	623	1,005	382	61.3%
7	Kaimuki	-	636	284	381	97	34.2%
8	Manoa	46	320	162	192	30	18.5%
9	Nuuanu	-	262	106	156	50	47.2%
10	Kalihi	-	412	138	247	109	79.0%
11	Iwilei	-	1,247	683	747	64	9.4%
12	Airport PH	696	2,047	1,058	1,225	167	15.8%
13	Salt Lake	-	414	256	248	(8)	-3.1%
14	PC Aiea	-	1,218	856	732	(124)	-14.5%
15	Waipahu	-	919	441	551	110	24.9%
16	Mililani	192	1,126	622	673	51	8.2%
17	Ewa	390	1,000	498	599	101	20.3%
18	Waianae	-	347	234	207	(27)	-11.5%
19	NorthShore	-	347	217	208	(9)	-4.1%
20	Koolauloa	537	528	334	316	(18)	-5.4%
21	Kaneohe	16	601	438	361	(77)	-17.6%
22	Kailua	14	803	519	480	(39)	-7.5%
23	E Honolulu	-	485	278	290	12	4.3%
	Total	27,711	27,697	16,589	16,589	-	0.0%

Table 15. Estimated 2000 Public and Private College Students

District		Public College Students				Private College Students			
No.	Name	Conventional	UrbanSim	Difference	%+/- Diff.	Conventional	UrbanSim	Difference	%+/- Diff.
1	Downtown	-	-	-	n/a	5,218	5,008	(210)	-4.0%
2	Kakaako	-	-	-	n/a	-	-	-	n/a
3	Makiki	-	-	-	n/a	33	32	(1)	-3.0%
4	McCully	-	-	-	n/a	139	133	(6)	-4.3%
5	Waikiki	-	-	-	n/a	-	-	-	n/a
6	Diamond Hd	8,163	7,833	(330)	-4.0%	-	-	-	n/a
7	Kaimuki	-	-	-	n/a	888	852	(36)	-4.1%
8	Manoa	22,234	21,337	(897)	-4.0%	-	-	-	n/a
9	Nuuanu	-	-	-	n/a	-	-	-	n/a
10	Kalihi	-	-	-	n/a	-	-	-	n/a
11	Iwilei	5,260	5,048	(212)	-4.0%	-	-	-	n/a
12	Airport PH	-	-	-	n/a	-	-	-	n/a
13	Salt Lake	-	-	-	n/a	-	-	-	n/a
14	PC Aiea	-	-	-	n/a	-	-	-	n/a
15	Waipahu	7,906	7,587	(319)	-4.0%	-	-	-	n/a
16	Mililani	-	-	-	n/a	-	-	-	n/a
17	Ewa	-	-	-	n/a	-	-	-	n/a
18	Waianae	-	-	-	n/a	-	-	-	n/a
19	NorthShore	-	-	-	n/a	-	-	-	n/a
20	Koolauloa	-	-	-	n/a	2,193	2,104	(89)	-4.1%
21	Kaneohe	1,814	1,741	(73)	-4.0%	-	-	-	n/a
22	Kailua	-	-	-	n/a	-	-	-	n/a
23	E Honolulu	-	-	-	n/a	122	117	(5)	-4.1%
	Total	45,377	43,546	(1,831)	-4.0%	8,593	8,246	(347)	-4.0%

Table 16. Estimated 2000 Public and Private K-12 Students

District		Public K-12 Students				Private K-12 Students			
No.	Name	Conventional	UrbanSim	Difference	%+/- Diff.	Conventional	UrbanSim	Difference	%+/- Diff.
1	Downtown	1,681	1,662	(19)	-1.1%	688	681	(7)	-1.0%
2	Kakaako	2,229	3,345	1,116	50.1%	-	-	-	n/a
3	Makiki	992	1,303	311	31.4%	6,251	8,210	1,959	31.3%
4	McCully	3,089	3,946	857	27.7%	2,075	2,651	576	27.8%
5	Waikiki	893	1,422	529	59.2%	255	406	151	59.2%
6	Diamond Hd	4,034	4,237	203	5.0%	76	80	4	5.3%
7	Kaimuki	3,110	3,513	403	13.0%	2,705	3,053	348	12.9%
8	Manoa	1,647	1,759	112	6.8%	1,988	2,123	135	6.8%
9	Nuuanu	6,080	6,849	769	12.6%	3,026	3,411	385	12.7%
10	Kalihi	5,104	4,512	(592)	-11.6%	4,478	3,962	(516)	-11.5%
11	Iwilei	5,298	4,327	(971)	-18.3%	824	673	(151)	-18.3%
12	Airport PH	6,232	4,542	(1,690)	-27.1%	923	673	(250)	-27.1%
13	Salt Lake	8,502	7,451	(1,051)	-12.4%	254	223	(31)	-12.2%
14	PC Aiea	13,610	12,853	(757)	-5.6%	884	835	(49)	-5.5%
15	Waipahu	7,913	6,976	(937)	-11.8%	680	599	(81)	-11.9%
16	Mililani	16,537	13,752	(2,785)	-16.6%	1,263	1,051	(212)	-16.8%
17	Ewa	8,753	8,122	(631)	-7.2%	450	417	(33)	-7.3%
18	Waianae	11,043	8,067	(2,976)	-26.9%	100	73	(27)	-27.0%
19	NorthShore	2,781	2,411	(370)	-13.3%	275	238	(37)	-13.5%
20	Koolauloa	4,234	3,108	(1,126)	-26.6%	-	-	-	n/a
21	Kaneohe	8,683	7,064	(1,619)	-18.6%	1,031	840	(191)	-18.5%
22	Kailua	8,484	7,106	(1,378)	-16.2%	1,383	1,159	(224)	-16.2%
23	E Honolulu	6,055	5,493	(562)	-9.3%	518	470	(49)	-9.4%
	Total	136,984	123,820	(13,164)	-9.6%	30,128	31,828	1,700	5.6%

2030 Land Use Model Inputs to the Travel Model

Table 1. Estimated 2030 Households

District	Total Households				% Change Since 2000	
No. Name	Conventional	UrbanSim	Difference	%+/- Diff.	Conventional	UrbanSim
1 Downtown	12,024	8,174	(3,850)	-32.0%	81.2%	23.3%
2 Kakaako	17,001	4,093	(12,908)	-75.9%	452.5%	32.2%
3 Makiki	20,887	19,605	(1,282)	-6.1%	19.6%	12.7%
4 McCully	20,417	18,853	(1,564)	-7.7%	26.0%	13.9%
5 Waikiki	15,341	13,553	(1,788)	-11.7%	22.0%	12.4%
6 Diamond Hd	10,194	13,954	3,760	36.9%	7.3%	39.7%
7 Kaimuki	11,499	15,180	3,681	32.0%	13.3%	38.4%
8 Manoa	6,545	8,014	1,469	22.4%	5.4%	29.2%
9 Nuuanu	13,497	16,394	2,897	21.5%	14.9%	31.1%
10 Kalihi	10,302	13,839	3,537	34.3%	7.6%	40.0%
11 Iwilei	7,284	6,592	(692)	-9.5%	30.8%	12.7%
12 Airport PH	6,908	7,317	409	5.9%	18.1%	17.8%
13 Salt Lake	15,346	18,210	2,864	18.7%	2.6%	24.1%
14 PC Alea	24,053	33,969	9,916	41.2%	1.3%	38.5%
15 Waipahu	31,397	27,729	(3,668)	-11.7%	79.5%	44.7%
16 Mililani	28,406	35,325	6,919	24.4%	12.3%	41.3%
17 Ewa	54,996	29,462	(25,534)	-46.4%	190.9%	46.5%
18 Waianae	13,694	14,864	1,170	8.5%	29.8%	55.8%
19 NorthShore	6,853	6,548	(305)	-4.5%	16.3%	30.1%
20 Koolauloa	4,668	4,981	313	6.7%	26.8%	87.9%
21 Kaneohe	20,301	24,259	3,958	19.5%	5.3%	32.0%
22 Kailua	16,908	21,076	4,168	24.7%	4.7%	43.6%
23 E Honolulu	18,477	25,008	6,531	35.3%	15.9%	62.7%
Total	386,998	386,999	1	0.0%	35.1%	35.1%

Table 2. Estimated 2030 Housing Units and Vacancy Rates[2]

District	2030 Housing Units				% Change Since 2000		% Vacancy	
No. Name	Conventional	UrbanSim	Difference	%+/- Diff.	Conventional	UrbanSim	Conventional	UrbanSim
1 Downtown	13,565	8,222	(5,343)	-39.4%	90.5%	23.5%	11.4%	0.6%
2 Kakaako	20,722	3,956	(16,766)	-80.9%	422.0%	32.4%	18.0%	-3.5%
3 Makiki	22,782	19,785	(2,997)	-13.2%	19.6%	13.2%	8.3%	0.9%
4 McCully	23,047	19,054	(3,993)	-17.3%	26.3%	13.5%	11.4%	1.1%
5 Waikiki	24,474	13,751	(10,723)	-43.8%	21.6%	12.5%	37.3%	1.4%
6 Diamond Hd	11,016	14,401	3,385	30.7%	7.0%	35.4%	7.5%	3.1%
7 Kaimuki	12,024	15,550	3,526	29.3%	13.1%	37.1%	4.4%	2.4%
8 Manoa	6,881	8,578	1,697	24.7%	5.7%	24.9%	4.9%	6.6%
9 Nuuanu	14,337	16,766	2,429	16.9%	15.0%	30.3%	5.9%	2.2%
10 Kalihi	10,921	14,272	3,351	30.7%	7.8%	38.4%	5.7%	3.0%
11 Iwilei	8,062	6,896	(1,166)	-14.5%	31.0%	15.6%	9.7%	4.4%
12 Airport PH	7,666	7,678	12	0.2%	17.5%	20.0%	9.9%	4.7%
13 Salt Lake	16,791	18,747	1,956	11.6%	2.5%	23.5%	8.6%	2.9%
14 PC Alea	24,913	35,022	10,109	40.6%	1.3%	34.7%	3.5%	3.0%
15 Waipahu	32,978	28,949	(4,029)	-12.2%	78.5%	41.8%	4.8%	4.2%
16 Mililani	30,682	36,836	6,154	20.1%	11.9%	33.7%	7.4%	4.1%
17 Ewa	60,399	32,456	(27,943)	-46.3%	190.7%	42.8%	8.9%	9.2%
18 Waianae	15,969	17,584	1,615	10.1%	29.0%	45.4%	14.2%	15.5%
19 NorthShore	7,775	10,482	2,707	34.8%	17.0%	51.6%	11.9%	37.5%
20 Koolauloa	5,563	6,671	1,108	19.9%	24.4%	48.3%	16.1%	25.3%
21 Kaneohe	21,153	27,653	6,500	30.7%	5.3%	31.9%	4.0%	12.3%
22 Kailua	17,664	23,659	5,995	33.9%	4.7%	33.1%	4.3%	10.9%
23 E Honolulu	19,434	26,056	6,622	34.1%	16.2%	43.8%	4.9%	4.0%
Total	428,818	413,024	(15,794)	-3.7%	35.7%	32.1%	9.8%	6.3%

Table 3. Estimated 2030 Population Living in Households

District	Population Living in Households				% Change Since 2000		Average Size of Household		
No. Name	Conventional	UrbanSim	Difference	%+/- Diff.	Conventional	UrbanSim	Conventional	UrbanSim	%+/- Diff.
1 Downtown	22,928	20,173	(2,755)	-12.0%	65.9%	22.5%	1.91	2.47	29.4%
2 Kakaako	30,540	11,901	(18,639)	-61.0%	435.1%	48.6%	1.80	2.91	61.9%
3 Makiki	39,983	50,179	10,196	25.5%	18.1%	15.8%	1.91	2.56	33.7%
4 McCully	39,119	48,914	9,795	25.0%	23.4%	20.2%	1.92	2.59	35.4%
5 Waikiki	26,034	35,519	9,485	36.4%	20.1%	24.1%	1.70	2.62	64.4%
6 Diamond Hd	26,809	39,559	12,750	47.6%	4.8%	35.6%	2.63	2.83	7.8%
7 Kaimuki	31,418	43,306	11,888	37.8%	11.8%	37.0%	2.73	2.85	4.4%
8 Manoa	17,050	21,858	4,808	28.2%	2.4%	23.1%	2.61	2.73	4.7%
9 Nuuanu	34,612	45,022	10,410	30.1%	12.3%	26.7%	2.56	2.75	7.1%
10 Kalihi	39,959	38,796	(1,163)	-2.9%	6.3%	25.8%	3.88	2.80	-27.7%
11 Iwilei	24,811	17,711	(7,100)	-28.6%	22.8%	1.3%	3.41	2.69	-21.1%
12 Airport PH	22,883	20,542	(2,341)	-10.2%	15.7%	8.0%	3.31	2.81	-15.2%
13 Salt Lake	46,378	50,548	4,170	9.0%	0.5%	12.1%	3.02	2.78	-9.2%
14 PC Alea	70,822	95,840	25,018	35.3%	-0.8%	27.2%	2.94	2.82	-4.2%
15 Waipahu	100,146	77,735	(22,411)	-22.4%	60.0%	25.4%	3.19	2.80	-12.1%
16 Mililani	83,208	104,966	21,758	26.1%	4.7%	33.3%	2.93	2.97	1.4%
17 Ewa	184,545	81,917	(102,628)	-55.6%	170.6%	33.5%	3.35	2.78	-17.1%
18 Waianae	50,252	43,627	(6,625)	-13.2%	20.0%	41.7%	3.67	2.94	-20.0%
19 NorthShore	19,560	21,561	2,001	10.2%	8.8%	25.5%	2.85	3.29	15.4%
20 Koolauloa	15,971	16,922	951	6.0%	15.8%	82.6%	3.42	3.40	-0.7%
21 Kaneohe	60,074	69,405	9,331	15.5%	-2.1%	22.6%	2.96	2.86	-3.3%
22 Kailua	49,733	58,362	8,629	17.4%	-2.5%	28.8%	2.94	2.77	-5.9%
23 E Honolulu	49,513	71,943	22,430	45.3%	7.6%	55.6%	2.68	2.88	7.4%
Total	1,086,348	1,086,306	(42)	0.0%	28.5%	28.5%	2.81	2.81	0.0%

Table 4. Estimated 2030 Mean Household Income[3]

District	Mean Household Income			% Change Since 2000	
No. Name	Conventional	UrbanSim	%+/- Diff.	Conventional	UrbanSim
1 Downtown	$ 28,091	$ 33,662	19.8%	-5.3%	0.0%
2 Kakaako	$ 45,776	$ 25,561	-44.2%	135.0%	21.3%
3 Makiki	$ 68,544	$ 100,212	46.2%	-34.4%	-11.2%
4 McCully	$ 56,938	$ 98,846	73.6%	-30.5%	-2.0%
5 Waikiki	$ 46,573	$ 69,048	48.3%	-32.7%	-6.0%
6 Diamond Hd	$ 45,766	$ 88,702	93.8%	-40.8%	10.2%
7 Kaimuki	$ 50,887	$ 95,123	86.9%	-36.8%	13.5%
8 Manoa	$ 36,294	$ 45,065	24.2%	-42.0%	-18.3%
9 Nuuanu	$ 60,120	$ 95,969	59.6%	-36.6%	-4.5%
10 Kalihi	$ 38,422	$ 81,901	113.2%	-40.5%	13.2%
11 Iwilei	$ 19,575	$ 31,252	59.7%	-30.5%	-8.2%
12 Airport PH	$ 19,239	$ 41,413	115.3%	-35.5%	5.4%
13 Salt Lake	$ 63,537	$ 104,703	64.8%	-42.9%	-3.9%
14 PC Alea	$ 116,906	$ 205,222	75.5%	-44.0%	6.3%
15 Waipahu	$ 138,359	$ 167,445	21.0%	-0.3%	20.0%
16 Mililani	$ 95,007	$ 232,124	144.3%	-40.0%	28.3%
17 Ewa	$ 244,043	$ 178,024	-27.1%	72.7%	28.5%
18 Waianae	$ 43,480	$ 103,361	137.7%	-28.5%	67.7%
19 NorthShore	$ 24,350	$ 48,945	101.0%	-36.8%	31.1%
20 Koolauloa	$ 15,929	$ 39,132	145.7%	-30.3%	84.5%
21 Kaneohe	$ 90,423	$ 149,416	65.2%	-42.0%	5.4%
22 Kailua	$ 85,096	$ 130,193	53.0%	-42.2%	7.7%
23 E Honolulu	$ 115,503	$ 163,544	41.6%	-36.3%	11.6%
Total	$ 48,123	$ 49,189	2.2%	-1.4%	1.3%

Table 5. Estimated 2030 Total Employment and Non-Residential Floor Area[4]

District	Total Employment				% Change Since 2000		Non-Residential Sq Ft (000's)		
No. Name	Conventional	UrbanSim	Difference	%+/- Diff.	Conventional	UrbanSim	2000	2030	% Change
1 Downtown	64,983	70,923	5,940	9.1%	13.8%	14.5%	26,907	29,455	9.5%
2 Kakaako	39,684	30,199	(9,485)	-23.9%	59.5%	30.6%	11,123	14,070	26.5%
3 Makiki	23,200	21,666	(1,534)	-6.6%	7.0%	12.9%	7,247	7,596	4.8%
4 McCully	40,727	30,518	(10,209)	-25.1%	35.8%	17.0%	10,228	10,991	7.5%
5 Waikiki	44,913	31,419	(13,494)	-30.0%	21.6%	-2.3%	12,677	13,124	3.5%
6 Diamond Hd	13,675	14,604	929	6.8%	20.1%	24.0%	4,023	5,129	27.5%
7 Kaimuki	9,658	10,913	1,255	13.0%	18.1%	43.4%	2,154	2,834	31.6%
8 Manoa	15,581	13,192	(2,389)	-15.3%	7.7%	20.1%	4,338	4,602	6.1%
9 Nuuanu	14,189	11,447	(2,742)	-19.3%	23.9%	26.6%	2,678	3,066	14.5%
10 Kalihi	7,949	9,156	1,207	15.2%	35.3%	39.7%	1,874	2,488	32.7%
11 Iwilei	42,091	44,404	2,313	5.5%	7.5%	14.0%	21,824	24,039	10.2%
12 Airport PH	57,214	75,244	18,030	31.5%	1.0%	32.7%	34,588	39,833	15.2%
13 Salt Lake	25,082	33,934	8,852	35.3%	7.7%	15.1%	11,826	12,327	4.2%
14 PC Alea	31,650	37,854	6,204	19.6%	12.4%	30.0%	11,171	13,687	22.5%
15 Waipahu	33,955	22,996	(10,959)	-32.3%	121.4%	47.0%	6,178	9,251	49.8%
16 Mililani	38,425	51,554	13,129	34.2%	15.0%	38.3%	14,765	17,228	15.7%
17 Ewa	63,932	30,599	(33,333)	-52.1%	246.1%	58.9%	7,799	13,781	76.7%
18 Waianae	11,196	12,680	1,484	13.3%	41.7%	64.6%	2,556	5,021	96.4%
19 NorthShore	4,137	6,802	2,665	64.4%	-10.6%	49.3%	1,406	2,242	59.4%
20 Koolauloa	6,753	7,316	563	8.3%	13.8%	39.8%	1,863	2,523	35.5%
21 Kaneohe	22,159	31,312	9,153	41.3%	0.9%	34.6%	8,340	9,927	19.0%
22 Kailua	15,436	20,352	4,916	31.8%	-1.4%	22.4%	5,491	6,435	17.2%
23 E Honolulu	6,349	13,854	7,505	118.2%	-6.5%	74.5%	2,250	3,625	61.1%
Total	632,938	632,938	-	0.0%	26.8%	26.8%	213,305	253,273	16.7%

Table 6. Estimated 2000 and 2030 Home Access to Employment Ratings

District		0-Cars			1-Car			2-Cars		
No.	Name	2000	2030	% Change	2000	2030	% Change	2000	2030	% Change
1	Downtown	6,574	2,279	-65.3%	15,836	15,820	-0.1%	44,503	15,117	-66.0%
2	Kakaako	1,720	2,701	57.0%	7,747	16,388	111.5%	39,674	15,521	-60.9%
3	Makiki	3,518	3,113	-11.5%	7,591	16,451	116.7%	38,433	15,452	-59.8%
4	McCully	4,595	3,234	-29.6%	7,132	17,748	148.8%	35,040	16,783	-52.1%
5	Waikiki	2,009	3,773	87.8%	4,336	19,367	346.7%	31,434	18,127	-42.3%
6	Diamond Hd	5,750	5,029	-12.5%	7,866	20,391	159.2%	30,978	18,810	-39.3%
7	Kaimuki	3,820	5,069	32.7%	5,926	20,692	249.2%	29,981	19,043	-36.5%
8	Manoa	4,756	4,875	2.5%	7,044	19,147	171.8%	32,382	17,518	-45.9%
9	Nuuanu	4,274	3,721	-12.9%	8,204	16,712	103.7%	36,857	15,408	-58.2%
10	Kalihi	5,222	4,160	-20.3%	7,693	16,171	110.2%	35,549	14,850	-58.2%
11	Iwilei	14,195	3,200	-77.5%	17,953	15,009	-16.4%	41,660	14,122	-66.3%
12	Airport PH	6,636	4,286	-35.4%	8,895	16,856	89.5%	34,358	15,716	-54.3%
13	Salt Lake	4,133	5,314	28.6%	6,395	18,220	184.8%	32,662	16,665	-49.0%
14	PC Aiea	3,648	6,818	86.9%	5,658	22,478	297.3%	29,767	20,808	-30.1%
15	Waipahu	1,774	7,646	331.0%	3,517	30,441	765.5%	24,907	29,391	18.0%
16	Mililani	2,006	10,568	427.4%	3,614	37,799	945.8%	22,868	37,501	64.0%
17	Ewa	708	9,770	1279.8%	2,072	41,055	1880.9%	18,535	40,493	118.5%
18	Waianae	227	42,921	18786.9%	989	128,363	12882.4%	10,032	130,006	1195.9%
19	NorthShore	420	21,152	4941.3%	1,245	63,869	5028.9%	11,081	64,591	482.9%
20	Koolauloa	130	16,853	12884.4%	772	66,544	8517.8%	8,162	65,794	706.1%
21	Kaneohe	1,969	7,702	290.9%	3,180	25,850	713.0%	22,022	23,953	8.8%
22	Kailua	1,696	6,318	272.4%	3,166	26,141	725.7%	20,263	24,514	21.0%
23	E Honolulu	583	8,178	1301.7%	2,258	30,581	1254.2%	22,484	28,410	26.4%
	Total	79,963	188,698	136.0%	139,094	702,092	404.8%	653,832	678,592	3.8%

Table 7. Estimated 2000 and 2030 Work Access to Population Ratings

District		0-Cars			1-Car			2-Cars		
No.	Name	2000	2030	% Change	2000	2030	% Change	2000	2030	% Change
1	Downtown	10,204	4,064	-60.2%	14,312	31,302	118.7%	50,635	29,094	-42.5%
2	Kakaako	4,820	4,685	-2.8%	8,330	32,129	285.7%	48,587	29,535	-39.2%
3	Makiki	12,903	5,003	-61.2%	16,495	30,870	87.2%	54,264	28,294	-47.9%
4	McCully	11,158	4,909	-56.0%	14,367	32,948	129.3%	51,262	30,487	-40.5%
5	Waikiki	4,955	5,737	15.8%	7,887	36,000	356.5%	44,761	32,994	-26.3%
6	Diamond Hd	13,990	7,590	-45.8%	15,935	35,551	115.8%	48,265	33,217	-31.2%
7	Kaimuki	10,173	7,609	-25.2%	13,119	37,007	182.1%	46,518	33,578	-28.0%
8	Manoa	8,573	7,358	-16.0%	11,878	34,600	191.3%	48,641	31,171	-35.9%
9	Nuuanu	10,956	6,105	-44.3%	14,616	30,967	111.9%	52,196	27,941	-46.5%
10	Kalihi	10,162	6,612	-34.9%	13,536	29,607	118.7%	52,096	26,401	-49.3%
11	Iwilei	11,174	5,135	-54.0%	14,746	28,729	94.8%	53,642	26,079	-51.4%
12	Airport PH	3,882	6,391	64.6%	7,005	31,198	345.4%	47,283	27,920	-41.0%
13	Salt Lake	4,310	8,258	91.6%	7,495	32,946	339.6%	46,888	29,075	-38.0%
14	PC Aiea	6,384	9,607	50.5%	9,404	37,792	301.9%	46,643	33,764	-27.6%
15	Waipahu	4,849	10,851	123.8%	7,601	50,621	565.9%	41,955	46,795	11.5%
16	Mililani	3,848	15,743	309.1%	6,209	63,465	922.1%	35,304	60,184	70.5%
17	Ewa	1,656	14,092	750.8%	3,869	68,193	1662.8%	31,790	64,447	102.7%
18	Waianae	532	62,863	11712.6%	1,799	210,063	11576.4%	17,788	204,910	1052.0%
19	NorthShore	717	31,364	4274.6%	2,045	104,855	5027.1%	18,621	101,332	444.2%
20	Koolauloa	222	26,349	11776.3%	1,174	113,423	9564.5%	13,113	107,570	720.3%
21	Kaneohe	4,604	12,176	164.5%	6,916	45,333	555.5%	34,790	40,760	17.2%
22	Kailua	4,014	10,026	149.8%	5,132	45,553	642.8%	31,936	41,477	29.9%
23	E Honolulu	1,544	12,480	708.5%	3,881	54,119	1294.5%	33,710	49,378	46.5%
	Total	145,738	285,016	95.6%	209,752	1,218,271	480.8%	950,790	1,136,404	19.5%

Table 8. Estimated 2030 Employment in Wholesale/TCPU and Manufacturing Sectors

District		Wholesale/TCPU Employment				Manufacturing Employment			
No.	Name	Conventional	UrbanSim	Difference	%+/- Diff.	Conventional	UrbanSim	Difference	%+/- Diff.
1	Downtown	6,117	6,155	38	0.6%	1,499	6,935	5,436	362.6%
2	Kakaako	5,320	3,169	(2,151)	-40.4%	1,975	1,695	(280)	-14.2%
3	Makiki	1,369	737	(632)	-46.2%	569	185	(384)	-67.5%
4	McCully	2,796	1,110	(1,686)	-60.3%	1,270	293	(977)	-76.9%
5	Waikiki	1,410	891	(519)	-36.8%	616	1,039	423	68.7%
6	Diamond Hd	542	197	(345)	-63.7%	331	59	(272)	-82.2%
7	Kaimuki	386	193	(193)	-50.0%	445	163	(282)	-63.4%
8	Manoa	417	223	(194)	-46.5%	118	66	(52)	-44.1%
9	Nuuanu	391	265	(126)	-32.2%	268	134	(134)	-50.0%
10	Kalihi	208	256	48	23.1%	108	82	(26)	-24.1%
11	Iwilei	6,305	5,293	(1,012)	-16.1%	7,954	4,099	(3,855)	-48.5%
12	Airport PH	12,651	12,601	(50)	-0.4%	5,257	4,144	(1,113)	-21.2%
13	Salt Lake	762	1,740	978	128.3%	1,441	3,698	2,257	156.6%
14	PC Aiea	1,943	3,468	1,525	78.5%	2,846	2,492	(354)	-12.4%
15	Waipahu	1,003	1,911	908	90.5%	3,219	1,070	(2,149)	-66.8%
16	Mililani	1,591	3,522	1,931	121.4%	568	2,812	2,244	395.1%
17	Ewa	3,984	2,004	(1,980)	-49.7%	4,279	1,188	(3,091)	-72.2%
18	Waianae	255	1,072	817	320.4%	136	603	467	343.4%
19	NorthShore	146	548	402	275.3%	335	460	125	37.3%
20	Koolauloa	305	531	226	74.1%	141	398	257	182.3%
21	Kaneohe	936	2,240	1,304	139.3%	427	1,816	1,389	325.3%
22	Kailua	669	1,419	750	112.1%	670	1,071	401	59.9%
23	E Honolulu	510	471	(39)	-7.6%	218	188	(30)	-13.8%
	Total	50,016	50,016	-	0.0%	34,690	34,690	-	0.0%

Table 9. Estimated 2030 Employment in FIRE and Service Sectors

District		Finance, Insur., Real Est. Employment				Service Employment			
No.	Name	Conventional	UrbanSim	Difference	%+/- Diff.	Conventional	UrbanSim	Difference	%+/- Diff.
1	Downtown	11,086	7,327	(3,759)	-33.9%	27,838	33,879	6,041	21.7%
2	Kakaako	2,165	1,682	(483)	-22.3%	13,856	11,845	(2,011)	-14.5%
3	Makiki	1,584	944	(640)	-40.4%	14,515	13,280	(1,235)	-8.5%
4	McCully	5,381	1,853	(3,528)	-65.6%	15,698	11,564	(4,134)	-26.3%
5	Waikiki	2,279	1,224	(1,055)	-46.3%	12,009	7,928	(4,081)	-34.0%
6	Diamond Hd	908	276	(632)	-69.6%	6,584	4,207	(2,387)	-36.2%
7	Kaimuki	624	317	(307)	-49.2%	5,278	3,360	(1,918)	-36.3%
8	Manoa	474	193	(281)	-59.3%	12,534	7,804	(4,730)	-37.7%
9	Nuuanu	782	444	(338)	-43.2%	10,623	5,758	(4,865)	-45.8%
10	Kalihi	456	441	(15)	-3.3%	5,255	4,175	(1,080)	-20.6%
11	Iwilei	2,911	2,234	(677)	-23.3%	14,253	17,066	2,813	19.7%
12	Airport PH	1,852	3,512	1,660	89.6%	11,212	27,592	16,380	146.1%
13	Salt Lake	337	2,728	2,391	709.5%	9,653	14,207	4,554	47.2%
14	PC Aiea	1,532	3,445	1,913	124.9%	11,161	14,350	3,189	28.6%
15	Waipahu	1,935	1,688	(247)	-12.8%	16,099	7,747	(8,352)	-51.9%
16	Mililani	1,860	5,157	3,297	177.3%	13,625	20,869	7,244	53.2%
17	Ewa	3,370	1,126	(2,244)	-66.6%	22,102	11,753	(10,349)	-46.8%
18	Waianae	472	1,044	572	121.2%	6,784	4,837	(1,947)	-28.7%
19	NorthShore	152	647	495	325.7%	1,269	1,997	729	57.5%
20	Koolauloa	270	691	421	155.9%	3,840	2,547	(1,293)	-33.7%
21	Kaneohe	609	3,085	2,476	406.6%	7,268	12,865	5,597	77.0%
22	Kailua	739	1,759	1,020	138.0%	8,296	7,908	(388)	-4.7%
23	E Honolulu	526	487	(39)	-7.4%	3,078	5,301	2,223	72.2%
	Total	42,304	42,304	-	0.0%	252,839	252,839	-	0.0%

Table 10. Estimated 2030 Employment in Military and Government Sectors

District	Military Employment				Government Employment			
No. Name	Conventional	UrbanSim	Difference	%+/- Diff.	Conventional	UrbanSim	Difference	%+/- Diff.
1 Downtown	149	319	170	114.1%	9,425	3,558	(5,867)	-62.2%
2 Kakaako	205	524	319	155.6%	1,917	1,548	(369)	-19.2%
3 Makiki	44	526	482	1095.5%	1,460	1,621	161	11.0%
4 McCully	21	439	418	1990.5%	442	2,364	1,922	434.8%
5 Waikiki	148	485	337	227.7%	425	1,403	978	230.1%
6 Diamond Hd	345	541	196	56.8%	690	2,620	1,930	279.7%
7 Kaimuki	7	508	501	7157.1%	227	1,800	1,573	693.0%
8 Manoa	82	656	574	700.0%	353	1,368	1,015	287.5%
9 Nuuanu	37	910	873	2359.5%	289	1,381	1,092	377.9%
10 Kalihi	3	771	768	25600.0%	405	1,112	707	174.6%
11 Iwilei	133	1,004	871	654.9%	1,363	2,505	1,142	83.8%
12 Airport PH	10,340	6,544	(3,796)	-36.7%	5,894	4,793	(1,101)	-18.7%
13 Salt Lake	5,924	3,763	(2,161)	-36.5%	3,930	2,072	(1,858)	-47.3%
14 PC Alea	2,675	3,381	706	26.4%	1,548	1,252	(296)	-19.1%
15 Waipahu	4	1,785	1,781	44525.0%	594	1,650	1,056	177.8%
16 Mililani	12,223	7,040	(5,183)	-42.4%	2,627	1,916	(711)	-27.1%
17 Ewa	354	2,356	2,002	565.5%	6,763	2,757	(4,006)	-59.2%
18 Waianae	45	1,043	998	2217.8%	404	620	216	53.5%
19 NorthShore	138	322	184	133.3%	62	470	408	658.1%
20 Koolauloa	20	214	194	970.0%	133	504	371	278.9%
21 Kaneohe	7,211	4,613	(2,598)	-36.0%	1,475	817	(658)	-44.6%
22 Kailua	289	1,478	1,189	411.4%	623	1,033	410	65.8%
23 E Honolulu	-	1,175	1,175	n/a	244	2,129	1,885	772.5%
Total	40,397	40,397	-	0.0%	41,293	41,293	-	0.0%

Table 11. Estimated 2030 Employment in Agriculture and Construction Sectors

District	Agricultural Employment				Construction Employment			
No. Name	Conventional	UrbanSim	Difference	%+/- Diff.	Conventional	UrbanSim	Difference	%+/- Diff.
1 Downtown	310	102	(208)	-67.1%	1,641	1,998	357	21.8%
2 Kakaako	253	135	(118)	-46.6%	3,191	1,358	(1,833)	-57.4%
3 Makiki	31	94	63	203.2%	740	480	(260)	-35.1%
4 McCully	174	110	(64)	-36.8%	1,802	296	(1,506)	-83.6%
5 Waikiki	117	93	(24)	-20.5%	1,524	667	(857)	-56.2%
6 Diamond Hd	28	78	50	178.6%	390	201	(189)	-48.5%
7 Kaimuki	52	109	57	109.6%	405	187	(218)	-53.8%
8 Manoa	35	114	79	225.7%	241	162	(79)	-32.8%
9 Nuuanu	29	139	110	379.3%	519	227	(292)	-56.3%
10 Kalihi	46	121	75	163.0%	308	289	(19)	-6.2%
11 Iwilei	303	240	(63)	-20.8%	888	2,585	1,697	191.1%
12 Airport PH	77	498	421	546.8%	514	3,775	3,261	634.4%
13 Salt Lake	4	219	215	5375.0%	277	1,308	1,031	372.2%
14 PC Alea	131	382	251	191.6%	708	2,132	1,424	201.1%
15 Waipahu	142	320	178	125.4%	3,282	1,665	(1,617)	-49.3%
16 Mililani	339	532	193	56.9%	1,041	2,889	1,848	177.5%
17 Ewa	728	469	(259)	-35.6%	7,675	2,500	(5,175)	-67.4%
18 Waianae	648	321	(327)	-50.5%	560	866	306	54.6%
19 NorthShore	624	152	(472)	-75.6%	300	391	91	30.3%
20 Koolauloa	376	149	(227)	-60.4%	181	291	110	60.8%
21 Kaneohe	452	426	(26)	-5.8%	612	1,332	720	117.6%
22 Kailua	421	344	(77)	-18.3%	426	1,402	976	229.1%
23 E Honolulu	56	229	173	308.9%	245	469	224	91.4%
Total	5,376	5,376	-	0.0%	27,470	27,470	-	0.0%

Table 12. Estimated 2030 Employment in the Retail Sector

District	Resident-Oriented Retail Employment				Visitor-Oriented Retail Employment			
No. Name	Conventional	UrbanSim	Difference	%+/- Diff.	Conventional	UrbanSim	Difference	%+/- Diff.
1 Downtown	5,873	10,123	4,250	72.4%	-	-	-	n/a
2 Kakaako	9,552	7,868	(1,684)	-17.6%	-	-	-	n/a
3 Makiki	2,477	3,272	795	32.1%	-	-	-	n/a
4 McCully	9,149	8,320	(829)	-9.1%	2,064	1,520	(544)	-26.4%
5 Waikiki	-	-	-	n/a	19,806	14,097	(5,709)	-28.8%
6 Diamond Hd	3,241	4,358	1,117	34.5%	-	-	-	n/a
7 Kaimuki	1,904	2,959	1,055	55.4%	-	-	-	n/a
8 Manoa	1,087	1,835	748	68.8%	-	-	-	n/a
9 Nuuanu	990	1,799	809	81.7%	-	-	-	n/a
10 Kalihi	929	1,509	580	62.4%	-	-	-	n/a
11 Iwilei	7,103	8,283	1,180	16.6%	-	-	-	n/a
12 Airport PH	8,215	10,254	2,039	24.8%	-	-	-	n/a
13 Salt Lake	2,392	3,998	1,606	67.1%	-	-	-	n/a
14 PC Alea	8,050	6,600	(1,450)	-18.0%	-	-	-	n/a
15 Waipahu	7,677	4,663	(3,014)	-39.3%	-	-	-	n/a
16 Mililani	4,448	6,460	2,012	45.2%	-	-	-	n/a
17 Ewa	12,285	5,489	(6,796)	-55.3%	-	-	-	n/a
18 Waianae	1,576	2,156	580	36.8%	-	-	-	n/a
19 NorthShore	1,106	1,533	427	38.6%	-	-	-	n/a
20 Koolauloa	1,217	1,645	428	35.2%	-	-	-	n/a
21 Kaneohe	3,148	3,939	791	25.1%	-	-	-	n/a
22 Kailua	3,291	3,652	361	11.0%	-	-	-	n/a
23 E Honolulu	1,472	2,721	1,249	84.9%	-	-	-	n/a
Total	97,182	103,436	6,254	6.4%	21,870	15,617	(6,253)	-28.6%

Table 13. Estimated 2030 Hotel Rooms and Employment in the Hotel Sector

District	Hotel Rooms		Hotel Employment				Resort Condo Units	
No. Name	Conventional	UrbanSim	Conventional	UrbanSim	Difference	%+/- Diff.	Conventional	UrbanSim
1 Downtown	69	1,032	1,045	527	(518)	-49.6%	77	160
2 Kakaako	-	730	1,250	375	(875)	-70.0%	-	-
3 Makiki	40	1,028	411	527	116	28.2%	21	27
4 McCully	1,164	5,164	1,930	2,650	720	37.3%	401	227
5 Waikiki	23,205	6,997	6,579	3,592	(2,987)	-45.4%	9,873	10,477
6 Diamond Hd	893	4,025	606	2,067	1,461	241.1%	3	1
7 Kaimuki	-	2,563	330	1,317	987	299.1%	-	-
8 Manoa	40	1,501	240	771	531	221.3%	11	1
9 Nuuanu	-	761	261	390	129	49.4%	-	-
10 Kalihi	-	782	231	400	169	73.2%	-	-
11 Iwilei	-	2,136	878	1,095	217	24.7%	-	-
12 Airport PH	863	2,981	1,202	1,531	329	27.4%	290	55
13 Salt Lake	-	392	362	201	(161)	-44.5%	-	-
14 PC Alea	29	890	1,056	352	(704)	-66.7%	44	99
15 Waipahu	-	970	-	497	497	n/a	-	-
16 Mililani	659	697	103	357	254	246.6%	74	22
17 Ewa	8,770	1,868	2,392	957	(1,435)	-60.0%	2	1
18 Waianae	382	231	316	118	(198)	-62.7%	1,121	702
19 NorthShore	-	551	6	282	276	4600.0%	544	24
20 Koolauloa	1,620	675	270	346	76	28.1%	116	77
21 Kaneohe	109	352	21	179	158	752.4%	147	16
22 Kailua	141	558	12	286	274	2283.3%	190	20
23 E Honolulu	-	1,336	-	684	684	n/a	-	-
Total	37,984	38,020	19,501	19,501	-	0.0%	12,714	11,909

Table 14. Estimated 2030 Public and Private College Students

District	Public College Students				Private College Students			
No. Name	Conventional	UrbanSim	Difference	%+/- Diff.	Conventional	UrbanSim	Difference	%+/- Diff.
1 Downtown	-	-	-	n/a	6,315	6,766	451	7.1%
2 Kakaako	-	-	-	n/a	-	-	-	n/a
3 Makiki	-	-	-	n/a	40	44	4	10.0%
4 McCully	-	-	-	n/a	168	178	10	6.0%
5 Waikiki	-	-	-	n/a	-	-	-	n/a
6 Diamond Hd	9,879	10,582	703	7.1%	-	-	-	n/a
7 Kaimuki	-	-	-	n/a	1,075	1,151	76	7.1%
8 Manoa	26,908	28,827	1,919	7.1%	-	-	-	n/a
9 Nuuanu	-	-	-	n/a	-	-	-	n/a
10 Kalihi	-	-	-	n/a	-	-	-	n/a
11 Iwilei	6,366	6,821	455	7.1%	-	-	-	n/a
12 Airport PH	-	-	-	n/a	-	-	-	n/a
13 Salt Lake	-	-	-	n/a	-	-	-	n/a
14 PC Aiea	-	-	-	n/a	-	-	-	n/a
15 Waipahu	9,568	10,249	681	7.1%	-	-	-	n/a
16 Mililani	-	-	-	n/a	-	-	-	n/a
17 Ewa	7,600	-	(7,600)	-100.0%	-	-	-	n/a
18 Waianae	-	-	-	n/a	-	-	-	n/a
19 NorthShore	-	-	-	n/a	-	-	-	n/a
20 Koolauloa	-	-	-	n/a	2,654	2,843	189	7.1%
21 Kaneohe	2,195	2,352	157	7.2%	-	-	-	n/a
22 Kailua	-	-	-	n/a	-	-	-	n/a
23 E Honolulu	-	-	-	n/a	148	158	10	6.8%
Total	62,516	58,831	(3,685)	-5.9%	10,400	11,140	740	7.1%

Table 15. Estimated 2030 Public and Private K-12 Students

District	Public K-12 Students				Private K-12 Students			
No. Name	Conventional	UrbanSim	Difference	%+/- Diff.	Conventional	UrbanSim	Difference	%+/- Diff.
1 Downtown	2,512	2,193	(319)	-12.7%	1,175	898	(277)	-23.6%
2 Kakaako	11,692	5,221	(6,471)	-55.3%	-	-	-	n/a
3 Makiki	1,172	1,469	297	25.3%	6,643	9,254	2,611	39.3%
4 McCully	3,649	4,788	1,139	31.2%	2,451	3,217	766	31.3%
5 Waikiki	1,085	1,801	716	66.0%	255	514	259	101.6%
6 Diamond Hd	4,329	6,414	2,085	48.2%	76	123	47	61.8%
7 Kaimuki	3,111	5,144	2,033	65.3%	2,721	4,471	1,750	64.3%
8 Manoa	1,647	2,378	731	44.4%	1,989	2,869	880	44.2%
9 Nuuanu	6,735	9,500	2,765	41.1%	3,398	4,728	1,330	39.1%
10 Kalihi	5,774	6,027	253	4.4%	5,065	5,293	228	4.5%
11 Iwilei	6,506	4,311	(2,195)	-33.7%	1,082	670	(412)	-38.1%
12 Airport PH	5,671	4,010	(1,661)	-29.3%	840	594	(246)	-29.3%
13 Salt Lake	8,370	7,860	(510)	-6.1%	246	235	(11)	-4.5%
14 PC Aiea	12,836	16,156	3,320	25.9%	831	1,050	219	26.4%
15 Waipahu	12,319	7,744	(4,575)	-37.1%	680	666	(14)	-2.1%
16 Mililani	15,649	16,118	469	3.0%	1,195	1,235	40	3.3%
17 Ewa	20,845	9,916	(10,929)	-52.4%	450	507	57	12.7%
18 Waianae	13,041	10,117	(2,924)	-22.4%	119	92	(27)	-22.7%
19 NorthShore	2,887	2,934	47	1.6%	285	290	5	1.8%
20 Koolauloa	4,798	5,490	692	14.4%	-	-	-	n/a
21 Kaneohe	8,202	8,066	(136)	-1.7%	976	960	(16)	-1.6%
22 Kailua	7,825	8,822	997	12.7%	1,276	1,440	164	12.8%
23 E Honolulu	6,218	8,495	2,277	36.6%	532	727	195	36.7%
Total	166,873	154,974	(11,899)	-7.1%	32,285	39,833	7,548	23.4%

APPENDIX M
Conceptual Water Master Plan

Conceptual Water Master Plan for the Hoopili Project in Ewa, Oahu

Prepared for:

Bills Engineering Inc.
1124 Fort Street Mall - Suite 200
Honolulu, Hawaii 96813

Prepared by:

Tom Nance Water Resource Engineering
680 Ala Moana Boulevard - Suite 406
Honolulu, Hawaii 96813

November 2007

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Introduction

The proposed Hoopili project would consist of residential, commercial, industrial, mixed uses, parks, and public facilities on 1555 acres of land in Ewa, Oahu. Figure 1 is a conceptual land use plan for the project which would be undertaken by the D.R. Horton-Schuler Division. It is the intention of the developer to use non-potable water for irrigation to limit the project's use of potable water.

This conceptual water master plan identifies the required supply and offsite water system infrastructure for both the potable and non-potable systems. Because the present land use plan is conceptual in nature and the project's interior roadways have not yet been defined, sizing and analyses of the project's interior distribution mains are not presented herein.

Delineation of Service Pressure Zones

Potable System. The potable system would be built to Honolulu Board of Water Supply (BWS) standards and dedicated to that agency. To incorporate the Hoopili system into that of BWS, two service pressure zones would be created: a lower, 228-foot zone to match existing BWS storage reservoirs in Kunia and Honouliuli; and an upper service zone, tentatively selected at 440-foot elevation. Depending on land acquisition and other issues that will be evaluated subsequently, the upper service zone may use a 395- rather than 440-foot tank spillway elevation. Figure 2 shows the boundary of the two service pressure zones. About two-thirds of the project area is in the upper service zone.

Non-Potable System. At present, BWS' regional non-potable system does not serve the Hoopili project area. As such, the Hoopili non-potable system would be privately owned and operated at least initially. However, to make future dedication to BWS possible if and when the BWS regional system is expanded, the private Hoopili system would use a compatible service zone delineation. For the purposes of this conceptual water master plan, it is assumed that the non-potable system's service zone delineation would be identical to the potable system: a lower 228-foot; and an upper 440-foot zone. It is recognized that the lower zone may ultimately be based on a 215- rather than 228-foot tank.

Projected Potable and Non-Potable Supply Requirements

Table 1 summarizes water use demand factors and infrastructure sizing criteria that are the basis of this master plan. The water use criteria are identical to those formulated by BWS and incorporated into the Ewa Water Master Plan done by the Ewa Plain Water Development Corporation (EPWDC) in 1987. These criteria allow for a difference between water use and water demand. The water use amount establishes the well supply requirement. Water demand is nominally 20 percent greater than water use and it is the basis of reservoir and pipeline sizing. The infrastucture sizing criteria reflect the fact that the non-potable system will initially be supplied by direct pumping without reservoir storage.

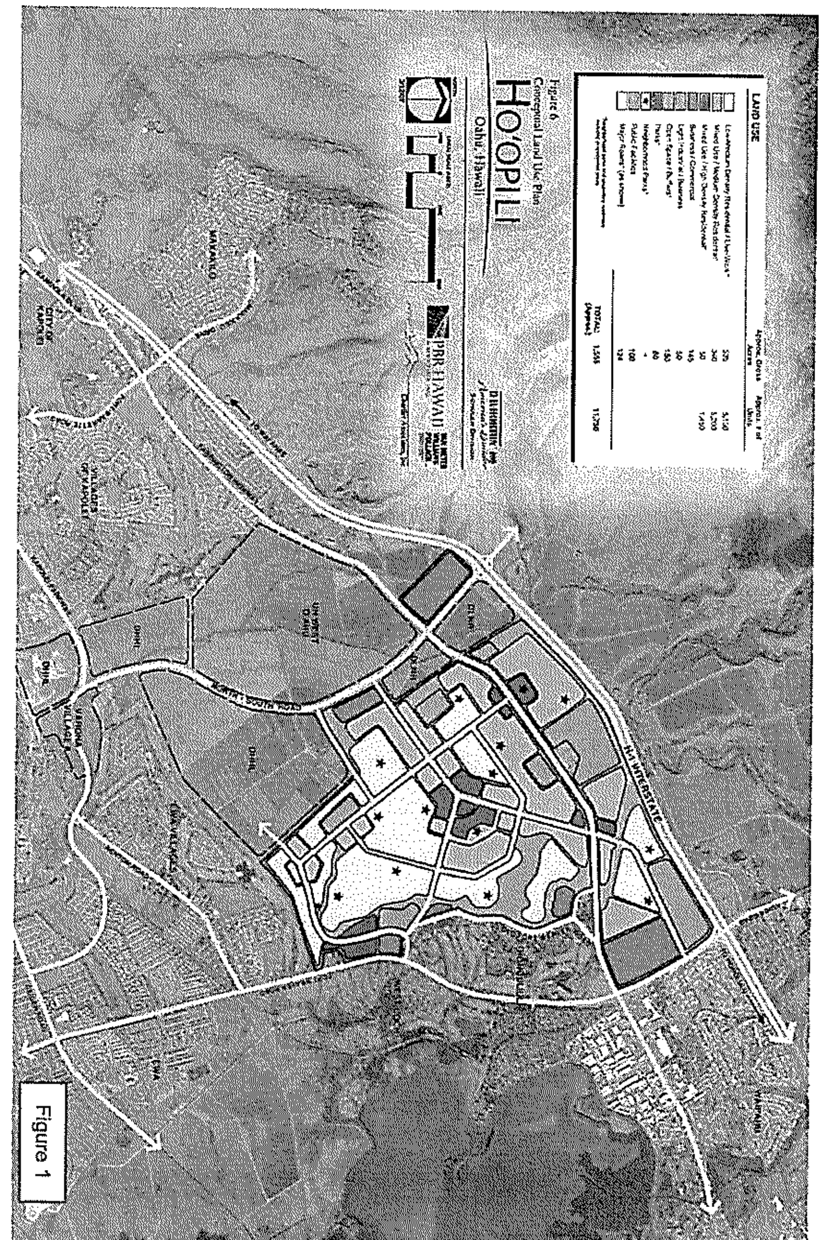

Figure 1

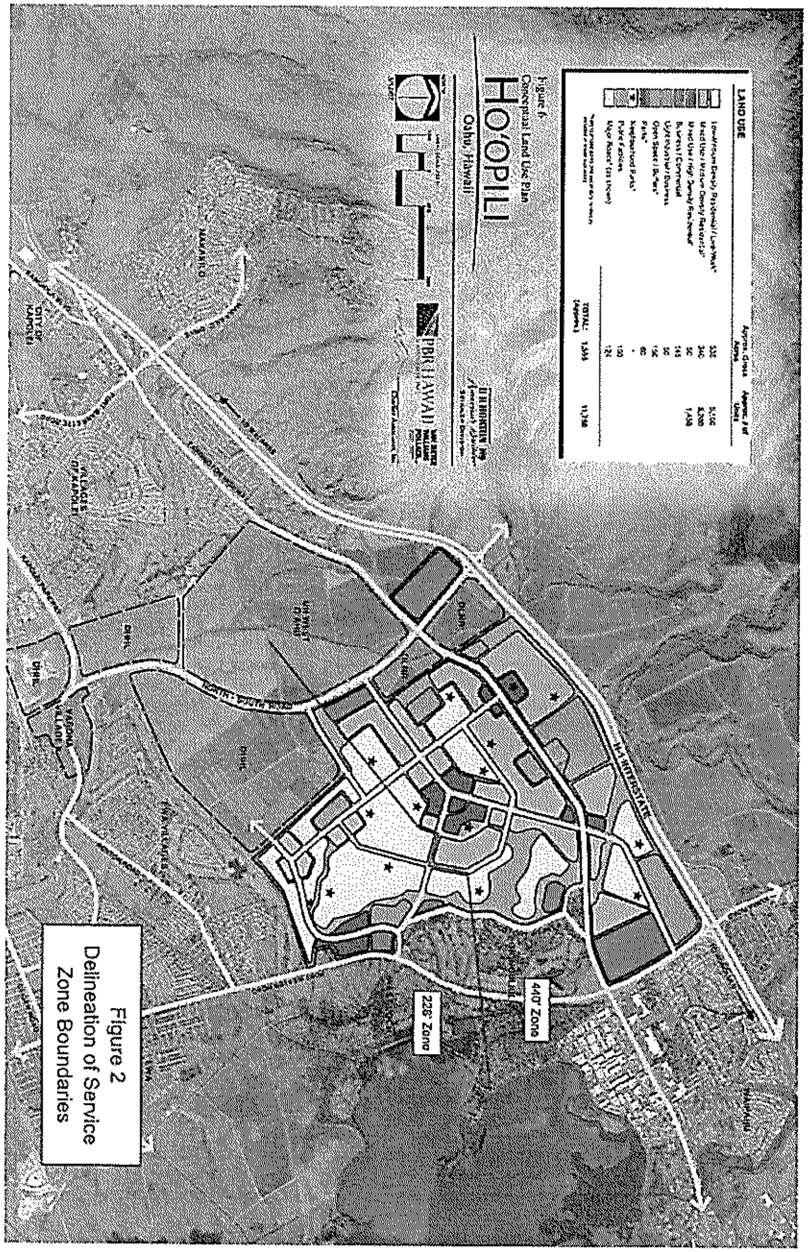

Figure 2
Delineation of Service Zone Boundaries

Table 1. Summary of Water System Design Criteria

WATER USE CRITERIA

Land Use	Unit	All Potable System	Dual System			
			Average Water Use		Average Daily Demand	
			Potable	Non-Potable	Potable	Non-Potable
Residential						
Single Family	GPD / Unit	500	345	155	414	186
Multi-Family Low Rise	GPD / Unit	400	276	124	331	149
Multi-Family High Rise	GPD / Unit	300	207	93	248	112
Commercial	GPD / Acre	3,000	1,800	1,200	2,160	1,440
Resort	GPD / Unit	350	203	147	244	176
	GPD / Acre	4,000	2,320	1,680	2,784	2,016
Golf Course and Parks	GPD / Acre	4,000	600	3,400	720	4,080
School	GPD / Student	60	35	25	42	30
Industrial	GPD / Acre	4,000	1,184	2,816	1,421	3,379
Commercial / Industrial	GPD / 1,000 Ft^2	100	60	40	72	48
Commercial / Residential	GPD / 1,000 Ft^2	120	83	37	100	44

PIPELINE, STORAGE, AND WELL PUMP SIZING CRITERIA

1. Demand Factors

   a. AVERAGE DAY DEMAND. For land uses served by a dual system, a 1.2 factor is applied to the AVERAGE WATER USE rates to derive the AVERAGE DAY DEMAND. For land uses served only by the potable system, AVERAGE WATER USE and AVERAGE DAY DEMAND are identical.

   b. MAXIMUM DAY DEMAND = (1.5) AVERAGE DAY DEMAND.
   c. PEAK HOUR RATE = (3.0) AVERAGE DAY DEMAND

   (Note: Peak rate in the non-potable pipelines is defined as delivery of the Maximum Day Demand in a 12-hour period. This is equivalent to 3.0 times the Average Demand).

2. Fire protection will be provided by the potable system.

3. Reservoir Storage:

   a. The potable reservoir storage volume shall be equivalent to the maximum day demand.
   b. The private non-potable system will be supplied by direct well pumping with no reservoir storage.

4. Potable and non-potable pipelines shall be sized for PEAK HOUR flowrates with a minimum residual pressure of 40 psi and maximum velocity in the main of 6 feet per second (fps) for potable lines and 8 fps for non-potable lines. Hydraulic analyses will utilize tank spillway elevations as the initial hydraulic grade line elevations. Pipelines providing fire protection shall also be sized for MAXIMUM DAY flow plus fire flow with a residual of 20 psi at the critical fire hydrant. Hydraulic analyses will use three-quarters full tank water surface elevations as initial hydraulic grade line elevations.

5. Well pumps for potable system shall provide MAXIMUM DAY DEMAND in an operating time of 16 hours with the largest pump unit as standby. The well pumps for the private non-potable systems shall provide the MAXIMUM DAY DEMAND in a time of 12 hours with the largest pump as standby.

Based on the land use plan shown on Figure 1 and the water use criteria in Table 1, the Hoopili project's potable and non-potable water use and water demand totals are summarized below. The total potable supply requirement for both service zones is 3.87 MGD. It has been reduced by 1.75 MGD by the commitment to install a dual water system in both service zones throughout the project

Projected Average Potable Water Use and Average Potable Water Demand

Service Pressure Zone	Average Water Use (MGD)	Average Water Demand (MGD)
440-Foot	2.96	3.52
228-Foot	0.91	1.02
Both Zones	3.87	4.54

Projected Average Non-Potable Water Use and Average Non-Potable Demand

Service Pressure Zone	Average Water Use (MGD)	Average Water Demand (MGD)
440-Foot	1.44	1.74
228-Foot	0.31	0.37
Both Zones	1.75	2.11

Potable System

Well Supply. At full build-out, the Hoopili project will require an average potable well supply of 3.87 MGD. It is intended that the well supply would be provided from existing BWS sources with the developer paying the appropriate Facilities Charges. BWS' Ewa Shaft (State No. 2202-21) has a permitted use of 12.154 MGD and its entire allocation has been committed to development in the Ewa Development Plan area on a first-come, first-serve basis. Depending on the remaining unallocated supply from the Ewa Shaft at the time the Hoopili project is built-out, other BWS sources may also provide some of the supply. These other sources may include existing BWS wells in Waipahu that serve the Ewa area and/or a desalinization plant at the makai end of Campbell Industrial Park.

Reservoir Storage. Storage for the Hoopili project will be required in the 440- and 228-foot service zones. Required storage in the 440-foot zone is 5.28 million gallons (MG), the project's maximum day demand at full build-out. A 5.5 MG tank would be installed next to the existing 1.0 MG Honouliuli 440 tank to meet this requirement.

Required reservoir storage in the 228-foot service zone, again based on maximum day demand at full build-out, is 1.53 MG. BWS owns a site next to its existing 5.0 MG Honouliuli 228 tank which is large enough for a 5.5 MG tank. Ultimately, BWS will install a large storage tank at this site funded by Facilities Charges it collects. The Hoopili project will pay the applicable portion of Facilities Charges for storage as its contribution to the construction of that storage reservoir.

Offsite Transmission for the 440-Foot Service Zone. Figure 3 illustrates how transmission from the new 5.5 MG, 440-foot tank to the Hoopili project makai of H-1 freeway would be accomplished. It consists of the following:

- The 42-inch main between the existing Honouliuli 440 and Honouliuli 228 tanks would be converted to a transmission/distribution main for the Hoopili project. The mauka-makai transmission of water from BWS' Honouliuli wells between the 440 and 228 tanks would occur through a new 24-inch pipeline installed by the Hoopili developer. The size of the existing 42-inch pipeline was selected when it was anticipated that the Honouliuli Well Fields (Honouliuli Wells I and II) would ultimately consist of 12 wells with a combined pumping capacity of 21,000 GPM. With BWS' acquisition of the Ewa Shaft, the Honouliuli Well fields will not be expanded beyond their present six wells and combined 7875 GPM pumping capacity. A 24-inch pipeline will provide adequate capacity for these six wells.

- A new booster pump station would be installed at the existing Honouliuli 228 tank site to deliver water via the existing 42-inch pipeline up to the new Honouliuli 440 tank. As water in the 440 tank would "float" on the system, separate inflow and outflow would be installed at the tank to create positive turnover in the tank.

- Makai of the Honouliuli 228-foot tank, the transmission pipeline would be sized for the project's requirements in the 440-foot zone. Tentatively, the size of the pipeline beneath H-1 freeway to Farrington Highway would be 30-inch. Two routes for the pipeline have been preliminarily investigated, tunneling beneath the freeway or running the line back (east) to and beneath the Honouliuli Gulch Bridge. If there is insufficient space to go beneath the bridge, the tunneling option would be selected. BWS may consider oversizing the 30-inch pipe for use by other projects in the 440-foot zone.

Proposed University of Hawaii West Oahu (UHWO) 440'-System. A 440-foot service zone to serve the UHWO campus is currently in the preliminary design stage. There have been discussions between UHWO and Hoopili regarding combining the offsite elements of both 440-foot zone systems. Such a combination may include the following:

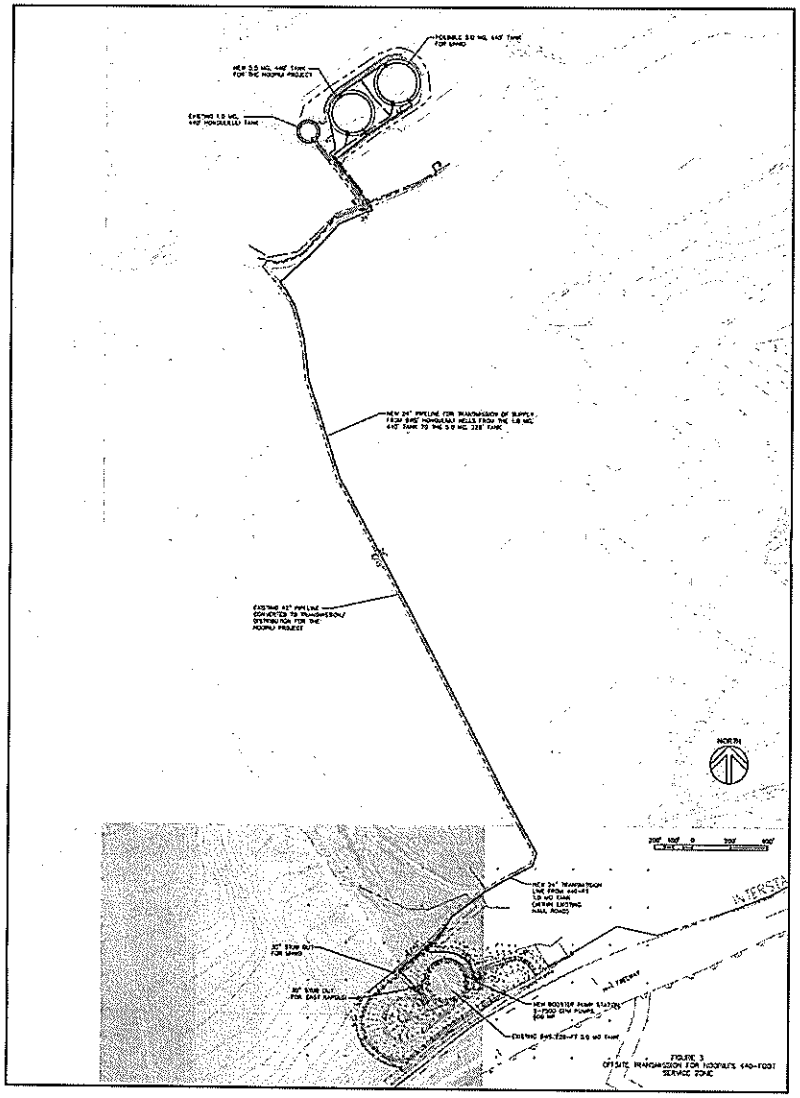

FIGURE 3
OFFSITE TRANSMISSION FOR HOOPILI'S 440-FOOT SERVICE ZONE

- UHWO, which has a 5.0 MG storage requirement in the 440-foot zone, would build its tank next to the existing 1.0 MG Honouliuli 440 and proposed 5.5 MG 440 tank for Hoopili.

- UHWO and Hoopili would share in the construction of the booster station at the 5.0 MG Honouliuli 228 tank and the 24-inch mauka-makai transmission pipeline described above.

- The existing 42-inch main, which will be converted for use by Hoopili, would have adequate capacity for the UHWO project as well.

- Transmission/distribution to UHWO from the site of the Honouliuli 228 tank could either run on the mauka side of H-1 freeway or participate with Hoopili in a route beneath H-1 freeway.

Offsite Transmission for the 228-Foot Service Zone. Existing transmission for the 228-foot service zone on the east side of the Ewa Plain is provided by a 42-inch pipeline which runs from the 5.0 MG Honouliuli 228 tank back to and beneath the Honouliuli Gulch Bridge. It then takes a diagonal path to the intersection of Farrington Highway and "Pipeline" Road and then goes down Pipeline Road to users. The pipeline was installed by EPWDC in the 1980s and has no available capacity for the Hoopili project. Hoopili's requirements in the 228-foot zone are relatively modest, an average demand of 1.02 MGD and peak of 3.06 MGD. A new pipeline, tentatively selected to be 20-inch, would be installed from the Honouliuli 228 tank across or beneath H-1 freeway (the pipe size is discussed in a section following). As with the pipeline from the 440-foot tank(s), the crossing of H-1 freeway would either be by a tunnel beneath the freeway or the longer route back to and beneath the Honouliuli Gulch Bridge. BWS may also elect to oversize this pipeline.

Relocation of the Existing 42-Inch, 228-Foot Service Zone Pipeline. The existing 42-inch main down Pipeline Road cuts across Hoopili development areas and is not aligned with the project's major roadways. Realignment of major sections of the 42-inch main and/or adjustments to the land use plan will be necessary.

Hydraulic Analyses. As this water master plan is based on a conceptual land use plan, the roadways and distribution pipelines within the Hoopili project are not yet defined. Service to Hoopili's 440-foot zone would essentially be a stand-alone system. As such, its hydraulic analysis can be deferred until after the land use plan is finalized. Hoopili's 228-foot zone would be incorporated into BWS' Fort Weaver Road corridor system. Even at the present conceptual land use plan level, it is important to demonstrate that the addition of the Hoopili project will not adversely impact service to present and future customers in the Fort Weaver Corridor and in Kapolei and Barbers Point. Details of these analyses are presented in Appendices A, B, and C and can be summarized as follows:

- Appendix A illustrates the hydraulic model used for the simulations, including a new 20-inch pipeline for Hoopili's 228-foot service zone.

- Appendix B is a simulation for "existing" conditions in BWS' system in the Fort Weaver corridor. It includes full build-out of the Ewa by Gentry and Ocean Pointe projects. For continuity and clarity, this computer run is identical to the simulation in Appendix A of the "November 2006 Potable and Non-Potable Water Master Plans for the Ocean Pointe Project In Ewa, Oahu". Details of the assumptions incorporated in this analysis are explained in that report.

- Appendix C is simulation with the addition of a 20-inch pipeline to and through Hoopili's 228-foot zone to BWS' Fort Weaver Corridor system.

The simulation results in Appendix C demonstrate that a 20-inch pipeline from the Honouliuli 228 tank down to and through Hoopili's 228-foot service zone, with two points of connection to the existing 42-inch pipeline, would decrease flow and velocities in the 42-inch main and increase delivery pressures to customers in the lower portion of BWS' 228-foot service zone by about two (2) psi.

Non-Potable System

Well Supply. At least until BWS' regional non-potable system is expanded to include the Hoopili project area, supply for its non-potable system would be provided from the battery of wells commonly known as EP 5 & 6 and identified as State Well Nos. 2202-03 to 14 (old Well Nos. 259 A to L). This battery consists of 12 wells which were drilled in 1896-97. All of the wells have 12-inch casing to 70-foot depths and total depths which vary between 303 and 312 feet. The lower 233 to 242 feet of the wells are open hole. Nominal ground elevation at the well battery is 50 feet.

The battery has two 36-inch pipe manifolds, each of which connects six wells to a common header which delivers water into a square-shaped and very deep concrete vault (the vault is 22 feet on a side and 48 feet deep). The two manifold pipelines enter the vault on opposite sides and each has its own isolation gate valve in the vault. At the close of plantation operations in the 1990s, a 4500 GPM end suction pump was connected to one of the manifolds (EP 5) and a 5600 GPM end suction pump was connected to the other (EP 6). Their combined pumping capacity of 10,100 GPM (14.5 MGD) is far greater than would be required for the Hoopili project.

At present, smaller-sized, end suction pumps are connected to the manifolds and these provide agricultural irrigation for Aloun Farms in the area of the Hoopili project. To convert the EP 5 & 6 facility for use by the Hoopili project, the following would be done:

- The present end-suction pumps, electrical equipment, and all piping (back to the incoming isolation valves) would be removed from the vault.

- As best as can be determined from measurements and old records, the bottom of the vault is on the order of two to three feet above sea level. The piezometric head in the volcanics tapped by the 12 wells is 17 to 18 feet above sea level. The isolation valves on both manifolds would be opened, thereby filling the vault and creating a sump with a water depth on the order of 14 to 16 feet.

- Two pump stations, one for each of Hoopili's two service pressure zones, would be installed at ground level over the vault. Each station would have multiple line shaft turbine pumps and automated start/stop operation based on service pressure. Their operation would be essentially identical to golf course pump stations.

- Based on BWS' design criteria and the fact that the system would initially have no reservoir storage, the well pumping capacity would be selected to provide the maximum day supply requirement in a 12-hour period. This conforms with BWS' Non-Potable Water System Planning Factors and Design Standards (Revised November 3, 2006). Based on this, the station pumping capacities that would be installed for the Hoopili project would be as follows:

Service Pressure Zone	Average Demand (MGD)	Station Pumping Capacity	
		Required MGD	Nominal GPM
228	1.74	5.22	3700
440	0.37	1.11	800

Water Use Permit (WUP) for EP 5 & 6. There are three former plantation well batteries along old Fort Weaver Road in lower Honouliuli. In addition to EP 5 & 6, the other two well batteries are EP 3 & 4 (State Nos. 2102-02 and 04-22) and EP 7 & 8 (State Nos. 2202-15 to 20). In January 2000, the Commission on Water Resource Management (CWRM) revoked the individual WUPs for these three batteries and reconsolidated them under one new permit, WUP No. 805. The permitted use of 7.969 MGD under WUP No. 805 can be drawn from any of the well batteries but the use is specifically limited to agriculture. Landscape irrigation of an urbanized area such as the Hoopili project does not qualify as an agricultural use. It will be necessary to modify WUP No. 805 or to obtain a new permit for Hoopili's non-potable use. CWRM's processing procedures are the same for a WUP modification as they are for obtaining a new permit. Based on the project's current concept plan, the required permitted use for Hoopili would be 1.75 MGD. The remaining amount of WUP 805 would not be needed by the project and would become available for other users in the Waipahu-Waiawa Aquifer System. Use of the EP 3 & 4 and EP 7 & 8 well batteries would also no longer be needed as all of the project's non-potable supply would be drawn from the EP 5 & 6 well battery.

Reservoir Storage. Unless and until BWS' regional non-potable system is expanded to provide service to the Hoopili project area, the non-potable system would have direct pumping from EP 5 & 6 with no reservoir storage.

Transmission/Distribution Pipelines in the Lower (215- or 228-Foot) Service Zone. BWS' (draft) Ewa Non-Potable Water Master Plan envisions the installation of a storage reservoir on the west side of the North-South Road and on the makai side of H-1 freeway. The tank would have a 215- or 228-foot spillway elevation. This possible storage tank location is on the opposite side of the Hoopili project from the EP 5 & 6 well battery (EP 5 & 6 is on the eastern edge of the project site and just off old Fort Weaver Road). To enable the initial, pumped delivery system using EP 5 & 6 to be compatible with BWS' expansion of its regional non-potable system, all pipelines would meet BWS' construction standards and their sizes would be selected for both pumped delivery from EP 5 & 6 and gravity delivery from BWS' North-South Road Reservoir.

Transmission/Distribution Pipelines in the Upper (440-Foot) Service Zone. BWS' (draft) Ewa Non-Potable Water Master Plan does not include an upper service zone above the North-South Road Reservoir. If one were to be constructed, a tank mauka of H-1 freeway and booster pumping to it would be required. In addition to Hoopili, such an upper system could also serve UH West Oahu and the State DLNR parcels adjacent to Farrington Highway. As with the lower service zone system, Hoopili's non-potable pipelines in its upper service zone would meet BWS standards and would be sized for both pumped supply from EP 5 & 6 and gravity delivery from a possible BWS reservoir on the mauka side of H-1.

Appendix A

Hydraulic Model for Simulations of BWS' 228-Foot Service Zone in the Fort Weaver Corridor

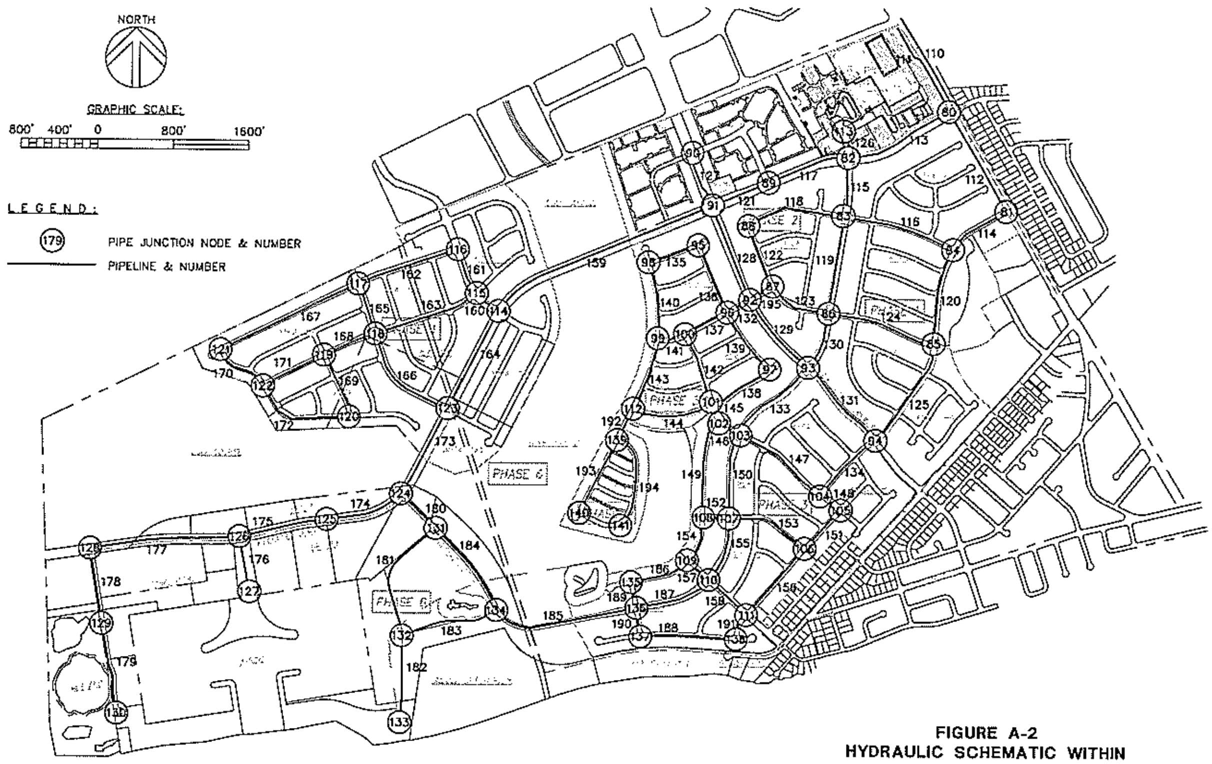

FIGURE A-2
HYDRAULIC SCHEMATIC WITHIN OCEAN POINTE

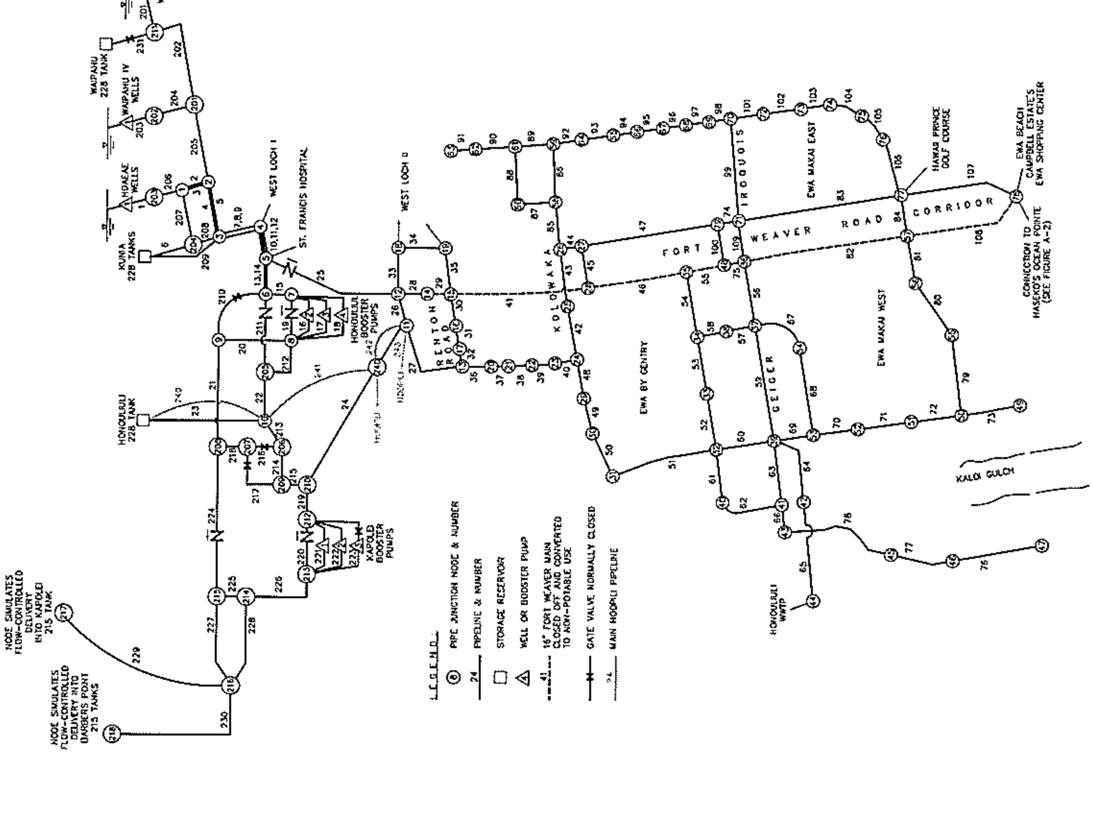

FIGURE A-1
HYDRAULIC MODEL OF THE BWS SYSTEM IN THE FORT WEAVER CORRIDOR

Appendix B

Computer Simulation of "Existing Conditions" in BWS' 228-Foot Service Zone in the Fort Weaver Corridor

DATE = 03-17-2003
JOB NAME =


```
* * * * * * * * * *   K Y P I P E 2   * * * * * * * * * *
*   University of Kentucky Hydraulic Analysis Program   *
* Distribution of Pressure and Flows in Piping Networks *
*       1000 PIPE VERSION - 1.10    (08/25/92)          *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * *
```

DATE: 3/17/2003
TIME: 10:50:11

INPUT DATA FILENAME -------------- OP2003.DAT
TABULATED OUTPUT FILENAME -------- OP2003.OUT
POSTPROCESSOR RESULTS FILENAME --- OP2003.RES

S U M M A R Y   O F   O R I G I N A L   D A T A

U N I T S   S P E C I F I E D

FLOWRATE .... = gallons/minute
HEAD (HGL) .... = feet
PRESSURE .... = psig

P I P E L I N E   D A T A

STATUS CODE: XX -CLOSED PIPE FG -FIXED GRADE NODE PU -PUMP LINE
CV -CHECK VALVE RV -REGULATING VALVE

PIPE NUMBER	NODE NOS. #1	NODE NOS. #2	LENGTH (ft)	DIAMETER (in)	ROUGHNESS COEFF.	MINOR LOSS COEFF.	FGN-HGL (ft)
1-FGPU	0	1	30.0	36.0	130.00	.00	10.00
2	1	2	1000.0	30.0	130.00	.00	
3	1	2	1000.0	12.0	110.00	.00	
4	2	3	2500.0	36.0	130.00	.00	
5	2	3	2500.0	30.0	130.00	.00	
6-FG	0	3	2600.0	20.0	120.00	.00	223.00
7	3	4	1350.0	36.0	130.00	.00	
8	3	4	1350.0	30.0	130.00	.00	
9	3	4	1350.0	20.0	120.00	.00	
10	4	5	1650.0	36.0	130.00	.00	
11	4	5	1650.0	30.0	130.00	.00	
12	4	5	1650.0	20.0	120.00	.00	
13	5	6	1850.0	36.0	130.00	.00	
14	5	6	1850.0	30.0	130.00	.00	
15	6	7	370.0	30.0	130.00	.00	

16-PU	7	8	20.0	30.0	130.00	.00	
17-PU	7	8	20.0	30.0	130.00	.00	
18-PU	7	8	20.0	30.0	130.00	.00	
19-CV	7	8	20.0	30.0	130.00	.00	
20	8	9	70.0	30.0	130.00	.00	
21	9	10	3000.0	30.0	130.00	.00	
22	9	10	3000.0	30.0	130.00	.00	
23-FG	0	10	4530.0	42.0	130.00	.00	223.00
24	10	11	8250.0	42.0	130.00	.00	
25-CV	5	12	7150.0	16.0	120.00	.00	
26	11	12	1900.0	16.0	120.00	.00	
27	11	13	3750.0	42.0	130.00	.00	
28	12	14	2850.0	16.0	120.00	.00	
29-XX	14	15	650.0	16.0	120.00	.00	
30	16	15	1300.0	16.0	120.00	.00	
31	17	16	700.0	16.0	120.00	.00	
32	13	17	200.0	16.0	120.00	.00	
33	12	18	2000.0	12.0	110.00	.00	
34	18	19	1800.0	12.0	110.00	.00	
35	15	19	3200.0	12.0	110.00	.00	
36	13	20	1250.0	36.0	130.00	.00	
37	20	21	230.0	36.0	130.00	.00	
38	21	22	200.0	36.0	130.00	.00	
39	22	23	200.0	36.0	130.00	.00	
40	23	24	380.0	36.0	130.00	.00	
41-XX	15	28	2480.0	16.0	120.00	.00	
42	24	25	1100.0	36.0	130.00	.00	
43	25	26	180.0	30.0	130.00	.00	
44	26	27	100.0	36.0	130.00	.00	
45	28	27	150.0	16.0	120.00	.00	
46-XX	28	35	2000.0	16.0	120.00	.00	
47	27	79	2450.0	36.0	130.00	.00	
48	24	29	110.0	16.0	120.00	.00	
49	29	30	730.0	12.0	110.00	.00	
50	30	31	970.0	12.0	110.00	.00	
51	31	32	1700.0	12.0	110.00	.00	
52	33	32	570.0	12.0	110.00	.00	
53	34	33	580.0	12.0	110.00	.00	
54	35	34	800.0	12.0	110.00	.00	
55-XX	35	48	730.0	16.0	120.00	.00	
56	36	37	700.0	12.0	110.00	.00	
57	38	37	350.0	12.0	110.00	.00	
58	34	38	700.0	12.0	110.00	.00	
59	37	39	1300.0	12.0	110.00	.00	
60	32	39	870.0	12.0	110.00	.00	
61	32	40	1140.0	12.0	110.00	.00	
62	40	41	1150.0	12.0	110.00	.00	
63	39	41	1390.0	12.0	110.00	.00	
64	39	42	1480.0	12.0	110.00	.00	
65	42	44	122.0	12.0	110.00	.00	
66	41	43	890.0	16.0	120.00	.00	
67	37	54	1000.0	12.0	110.00	.00	
68	54	53	1030.0	12.0	110.00	.00	
69	53	39	730.0	12.0	110.00	.00	
70	53	52	805.0	12.0	110.00	.00	

71	52	51	400.0	12.0	110.00	.00
72	50	51	580.0	12.0	110.00	.00
73	50	49	965.0	12.0	110.00	.00
74	79	71	150.0	36.0	130.00	.00
75-XX	48	36	170.0	16.0	120.00	.00
76	46	47	1390.0	8.0	110.00	.00
77	45	46	1390.0	12.0	110.00	.00
78	43	45	1390.0	12.0	110.00	.00
79	55	50	1015.0	12.0	110.00	.00
80	56	55	1000.0	12.0	110.00	.00
81	57	56	465.0	12.0	110.00	.00
82-XX	36	57	2000.0	16.0	120.00	.00
83	71	77	2000.0	36.0	130.00	.00
84	77	57	150.0	12.0	110.00	.00
85	26	58	360.0	12.0	110.00	.00
86	58	59	630.0	12.0	110.00	.00
87	58	60	650.0	8.0	110.00	.00
88	60	61	650.0	8.0	110.00	.00
89	59	61	550.0	12.0	110.00	.00
90	61	62	720.0	12.0	110.00	.00
91	62	63	950.0	12.0	110.00	.00
92	59	64	310.0	12.0	110.00	.00
93	64	65	420.0	12.0	110.00	.00
94	65	66	320.0	12.0	110.00	.00
95	67	66	570.0	12.0	110.00	.00
96	68	67	400.0	12.0	110.00	.00
97	69	68	250.0	12.0	110.00	.00
98	70	69	330.0	12.0	110.00	.00
99	71	70	1320.0	12.0	110.00	.00
100	79	48	40.0	16.0	120.00	.00
101	70	72	410.0	12.0	110.00	.00
102	72	73	390.0	12.0	110.00	.00
103	73	74	780.0	12.0	110.00	.00
104	75	74	465.0	12.0	110.00	.00
105	76	75	810.0	12.0	110.00	.00
106	77	76	700.0	12.0	110.00	.00
107	77	78	1580.0	36.0	130.00	.00
108-XX	57	78	1580.0	16.0	120.00	.00
109	71	36	210.0	12.0	110.00	.00
110	78	80	900.0	20.0	120.00	.00
111	78	80	900.0	12.0	110.00	.00
112	80	81	1210.0	20.0	120.00	.00
113	80	82	1200.0	16.0	120.00	.00
114	81	84	710.0	16.0	120.00	.00
115	82	83	650.0	8.0	110.00	.00
116	84	83	1200.0	8.0	110.00	.00
117	82	89	1530.0	16.0	120.00	.00
118	83	85	1030.0	8.0	110.00	.00
119	84	86	1050.0	16.0	120.00	.00
120	89	90	1070.0	12.0	110.00	.00
121	90	87	950.0	12.0	110.00	.00
122	85	87	620.0	8.0	110.00	.00
123	86	85	1150.0	8.0	110.00	.00
124	87	88	1050.0	8.0	110.00	.00
125	86	88	1200.0	16.0	120.00	.00

126	90	91	790.0	8.0	110.00	.00
127	87	93	1030.0	12.0	110.00	.00
128	88	94	820.0	16.0	120.00	.00
129	91	92	810.0	8.0	110.00	.00
130	92	93	410.0	8.0	110.00	.00
131	93	94	1100.0	8.0	110.00	.00
132	94	95	280.0	16.0	110.00	.00
133	93	100	900.0	12.0	110.00	.00
134	95	101	540.0	12.0	110.00	.00
135	100	101	900.0	8.0	110.00	.00
136	100	102	720.0	12.0	110.00	.00
137	101	103	950.0	12.0	110.00	.00
138	102	103	560.0	12.0	110.00	.00
139	103	104	380.0	8.0	110.00	.00
140	102	105	840.0	16.0	120.00	.00
141	105	107	940.0	16.0	120.00	.00
142	107	109	1400.0	16.0	120.00	.00
143	109	110	620.0	16.0	120.00	.00
144	104	106	700.0	8.0	110.00	.00
145	106	108	1300.0	8.0	110.00	.00
146-XX	108	110	2050.0	8.0	110.00	.00
147	110	111	1400.0	16.0	120.00	.00
148	91	96	300.0	8.0	110.00	.00
149	96	97	780.0	8.0	110.00	.00
150	92	97	870.0	8.0	110.00	.00
151	97	98	380.0	8.0	110.00	.00
152	98	99	880.0	8.0	110.00	.00
153	98	99	1440.0	8.0	110.00	.00
154	89	112	970.0	20.0	120.00	.00
155	112	113	2420.0	20.0	120.00	.00
156	113	114	900.0	20.0	120.00	.00
157	114	115	2250.0	16.0	120.00	.00
158	115	116	1760.0	16.0	120.00	.00
159	116	117	1350.0	16.0	120.00	.00
160	117	118	1080.0	16.0	120.00	.00

P U M P   D A T A

THERE IS A PUMP IN LINE 1 DESCRIBED BY THE FOLLOWING DATA:

HEAD (ft)	FLOWRATE (gpm)
415.00	.00
230.00	6700.00
105.00	9450.00

THERE IS A PUMP IN LINE 16 DESCRIBED BY THE FOLLOWING DATA:

HEAD (ft)	FLOWRATE (gpm)
150.00	.00
110.00	5000.00
45.00	8200.00

THERE IS A PUMP IN LINE 17 DESCRIBED BY THE FOLLOWING DATA:

HEAD (ft)	FLOWRATE (gpm)
150.00	.00
110.00	5000.00
45.00	8200.00

THERE IS A PUMP IN LINE 18 DESCRIBED BY THE FOLLOWING DATA:

HEAD (ft)	FLOWRATE (gpm)
150.00	.00
110.00	5000.00
45.00	8200.00

J U N C T I O N   N O D E   D A T A

JUNCTION NUMBER	JUNCTION TITLE	EXTERNAL DEMAND (gpm)	JUNCTION ELEVATION (ft)	CONNECTING PIPES					
1		.00	120.00	1	2	3			
2		.00	75.00	2	3	4	5		
3		.00	77.00	4	5	6	7	8	9
4		958.00	50.00	7	8	9	10	11	12
5		208.00	85.00	10	11	12	13	14	25
6		.00	95.00	13	14	15			
7		.00	98.00	15	16	17	18	19	
8		.00	98.00	16	17	18	19	20	
9		.00	102.00	20	21	22			
10		20830.00	175.00	21	22	23	24		
11		.00	55.00	24	26	27			
12		471.00	25.00	25	26	28	33		
13		312.00	45.00	27	32	36			
14		.00	45.00	28	29				
15		250.00	45.00	29	30	35	41		
16		334.00	45.00	30	31				
17		125.00	45.00	31	32				
18		469.00	20.00	33	34				
19		469.00	30.00	34	35				
20		243.00	38.00	36	37				
21		143.00	37.00	37	38				
22		143.00	36.00	38	39				
23		144.00	35.00	39	40				
24		.00	34.00	40	42	48			
25		.00	33.00	42	43				
26		.00	28.00	43	44	85			

27	.00	28.00	44	45	47		
28	.00	27.00	41	45	46		
29	199.00	35.00	48	49			
30	373.00	36.00	49	50			
31	429.00	37.00	50	51			
32	.00	34.00	51	52	60	61	
33	198.00	33.00	52	53			
34	183.00	31.00	53	54	58		
35	.00	34.00	46	54	55		
36	.00	34.00	56	75	82	109	
37	.00	34.00	56	57	59	67	
38	323.00	33.00	57	58			
39	.00	33.00	59	60	63	64	69
40	301.00	33.00	61	62			
41	.00	34.00	62	63	66		
42	42.00	34.00	64	65			
43	101.00	34.00	66	78			
44	1042.00	33.00	65				
45	219.00	30.00	77	78			
46	219.00	28.00	76	77			
47	198.00	25.00	76				
48	.00	35.00	55	75	100		
49	150.00	25.00	73				
50	178.00	26.00	72	73	79		
51	355.00	27.00	71	72			
52	.00	28.00	70	71			
53	70.00	29.00	68	69	70		
54	311.00	31.00	67	68			
55	199.00	27.00	79	80			
56	353.00	27.00	80	81			
57	.00	28.00	81	82	84	108	
58	.00	32.00	85	86	87		
59	.00	31.00	86	89	92		
60	166.00	31.00	87	88			
61	8.00	31.00	88	89	90		
62	127.00	32.00	90	91			
63	323.00	38.00	91				
64	180.00	30.00	92	93			
65	334.00	30.00	93	94			
66	525.00	30.00	94	95			
67	106.00	30.00	95	96			
68	106.00	30.00	96	97			
69	106.00	30.00	97	98			
70	.00	32.00	98	99	101		
71	.00	34.00	74	83	99	109	
72	422.00	32.00	101	102			
73	294.00	31.00	102	103			
74	228.00	30.00	103	104			
75	527.00	30.00	104	105			
76	193.00	29.00	105	106			
77	31.00	28.00	83	84	106	107	
78	4185.00	20.00	107	108	110	111	
79	.00	35.00	47	74	100		
80	.00	25.00	110	111	112	113	
81	29.80	25.00	112	114			

82	141.80	25.00	113	115	117	
83	274.60	25.00	115	116	118	
84	171.70	25.00	114	116	119	
85	213.80	25.00	118	122	123	
86	278.90	25.00	119	123	125	
87	197.60	25.00	121	122	124	127
88	91.50	25.00	124	125	128	
89	266.70	25.00	117	120	154	
90	229.60	25.00	120	121	126	
91	126.70	20.00	126	129	148	
92	72.80	20.00	129	130	150	
93	93.80	20.00	127	130	131	133
94	93.80	20.00	128	131	132	
95	44.60	20.00	132	134		
96	.00	20.00	148	149		
97	29.70	20.00	149	150	151	
98	68.80	20.00	151	152	153	
99	68.80	20.00	152	153		
100	85.90	20.00	133	135	136	
101	85.90	20.00	134	135	137	
102	36.70	15.00	136	138	140	
103	36.70	15.00	137	138	139	
104	.00	15.00	139	144		
105	183.30	15.00	140	141		
106	22.10	15.00	144	145		
107	170.50	15.00	141	142		
108	.00	15.00	145	146		
109	210.00	15.00	142	143		
110	121.50	15.00	143	146	147	
111	188.50	15.00	147			
112	179.20	25.00	154	155		
113	707.00	20.00	155	156		
114	527.30	20.00	156	157		
115	1059.20	15.00	157	158		
116	285.50	15.00	158	159		
117	165.70	15.00	159	160		
118	165.70	15.00	160			

O U T P U T   O P T I O N   D A T A

OUTPUT SELECTION: ALL RESULTS ARE INCLUDED IN THE TABULATED OUTPUT
MAXIMUM AND MINIMUM PRESSURES = 10
MAXIMUM AND MINIMUM VELOCITIES = 10

S Y S T E M   C O N F I G U R A T I O N

NUMBER OF PIPES ....(p) = 160
NUMBER OF JUNCTION NODES ....(j) = 118
NUMBER OF PRIMARY LOOPS ....(l) = 40
NUMBER OF FIXED GRADE NODES ....(f) = 3
NUMBER OF SUPPLY ZONES ....(z) = 1

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S I M U L A T I O N   R E S U L T S
****

THE RESULTS ARE OBTAINED AFTER 4 TRIALS WITH AN ACCURACY = .00302

P I P E L I N E   R E S U L T S

STATUS CODE: XX -CLOSED PIPE   FG -FIXED GRADE NODE   PU -PUMP LINE
CV -CHECK VALVE   RV -REGULATING VALVE   TK -STORAGE TANK

PIPE NUMBER	NODE NOS. #1	#2	FLOWRATE (gpm)	HEAD LOSS (ft)	PUMP HEAD (ft)	MINOR LOSS (ft)	LINE VELO. (ft/s)	HL/ 1000 (ft/ft)
1-FGPU	0	1	8647.38	.02	143.67	.00	2.73	.65
2	1	2	8036.31	1.39	.00	.00	3.65	1.39
3	1	2	611.06	1.39	.00	.00	1.73	1.39
4	2	3	5340.74	.67	.00	.00	1.68	.27
5	2	3	3306.64	.67	.00	.00	1.50	.27
6-FG	0	3	12802.12	71.41	.00	.00	13.07	27.47
7	3	4	11811.99	1.57	.00	.00	3.72	1.17
8	3	4	7313.19	1.57	.00	.00	3.32	1.17
9	3	4	2324.33	1.57	.00	.00	2.37	1.17
10	4	5	11284.43	1.77	.00	.00	3.56	1.07
11	4	5	6986.55	1.77	.00	.00	3.17	1.07
12	4	5	2220.52	1.77	.00	.00	2.27	1.07
13	5	6	12527.44	2.40	.00	.00	3.95	1.30
14	5	6	7756.07	2.40	.00	.00	3.52	1.30
15	6	7	20283.50	2.85	.00	.00	9.21	7.71
16-PU	7	8	6761.17	.02	77.94	.00	3.07	1.01
17-PU	7	8	6761.17	.02	77.94	.00	3.07	1.01
18-PU	7	8	6761.17	.02	77.94	.00	3.07	1.01
19-XXCV	7	8						
20	8	9	20283.50	.54	.00	.00	9.21	7.71
21	9	10	10141.75	6.41	.00	.00	4.60	2.14
22	9	10	10141.75	6.41	.00	.00	4.60	2.14
23-FG	0	10	23679.20	9.04	.00	.00	5.48	1.99
24	10	11	23132.70	15.76	.00	.00	5.36	1.91
25-XXCV	5	12						
26	11	12	1260.69	2.11	.00	.00	2.01	1.11
27	11	13	21872.01	6.46	.00	.00	5.06	1.72
28	12	14	.00	.00	.00	.00	.00	.00
29-XX	14	15						
30	16	15	398.31	.17	.00	.00	.64	.13
31	17	16	732.31	.28	.00	.00	1.17	.41
32	13	17	857.31	.11	.00	.00	1.37	.54
33	12	18	789.69	4.46	.00	.00	2.24	2.23
34	18	19	320.69	.76	.00	.00	.91	.42
35	15	19	148.31	.32	.00	.00	.42	.10

36	13	20	20702.70	4.12	.00	.00	6.53	3.29
37	20	21	20459.70	.74	.00	.00	6.45	3.22
38	21	22	20316.70	.64	.00	.00	6.40	3.18
39	22	23	20173.70	.63	.00	.00	6.36	3.14
40	23	24	20029.70	1.18	.00	.00	6.31	3.10
41-XX	15	28						
42	24	25	17955.43	2.78	.00	.00	5.66	2.53
43	25	26	17955.43	1.11	.00	.00	8.15	6.15
44	26	27	16197.92	.21	.00	.00	5.11	2.09
45	28	27	.00	.00	.00	.00	.00	.00
46-XX	28	35						
47	27	79	16197.92	5.12	.00	.00	5.11	2.09
48	24	29	2074.27	.31	.00	.00	3.31	2.80
49	29	30	1875.27	8.08	.00	.00	5.32	11.07
50	30	31	1502.27	7.12	.00	.00	4.26	7.34
51	31	32	1073.27	6.70	.00	.00	3.04	3.94
52	33	32	27.23	.00	.00	.00	.08	.00
53	34	33	225.23	.13	.00	.00	.64	.22
54	35	34	.00	.00	.00	.00	.00	.00
55-XX	35	48						
56	36	37	2004.88	8.77	.00	.00	5.69	12.53
57	38	37	-731.23	.68	.00	.00	2.07	1.94
58	34	38	-408.23	.46	.00	.00	1.16	.66
59	37	39	666.27	2.12	.00	.00	1.89	1.63
60	32	39	505.81	.85	.00	.00	1.43	.98
61	32	40	594.69	1.50	.00	.00	1.69	1.32
62	40	41	293.69	.41	.00	.00	.83	.36
63	39	41	443.31	1.06	.00	.00	1.26	.77
64	39	42	1084.00	5.94	.00	.00	3.07	4.01
65	42	44	1042.00	.45	.00	.00	2.96	3.73
66	41	43	737.00	.37	.00	.00	1.18	.41
67	37	54	607.38	1.37	.00	.00	1.72	1.37
68	54	53	296.38	.37	.00	.00	.84	.36
69	53	39	355.22	.37	.00	.00	1.01	.51
70	53	52	-128.85	.06	.00	.00	.37	.08
71	52	51	-128.85	.03	.00	.00	.37	.08
72	50	51	483.85	.52	.00	.00	1.37	.90
73	50	49	150.00	.10	.00	.00	.43	.10
74	79	71	16197.92	.31	.00	.00	5.11	2.09
75-XX	48	36						
76	46	47	198.00	1.72	.00	.00	1.26	1.24
77	45	46	417.00	.95	.00	.00	1.18	.68
78	43	45	636.00	2.08	.00	.00	1.80	1.49
79	55	50	811.85	2.38	.00	.00	2.30	2.35
80	56	55	1010.85	3.53	.00	.00	2.87	3.53
81	57	56	1363.85	2.85	.00	.00	3.87	6.14
82-XX	36	57						
83	71	77	13163.44	2.85	.00	.00	4.15	1.42
84	77	57	1363.85	.92	.00	.00	3.87	6.14
85	26	58	1757.51	3.53	.00	.00	4.99	9.82
86	58	59	1361.36	3.85	.00	.00	3.86	6.12
87	58	60	396.15	2.91	.00	.00	2.53	4.48
88	60	61	230.15	1.07	.00	.00	1.47	1.64
89	59	61	227.85	.12	.00	.00	.65	.22
90	61	62	450.00	.57	.00	.00	1.28	.79

91	62	63	323.00	.40	.00	.00	.92	.43
92	59	64	1133.51	1.35	.00	.00	3.22	4.36
93	64	65	953.51	1.33	.00	.00	2.70	3.16
94	65	66	619.51	.46	.00	.00	1.76	1.42
95	67	66	-94.51	.02	.00	.00	.27	.04
96	68	67	11.49	.00	.00	.00	.03	.00
97	69	68	117.49	.02	.00	.00	.33	.07
98	70	69	223.49	.07	.00	.00	.63	.22
99	71	70	1029.60	4.81	.00	.00	2.92	3.65
100	79	48	.00	.00	.00	.00	.00	.00
101	70	72	806.11	.95	.00	.00	2.29	2.32
102	72	73	384.11	.23	.00	.00	1.09	.59
103	73	74	90.11	.03	.00	.00	.26	.04
104	75	74	137.89	.04	.00	.00	.39	.09
105	76	75	664.89	1.31	.00	.00	1.89	1.62
106	77	76	857.89	1.82	.00	.00	2.43	2.60
107	77	78	10910.70	1.59	.00	.00	3.44	1.01
108-XX	57	78						
109	71	36	2004.88	2.63	.00	.00	5.69	12.53
110	78	80	5427.26	5.04	.00	.00	5.54	5.60
111	78	80	1298.44	5.04	.00	.00	3.68	5.60
112	80	81	3092.59	2.39	.00	.00	3.16	1.98
113	80	82	3633.11	9.48	.00	.00	5.80	7.90
114	81	84	3062.79	4.09	.00	.00	4.89	5.76
115	82	83	266.56	1.40	.00	.00	1.70	2.15
116	84	83	355.42	4.40	.00	.00	2.27	3.66
117	82	89	3224.76	9.69	.00	.00	5.15	6.34
118	83	85	347.37	3.62	.00	.00	2.22	3.51
119	84	86	2535.67	4.26	.00	.00	4.05	4.06
120	89	90	-131.54	.09	.00	.00	.37	.08
121	90	87	-472.25	.82	.00	.00	1.34	.86
122	85	87	467.44	3.77	.00	.00	2.98	6.09
123	86	85	333.86	3.75	.00	.00	2.13	3.26
124	87	88	-391.85	4.61	.00	.00	2.50	4.39
125	86	88	1922.91	2.92	.00	.00	3.07	2.43
126	90	91	111.11	.34	.00	.00	.71	.43
127	87	93	189.43	.16	.00	.00	.54	.16
128	88	94	1439.56	1.17	.00	.00	2.30	1.42
129	91	92	-78.16	.18	.00	.00	.50	.22
130	92	93	-255.69	.82	.00	.00	1.63	1.99
131	93	94	-335.07	3.61	.00	.00	2.14	3.29
132	94	95	1010.69	.24	.00	.00	1.61	.87
133	93	100	175.01	.12	.00	.00	.50	.14
134	95	101	966.09	1.75	.00	.00	2.74	3.24
135	100	101	-251.39	1.74	.00	.00	1.60	1.93
136	100	102	340.51	.34	.00	.00	.97	.47
137	101	103	628.79	1.39	.00	.00	1.78	1.46
138	102	103	-569.99	.68	.00	.00	1.62	1.22
139	103	104	22.10	.01	.00	.00	.14	.02
140	102	105	873.80	.47	.00	.00	1.39	.56
141	105	107	690.50	.34	.00	.00	1.10	.36
142	107	109	520.00	.30	.00	.00	.83	.22
143	109	110	310.00	.05	.00	.00	.49	.08
144	104	106	22.10	.01	.00	.00	.14	.02
145	106	108	.00	.00	.00	.00	.00	.00

146-XX	108	110						
147	110	111	188.50	.05	.00	.00	.30	.03
148	91	96	62.57	.04	.00	.00	.40	.15
149	96	97	62.57	.11	.00	.00	.40	.15
150	92	97	104.73	.33	.00	.00	.67	.38
151	97	98	137.60	.24	.00	.00	.88	.63
152	98	99	38.94	.05	.00	.00	.25	.06
153	98	99	29.86	.05	.00	.00	.19	.04
154	89	112	3089.60	1.92	.00	.00	3.16	1.97
155	112	113	2910.40	4.28	.00	.00	2.97	1.77
156	113	114	2203.40	.95	.00	.00	2.25	1.06
157	114	115	1676.10	4.24	.00	.00	2.67	1.89
158	115	116	616.90	.52	.00	.00	.98	.30
159	116	117	331.40	.13	.00	.00	.53	.09
160	117	118	165.70	.03	.00	.00	.26	.03

J U N C T I O N   N O D E   R E S U L T S

JUNCTION NUMBER	JUNCTION TITLE	EXTERNAL DEMAND (gpm)	HYDRAULIC GRADE (ft)	JUNCTION ELEVATION (ft)	PRESSURE HEAD (ft)	JUNCTION PRESSURE (psi)
1		.00	153.65	120.00	33.65	14.58
2		.00	152.26	75.00	77.26	33.48
3		.00	151.59	77.00	74.59	32.32
4		958.00	150.02	50.00	100.02	43.34
5		208.00	148.25	85.00	63.25	27.41
6		.00	145.84	95.00	50.84	22.03
7		.00	143.00	98.00	45.00	19.50
8		.00	220.91	98.00	122.91	53.26
9		.00	220.37	102.00	118.37	51.29
10		20830.00	213.96	175.00	38.96	16.88
11		.00	198.21	55.00	143.21	62.06
12		471.00	196.09	25.00	171.09	74.14
13		312.00	191.75	45.00	146.75	63.59
14		.00	196.09	45.00	151.09	65.47
15		250.00	191.19	45.00	146.19	63.35
16		334.00	191.36	45.00	146.36	63.42
17		125.00	191.64	45.00	146.64	63.54
18		469.00	191.63	20.00	171.63	74.37
19		469.00	190.87	30.00	160.87	69.71
20		243.00	187.63	38.00	149.63	64.84
21		143.00	186.89	37.00	149.89	64.95
22		143.00	186.25	36.00	150.25	65.11
23		144.00	185.62	35.00	150.62	65.27
24		.00	184.45	34.00	150.45	65.19
25		.00	181.66	33.00	148.66	64.42
26		.00	180.55	28.00	152.55	66.10
27		.00	180.34	28.00	152.34	66.01
28		.00	180.34	27.00	153.34	66.45
29		199.00	184.14	35.00	149.14	64.63
30		373.00	176.06	36.00	140.06	60.69
31		429.00	168.93	37.00	131.93	57.17

32	.00	162.23	34.00	128.23	55.57
33	198.00	162.23	33.00	129.23	56.00
34	183.00	162.36	31.00	131.36	56.92
35	.00	162.36	34.00	128.36	55.62
36	.00	172.27	34.00	138.27	59.92
37	.00	163.50	34.00	129.50	56.12
38	323.00	162.82	33.00	129.82	56.26
39	.00	161.38	33.00	128.38	55.63
40	301.00	160.73	33.00	127.73	55.35
41	.00	160.32	34.00	126.32	54.74
42	42.00	155.44	34.00	121.44	52.63
43	101.00	159.95	34.00	125.95	54.58
44	1042.00	154.99	33.00	121.99	52.86
45	219.00	157.87	30.00	127.87	55.41
46	219.00	156.92	28.00	128.92	55.87
47	198.00	155.20	25.00	130.20	56.42
48	.00	175.22	35.00	140.22	60.76
49	150.00	162.27	25.00	137.27	59.48
50	178.00	162.37	26.00	136.37	59.09
51	355.00	161.85	27.00	134.85	58.43
52	.00	161.81	28.00	133.81	57.99
53	70.00	161.75	29.00	132.75	57.53
54	311.00	162.13	31.00	131.13	56.82
55	199.00	164.75	27.00	137.75	59.69
56	353.00	168.28	27.00	141.28	61.22
57	.00	171.13	28.00	143.13	62.02
58	.00	177.01	32.00	145.01	62.84
59	.00	173.16	31.00	142.16	61.60
60	166.00	174.10	31.00	143.10	62.01
61	8.00	173.04	31.00	142.04	61.55
62	127.00	172.47	32.00	140.47	60.87
63	323.00	172.07	38.00	134.07	58.09
64	180.00	171.81	30.00	141.81	61.45
65	334.00	170.48	30.00	140.48	60.87
66	525.00	170.02	30.00	140.02	60.68
67	106.00	170.00	30.00	140.00	60.67
68	106.00	170.00	30.00	140.00	60.67
69	106.00	170.02	30.00	140.02	60.67
70	.00	170.09	32.00	138.09	59.84
71	.00	174.90	34.00	140.90	61.06
72	422.00	169.14	32.00	137.14	59.43
73	294.00	168.91	31.00	137.91	59.76
74	228.00	168.88	30.00	138.88	60.18
75	527.00	168.92	30.00	138.92	60.20
76	193.00	170.23	29.00	141.23	61.20
77	31.00	172.05	28.00	144.05	62.42
78	4185.00	170.46	20.00	150.46	65.20
79	.00	175.22	35.00	140.22	60.76
80	.00	165.42	25.00	140.42	60.85
81	29.80	163.03	25.00	138.03	59.81
82	141.80	155.94	25.00	130.94	56.74
83	274.60	154.54	25.00	129.54	56.13
84	171.70	158.94	25.00	133.94	58.04
85	213.80	150.92	25.00	125.92	54.57
86	278.90	154.67	25.00	129.67	56.19

87	197.60	147.15	25.00	122.15	52.93
88	91.50	151.76	25.00	126.76	54.93
89	266.70	146.24	25.00	121.24	52.54
90	229.60	146.33	25.00	121.33	52.58
91	126.70	145.99	20.00	125.99	54.60
92	72.80	146.17	20.00	126.17	54.68
93	93.80	146.98	20.00	126.98	55.03
94	93.80	150.59	20.00	130.59	56.59
95	44.60	150.35	20.00	130.35	56.48
96	.00	145.95	20.00	125.95	54.58
97	29.70	145.84	20.00	125.84	54.53
98	68.80	145.60	20.00	125.60	54.43
99	68.80	145.55	20.00	125.55	54.40
100	85.90	146.86	20.00	126.86	54.97
101	85.90	148.60	20.00	128.60	55.73
102	36.70	146.52	15.00	131.52	56.99
103	36.70	147.21	15.00	132.21	57.29
104	.00	147.20	15.00	132.20	57.29
105	183.30	146.05	15.00	131.05	56.79
106	22.10	147.18	15.00	132.18	57.28
107	170.50	145.71	15.00	130.71	56.64
108	.00	147.18	15.00	132.18	57.28
109	210.00	145.40	15.00	130.40	56.51
110	121.50	145.35	15.00	130.35	56.49
111	188.50	145.31	15.00	130.31	56.47
112	179.20	144.33	25.00	119.33	51.71
113	707.00	140.05	20.00	120.05	52.02
114	527.30	139.10	20.00	119.10	51.61
115	1059.20	134.86	15.00	119.86	51.94
116	285.50	134.34	15.00	119.34	51.71
117	165.70	134.21	15.00	119.21	51.66
118	165.70	134.18	15.00	119.18	51.65

M A X I M U M   A N D   M I N I M U M   V A L U E S

P R E S S U R E S

JUNCTION NUMBER	MAXIMUM PRESSURES (psi)	JUNCTION NUMBER	MINIMUM PRESSURES (psi)
18	74.37	1	14.58
12	74.14	10	16.88
19	69.71	7	19.50
28	66.45	6	22.03
26	66.10	5	27.41
27	66.01	3	32.32
14	65.47	2	33.48
23	65.27	4	43.34
78	65.20	9	51.29
24	65.19	114	51.61

V E L O C I T I E S

PIPE NUMBER	MAXIMUM VELOCITY (ft/s)	PIPE NUMBER	MINIMUM VELOCITY (ft/s)
6	13.07	96	.03
15	9.21	52	.08
20	9.21	139	.14
43	8.15	144	.14
36	6.53	153	.19
37	6.45	152	.25
38	6.40	103	.26
39	6.36	160	.26
40	6.31	95	.27
113	5.80	147	.30

S U M M A R Y O F I N F L O W S A N D O U T F L O W S

(+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
(-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

PIPE NUMBER	FLOWRATE (gpm)
1	8647.38
6	12802.12
23	23679.20

NET SYSTEM INFLOW = 45128.70
NET SYSTEM OUTFLOW = .00
NET SYSTEM DEMAND = 45128.70

D A T A C H A N G E S F O R N E X T S I M U L A T I O N

D E M A N D C H A N G E S

DEMAND TYPE = 1 - GDF = .500

THE FOLLOWING SPECIFIC DEMAND CHANGES ARE MADE :

JUNCTION NUMBER	DEMAND (gpm)
10	20833.00
111	4094.00

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S I M U L A T I O N R E S U L T S

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THE RESULTS ARE OBTAINED AFTER 3 TRIALS WITH AN ACCURACY = .00048

P I P E L I N E R E S U L T S

STATUS CODE: XX -CLOSED PIPE FG -FIXED GRADE NODE PU -PUMP LINE
CV -CHECK VALVE RV -REGULATING VALVE TK -STORAGE TANK

PIPE NUMBER	NODE NOS. #1	NODE NOS. #2	FLOWRATE (gpm)	HEAD LOSS (ft)	PUMP HEAD (ft)	MINOR LOSS (ft)	LINE VELO. (ft/s)	HL/ 1000 (ft/ft)
1-FGPU	0	1	8548.21	.02	148.33	.00	2.69	.64
2	1	2	7944.15	1.36	.00	.00	3.61	1.36
3	1	2	604.06	1.36	.00	.00	1.71	1.36
4	2	3	5279.49	.66	.00	.00	1.66	.26
5	2	3	3268.72	.66	.00	.00	1.48	.26
6-FG	0	3	12339.74	66.71	.00	.00	12.60	25.66
7	3	4	11502.72	1.50	.00	.00	3.63	1.11
8	3	4	7121.75	1.50	.00	.00	3.23	1.11
9	3	4	2263.48	1.50	.00	.00	2.31	1.11
10	4	5	11238.95	1.75	.00	.00	3.54	1.06
11	4	5	6958.43	1.75	.00	.00	3.16	1.06
12	4	5	2211.57	1.75	.00	.00	2.26	1.06
13	5	6	12540.61	2.41	.00	.00	3.95	1.30
14	5	6	7764.34	2.41	.00	.00	3.52	1.30
15	6	7	20304.95	2.86	.00	.00	9.22	7.72
16-PU	7	8	6768.32	.02	77.79	.00	3.07	1.01
17-PU	7	8	6768.32	.02	77.79	.00	3.07	1.01
18-PU	7	8	6768.32	.02	77.79	.00	3.07	1.01
19-XXCV	7	8						
20	8	9	20304.95	.54	.00	.00	9.22	7.72
21	9	10	10152.48	6.42	.00	.00	4.61	2.14
22	9	10	10152.48	6.42	.00	.00	4.61	2.14
23-FG	0	10	16094.15	4.42	.00	.00	3.73	.98
24	10	11	15566.10	7.57	.00	.00	3.60	.92
25-XXCV	5	12						
26	11	12	733.57	.78	.00	.00	1.17	.41
27	11	13	14832.53	3.15	.00	.00	3.43	.84
28	12	14	.00	.00	.00	.00	.00	.00
29-XX	14	15						
30	16	15	95.93	.01	.00	.00	.15	.01
31	17	16	262.93	.04	.00	.00	.42	.06
32	13	17	325.43	.02	.00	.00	.52	.09
33	12	18	498.07	1.90	.00	.00	1.41	.95
34	18	19	263.57	.53	.00	.00	.75	.29
35	15	19	-29.07	.02	.00	.00	.08	.00
36	13	20	14351.10	2.09	.00	.00	4.52	1.67
37	20	21	14229.60	.38	.00	.00	4.48	1.65
38	21	22	14158.10	.33	.00	.00	4.46	1.63
39	22	23	14086.60	.32	.00	.00	4.44	1.61

40	23	24	14014.60	.61	.00	.00	4.42	1.60
41-XX	15	28						
42	24	25	12841.88	1.50	.00	.00	4.05	1.36
43	25	26	12841.88	.60	.00	.00	5.83	3.31
44	26	27	11804.22	.12	.00	.00	3.72	1.16
45	28	27	.00	.00	.00	.00	.00	.00
46-XX	28	35						
47	27	79	11804.22	2.85	.00	.00	3.72	1.16
48	24	29	1172.72	.11	.00	.00	1.87	.97
49	29	30	1073.22	2.88	.00	.00	3.04	3.94
50	30	31	886.72	2.68	.00	.00	2.52	2.77
51	31	32	672.22	2.82	.00	.00	1.91	1.66
52	33	32	-35.07	.00	.00	.00	.10	.01
53	34	33	63.93	.01	.00	.00	.18	.02
54	35	34	.00	.00	.00	.00	.00	.00
55-XX	35	48						
56	36	37	977.74	2.32	.00	.00	2.77	3.31
57	38	37	-316.93	.14	.00	.00	.90	.41
58	34	38	-155.43	.08	.00	.00	.44	.11
59	37	39	335.38	.59	.00	.00	.95	.46
60	32	39	320.13	.36	.00	.00	.91	.42
61	32	40	317.02	.47	.00	.00	.90	.41
62	40	41	166.52	.14	.00	.00	.47	.12
63	39	41	201.98	.25	.00	.00	.57	.18
64	39	42	542.00	1.64	.00	.00	1.54	1.11
65	42	44	521.00	.13	.00	.00	1.48	1.03
66	41	43	368.50	.10	.00	.00	.59	.11
67	37	54	325.43	.43	.00	.00	.92	.43
68	54	53	169.93	.13	.00	.00	.48	.13
69	53	39	88.47	.03	.00	.00	.25	.04
70	53	52	46.46	.01	.00	.00	.13	.01
71	52	51	46.46	.00	.00	.00	.13	.01
72	50	51	131.04	.05	.00	.00	.37	.08
73	50	49	75.00	.03	.00	.00	.21	.03
74	79	71	11804.22	.17	.00	.00	3.72	1.16
75-XX	48	36						
76	46	47	99.00	.48	.00	.00	.63	.34
77	45	46	208.50	.26	.00	.00	.59	.19
78	43	45	318.00	.58	.00	.00	.90	.41
79	55	50	295.04	.37	.00	.00	.84	.36
80	56	55	394.54	.62	.00	.00	1.12	.62
81	57	56	571.04	.57	.00	.00	1.62	1.22
82-XX	36	57						
83	71	77	10314.94	1.81	.00	.00	3.25	.91
84	77	57	571.04	.18	.00	.00	1.62	1.22
85	26	58	1037.66	1.33	.00	.00	2.94	3.70
86	58	59	810.09	1.47	.00	.00	2.30	2.34
87	58	60	227.57	1.04	.00	.00	1.45	1.60
88	60	61	144.57	.45	.00	.00	.92	.69
89	59	61	84.43	.02	.00	.00	.24	.04
90	61	62	225.00	.16	.00	.00	.64	.22
91	62	63	161.50	.11	.00	.00	.46	.12
92	59	64	725.66	.59	.00	.00	2.06	1.91
93	64	65	635.66	.63	.00	.00	1.80	1.49
94	65	66	468.66	.27	.00	.00	1.33	.85

95	67	66	-206.16	.11	.00	.00	.58	.19
96	68	67	-153.16	.04	.00	.00	.43	.11
97	69	68	-100.16	.01	.00	.00	.28	.05
98	70	69	-47.16	.00	.00	.00	.13	.01
99	71	70	511.54	1.32	.00	.00	1.45	1.00
100	79	48	.00	.00	.00	.00	.00	.00
101	70	70	558.70	.48	.00	.00	1.58	1.18
102	72	73	347.70	.19	.00	.00	.99	.49
103	73	74	200.70	.14	.00	.00	.57	.18
104	75	74	-86.70	.02	.00	.00	.25	.04
105	76	75	176.80	.11	.00	.00	.50	.14
106	77	76	273.30	.22	.00	.00	.78	.31
107	77	78	9455.10	1.22	.00	.00	2.98	.77
108-XX	57	78						
109	71	36	977.74	.70	.00	.00	2.77	3.31
110	78	80	5941.20	5.96	.00	.00	6.07	6.63
111	78	80	1421.40	5.96	.00	.00	4.03	6.63
112	80	81	3847.34	3.59	.00	.00	3.93	2.96
113	80	82	3515.26	8.92	.00	.00	5.61	7.43
114	81	84	3832.44	6.19	.00	.00	6.12	8.72
115	82	83	405.48	3.04	.00	.00	2.59	4.68
116	84	83	243.39	2.18	.00	.00	1.55	1.82
117	82	89	3038.88	8.68	.00	.00	4.85	5.68
118	83	85	511.57	7.41	.00	.00	3.27	7.19
119	84	86	3503.20	7.76	.00	.00	5.59	7.39
120	89	90	1360.73	6.54	.00	.00	3.86	6.11
121	90	87	725.88	1.81	.00	.00	2.06	1.91
122	85	87	631.56	6.59	.00	.00	4.03	10.63
123	86	85	226.88	1.84	.00	.00	1.45	1.60
124	87	88	-191.55	1.22	.00	.00	1.22	1.17
125	86	88	3136.87	7.22	.00	.00	5.01	6.02
126	90	91	520.05	5.86	.00	.00	3.32	7.42
127	87	93	1450.19	7.08	.00	.00	4.11	6.88
128	88	94	2899.56	4.27	.00	.00	4.63	5.20
129	91	92	261.37	1.68	.00	.00	1.67	2.07
130	92	93	336.65	1.36	.00	.00	2.15	3.31
131	93	94	-354.89	4.02	.00	.00	2.27	3.65
132	94	95	2497.77	1.30	.00	.00	3.99	4.64
133	93	100	2094.83	12.23	.00	.00	5.94	13.59
134	95	101	2475.47	10.00	.00	.00	7.02	18.52
135	100	101	-442.62	4.95	.00	.00	2.82	5.50
136	100	102	2494.50	13.52	.00	.00	7.08	18.78
137	101	103	1989.90	11.74	.00	.00	5.64	12.36
138	102	103	-1960.50	6.73	.00	.00	5.56	12.02
139	103	104	11.05	.00	.00	.00	.07	.01
140	102	105	4436.65	9.61	.00	.00	7.08	11.44
141	105	107	4345.00	10.35	.00	.00	6.93	11.01
142	107	109	4259.75	14.85	.00	.00	6.80	10.61
143	109	110	4154.75	6.28	.00	.00	6.63	10.13
144	104	106	11.05	.00	.00	.00	.07	.01
145	106	108	.00	.00	.00	.00	.00	.00
146-XX	108	110						
147	110	111	4094.00	13.80	.00	.00	6.53	9.86
148	91	96	195.33	.36	.00	.00	1.25	1.21
149	96	97	195.33	.94	.00	.00	1.25	1.21

150	92	97	-111.68	.37	.00	.00	.71	.43
151	97	98	68.80	.07	.00	.00	.44	.18
152	98	99	19.47	.01	.00	.00	.12	.02
153	98	99	14.93	.01	.00	.00	.10	.01
154	89	112	1544.80	.53	.00	.00	1.58	.55
155	112	113	1455.20	1.18	.00	.00	1.49	.49
156	113	114	1101.70	.26	.00	.00	1.13	.29
157	114	115	838.05	1.18	.00	.00	1.34	.52
158	115	116	308.45	.14	.00	.00	.49	.08
159	116	117	165.70	.04	.00	.00	.26	.03
160	117	118	82.85	.01	.00	.00	.13	.01

J U N C T I O N   N O D E   R E S U L T S

JUNCTION NUMBER	JUNCTION TITLE	EXTERNAL DEMAND (gpm)	HYDRAULIC GRADE (ft)	JUNCTION ELEVATION (ft)	PRESSURE HEAD (ft)	JUNCTION PRESSURE (psi)
1		.00	158.31	120.00	38.31	16.60
2		.00	156.95	75.00	81.95	35.51
3		.00	156.29	77.00	79.29	34.36
4		479.00	154.79	50.00	104.79	45.41
5		104.00	153.04	85.00	68.04	29.48
6		.00	150.63	95.00	55.63	24.11
7		.00	147.77	98.00	49.77	21.57
8		.00	225.54	98.00	127.54	55.27
9		.00	225.00	102.00	123.00	53.30
10		20833.00	218.58	175.00	43.58	18.88
11		.00	211.01	55.00	156.01	67.61
12		235.50	210.24	25.00	185.24	80.27
13		156.00	207.87	45.00	162.87	70.58
14		.00	210.24	45.00	165.24	71.60
15		125.00	207.80	45.00	162.80	70.54
16		167.00	207.81	45.00	162.81	70.55
17		62.50	207.85	45.00	162.85	70.57
18		234.50	208.34	20.00	188.34	81.61
19		234.50	207.81	30.00	177.81	77.05
20		121.50	205.78	38.00	167.78	72.70
21		71.50	205.40	37.00	168.40	72.97
22		71.50	205.08	36.00	169.08	73.27
23		72.00	204.75	35.00	169.75	73.56
24		.00	204.14	34.00	170.14	73.73
25		.00	202.65	33.00	169.65	73.51
26		.00	202.05	28.00	174.05	75.42
27		.00	201.94	28.00	173.94	75.37
28		.00	201.94	27.00	174.94	75.81
29		99.50	204.04	35.00	169.04	73.25
30		186.50	201.16	36.00	165.16	71.57
31		214.50	198.48	37.00	161.48	69.97
32		.00	195.66	34.00	161.66	70.05
33		99.00	195.66	33.00	162.66	70.49
34		91.50	195.67	31.00	164.67	71.36
35		.00	195.67	34.00	161.67	70.06

36	.00	198.21	34.00	164.21	71.16
37	.00	195.89	34.00	161.89	70.15
38	161.50	195.75	33.00	162.75	70.52
39	.00	195.30	33.00	162.30	70.33
40	150.50	195.20	33.00	162.20	70.28
41	.00	195.05	34.00	161.05	69.79
42	21.00	193.66	34.00	159.66	69.18
43	50.50	194.95	34.00	160.95	69.75
44	521.00	193.53	33.00	160.53	69.56
45	109.50	194.37	30.00	164.37	71.23
46	109.50	194.11	28.00	166.11	71.98
47	99.00	193.63	25.00	168.63	73.07
48	.00	199.08	35.00	164.08	71.10
49	75.00	195.33	25.00	170.33	73.81
50	89.00	195.36	26.00	169.36	73.39
51	177.50	195.31	27.00	168.31	72.94
52	.00	195.32	28.00	167.32	72.50
53	35.00	195.33	29.00	166.33	72.08
54	155.50	195.46	31.00	164.46	71.27
55	99.50	195.73	27.00	168.73	73.11
56	176.50	196.34	27.00	169.34	73.38
57	.00	196.91	28.00	168.91	73.20
58	.00	200.72	32.00	168.72	73.11
59	.00	199.25	31.00	168.25	72.91
60	83.00	199.68	31.00	168.68	73.09
61	4.00	199.23	31.00	168.23	72.90
62	63.50	199.07	32.00	167.07	72.40
63	161.50	198.96	38.00	160.96	69.75
64	90.00	198.66	30.00	168.66	73.08
65	167.00	198.03	30.00	168.03	72.81
66	262.50	197.76	30.00	167.76	72.69
67	53.00	197.65	30.00	167.65	72.65
68	53.00	197.61	30.00	167.61	72.63
69	53.00	197.60	30.00	167.60	72.62
70	.00	197.59	32.00	165.59	71.76
71	.00	198.91	34.00	164.91	71.46
72	211.00	197.11	32.00	165.11	71.55
73	147.00	196.92	31.00	165.92	71.90
74	114.00	196.78	30.00	166.78	72.27
75	263.50	196.76	30.00	166.76	72.26
76	96.50	196.88	29.00	167.88	72.75
77	15.50	197.10	28.00	169.10	73.28
78	2092.50	195.88	20.00	175.88	76.21
79	.00	199.08	35.00	164.08	71.10
80	.00	189.91	25.00	164.91	71.46
81	14.90	186.33	25.00	161.33	69.91
82	70.90	180.99	25.00	155.99	67.60
83	137.30	177.95	25.00	152.95	66.28
84	85.85	180.13	25.00	155.13	67.22
85	106.90	170.54	25.00	145.54	63.07
86	139.45	172.38	25.00	147.38	63.86
87	98.80	163.95	25.00	138.95	60.21
88	45.75	165.15	25.00	140.15	60.73
89	133.35	172.31	25.00	147.31	63.83
90	114.80	165.77	25.00	140.77	61.00

91	63.35	159.91	20.00	139.91	60.63
92	36.40	158.23	20.00	138.23	59.90
93	46.90	156.87	20.00	136.87	59.31
94	46.90	160.89	20.00	140.89	61.05
95	22.30	159.59	20.00	139.59	60.49
96	.00	159.55	20.00	139.55	60.47
97	14.85	158.60	20.00	138.60	60.06
98	34.40	158.54	20.00	138.54	60.03
99	34.40	158.52	20.00	138.52	60.03
100	42.95	144.64	20.00	124.64	54.01
101	42.95	149.59	20.00	129.59	56.16
102	18.35	131.12	15.00	116.12	50.32
103	18.35	137.85	15.00	122.85	53.24
104	.00	137.85	15.00	122.85	53.23
105	91.65	121.51	15.00	106.51	46.15
106	11.05	137.84	15.00	122.84	53.23
107	85.25	111.16	15.00	96.16	41.67
108	.00	137.84	15.00	122.84	53.23
109	105.00	96.31	15.00	81.31	35.23
110	60.75	90.03	15.00	75.03	32.51
111	4094.00	76.23	15.00	61.23	26.53
112	89.60	171.78	25.00	146.78	63.60
113	353.50	170.59	20.00	150.59	65.26
114	263.65	170.33	20.00	150.33	65.14
115	529.60	169.15	15.00	154.15	66.80
116	142.75	169.01	15.00	154.01	66.74
117	82.85	168.98	15.00	153.98	66.72
118	82.85	168.97	15.00	153.97	66.72

M A X I M U M   A N D   M I N I M U M   V A L U E S

P R E S S U R E S

JUNCTION NUMBER	MAXIMUM PRESSURES (psi)	JUNCTION NUMBER	MINIMUM PRESSURES (psi)
18	81.61	1	16.60
12	80.27	10	18.88
19	77.05	7	21.57
78	76.21	6	24.11
28	75.81	111	26.53
26	75.42	5	29.48
27	75.37	110	32.51
49	73.81	3	34.36
24	73.73	109	35.23
23	73.56	2	35.51

V E L O C I T I E S

PIPE NUMBER	MAXIMUM VELOCITY (ft/s)	PIPE NUMBER	MINIMUM VELOCITY (ft/s)
6	12.60	139	.07
15	9.22	144	.07
20	9.22	35	.08
140	7.08	153	.10
136	7.08	52	.10
134	7.02	152	.12
141	6.93	70	.13
142	6.80	71	.13
143	6.63	160	.13
147	6.53	98	.13

S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

(+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
(-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

PIPE NUMBER	FLOWRATE (gpm)
1	8548.21
6	12339.74
23	16094.15

NET SYSTEM INFLOW = 36982.09
NET SYSTEM OUTFLOW = .00
NET SYSTEM DEMAND = 36982.11

D A T A   C H A N G E S   F O R   N E X T   S I M U L A T I O N

D E M A N D   C H A N G E S

DEMAND TYPE = 1 - GDF = .500

THE FOLLOWING SPECIFIC DEMAND CHANGES ARE MADE :

JUNCTION NUMBER	DEMAND (gpm)
118	4083.00
10	20833.00

****
S I M U L A T I O N   R E S U L T S
****

THE RESULTS ARE OBTAINED AFTER 3 TRIALS WITH AN ACCURACY = .00288

P I P E L I N E   R E S U L T S

STATUS CODE: XX -CLOSED PIPE FG -FIXED GRADE NODE PU -PUMP LINE
CV -CHECK VALVE RV -REGULATING VALVE TK -STORAGE TANK

PIPE NUMBER	NODE NOS. #1	#2	FLOWRATE (gpm)	HEAD LOSS (ft)	PUMP HEAD (ft)	MINOR LOSS (ft)	LINE VELO. (ft/s)	HL/ 1000 (ft/ft)
1-FGPU	0	1	8548.21	.02	148.33	.00	2.69	.64
2	1	2	7944.15	1.36	.00	.00	3.61	1.36
3	1	2	604.06	1.36	.00	.00	1.71	1.36
4	2	3	5279.49	.66	.00	.00	1.66	.26
5	2	3	3268.72	.66	.00	.00	1.48	.26
6-FG	0	3	12339.75	66.71	.00	.00	12.60	25.66
7	3	4	11502.73	1.50	.00	.00	3.63	1.11
8	3	4	7121.75	1.50	.00	.00	3.23	1.11
9	3	4	2263.48	1.50	.00	.00	2.31	1.11
10	4	5	11238.95	1.75	.00	.00	3.54	1.06
11	4	5	6958.44	1.75	.00	.00	3.16	1.06
12	4	5	2211.58	1.75	.00	.00	2.26	1.06
13	5	6	12540.62	2.41	.00	.00	3.95	1.30
14	5	6	7764.35	2.41	.00	.00	3.52	1.30
15	6	7	20304.97	2.86	.00	.00	9.22	7.72
16-PU	7	8	6768.32	.02	77.79	.00	3.07	1.01
17-PU	7	8	6768.32	.02	77.79	.00	3.07	1.01
18-PU	7	8	6768.32	.02	77.79	.00	3.07	1.01
19-XXCV	7	8						
20	8	9	20304.97	.54	.00	.00	9.22	7.72
21	9	10	10152.48	6.42	.00	.00	4.61	2.14
22	9	10	10152.48	6.42	.00	.00	4.61	2.14
23-FG	0	10	16094.53	4.42	.00	.00	3.73	.98
24	10	11	15566.50	7.57	.00	.00	3.60	.92
25-XXCV	5	12						
26	11	12	733.58	.78	.00	.00	1.17	.41
27	11	13	14832.92	3.15	.00	.00	3.43	.84
28	12	14	.00	.00	.00	.00	.00	.00
29-XX	14	15						
30	16	15	95.92	.01	.00	.00	.15	.01
31	17	16	262.92	.04	.00	.00	.42	.06
32	13	17	325.42	.02	.00	.00	.52	.09
33	12	18	498.08	1.90	.00	.00	1.41	.95
34	18	19	263.58	.53	.00	.00	.75	.29
35	15	19	-29.08	.02	.00	.00	.08	.00
36	13	20	14351.50	2.09	.00	.00	4.52	1.67
37	20	21	14230.00	.38	.00	.00	4.48	1.65
38	21	22	14158.50	.33	.00	.00	4.46	1.63
39	22	23	14087.00	.32	.00	.00	4.44	1.61
40	23	24	14015.00	.61	.00	.00	4.42	1.60
41-XX	15	28						
42	24	25	12842.26	1.50	.00	.00	4.05	1.36
43	25	26	12842.26	.60	.00	.00	5.83	3.31

44	26	27	11804.59	.12	.00	.00	3.72	1.16
45	28	27	.00	.00	.00	.00	.00	.00
46-XX	28	35						
47	27	79	11804.59	2.85	.00	.00	3.72	1.16
48	24	29	1172.74	.11	.00	.00	1.87	.97
49	29	30	1073.24	2.88	.00	.00	3.04	3.94
50	30	31	886.74	2.68	.00	.00	2.52	2.77
51	31	32	672.24	2.82	.00	.00	1.91	1.66
52	33	32	-35.08	.00	.00	.00	.10	.01
53	34	33	63.92	.01	.00	.00	.18	.02
54	35	34	.00	.00	.00	.00	.00	.00
55-XX	35	48						
56	36	37	977.74	2.32	.00	.00	2.77	3.31
57	38	37	-316.92	.14	.00	.00	.90	.41
58	34	38	-155.42	.08	.00	.00	.44	.11
59	37	39	335.38	.59	.00	.00	.95	.46
60	32	39	320.14	.36	.00	.00	.91	.42
61	32	40	317.02	.47	.00	.00	.90	.41
62	40	41	166.52	.14	.00	.00	.47	.12
63	39	41	201.98	.25	.00	.00	.57	.18
64	39	42	542.00	1.64	.00	.00	1.54	1.11
65	42	44	521.00	.13	.00	.00	1.48	1.03
66	41	43	368.50	.10	.00	.00	.59	.11
67	37	54	325.43	.43	.00	.00	.92	.43
68	54	53	169.93	.13	.00	.00	.48	.13
69	53	39	88.46	.03	.00	.00	.25	.04
70	53	52	46.48	.01	.00	.00	.13	.01
71	52	51	46.48	.00	.00	.00	.13	.01
72	50	51	131.02	.05	.00	.00	.37	.08
73	50	49	75.00	.03	.00	.00	.21	.03
74	79	71	11804.59	.17	.00	.00	3.72	1.16
75-XX	48	36						
76	46	47	99.00	.48	.00	.00	.63	.34
77	45	46	208.50	.26	.00	.00	.59	.19
78	43	45	318.00	.58	.00	.00	.90	.41
79	55	50	295.02	.37	.00	.00	.84	.36
80	56	55	394.52	.62	.00	.00	1.12	.62
81	57	56	571.02	.57	.00	.00	1.62	1.22
82-XX	36	57						
83	71	77	10315.31	1.81	.00	.00	3.25	.91
84	77	57	571.02	.18	.00	.00	1.62	1.22
85	26	58	1037.68	1.33	.00	.00	2.94	3.70
86	58	59	810.11	1.47	.00	.00	2.30	2.34
87	58	60	227.57	1.04	.00	.00	1.45	1.60
88	60	61	144.57	.45	.00	.00	.92	.69
89	59	61	84.43	.02	.00	.00	.24	.04
90	61	62	225.00	.16	.00	.00	.64	.22
91	62	63	161.50	.11	.00	.00	.46	.12
92	59	64	725.68	.59	.00	.00	2.06	1.91
93	64	65	635.68	.63	.00	.00	1.80	1.49
94	65	66	468.68	.27	.00	.00	1.33	.85
95	67	66	-206.18	.11	.00	.00	.58	.19
96	68	67	-153.18	.04	.00	.00	.43	.11
97	69	68	-100.18	.01	.00	.00	.28	.05
98	70	69	-47.18	.00	.00	.00	.13	.01

99	71	70	511.54	1.32	.00	.00	1.45	1.00
100	79	48	.00	.00	.00	.00	.00	.00
101	70	72	558.71	.48	.00	.00	1.58	1.18
102	72	73	347.71	.19	.00	.00	.99	.49
103	73	74	200.71	.14	.00	.00	.57	.18
104	75	74	-86.71	.02	.00	.00	.25	.04
105	76	75	176.79	.11	.00	.00	.50	.14
106	77	76	273.29	.22	.00	.00	.78	.31
107	77	78	9455.50	1.22	.00	.00	2.98	.77
108-XX	57	78						
109	71	36	977.74	.70	.00	.00	2.77	3.31
110	78	80	5941.53	5.96	.00	.00	6.07	6.63
111	78	80	1421.47	5.96	.00	.00	4.03	6.63
112	80	81	3011.59	2.28	.00	.00	3.08	1.88
113	80	82	4351.41	13.24	.00	.00	6.94	11.04
114	81	84	2996.69	3.93	.00	.00	4.78	5.53
115	82	83	-74.06	.13	.00	.00	.47	.20
116	84	83	453.75	6.91	.00	.00	2.90	5.76
117	82	89	4354.57	16.91	.00	.00	6.95	11.05
118	83	85	242.39	1.86	.00	.00	1.55	1.80
119	84	86	2457.09	4.02	.00	.00	3.92	3.83
120	89	90	-1323.73	6.22	.00	.00	3.75	5.81
121	90	87	-1180.04	4.46	.00	.00	3.35	4.70
122	85	87	514.95	4.51	.00	.00	3.29	7.28
123	86	85	379.45	4.76	.00	.00	2.42	4.14
124	87	88	-463.94	6.30	.00	.00	2.96	6.00
125	86	88	1938.18	2.96	.00	.00	3.09	2.47
126	90	91	-258.49	1.61	.00	.00	1.65	2.03
127	87	93	-299.96	.38	.00	.00	.85	.37
128	88	94	1428.50	1.15	.00	.00	2.28	1.40
129	91	92	-226.92	1.29	.00	.00	1.45	1.60
130	92	93	-441.89	2.25	.00	.00	2.82	5.48
131	93	94	-389.64	4.78	.00	.00	2.49	4.34
132	94	95	991.96	.23	.00	.00	1.58	.84
133	93	100	-399.11	.57	.00	.00	1.13	.63
134	95	101	969.66	1.76	.00	.00	2.75	3.26
135	100	101	-290.98	2.28	.00	.00	1.86	2.53
136	100	102	-151.08	.08	.00	.00	.43	.10
137	101	103	635.73	1.42	.00	.00	1.80	1.49
138	102	103	-606.33	.77	.00	.00	1.72	1.37
139	103	104	11.05	.00	.00	.00	.07	.01
140	102	105	436.90	.13	.00	.00	.70	.16
141	105	107	345.25	.10	.00	.00	.55	.10
142	107	109	260.00	.08	.00	.00	.41	.06
143	109	110	155.00	.01	.00	.00	.25	.02
144	104	106	11.05	.00	.00	.00	.07	.01
145	106	108	.00	.00	.00	.00	.00	.00
146-XX	108	110						
147	110	111	94.25	.01	.00	.00	.15	.01
148	91	96	-94.92	.10	.00	.00	.61	.32
149	96	97	-94.92	.25	.00	.00	.61	.32
150	92	97	178.57	.89	.00	.00	1.14	1.02
151	97	98	68.80	.07	.00	.00	.44	.18
152	98	99	19.47	.01	.00	.00	.12	.02
153	98	99	14.93	.01	.00	.00	.10	.01

154	89	112	5544.95	5.66	.00	.00	5.66	5.83
155	112	113	5455.35	13.69	.00	.00	5.57	5.66
156	113	114	5101.85	4.50	.00	.00	5.21	5.00
157	114	115	4838.20	30.22	.00	.00	7.72	13.43
158	115	116	4308.60	19.07	.00	.00	6.87	10.84
159	116	117	4165.85	13.74	.00	.00	6.65	10.18
160	117	118	4083.00	10.59	.00	.00	6.51	9.81

J U N C T I O N   N O D E   R E S U L T S

JUNCTION NUMBER	JUNCTION TITLE	EXTERNAL DEMAND (gpm)	HYDRAULIC GRADE (ft)	JUNCTION ELEVATION (ft)	PRESSURE HEAD (ft)	JUNCTION PRESSURE (psi)
1		.00	158.31	120.00	38.31	16.60
2		.00	156.95	75.00	81.95	35.51
3		.00	156.29	77.00	79.29	34.36
4		479.00	154.79	50.00	104.79	45.41
5		104.00	153.04	85.00	68.04	29.48
6		.00	150.63	95.00	55.63	24.11
7		.00	147.77	98.00	49.77	21.57
8		.00	225.54	98.00	127.54	55.27
9		.00	225.00	102.00	123.00	53.30
10		20833.00	218.58	175.00	43.58	18.88
11		.00	211.01	55.00	156.01	67.61
12		235.50	210.24	25.00	185.24	80.27
13		156.00	207.87	45.00	162.87	70.58
14		.00	210.24	45.00	165.24	71.60
15		125.00	207.80	45.00	162.80	70.54
16		167.00	207.81	45.00	162.81	70.55
17		62.50	207.85	45.00	162.85	70.57
18		234.50	208.34	20.00	188.34	81.61
19		234.50	207.81	30.00	177.81	77.05
20		121.50	205.78	38.00	167.78	72.70
21		71.50	205.40	37.00	168.40	72.97
22		71.50	205.07	36.00	169.07	73.27
23		72.00	204.75	35.00	169.75	73.56
24		.00	204.14	34.00	170.14	73.73
25		.00	202.65	33.00	169.65	73.51
26		.00	202.05	28.00	174.05	75.42
27		.00	201.94	28.00	173.94	75.37
28		.00	201.94	27.00	174.94	75.81
29		99.50	204.04	35.00	169.04	73.25
30		186.50	201.16	36.00	165.16	71.57
31		214.50	198.48	37.00	161.48	69.97
32		.00	195.66	34.00	161.66	70.05
33		99.00	195.66	33.00	162.66	70.49
34		91.50	195.67	31.00	164.67	71.36
35		.00	195.67	34.00	161.67	70.06
36		.00	198.21	34.00	164.21	71.16
37		.00	195.89	34.00	161.89	70.15
38		161.50	195.75	33.00	162.75	70.52
39		.00	195.30	33.00	162.30	70.33

40	150.50	195.19	33.00	162.19	70.28
41	.00	195.05	34.00	161.05	69.79
42	21.00	193.65	34.00	159.65	69.18
43	50.50	194.95	34.00	160.95	69.74
44	521.00	193.53	33.00	160.53	69.56
45	109.50	194.37	30.00	164.37	71.23
46	109.50	194.11	28.00	166.11	71.98
47	99.00	193.63	25.00	168.63	73.07
48	.00	199.08	35.00	164.08	71.10
49	75.00	195.33	25.00	170.33	73.81
50	89.00	195.36	26.00	169.36	73.39
51	177.50	195.31	27.00	168.31	72.94
52	.00	195.32	28.00	167.32	72.50
53	35.00	195.33	29.00	166.33	72.08
54	155.50	195.46	31.00	164.46	71.27
55	99.50	195.72	27.00	168.72	73.11
56	176.50	196.34	27.00	169.34	73.38
57	.00	196.91	28.00	168.91	73.19
58	.00	200.72	32.00	168.72	73.11
59	.00	199.25	31.00	168.25	72.91
60	83.00	199.68	31.00	168.68	73.09
61	4.00	199.23	31.00	168.23	72.90
62	63.50	199.07	32.00	167.07	72.40
63	161.50	198.96	38.00	160.96	69.75
64	90.00	198.65	30.00	168.65	73.08
65	167.00	198.03	30.00	168.03	72.81
66	262.50	197.76	30.00	167.76	72.69
67	53.00	197.65	30.00	167.65	72.65
68	53.00	197.61	30.00	167.61	72.63
69	53.00	197.59	30.00	167.59	72.62
70	.00	197.59	32.00	165.59	71.76
71	.00	198.91	34.00	164.91	71.46
72	211.00	197.11	32.00	165.11	71.55
73	147.00	196.92	31.00	165.92	71.90
74	114.00	196.78	30.00	166.78	72.27
75	263.50	196.76	30.00	166.76	72.26
76	96.50	196.88	29.00	167.88	72.75
77	15.50	197.09	28.00	169.09	73.27
78	2092.50	195.88	20.00	175.88	76.21
79	.00	199.08	35.00	164.08	71.10
80	.00	189.91	25.00	164.91	71.46
81	14.90	187.63	25.00	162.63	70.47
82	70.90	176.67	25.00	151.67	65.72
83	137.30	176.80	25.00	151.80	65.78
84	85.85	183.71	25.00	158.71	68.77
85	106.90	174.94	25.00	149.94	64.97
86	139.45	179.68	25.00	154.68	67.03
87	98.80	170.43	25.00	145.43	63.02
88	45.75	176.72	25.00	151.72	65.75
89	133.35	159.76	25.00	134.76	58.40
90	114.80	165.98	25.00	140.98	61.09
91	63.35	167.58	20.00	147.58	63.95
92	36.40	168.87	20.00	148.87	64.51
93	46.90	170.81	20.00	150.81	65.35
94	46.90	175.57	20.00	155.57	67.42

95	22.30	175.34	20.00	155.34	67.31
96	.00	167.68	20.00	147.68	63.99
97	14.85	167.98	20.00	147.98	64.13
98	34.40	167.92	20.00	147.92	64.10
99	34.40	167.90	20.00	147.90	64.09
100	42.95	171.38	20.00	151.38	65.60
101	42.95	173.58	20.00	153.58	66.55
102	18.35	171.45	15.00	156.45	67.80
103	18.35	172.16	15.00	157.16	68.10
104	.00	172.15	15.00	157.15	68.10
105	91.65	171.32	15.00	156.32	67.74
106	11.05	172.15	15.00	157.15	68.10
107	85.25	171.22	15.00	156.22	67.70
108	.00	172.15	15.00	157.15	68.10
109	105.00	171.14	15.00	156.14	67.66
110	60.75	171.13	15.00	156.13	67.65
111	94.25	171.11	15.00	156.11	67.65
112	89.60	154.10	25.00	129.10	55.94
113	353.50	140.41	20.00	120.41	52.18
114	263.65	135.91	20.00	115.91	50.23
115	529.60	105.69	15.00	90.69	39.30
116	142.75	86.62	15.00	71.62	31.04
117	82.85	72.88	15.00	57.88	25.08
118	4083.00	62.29	15.00	47.29	20.49

M A X I M U M   A N D   M I N I M U M   V A L U E S

P R E S S U R E S

JUNCTION NUMBER	MAXIMUM PRESSURES (psi)	JUNCTION NUMBER	MINIMUM PRESSURES (psi)
18	81.61	1	16.60
12	80.27	10	18.88
19	77.05	118	20.49
78	76.21	7	21.57
28	75.81	6	24.11
26	75.42	117	25.08
27	75.37	5	29.48
49	73.81	116	31.04
24	73.73	3	34.36
23	73.56	2	35.51

V E L O C I T I E S

PIPE NUMBER	MAXIMUM VELOCITY (ft/s)	PIPE NUMBER	MINIMUM VELOCITY (ft/s)
6	12.60	139	.07
15	9.22	144	.07

20	9.22	35	.08
157	7.72	153	.10
117	6.95	52	.10
113	6.94	152	.12
158	6.87	70	.13
159	6.65	71	.13
160	6.51	98	.13
110	6.07	147	.15

S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

(+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
(-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

PIPE NUMBER	FLOWRATE (gpm)
1	8548.21
6	12339.75
23	16094.53

NET SYSTEM INFLOW = 36982.50
NET SYSTEM OUTFLOW = .00
NET SYSTEM DEMAND = 36982.50

**** KYPIPE SIMULATION COMPLETED ****

DATE: 3/17/2003
TIME: 10:50:12

Appendix C

Computer Simulation of BWS' 228-Foot Service Zone in the Fort Weaver Corridor With the Addition of the Hoopili Project

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* * * * * * * * * *   K Y P I P E 2   * * * * * * * * * *
*   University of Kentucky Hydraulic Analysis Program   *
* Distribution of Pressure and Flows in Piping Networks *
*         1000 PIPE VERSION - 1.10   (08/25/92)         *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * *
```

DATE: 11/16/2006
TIME: 8:47: 0

INPUT DATA FILENAME -------------- HOOPILI.DAT
TABULATED OUTPUT FILENAME -------- HOOPILI.OUT
POSTPROCESSOR RESULTS FILENAME --- HOOPILI.RES

S U M M A R Y   O F   O R I G I N A L   D A T A

U N I T S   S P E C I F I E D

FLOWRATE .... = gallons/minute
HEAD (HGL) .... = feet
PRESSURE .... = psig

P I P E L I N E   D A T A

STATUS CODE: XX -CLOSED PIPE FG -FIXED GRADE NODE PU -PUMP LINE
CV -CHECK VALVE RV -REGULATING VALVE

PIPE NUMBER	NODE NOS. #1	#2	LENGTH (ft)	DIAMETER (in)	ROUGHNESS COEFF.	MINOR LOSS COEFF.	FGN-HGL (ft)
1-FGPU	0	203	50.0	36.0	130.00	.00	10.00
2	1	2	980.0	30.0	130.00	.00	
3	1	2	980.0	12.0	110.00	.00	
4	2	3	2500.0	36.0	130.00	.00	
5	2	3	2500.0	30.0	130.00	.00	
6-FG	0	204	1800.0	20.0	120.00	.00	228.00
7	3	4	1350.0	36.0	130.00	.00	
8	3	4	1350.0	30.0	130.00	.00	
9	3	4	1350.0	20.0	120.00	.00	
10	4	5	1650.0	36.0	130.00	.00	
11	4	5	1650.0	30.0	130.00	.00	
12	4	5	1650.0	20.0	120.00	.00	
13	5	6	1850.0	36.0	130.00	.00	
14	5	6	1850.0	30.0	130.00	.00	
15	6	7	370.0	30.0	130.00	.00	
16-XXPU	7	8	20.0	30.0	130.00	.00	
17-XXPU	7	8	20.0	30.0	130.00	.00	
18-XXPU	7	8	20.0	30.0	130.00	.00	

19-CV	7	8	20.0	30.0	130.00	.00	
20	8	9	70.0	30.0	130.00	.00	
21	9	208	3000.0	30.0	130.00	.00	
22	205	10	3000.0	30.0	130.00	.00	
23-FG	0	10	4530.0	42.0	130.00	.00	228.00
24	210	11	8250.0	42.0	130.00	.00	
25-CV	5	12	7150.0	16.0	120.00	.00	
26	12	11	1900.0	16.0	120.00	.00	
27	11	13	3750.0	42.0	130.00	.00	
28	12	14	2850.0	16.0	120.00	.00	
29-XX	14	15	650.0	16.0	120.00	.00	
30	16	15	1300.0	16.0	120.00	.00	
31	17	16	700.0	16.0	120.00	.00	
32	13	17	200.0	16.0	120.00	.00	
33	12	18	2000.0	12.0	110.00	.00	
34	18	19	1800.0	12.0	110.00	.00	
35	15	19	3200.0	12.0	110.00	.00	
36	13	20	1250.0	36.0	130.00	.00	
37	20	21	230.0	36.0	130.00	.00	
38	21	22	200.0	36.0	130.00	.00	
39	22	23	200.0	36.0	130.00	.00	
40	23	24	380.0	36.0	130.00	.00	
41-XX	15	28	2480.0	16.0	120.00	.00	
42	24	25	1100.0	36.0	130.00	.00	
43	25	26	180.0	30.0	130.00	.00	
44	26	27	100.0	36.0	130.00	.00	
45	28	27	150.0	16.0	120.00	.00	
46-XX	28	35	2000.0	16.0	120.00	.00	
47	27	79	2450.0	36.0	130.00	.00	
48	24	29	110.0	16.0	120.00	.00	
49	29	30	730.0	12.0	110.00	.00	
50	30	31	970.0	12.0	110.00	.00	
51	31	32	1700.0	12.0	110.00	.00	
52	33	32	570.0	12.0	110.00	.00	
53	34	33	580.0	12.0	110.00	.00	
54	35	34	800.0	12.0	110.00	.00	
55-XX	35	48	730.0	16.0	120.00	.00	
56	36	37	700.0	12.0	110.00	.00	
57	37	38	350.0	12.0	110.00	.00	
58	38	34	700.0	12.0	110.00	.00	
59	37	39	1300.0	12.0	110.00	.00	
60	32	39	870.0	12.0	110.00	.00	
61	32	40	1140.0	12.0	110.00	.00	
62	40	41	1150.0	12.0	110.00	.00	
63	39	41	1390.0	12.0	110.00	.00	
64	39	42	1480.0	12.0	110.00	.00	
65	42	44	122.0	12.0	110.00	.00	
66	41	43	890.0	16.0	120.00	.00	
67	37	54	1000.0	12.0	110.00	.00	
68	54	53	1030.0	12.0	110.00	.00	
69	53	39	730.0	12.0	110.00	.00	
70	52	53	805.0	12.0	110.00	.00	
71	51	52	400.0	12.0	110.00	.00	
72	50	51	580.0	12.0	110.00	.00	
73	50	49	965.0	12.0	110.00	.00	
74	79	71	150.0	36.0	130.00	.00	
75-XX	48	36	170.0	16.0	120.00	.00	
76	46	47	1390.0	8.0	110.00	.00	

77	45	46	1390.0	12.0	110.00	.00
78	43	45	1390.0	12.0	110.00	.00
79	55	50	1015.0	12.0	110.00	.00
80	56	55	1000.0	12.0	110.00	.00
81	57	56	465.0	12.0	110.00	.00
82-XX	36	57	2000.0	16.0	120.00	.00
83	71	77	2000.0	36.0	130.00	.00
84	77	57	150.0	12.0	110.00	.00
85	26	58	360.0	12.0	110.00	.00
86	58	59	630.0	12.0	110.00	.00
87	58	60	650.0	8.0	110.00	.00
88	60	61	650.0	8.0	110.00	.00
89	59	61	550.0	12.0	110.00	.00
90	61	62	720.0	12.0	110.00	.00
91	62	63	950.0	12.0	110.00	.00
92	59	64	310.0	12.0	110.00	.00
93	64	65	420.0	12.0	110.00	.00
94	65	66	320.0	12.0	110.00	.00
95	66	67	570.0	12.0	110.00	.00
96	68	67	400.0	12.0	110.00	.00
97	69	68	250.0	12.0	110.00	.00
98	70	69	330.0	12.0	110.00	.00
99	71	70	1320.0	12.0	110.00	.00
100	79	48	40.0	16.0	120.00	.00
101	70	72	410.0	12.0	110.00	.00
102	72	73	390.0	12.0	110.00	.00
103	73	74	780.0	12.0	110.00	.00
104	75	74	465.0	12.0	110.00	.00
105	76	75	810.0	12.0	110.00	.00
106	77	76	700.0	12.0	110.00	.00
107	77	78	1580.0	36.0	130.00	.00
108-XX	57	78	1580.0	16.0	120.00	.00
109	71	36	210.0	12.0	110.00	.00
110	78	80	900.0	20.0	120.00	.00
111	78	80	900.0	12.0	110.00	.00
112	80	81	1220.0	20.0	120.00	.00
113	80	82	1170.0	16.0	120.00	.00
114	81	84	700.0	16.0	120.00	.00
115	82	83	630.0	8.0	110.00	.00
116	84	83	1200.0	8.0	110.00	.00
117	82	89	900.0	16.0	120.00	.00
118	83	85	1060.0	8.0	110.00	.00
119	83	86	1035.0	8.0	110.00	.00
120	84	85	1050.0	16.0	120.00	.00
121	89	91	650.0	16.0	120.00	.00
122	87	88	710.0	8.0	110.00	.00
123	86	87	665.0	8.0	110.00	.00
124	85	86	1150.0	8.0	110.00	.00
125	85	94	1200.0	16.0	120.00	.00
126	82	113	280.0	8.0	110.00	.00
127	91	90	620.0	12.0	110.00	.00
128	91	92	1070.0	12.0	110.00	.00
129	93	92	950.0	12.0	110.00	.00
130	86	93	600.0	8.0	110.00	.00
131	94	93	1050.0	8.0	110.00	.00
132	92	96	280.0	8.0	110.00	.00
133	93	103	1040.0	12.0	110.00	.00
134	94	104	800.0	16.0	120.00	.00

135	95	98	550.0	8.0	110.00	.00	
136	96	95	780.0	8.0	110.00	.00	
137	96	100	520.0	8.0	110.00	.00	
138	97	101	730.0	8.0	110.00	.00	
139	96	97	770.0	8.0	110.00	.00	
140	98	99	800.0	8.0	110.00	.00	
141	100	99	310.0	8.0	110.00	.00	
142	101	100	810.0	8.0	110.00	.00	
143	99	112	790.0	8.0	110.00	.00	
144	101	112	870.0	8.0	110.00	.00	
145	102	101	150.0	8.0	110.00	.00	
146	103	102	270.0	8.0	110.00	.00	
147	104	103	1120.0	8.0	110.00	.00	
148	104	105	250.0	12.0	110.00	.00	
149	102	108	1090.0	8.0	110.00	.00	
150	103	107	900.0	12.0	110.00	.00	
151	105	106	560.0	12.0	110.00	.00	
152	107	108	290.0	8.0	110.00	.00	
153	106	107	920.0	8.0	110.00	.00	
154	108	109	500.0	8.0	110.00	.00	
155	107	110	710.0	12.0	110.00	.00	
156	106	111	930.0	12.0	110.00	.00	
157	109	110	310.0	8.0	110.00	.00	
158	111	110	550.0	8.0	110.00	.00	
159	91	114	2540.0	20.0	120.00	.00	
160	114	115	300.0	8.0	110.00	.00	
201-XXPU	0	211	50.0	24.0	130.00	.00	10.00
202	211	201	6650.0	36.0	130.00	.00	
203-FGPU	0	202	50.0	24.0	130.00	.00	10.00
204-XX	202	201	1900.0	20.0	120.00	.00	
205	201	2	4830.0	36.0	130.00	.00	
206	203	1	420.0	30.0	130.00	.00	
207	1	204	2700.0	12.0	110.00	.00	
208	204	3	800.0	20.0	120.00	.00	
209-FG	0	3	2600.0	24.0	130.00	.00	228.00
210-XX	6	9	150.0	30.0	130.00	.00	
211-CV	6	205	220.0	30.0	130.00	.00	
212	8	205	240.0	30.0	130.00	.00	
213	10	206	40.0	42.0	130.00	.00	
214	206	209	20.0	42.0	130.00	.00	
215	209	210	85.0	42.0	130.00	.00	
216-XX	207	206	50.0	30.0	130.00	.00	
217-XX	207	209	70.0	30.0	130.00	.00	
218	208	207	10.0	30.0	130.00	.00	
219	210	212	150.0	42.0	130.00	.00	
220-CV	212	213	50.0	24.0	130.00	.00	
221-PU	212	213	50.0	24.0	130.00	.00	
222-PU	212	213	50.0	24.0	130.00	.00	
223-XXPU	212	213	50.0	24.0	130.00	.00	
224-CV	208	215	260.0	30.0	130.00	.00	
225	214	215	60.0	24.0	130.00	.00	
226	213	214	110.0	42.0	130.00	.00	
227	215	216	14300.0	30.0	130.00	.00	
228	214	216	14300.0	36.0	130.00	.00	
229	216	217	2430.0	36.0	130.00	.00	
230	216	218	10400.0	30.0	130.00	.00	
231-XXFG	0	211	30.0	36.0	130.00	.00	228.00
161	115	116	510.0	8.0	110.00	.00	

162	116	117	1110.0	8.0	110.00	.00	
163	115	118	1150.0	8.0	110.00	.00	
164	114	123	1160.0	20.0	120.00	.00	
165	118	117	550.0	8.0	110.00	.00	
166	123	118	1160.0	8.0	110.00	.00	
167	117	121	1600.0	8.0	110.00	.00	
168	118	119	600.0	8.0	110.00	.00	
169	119	120	700.0	8.0	110.00	.00	
170	121	122	620.0	8.0	110.00	.00	
171	119	122	720.0	8.0	110.00	.00	
172	122	120	1090.0	8.0	110.00	.00	
173	123	124	1050.0	20.0	120.00	.00	
174	124	125	880.0	16.0	120.00	.00	
175	125	126	910.0	16.0	120.00	.00	
176	126	127	620.0	16.0	120.00	.00	
177	126	128	1600.0	16.0	120.00	.00	
178	128	129	830.0	16.0	120.00	.00	
179	129	130	950.0	16.0	120.00	.00	
180	131	124	510.0	16.0	120.00	.00	
181	131	132	1340.0	12.0	110.00	.00	
182	132	133	1010.0	16.0	120.00	.00	
183	134	132	1020.0	12.0	110.00	.00	
184	134	131	1090.0	16.0	120.00	.00	
185	136	134	1570.0	16.0	120.00	.00	
186	109	135	660.0	8.0	110.00	.00	
187	110	136	830.0	16.0	120.00	.00	
188	138	137	1040.0	8.0	110.00	.00	
189	135	136	280.0	8.0	110.00	.00	
190	137	136	280.0	8.0	110.00	.00	
191	111	138	290.0	8.0	110.00	.00	
192	112	139	380.0	8.0	110.00	.00	
193	139	140	900.0	8.0	110.00	.00	
194	139	141	1030.0	8.0	110.00	.00	
240-FG	0	10	2600.0	16.0	130.00	.00	228.00
241	10	240	7115.0	16.0	130.00	.00	
242	240	11	2750.0	16.0	120.00	.00	
243	240	11	2750.0	42.0	130.00	.00	

P U M P   D A T A

THERE IS A PUMP IN LINE 1 DESCRIBED BY THE FOLLOWING DATA:

HEAD (ft)	FLOWRATE (gpm)
415.00	.00
230.00	6700.00
105.00	9450.00

THERE IS A PUMP IN LINE 16 DESCRIBED BY THE FOLLOWING DATA:

HEAD (ft)	FLOWRATE (gpm)
138.00	.00
110.00	4900.00
101.00	6000.00

THERE IS A PUMP IN LINE 17 DESCRIBED BY THE FOLLOWING DATA:

HEAD (ft)	FLOWRATE (gpm)
138.00	.00
110.00	4900.00
101.00	6000.00

THERE IS A PUMP IN LINE 18 DESCRIBED BY THE FOLLOWING DATA:

HEAD (ft)	FLOWRATE (gpm)
138.00	.00
110.00	4900.00
101.00	6000.00

THERE IS A PUMP IN LINE 201 DESCRIBED BY THE FOLLOWING DATA:

HEAD (ft)	FLOWRATE (gpm)
345.00	.00
236.00	5700.00
200.00	6600.00

THERE IS A PUMP IN LINE 203 DESCRIBED BY THE FOLLOWING DATA:

HEAD (ft)	FLOWRATE (gpm)
362.00	.00
250.00	3150.00
187.00	3900.00

THERE IS A PUMP IN LINE 221 DESCRIBED BY THE FOLLOWING DATA:

HEAD (ft)	FLOWRATE (gpm)
85.00	.00
55.50	10500.00
48.00	11500.00

THERE IS A PUMP IN LINE 222 DESCRIBED BY THE FOLLOWING DATA:

HEAD (ft)	FLOWRATE (gpm)
85.00	.00
55.50	10500.00
48.00	11500.00

THERE IS A PUMP IN LINE 223 DESCRIBED BY THE FOLLOWING DATA:

HEAD (ft)	FLOWRATE (gpm)
85.00	.00
55.50	10500.00
48.00	11500.00

J U N C T I O N   N O D E   D A T A

JUNCTION NUMBER	JUNCTION TITLE	EXTERNAL DEMAND (gpm)	JUNCTION ELEVATION (ft)	CONNECTING PIPES					
1		.00	120.00	2	3	206	207		
2		.00	75.00	2	3	4	5	205	
3		.00	77.00	4	5	7	8	9	208
				209					
4		958.00	50.00	7	8	9	10	11	12
5		208.00	85.00	10	11	12	13	14	25
6		.00	95.00	13	14	15	210	211	
7		.00	98.00	15	16	17	18	19	
8		.00	98.00	16	17	18	19	20	212
9		.00	102.00	20	21	210			
10		.00	175.00	22	23	213	240	241	
11		1063.00	55.00	24	26	27	242	243	
12		471.00	25.00	25	26	28	33		
13		312.00	45.00	27	32	36			
14		.00	45.00	28	29				
15		250.00	45.00	29	30	35	41		
16		334.00	45.00	30	31				
17		125.00	45.00	31	32				
18		469.00	20.00	33	34				
19		469.00	30.00	34	35				
20		243.00	38.00	36	37				
21		143.00	37.00	37	38				
22		143.00	36.00	38	39				
23		144.00	35.00	39	40				
24		.00	34.00	40	42	48			
25		.00	33.00	42	43				
26		.00	28.00	43	44	85			
27		.00	28.00	44	45	47			
28		.00	27.00	41	45	46			
29		199.00	35.00	48	49				
30		373.00	36.00	49	50				
31		429.00	37.00	50	51				
32		.00	34.00	51	52	60	61		
33		198.00	33.00	52	53				
34		183.00	31.00	53	54	58			
35		.00	34.00	46	54	55			
36		.00	34.00	56	75	82	109		
37		.00	34.00	56	57	59	67		
38		323.00	33.00	57	58				
39		.00	33.00	59	60	63	64	69	
40		301.00	33.00	61	62				
41		.00	34.00	62	63	66			
42		42.00	34.00	64	65				
43		101.00	34.00	66	78				
44		1042.00	33.00	65					
45		219.00	30.00	77	78				
46		219.00	28.00	76	77				
47		198.00	25.00	76					

48	.00	35.00	55	75	100	
49	150.00	25.00	73			
50	178.00	26.00	72	73	79	
51	355.00	27.00	71	72		
52	.00	28.00	70	71		
53	70.00	29.00	68	69	70	
54	311.00	31.00	67	68		
55	199.00	27.00	79	80		
56	353.00	27.00	80	81		
57	.00	28.00	81	82	84	108
58	.00	32.00	85	86	87	
59	.00	31.00	86	89	92	
60	166.00	31.00	87	88		
61	8.00	31.00	88	89	90	
62	127.00	32.00	90	91		
63	323.00	38.00	91			
64	180.00	30.00	92	93		
65	334.00	30.00	93	94		
66	525.00	30.00	94	95		
67	106.00	30.00	95	96		
68	106.00	30.00	96	97		
69	106.00	30.00	97	98		
70	.00	32.00	98	99	101	
71	.00	34.00	74	83	99	109
72	422.00	32.00	101	102		
73	294.00	31.00	102	103		
74	228.00	30.00	103	104		
75	527.00	30.00	104	105		
76	193.00	29.00	105	106		
77	31.00	28.00	83	84	106	107
78	4185.00	20.00	107	108	110	111
79	.00	35.00	47	74	100	
80	53.90	25.00	110	111	112	113
81	68.80	25.00	112	114		
82	.00	25.00	113	115	117	126
83	220.80	25.00	115	116	118	119
84	157.20	25.00	114	116	120	
85	329.20	25.00	118	120	124	125
86	126.50	25.00	119	123	124	130
87	102.90	25.00	122	123		
88	.00	25.00	122			
89	126.70	25.00	117	121		
90	306.70	25.00	127			
91	6.50	20.00	121	127	128	159
92	.00	20.00	128	129	132	
93	33.80	20.00	129	130	131	133
94	197.40	20.00	125	131	134	
95	41.80	20.00	135	136		
96	84.50	20.00	132	136	137	139
97	42.60	20.00	138	139		
98	41.80	20.00	135	140		
99	57.70	20.00	140	141	143	
100	58.50	20.00	137	141	142	
101	58.50	20.00	138	142	144	145
102	.00	15.00	145	146	149	
103	97.80	15.00	133	146	147	150
104	97.80	15.00	134	147	148	
105	40.60	15.00	148	151		

106	36.50	15.00	151	153	156		
107	63.90	15.00	150	152	153	155	
108	36.50	15.00	149	152	154		
109	36.40	15.00	154	157	186		
110	.00	15.00	155	157	158	187	
111	36.40	15.00	156	158	191		
112	15.90	25.00	143	144	192		
113	281.60	20.00	126				
114	66.00	20.00	159	160	164		
115	161.70	20.00	160	161	163		
116	147.60	20.00	161	162			
117	86.00	20.00	162	165	167		
118	100.00	20.00	163	165	166	168	
119	63.70	20.00	168	169	171		
120	63.70	20.00	169	172			
121	44.80	20.00	167	170			
122	108.50	20.00	170	171	172		
123	142.00	20.00	164	166	173		
124	13.30	20.00	173	174	180		
125	441.70	20.00	174	175			
126	138.10	20.00	175	176	177		
127	190.80	20.00	176				
128	194.60	20.00	177	178			
129	38.70	20.00	178	179			
130	220.60	20.00	179				
131	276.20	20.00	180	181	184		
132	265.40	20.00	181	182	183		
133	202.80	20.00	182				
134	101.20	20.00	183	184	185		
135	63.50	20.00	186	189			
136	63.50	20.00	185	187	189	190	
137	63.50	20.00	188	190			
138	.00	20.00	188	191			
139	.00	20.00	192	193	194		
140	65.60	20.00	193				
141	65.60	20.00	194				
201	.00	70.00	202	204	205		
202	.00	135.00	203	204			
203	.00	130.00	1	206			
204	.00	80.00	6	207	208		
205	.00	102.00	22	211	212		
206	.00	175.00	213	214	216		
207	.00	175.00	216	217	218		
208	.00	175.00	21	218	224		
209	.00	175.00	214	215	217		
210	.00	175.00	24	215	219		
211	.00	208.00	201	202	231		
212	.00	175.00	219	220	221	222	223
213	.00	175.00	220	221	222	223	226
214	.00	175.00	225	226	228		
215	.00	175.00	224	225	227		
216	.00	130.00	227	228	229	230	
217	8333.00	215.00	229				
218	12500.00	215.00	230				
240	1063.00	95.00	241	242	243		

O U T P U T   O P T I O N   D A T A

OUTPUT SELECTION: ALL RESULTS ARE INCLUDED IN THE TABULATED OUTPUT
MAXIMUM AND MINIMUM PRESSURES = 10
MAXIMUM AND MINIMUM VELOCITIES = 10

S Y S T E M   C O N F I G U R A T I O N

NUMBER OF PIPES ....(p) = 229
NUMBER OF JUNCTION NODES ....(j) = 160
NUMBER OF PRIMARY LOOPS ....(l) = 62
NUMBER OF FIXED GRADE NODES ....(f) = 8
NUMBER OF SUPPLY ZONES ....(z) = 1

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S I M U L A T I O N   R E S U L T S
****

THE RESULTS ARE OBTAINED AFTER 5 TRIALS WITH AN ACCURACY = .00068

P I P E L I N E   R E S U L T S

STATUS CODE: XX -CLOSED PIPE   FG -FIXED GRADE NODE   PU -PUMP LINE
CV -CHECK VALVE   RV -REGULATING VALVE   TK -STORAGE TANK

PIPE NUMBER	NODE NOS. #1	#2	FLOWRATE (gpm)	HEAD LOSS (ft)	PUMP HEAD (ft)	MINOR LOSS (ft)	LINE VELO. (ft/s)	HL/ 1000 (ft/ft)
1-FGPU	0	203	7032.00	.02	216.07	.00	2.22	.45
2	1	2	6440.89	.90	.00	.00	2.92	.92
3	1	2	489.75	.90	.00	.00	1.39	.92
4	2	3	4280.46	.44	.00	.00	1.35	.18
5	2	3	2650.18	.44	.00	.00	1.20	.18
6-FG	0	204	2578.04	2.54	.00	.00	2.63	1.41
7	3	4	7806.58	.73	.00	.00	2.46	.54
8	3	4	4833.33	.73	.00	.00	2.19	.54
9	3	4	1536.16	.73	.00	.00	1.57	.54
10	4	5	7279.02	.78	.00	.00	2.29	.48
11	4	5	4506.70	.78	.00	.00	2.05	.48
12	4	5	1432.35	.78	.00	.00	1.46	.48
13	5	6	6712.62	.76	.00	.00	2.12	.41
14	5	6	4156.02	.76	.00	.00	1.89	.41
15	6	7	3931.33	.14	.00	.00	1.78	.37
16-XXPU	7	8						
17-XXPU	7	8						
18-XXPU	7	8						
19-CV	7	8	3931.33	.01	.00	.00	1.78	.37
20	8	9	.00	.00	.00	.00	.00	.00
21	9	208	.00	.00	.00	.00	.00	.00
22	205	10	10868.64	7.28	.00	.00	4.93	2.43
23-FG	0	10	29461.46	13.54	.00	.00	6.82	2.99

24	210	11	20799.42	12.94	.00	.00	4.82	1.57
25-CV	5	12	2141.43	21.22	.00	.00	3.42	2.97
26	12	11	752.24	.81	.00	.00	1.20	.43
27	11	13	21266.12	6.13	.00	.00	4.92	1.63
28	12	14	.00	.00	.00	.00	.00	.00
29-XX	14	15						
30	16	15	269.82	.08	.00	.00	.43	.06
31	17	16	603.82	.20	.00	.00	.96	.28
32	13	17	728.82	.08	.00	.00	1.16	.40
33	12	18	918.18	5.90	.00	.00	2.60	2.95
34	18	19	449.18	1.41	.00	.00	1.27	.78
35	15	19	19.82	.01	.00	.00	.06	.00
36	13	20	20225.30	3.94	.00	.00	6.37	3.16
37	20	21	19982.30	.71	.00	.00	6.30	3.09
38	21	22	19839.30	.61	.00	.00	6.25	3.04
39	22	23	19696.30	.60	.00	.00	6.21	3.00
40	23	24	19552.30	1.13	.00	.00	6.16	2.96
41-XX	15	28						
42	24	25	17492.12	2.65	.00	.00	5.51	2.41
43	25	26	17492.12	1.05	.00	.00	7.94	5.86
44	26	27	15752.08	.20	.00	.00	4.96	1.99
45	28	27	.00	.00	.00	.00	.00	.00
46-XX	28	35						
47	27	79	15752.08	4.87	.00	.00	4.96	1.99
48	24	29	2060.19	.30	.00	.00	3.29	2.76
49	29	30	1861.19	7.97	.00	.00	5.28	10.92
50	30	31	1488.19	7.00	.00	.00	4.22	7.22
51	31	32	1059.19	6.53	.00	.00	3.00	3.84
52	33	32	32.37	.00	.00	.00	.09	.01
53	34	33	230.37	.13	.00	.00	.65	.23
54	35	34	.00	.00	.00	.00	.00	.00
55-XX	35	48						
56	36	37	2008.83	8.80	.00	.00	5.70	12.58
57	37	38	736.37	.69	.00	.00	2.09	1.96
58	38	34	413.37	.47	.00	.00	1.17	.67
59	37	39	666.95	2.12	.00	.00	1.89	1.63
60	32	39	498.73	.83	.00	.00	1.41	.95
61	32	40	592.82	1.50	.00	.00	1.68	1.31
62	40	41	291.82	.41	.00	.00	.83	.35
63	39	41	445.18	1.07	.00	.00	1.26	.77
64	39	42	1084.00	5.94	.00	.00	3.07	4.01
65	42	44	1042.00	.45	.00	.00	2.96	3.73
66	41	43	737.00	.37	.00	.00	1.18	.41
67	37	54	605.51	1.36	.00	.00	1.72	1.36
68	54	53	294.51	.37	.00	.00	.84	.36
69	53	39	363.49	.39	.00	.00	1.03	.53
70	52	53	138.98	.07	.00	.00	.39	.09
71	51	52	138.98	.04	.00	.00	.39	.09
72	50	51	493.98	.54	.00	.00	1.40	.94
73	50	49	150.00	.10	.00	.00	.43	.10
74	79	71	15752.08	.30	.00	.00	4.96	1.99
75-XX	48	36						
76	46	47	198.00	1.72	.00	.00	1.26	1.24
77	45	46	417.00	.95	.00	.00	1.18	.68
78	43	45	636.00	2.08	.00	.00	1.80	1.49
79	55	50	821.98	2.44	.00	.00	2.33	2.40
80	56	55	1020.98	3.59	.00	.00	2.90	3.59
81	57	56	1373.98	2.89	.00	.00	3.90	6.22

82-XX	36	57						
83	71	77	12712.07	2.67	.00	.00	4.01	1.34
84	77	57	1373.98	.93	.00	.00	3.90	6.22
85	26	58	1740.03	3.47	.00	.00	4.94	9.64
86	58	59	1347.11	3.78	.00	.00	3.82	6.00
87	58	60	392.92	2.87	.00	.00	2.51	4.41
88	60	61	226.92	1.04	.00	.00	1.45	1.60
89	59	61	231.08	.13	.00	.00	.66	.23
90	61	62	450.00	.57	.00	.00	1.28	.79
91	62	63	323.00	.40	.00	.00	.92	.43
92	59	64	1116.03	1.31	.00	.00	3.17	4.23
93	64	65	936.03	1.28	.00	.00	2.66	3.06
94	65	66	602.03	.43	.00	.00	1.71	1.35
95	66	67	77.03	.02	.00	.00	.22	.03
96	68	67	28.97	.00	.00	.00	.08	.00
97	69	68	134.97	.02	.00	.00	.38	.08
98	70	69	240.97	.08	.00	.00	.68	.25
99	71	70	1031.19	4.83	.00	.00	2.93	3.66
100	79	48	.00	.00	.00	.00	.00	.00
101	70	72	790.22	.92	.00	.00	2.24	2.23
102	72	73	368.22	.21	.00	.00	1.04	.54
103	73	74	74.22	.02	.00	.00	.21	.03
104	75	74	153.78	.05	.00	.00	.44	.11
105	76	75	680.78	1.37	.00	.00	1.93	1.70
106	77	76	873.78	1.88	.00	.00	2.48	2.69
107	77	78	10433.30	1.46	.00	.00	3.29	.93
108-XX	57	78						
109	71	36	2008.83	2.64	.00	.00	5.70	12.58
110	78	80	5042.03	4.40	.00	.00	5.15	4.89
111	78	80	1206.27	4.40	.00	.00	3.42	4.89
112	80	81	2884.85	2.12	.00	.00	2.95	1.74
113	80	82	3309.55	7.78	.00	.00	5.28	6.65
114	81	84	2816.05	3.45	.00	.00	4.49	4.93
115	82	83	268.83	1.38	.00	.00	1.72	2.19
116	84	83	318.18	3.58	.00	.00	2.03	2.99
117	82	89	2759.12	4.27	.00	.00	4.40	4.75
118	83	85	47.28	.09	.00	.00	.30	.09
119	83	86	318.93	3.10	.00	.00	2.04	3.00
120	84	85	2340.67	3.68	.00	.00	3.73	3.50
121	89	91	2632.42	2.83	.00	.00	4.20	4.35
122	87	88	.00	.00	.00	.00	.00	.00
123	86	87	102.90	.25	.00	.00	.66	.37
124	85	86	296.40	3.01	.00	.00	1.89	2.62
125	85	94	1762.35	2.48	.00	.00	2.81	2.07
126	82	113	281.60	.67	.00	.00	1.80	2.38
127	91	90	306.70	.24	.00	.00	.87	.39
128	91	92	160.25	.12	.00	.00	.45	.12
129	93	92	210.38	.18	.00	.00	.60	.19
130	86	93	385.94	2.56	.00	.00	2.46	4.27
131	94	93	315.66	3.09	.00	.00	2.01	2.94
132	92	96	370.63	1.11	.00	.00	2.37	3.96
133	93	103	457.41	.84	.00	.00	1.30	.81
134	94	104	1249.29	.88	.00	.00	1.99	1.09
135	95	98	56.69	.07	.00	.00	.36	.12
136	96	95	98.49	.27	.00	.00	.63	.34
137	96	100	114.83	.24	.00	.00	.73	.45
138	97	101	30.21	.03	.00	.00	.19	.04
139	96	97	72.81	.15	.00	.00	.46	.19

140	98	99	14.89	.01	.00	.00	.10	.01
141	100	99	98.62	.11	.00	.00	.63	.34
142	101	100	42.29	.06	.00	.00	.27	.07
143	99	112	55.81	.09	.00	.00	.36	.12
144	101	112	91.29	.26	.00	.00	.58	.30
145	102	101	161.87	.13	.00	.00	1.03	.85
146	103	102	245.11	.50	.00	.00	1.56	1.84
147	104	103	303.18	3.06	.00	.00	1.94	2.73
148	104	105	848.31	.64	.00	.00	2.41	2.55
149	102	108	83.24	.27	.00	.00	.53	.25
150	103	107	417.68	.62	.00	.00	1.18	.69
151	105	106	807.71	1.30	.00	.00	2.29	2.33
152	107	108	124.12	.15	.00	.00	.79	.52
153	106	107	248.30	1.74	.00	.00	1.58	1.89
154	108	109	170.86	.47	.00	.00	1.09	.94
155	107	110	477.95	.63	.00	.00	1.36	.88
156	106	111	522.91	.97	.00	.00	1.48	1.04
157	109	110	10.71	.00	.00	.00	.07	.01
158	111	110	291.15	1.39	.00	.00	1.86	2.53
159	91	114	2158.97	2.58	.00	.00	2.20	1.02
160	114	115	520.04	2.22	.00	.00	3.32	7.42
201-XXPU	0	211						
202	211	201	.00	.00	.00	.00	.00	.00
203-FGPU	0	202	.00	.00	362.00	.00	.00	.00
204-XX	202	201						
205	201	2	.00	.00	.00	.00	.00	.00
206	203	1	7032.00	.46	.00	.00	3.19	1.08
207	1	204	101.36	.13	.00	.00	.29	.05
208	204	3	2679.40	1.21	.00	.00	2.74	1.52
209-FG	0	3	4566.02	3.75	.00	.00	3.24	1.44
210-XX	6	9						
211-CV	6	205	6937.31	.23	.00	.00	3.15	1.06
212	8	205	3931.33	.09	.00	.00	1.78	.37
213	10	206	41632.42	.23	.00	.00	9.64	5.67
214	206	209	41632.42	.11	.00	.00	9.64	5.67
215	209	210	41632.42	.48	.00	.00	9.64	5.67
216-XX	207	206						
217-XX	207	209						
218	208	207	.00	.00	.00	.00	.00	.00
219	210	212	20833.00	.24	.00	.00	4.82	1.57
220-XXCV	212	213						
221-PU	212	213	10416.50	.33	56.08	.00	7.39	6.65
222-PU	212	213	10416.50	.33	56.08	.00	7.39	6.65
223-XXPU	212	213						
224-XXCV	208	215						
225	214	215	7933.44	.24	.00	.00	5.63	4.02
226	213	214	20833.00	.17	.00	.00	4.82	1.57
227	215	216	7933.44	19.38	.00	.00	3.60	1.36
228	214	216	12899.56	19.62	.00	.00	4.07	1.37
229	216	217	8333.00	1.48	.00	.00	2.63	.61
230	216	218	12500.00	32.71	.00	.00	5.67	3.15
231-XXFG	0	211						
161	115	116	218.82	.76	.00	.00	1.40	1.49
162	116	117	71.22	.21	.00	.00	.45	.19
163	115	118	139.51	.75	.00	.00	.89	.65
164	114	123	1572.93	.66	.00	.00	1.61	.57
165	118	117	108.18	.22	.00	.00	.69	.40
166	123	118	255.96	2.31	.00	.00	1.63	2.00

167	117	121	93.40	.49	.00	.00	.60	.31
168	118	119	187.30	.67	.00	.00	1.20	1.12
169	119	120	62.29	.10	.00	.00	.40	.15
170	121	122	48.60	.06	.00	.00	.31	.09
171	119	122	61.31	.10	.00	.00	.39	.14
172	122	120	1.41	.00	.00	.00	.01	.00
173	123	124	1174.97	.35	.00	.00	1.20	.33
174	124	125	1224.50	.93	.00	.00	1.95	1.05
175	125	126	782.80	.42	.00	.00	1.25	.46
176	126	127	190.80	.02	.00	.00	.30	.03
177	126	128	453.90	.27	.00	.00	.72	.17
178	128	129	259.30	.05	.00	.00	.41	.06
179	129	130	220.60	.04	.00	.00	.35	.04
180	131	124	62.83	.00	.00	.00	.10	.00
181	131	132	164.99	.16	.00	.00	.47	.12
182	132	133	202.80	.04	.00	.00	.32	.04
183	134	132	303.21	.39	.00	.00	.86	.38
184	134	131	504.02	.22	.00	.00	.80	.20
185	136	134	908.43	.95	.00	.00	1.45	.61
186	109	135	123.75	.34	.00	.00	.79	.52
187	110	136	779.81	.38	.00	.00	1.24	.46
188	138	137	195.36	1.26	.00	.00	1.25	1.21
189	135	136	60.25	.04	.00	.00	.38	.14
190	137	136	131.86	.16	.00	.00	.84	.58
191	111	138	195.36	.35	.00	.00	1.25	1.21
192	112	139	131.20	.22	.00	.00	.84	.58
193	139	140	65.60	.14	.00	.00	.42	.16
194	139	141	65.60	.17	.00	.00	.42	.16
240-FG	0	10	3142.77	13.54	.00	.00	5.01	5.21
241	10	240	1840.45	13.76	.00	.00	2.94	1.93
242	240	11	59.76	.01	.00	.00	.10	.00
243	240	11	717.69	.01	.00	.00	.17	.00

J U N C T I O N   N O D E   R E S U L T S

JUNCTION NUMBER	JUNCTION TITLE	EXTERNAL DEMAND (gpm)	HYDRAULIC GRADE (ft)	JUNCTION ELEVATION (ft)	PRESSURE HEAD (ft)	JUNCTION PRESSURE (psi)
1		.00	225.59	120.00	105.59	45.76
2		.00	224.69	75.00	149.69	64.87
3		.00	224.25	77.00	147.25	63.81
4		958.00	223.51	50.00	173.51	75.19
5		208.00	222.73	85.00	137.73	59.68
6		.00	221.97	95.00	126.97	55.02
7		.00	221.84	98.00	123.84	53.66
8		.00	221.83	98.00	123.83	53.66
9		.00	221.83	102.00	119.83	51.93
10		.00	214.46	175.00	39.46	17.10
11		1063.00	200.69	55.00	145.69	63.13
12		471.00	201.50	25.00	176.50	76.49
13		312.00	194.56	45.00	149.56	64.81
14		.00	201.50	45.00	156.50	67.82
15		250.00	194.20	45.00	149.20	64.65
16		334.00	194.28	45.00	149.28	64.69
17		125.00	194.48	45.00	149.48	64.78

18	469.00	195.60	20.00	175.60	76.09
19	469.00	194.19	30.00	164.19	71.15
20	243.00	190.62	38.00	152.62	66.13
21	143.00	189.91	37.00	152.91	66.26
22	143.00	189.30	36.00	153.30	66.43
23	144.00	188.70	35.00	153.70	66.60
24	.00	187.57	34.00	153.57	66.55
25	.00	184.92	33.00	151.92	65.83
26	.00	183.86	28.00	155.86	67.54
27	.00	183.67	28.00	155.67	67.46
28	.00	183.67	27.00	156.67	67.89
29	199.00	187.27	35.00	152.27	65.98
30	373.00	179.30	36.00	143.30	62.10
31	429.00	172.30	37.00	135.30	58.63
32	.00	165.76	34.00	131.76	57.10
33	198.00	165.77	33.00	132.77	57.53
34	183.00	165.90	31.00	134.90	58.46
35	.00	165.90	34.00	131.90	57.16
36	.00	175.86	34.00	141.86	61.47
37	.00	167.06	34.00	133.06	57.66
38	323.00	166.37	33.00	133.37	57.79
39	.00	164.94	33.00	131.94	57.17
40	301.00	164.27	33.00	131.27	56.88
41	.00	163.86	34.00	129.86	56.27
42	42.00	159.00	34.00	125.00	54.17
43	101.00	163.50	34.00	129.50	56.12
44	1042.00	158.54	33.00	125.54	54.40
45	219.00	161.42	30.00	131.42	56.95
46	219.00	160.47	28.00	132.47	57.40
47	198.00	158.74	25.00	133.74	57.96
48	.00	178.80	35.00	143.80	62.31
49	150.00	165.87	25.00	140.87	61.05
50	178.00	165.97	26.00	139.97	60.66
51	355.00	165.43	27.00	138.43	59.99
52	.00	165.39	28.00	137.39	59.54
53	70.00	165.32	29.00	136.32	59.07
54	311.00	165.69	31.00	134.69	58.37
55	199.00	168.41	27.00	141.41	61.28
56	353.00	172.00	27.00	145.00	62.83
57	.00	174.90	28.00	146.90	63.66
58	.00	180.39	32.00	148.39	64.30
59	.00	176.61	31.00	145.61	63.10
60	166.00	177.53	31.00	146.53	63.49
61	8.00	176.49	31.00	145.49	63.05
62	127.00	175.92	32.00	143.92	62.37
63	323.00	175.52	38.00	137.52	59.59
64	180.00	175.30	30.00	145.30	62.96
65	334.00	174.02	30.00	144.02	62.41
66	525.00	173.59	30.00	143.59	62.22
67	106.00	173.57	30.00	143.57	62.21
68	106.00	173.57	30.00	143.57	62.21
69	106.00	173.59	30.00	143.59	62.22
70	.00	173.67	32.00	141.67	61.39
71	.00	178.50	34.00	144.50	62.62
72	422.00	172.76	32.00	140.76	60.99
73	294.00	172.55	31.00	141.55	61.34
74	228.00	172.52	30.00	142.52	61.76
75	527.00	172.57	30.00	142.57	61.78

76	193.00	173.95	29.00	144.95	62.81
77	31.00	175.83	28.00	147.83	64.06
78	4185.00	174.37	20.00	154.37	66.89
79	.00	178.80	35.00	143.80	62.31
80	53.90	169.97	25.00	144.97	62.82
81	68.80	167.85	25.00	142.85	61.90
82	.00	162.19	25.00	137.19	59.45
83	220.80	160.81	25.00	135.81	58.85
84	157.20	164.39	25.00	139.39	60.40
85	329.20	160.72	25.00	135.72	58.81
86	126.50	157.71	25.00	132.71	57.51
87	102.90	157.46	25.00	132.46	57.40
88	.00	157.46	25.00	132.46	57.40
89	126.70	157.92	25.00	132.92	57.60
90	306.70	154.85	25.00	129.85	56.27
91	6.50	155.09	20.00	135.09	58.54
92	.00	154.96	20.00	134.96	58.48
93	33.80	155.15	20.00	135.15	58.56
94	197.40	158.24	20.00	138.24	59.90
95	41.80	153.59	20.00	133.59	57.89
96	84.50	153.86	20.00	133.86	58.00
97	42.60	153.71	20.00	133.71	57.94
98	41.80	153.52	20.00	133.52	57.86
99	57.70	153.52	20.00	133.52	57.86
100	58.50	153.62	20.00	133.62	57.90
101	58.50	153.68	20.00	133.68	57.93
102	.00	153.81	15.00	138.81	60.15
103	97.80	154.30	15.00	139.30	60.36
104	97.80	157.36	15.00	142.36	61.69
105	40.60	156.72	15.00	141.72	61.41
106	36.50	155.42	15.00	140.42	60.85
107	63.90	153.69	15.00	138.69	60.10
108	36.50	153.53	15.00	138.53	60.03
109	36.40	153.06	15.00	138.06	59.83
110	.00	153.06	15.00	138.06	59.83
111	36.40	154.45	15.00	139.45	60.43
112	15.90	153.42	25.00	128.42	55.65
113	281.60	161.52	20.00	141.52	61.33
114	66.00	152.51	20.00	132.51	57.42
115	161.70	150.28	20.00	130.28	56.46
116	147.60	149.52	20.00	129.52	56.13
117	86.00	149.31	20.00	129.31	56.04
118	100.00	149.54	20.00	129.54	56.13
119	63.70	148.87	20.00	128.87	55.84
120	63.70	148.76	20.00	128.76	55.80
121	44.80	148.82	20.00	128.82	55.82
122	108.50	148.76	20.00	128.76	55.80
123	142.00	151.85	20.00	131.85	57.14
124	13.30	151.51	20.00	131.51	56.99
125	441.70	150.58	20.00	130.58	56.58
126	138.10	150.16	20.00	130.16	56.40
127	190.80	150.14	20.00	130.14	56.39
128	194.60	149.89	20.00	129.89	56.29
129	38.70	149.84	20.00	129.84	56.26
130	220.60	149.80	20.00	129.80	56.25
131	276.20	151.51	20.00	131.51	56.99
132	265.40	151.34	20.00	131.34	56.92
133	202.80	151.30	20.00	131.30	56.90

134	101.20	151.73	20.00	131.73	57.08
135	63.50	152.72	20.00	132.72	57.51
136	63.50	152.68	20.00	132.68	57.50
137	63.50	152.85	20.00	132.85	57.57
138	.00	154.10	20.00	134.10	58.11
139	.00	153.20	20.00	133.20	57.72
140	65.60	153.06	20.00	133.06	57.66
141	65.60	153.04	20.00	133.04	57.65
201	.00	224.69	70.00	154.69	67.03
202	.00	372.00	135.00	237.00	102.70
203	.00	226.05	130.00	96.05	41.62
204	.00	225.46	80.00	145.46	63.03
205	.00	221.74	102.00	119.74	51.89
206	.00	214.23	175.00	39.23	17.00
207	.00	221.83	175.00	46.83	20.29
208	.00	221.83	175.00	46.83	20.29
209	.00	214.12	175.00	39.12	16.95
210	.00	213.64	175.00	38.64	16.74
211	.00	224.69	208.00	16.69	7.23
212	.00	213.40	175.00	38.40	16.64
213	.00	269.15	175.00	94.15	40.80
214	.00	268.97	175.00	93.97	40.72
215	.00	268.73	175.00	93.73	40.62
216	.00	249.36	130.00	119.36	51.72
217	8333.00	247.87	215.00	32.87	14.24
218	12500.00	216.65	215.00	1.65	.71
240	1063.00	200.70	95.00	105.70	45.80

M A X I M U M   A N D   M I N I M U M   V A L U E S

P R E S S U R E S

JUNCTION NUMBER	MAXIMUM PRESSURES (psi)	JUNCTION NUMBER	MINIMUM PRESSURES (psi)
202	102.70	218	.71
12	76.49	211	7.23
18	76.09	217	14.24
4	75.19	212	16.64
19	71.15	210	16.74
28	67.89	209	16.95
14	67.82	206	17.00
26	67.54	10	17.10
27	67.46	207	20.29
201	67.03	208	20.29

V E L O C I T I E S

PIPE NUMBER	MAXIMUM VELOCITY (ft/s)	PIPE NUMBER	MINIMUM VELOCITY (ft/s)
213	9.64	172	.01
214	9.64	35	.06

215	9.64	157	.07
43	7.94	96	.08
221	7.39	52	.09
222	7.39	140	.10
23	6.82	242	.10
36	6.37	180	.10
37	6.30	243	.17
38	6.25	138	.19

S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

(+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
(-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

PIPE NUMBER	FLOWRATE (gpm)
1	7032.00
6	2578.04
23	29461.46
203	.00
209	4566.02
240	3142.77

NET SYSTEM INFLOW = 46780.30
NET SYSTEM OUTFLOW = .00
NET SYSTEM DEMAND = 46780.30

D A T A   C H A N G E S   F O R   N E X T   S I M U L A T I O N

D E M A N D   C H A N G E S

DEMAND TYPE = 1 - GDF = .500

THE FOLLOWING SPECIFIC DEMAND CHANGES ARE MADE :

JUNCTION NUMBER	DEMAND (gpm)
217	8333.00
218	12500.00
130	4072.00

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S I M U L A T I O N   R E S U L T S
****

THE RESULTS ARE OBTAINED AFTER 2 TRIALS WITH AN ACCURACY = .00482

P I P E L I N E   R E S U L T S

STATUS CODE: XX -CLOSED PIPE FG -FIXED GRADE NODE PU -PUMP LINE
CV -CHECK VALVE RV -REGULATING VALVE TK -STORAGE TANK

PIPE NUMBER	NODE NOS. #1	#2	FLOWRATE (gpm)	HEAD LOSS (ft)	PUMP HEAD (ft)	MINOR LOSS (ft)	LINE VELO. (ft/s)	HL/ 1000 (ft/ft)
1-FGPU	0	203	6984.69	.02	218.08	.00	2.20	.44
2	1	2	6260.22	.86	.00	.00	2.84	.87
3	1	2	476.01	.86	.00	.00	1.35	.87
4	2	3	4160.39	.42	.00	.00	1.31	.17
5	2	3	2575.84	.42	.00	.00	1.17	.17
6-FG	0	204	1607.56	1.06	.00	.00	1.64	.59
7	3	4	6357.27	.50	.00	.00	2.00	.37
8	3	4	3936.01	.50	.00	.00	1.79	.37
9	3	4	1250.97	.50	.00	.00	1.28	.37
10	4	5	6093.49	.56	.00	.00	1.92	.34
11	4	5	3772.70	.56	.00	.00	1.71	.34
12	4	5	1199.06	.56	.00	.00	1.22	.34
13	5	6	5799.55	.58	.00	.00	1.83	.31
14	5	6	3590.71	.58	.00	.00	1.63	.31
15	6	7	3396.26	.10	.00	.00	1.54	.28
16-XXPU	7	8						
17-XXPU	7	8						
18-XXPU	7	8						
19-CV	7	8	3396.26	.01	.00	.00	1.54	.28
20	8	9	.00	.00	.00	.00	.00	.00
21	9	208	.00	.00	.00	.00	.00	.00
22	205	10	9390.26	5.55	.00	.00	4.26	1.85
23-FG	0	10	23696.32	9.05	.00	.00	5.49	2.00
24	210	11	13560.59	5.86	.00	.00	3.14	.71
25-CV	5	12	1571.00	11.96	.00	.00	2.51	1.67
26	12	11	740.69	.79	.00	.00	1.18	.42
27	11	13	14459.04	3.00	.00	.00	3.35	.80
28	12	14	.00	.00	.00	.00	.00	.00
29-XX	14	15						
30	16	15	-.81	.00	.00	.00	.00	.00
31	17	16	166.19	.02	.00	.00	.27	.03
32	13	17	228.69	.01	.00	.00	.36	.05
33	12	18	594.81	2.64	.00	.00	1.69	1.32
34	18	19	360.31	.94	.00	.00	1.02	.52
35	15	19	-125.81	.24	.00	.00	.36	.07
36	13	20	14074.35	2.02	.00	.00	4.44	1.61
37	20	21	13952.85	.36	.00	.00	4.40	1.59
38	21	22	13881.35	.31	.00	.00	4.38	1.57
39	22	23	13809.85	.31	.00	.00	4.35	1.56
40	23	24	13737.85	.59	.00	.00	4.33	1.54
41-XX	15	28						
42	24	25	12575.39	1.44	.00	.00	3.96	1.31
43	25	26	12575.39	.57	.00	.00	5.71	3.18
44	26	27	11548.85	.11	.00	.00	3.64	1.12
45	28	27	.00	.00	.00	.00	.00	.00
46-XX	28	35						
47	27	79	11548.85	2.74	.00	.00	3.64	1.12
48	24	29	1162.46	.11	.00	.00	1.85	.96
49	29	30	1062.96	2.82	.00	.00	3.02	3.87

50	30	31	876.46	2.63	.00	.00	2.49	2.71
51	31	32	661.96	2.74	.00	.00	1.88	1.61
52	33	32	-31.62	.00	.00	.00	.09	.01
53	34	33	67.38	.01	.00	.00	.19	.02
54	35	34	.00	.00	.00	.00	.00	.00
55-XX	35	48						
56	36	37	978.65	2.32	.00	.00	2.78	3.32
57	37	38	320.38	.15	.00	.00	.91	.42
58	38	34	158.88	.08	.00	.00	.45	.11
59	37	39	334.53	.59	.00	.00	.95	.45
60	32	39	314.97	.35	.00	.00	.89	.41
61	32	40	315.37	.46	.00	.00	.89	.41
62	40	41	164.87	.14	.00	.00	.47	.12
63	39	41	203.63	.25	.00	.00	.58	.18
64	39	42	542.00	1.64	.00	.00	1.54	1.11
65	42	44	521.00	.13	.00	.00	1.48	1.03
66	41	43	368.50	.10	.00	.00	.59	.11
67	37	54	323.74	.43	.00	.00	.92	.43
68	54	53	168.24	.13	.00	.00	.48	.13
69	53	39	96.13	.03	.00	.00	.27	.05
70	52	53	-37.11	.01	.00	.00	.11	.01
71	51	52	-37.11	.00	.00	.00	.11	.01
72	50	51	140.39	.05	.00	.00	.40	.09
73	50	49	75.00	.03	.00	.00	.21	.03
74	79	71	11548.85	.17	.00	.00	3.64	1.12
75-XX	48	36						
76	46	47	99.00	.48	.00	.00	.63	.34
77	45	46	208.50	.26	.00	.00	.59	.19
78	43	45	318.00	.58	.00	.00	.90	.41
79	55	50	304.39	.39	.00	.00	.86	.38
80	56	55	403.89	.64	.00	.00	1.15	.64
81	57	56	580.39	.59	.00	.00	1.65	1.26
82-XX	36	57						
83	71	77	10059.04	1.73	.00	.00	3.17	.87
84	77	57	580.39	.19	.00	.00	1.65	1.26
85	26	58	1026.55	1.31	.00	.00	2.91	3.63
86	58	59	801.05	1.44	.00	.00	2.27	2.29
87	58	60	225.49	1.03	.00	.00	1.44	1.58
88	60	61	142.49	.44	.00	.00	.91	.67
89	59	61	86.51	.02	.00	.00	.25	.04
90	61	62	225.00	.16	.00	.00	.64	.22
91	62	63	161.50	.11	.00	.00	.46	.12
92	59	64	714.55	.57	.00	.00	2.03	1.85
93	64	65	624.55	.61	.00	.00	1.77	1.45
94	65	66	457.55	.26	.00	.00	1.30	.81
95	66	67	195.05	.10	.00	.00	.55	.17
96	68	67	-142.05	.04	.00	.00	.40	.09
97	69	68	-89.05	.01	.00	.00	.25	.04
98	70	69	-36.05	.00	.00	.00	.10	.01
99	71	70	511.15	1.32	.00	.00	1.45	1.00
100	79	48	.00	.00	.00	.00	.00	.00
101	70	72	547.20	.46	.00	.00	1.55	1.13
102	72	73	336.20	.18	.00	.00	.95	.46
103	73	74	189.20	.12	.00	.00	.54	.16
104	75	74	-75.20	.01	.00	.00	.21	.03
105	76	75	188.30	.13	.00	.00	.53	.16
106	77	76	284.80	.24	.00	.00	.81	.34
107	77	78	9178.35	1.15	.00	.00	2.89	.73

108-XX	57	78						
109	71	36	978.65	.70	.00	.00	2.78	3.32
110	78	80	5717.88	5.56	.00	.00	5.84	6.17
111	78	80	1367.97	5.56	.00	.00	3.88	6.17
112	80	81	3154.47	2.50	.00	.00	3.22	2.05
113	80	82	3904.43	10.56	.00	.00	6.23	9.03
114	81	84	3120.07	4.17	.00	.00	4.98	5.96
115	82	83	183.81	.68	.00	.00	1.17	1.08
116	84	83	362.65	4.56	.00	.00	2.31	3.80
117	82	89	3579.81	6.92	.00	.00	5.71	7.69
118	83	85	62.96	.16	.00	.00	.40	.15
119	83	86	373.10	4.15	.00	.00	2.38	4.01
120	84	85	2678.82	4.72	.00	.00	4.27	4.49
121	89	91	3516.46	4.83	.00	.00	5.61	7.44
122	87	88	.00	.00	.00	.00	.00	.00
123	86	87	51.45	.07	.00	.00	.33	.10
124	85	86	345.34	4.00	.00	.00	2.20	3.47
125	85	94	2231.84	3.85	.00	.00	3.56	3.20
126	82	113	140.80	.18	.00	.00	.90	.66
127	91	90	153.35	.07	.00	.00	.43	.11
128	91	92	-218.63	.22	.00	.00	.62	.21
129	93	92	482.64	.85	.00	.00	1.37	.90
130	86	93	603.75	5.87	.00	.00	3.85	9.78
131	94	93	452.41	6.02	.00	.00	2.89	5.73
132	92	96	264.02	.59	.00	.00	1.69	2.11
133	93	103	556.61	1.21	.00	.00	1.58	1.17
134	94	104	1680.73	1.52	.00	.00	2.68	1.90
135	95	98	43.08	.04	.00	.00	.27	.07
136	96	95	63.98	.12	.00	.00	.41	.15
137	96	100	91.64	.15	.00	.00	.58	.30
138	97	101	44.84	.06	.00	.00	.29	.08
139	96	97	66.14	.13	.00	.00	.42	.16
140	98	99	22.18	.02	.00	.00	.14	.02
141	100	99	42.55	.02	.00	.00	.27	.07
142	101	100	-19.84	.01	.00	.00	.13	.02
143	99	112	35.89	.04	.00	.00	.23	.05
144	101	112	37.66	.05	.00	.00	.24	.06
145	102	101	2.23	.00	.00	.00	.01	.00
146	103	102	214.63	.39	.00	.00	1.37	1.44
147	104	103	424.85	5.71	.00	.00	2.71	5.10
148	104	105	1206.98	1.22	.00	.00	3.42	4.90
149	102	108	212.40	1.54	.00	.00	1.36	1.41
150	103	107	717.93	1.68	.00	.00	2.04	1.87
151	105	106	1186.68	2.66	.00	.00	3.37	4.74
152	107	108	148.41	.21	.00	.00	.95	.73
153	106	107	363.43	3.51	.00	.00	2.32	3.82
154	108	109	342.56	1.71	.00	.00	2.19	3.42
155	107	110	901.00	2.02	.00	.00	2.56	2.85
156	106	111	805.00	2.15	.00	.00	2.28	2.31
157	109	110	101.82	.11	.00	.00	.65	.36
158	111	110	470.18	3.38	.00	.00	3.00	6.15
159	91	114	3578.49	6.58	.00	.00	3.65	2.59
160	114	115	401.03	1.37	.00	.00	2.56	4.58
201-XXPU	0	211						
202	211	201	.00	.00	.00	.00	.00	.00
203-FGPU	0	202	.00	.00	362.00	.00	.00	.00
204-XX	202	201						
205	201	2	.00	.00	.00	.00	.00	.00

206	203	1	6984.69	.45	.00	.00	3.17	1.07
207	1	204	248.46	.71	.00	.00	.70	.26
208	204	3	1856.02	.61	.00	.00	1.90	.77
209-FG	0	3	2952.00	1.67	.00	.00	2.09	.64
210-XX	6	9						
211-CV	6	205	5994.00	.18	.00	.00	2.72	.81
212	8	205	3396.26	.07	.00	.00	1.54	.28
213	10	206	34393.59	.16	.00	.00	7.96	3.98
214	206	209	34393.59	.08	.00	.00	7.96	3.98
215	209	210	34393.59	.34	.00	.00	7.96	3.98
216-XX	207	206						
217-XX	207	209						
218	208	207	.00	.00	.00	.00	.00	.00
219	210	212	20833.00	.24	.00	.00	4.82	1.57
220-XXCV	212	213						
221-PU	212	213	10416.50	.33	56.08	.00	7.39	6.65
222-PU	212	213	10416.50	.33	56.08	.00	7.39	6.65
223-XXPU	212	213						
224-XXCV	208	215						
225	214	215	7933.44	.24	.00	.00	5.63	4.02
226	213	214	20833.00	.17	.00	.00	4.82	1.57
227	215	216	7933.44	19.38	.00	.00	3.60	1.36
228	214	216	12899.56	19.62	.00	.00	4.07	1.37
229	216	217	8333.00	1.48	.00	.00	2.63	.61
230	216	218	12500.00	32.71	.00	.00	5.67	3.15
231-XXFG	0	211						
161	115	116	169.78	.48	.00	.00	1.08	.93
162	116	117	95.98	.36	.00	.00	.61	.32
163	115	118	150.41	.86	.00	.00	.96	.75
164	114	123	3144.46	2.37	.00	.00	3.21	2.04
165	118	117	.94	.00	.00	.00	.01	.00
166	123	118	-13.03	.01	.00	.00	.08	.01
167	117	121	53.91	.18	.00	.00	.34	.11
168	118	119	86.44	.16	.00	.00	.55	.27
169	119	120	27.78	.02	.00	.00	.18	.03
170	121	122	31.51	.03	.00	.00	.20	.04
171	119	122	26.80	.02	.00	.00	.17	.03
172	122	120	4.07	.00	.00	.00	.03	.00
173	123	124	3086.49	2.07	.00	.00	3.15	1.97
174	124	125	4573.95	10.65	.00	.00	7.30	12.10
175	125	126	4353.10	10.05	.00	.00	6.95	11.04
176	126	127	95.40	.01	.00	.00	.15	.01
177	126	128	4188.65	16.45	.00	.00	6.68	10.28
178	128	129	4091.35	8.17	.00	.00	6.53	9.85
179	129	130	4072.00	9.27	.00	.00	6.50	9.76
180	131	124	1494.11	.78	.00	.00	2.38	1.52
181	131	132	-279.54	.44	.00	.00	.79	.33
182	132	133	101.40	.01	.00	.00	.16	.01
183	134	132	513.64	1.03	.00	.00	1.46	1.01
184	134	131	1352.67	1.38	.00	.00	2.16	1.27
185	136	134	1916.91	3.80	.00	.00	3.06	2.42
186	109	135	222.54	1.02	.00	.00	1.42	1.54
187	110	136	1473.00	1.23	.00	.00	2.35	1.48
188	138	137	316.62	3.08	.00	.00	2.02	2.96
189	135	136	190.79	.32	.00	.00	1.22	1.16
190	137	136	284.87	.68	.00	.00	1.82	2.43
191	111	138	316.62	.86	.00	.00	2.02	2.96
192	112	139	65.60	.06	.00	.00	.42	.16

193	139	140	32.80	.04	.00	.00	.21	.04
194	139	141	32.80	.05	.00	.00	.21	.04
240-FG	0	10	2527.78	9.05	.00	.00	4.03	3.48
241	10	240	1220.76	6.43	.00	.00	1.95	.90
242	240	11	46.88	.01	.00	.00	.07	.00
243	240	11	642.39	.01	.00	.00	.15	.00

J U N C T I O N   N O D E   R E S U L T S

JUNCTION NUMBER	JUNCTION TITLE	EXTERNAL DEMAND (gpm)	HYDRAULIC GRADE (ft)	JUNCTION ELEVATION (ft)	PRESSURE HEAD (ft)	JUNCTION PRESSURE (psi)
1		.00	227.60	120.00	107.60	46.63
2		.00	226.75	75.00	151.75	65.76
3		.00	226.33	77.00	149.33	64.71
4		479.00	225.83	50.00	175.83	76.19
5		104.00	225.26	85.00	140.26	60.78
6		.00	224.68	95.00	129.68	56.20
7		.00	224.58	98.00	126.58	54.85
8		.00	224.58	98.00	126.58	54.85
9		.00	224.58	102.00	122.58	53.12
10		.00	218.95	175.00	43.95	19.05
11		531.50	212.51	55.00	157.51	68.26
12		235.50	213.30	25.00	188.30	81.60
13		156.00	209.51	45.00	164.51	71.29
14		.00	213.30	45.00	168.30	72.93
15		125.00	209.49	45.00	164.49	71.28
16		167.00	209.49	45.00	164.49	71.28
17		62.50	209.51	45.00	164.51	71.29
18		234.50	210.66	20.00	190.66	82.62
19		234.50	209.72	30.00	179.72	77.88
20		121.50	207.50	38.00	169.50	73.45
21		71.50	207.13	37.00	170.13	73.72
22		71.50	206.82	36.00	170.82	74.02
23		72.00	206.51	35.00	171.51	74.32
24		.00	205.92	34.00	171.92	74.50
25		.00	204.48	33.00	171.48	74.31
26		.00	203.91	28.00	175.91	76.23
27		.00	203.80	28.00	175.80	76.18
28		.00	203.80	27.00	176.80	76.61
29		99.50	205.82	35.00	170.82	74.02
30		186.50	202.99	36.00	166.99	72.36
31		214.50	200.37	37.00	163.37	70.79
32		.00	197.63	34.00	163.63	70.91
33		99.00	197.63	33.00	164.63	71.34
34		91.50	197.64	31.00	166.64	72.21
35		.00	197.64	34.00	163.64	70.91
36		.00	200.20	34.00	166.20	72.02
37		.00	197.87	34.00	163.87	71.01
38		161.50	197.72	33.00	164.72	71.38
39		.00	197.28	33.00	164.28	71.19
40		150.50	197.17	33.00	164.17	71.14
41		.00	197.03	34.00	163.03	70.65
42		21.00	195.64	34.00	161.64	70.04
43		50.50	196.93	34.00	162.93	70.60

44		521.00	195.51	33.00	162.51	70.42
45		109.50	196.35	30.00	166.35	72.09
46		109.50	196.09	28.00	168.09	72.84
47		99.00	195.61	25.00	170.61	73.93
48		.00	201.06	35.00	166.06	71.96
49		75.00	197.33	25.00	172.33	74.67
50		89.00	197.35	26.00	171.35	74.25
51		177.50	197.30	27.00	170.30	73.80
52		.00	197.31	28.00	169.31	73.37
53		35.00	197.31	29.00	168.31	72.94
54		155.50	197.44	31.00	166.44	72.13
55		99.50	197.74	27.00	170.74	73.99
56		176.50	198.39	27.00	171.39	74.27
57		.00	198.97	28.00	170.97	74.09
58		.00	202.61	32.00	170.61	73.93
59		.00	201.16	31.00	170.16	73.74
60		83.00	201.58	31.00	170.58	73.92
61		4.00	201.14	31.00	170.14	73.73
62		63.50	200.98	32.00	168.98	73.23
63		161.50	200.87	38.00	162.87	70.58
64		90.00	200.59	30.00	170.59	73.92
65		167.00	199.98	30.00	169.98	73.66
66		262.50	199.72	30.00	169.72	73.55
67		53.00	199.63	30.00	169.63	73.50
68		53.00	199.59	30.00	169.59	73.49
69		53.00	199.58	30.00	169.58	73.48
70		.00	199.58	32.00	167.58	72.62
71		.00	200.89	34.00	166.89	72.32
72		211.00	199.11	32.00	167.11	72.42
73		147.00	198.93	31.00	167.93	72.77
74		114.00	198.81	30.00	168.81	73.15
75		263.50	198.80	30.00	168.80	73.15
76		96.50	198.93	29.00	169.93	73.63
77		15.50	199.16	28.00	171.16	74.17
78		2092.50	198.01	20.00	178.01	77.14
79		.00	201.06	35.00	166.06	71.96
80		26.95	192.45	25.00	167.45	72.56
81		34.40	189.95	25.00	164.95	71.48
82		.00	181.89	25.00	156.89	67.98
83		110.40	181.21	25.00	156.21	67.69
84		78.60	185.78	25.00	160.78	69.67
85		164.60	181.06	25.00	156.06	67.63
86		63.25	177.06	25.00	152.06	65.89
87		51.45	176.99	25.00	151.99	65.86
88		.00	176.99	25.00	151.99	65.86
89		63.35	174.97	25.00	149.97	64.99
90		153.35	170.07	25.00	145.07	62.86
91		3.25	170.13	20.00	150.13	65.06
92		.00	170.36	20.00	150.36	65.15
93		16.90	171.19	20.00	151.19	65.52
94		98.70	177.21	20.00	157.21	68.13
95		20.90	169.64	20.00	149.64	64.85
96		42.25	169.76	20.00	149.76	64.90
97		21.30	169.64	20.00	149.64	64.84
98		20.90	169.60	20.00	149.60	64.83
99		28.85	169.59	20.00	149.59	64.82
100		29.25	169.61	20.00	149.61	64.83
101		29.25	169.59	20.00	149.59	64.82

102	.00	169.59	15.00	154.59	66.99
103	48.90	169.98	15.00	154.98	67.16
104	48.90	175.70	15.00	160.70	69.64
105	20.30	174.47	15.00	159.47	69.10
106	18.25	171.82	15.00	156.82	67.95
107	31.95	168.29	15.00	153.29	66.43
108	18.25	168.05	15.00	153.05	66.32
109	18.20	166.34	15.00	151.34	65.58
110	.00	166.27	15.00	151.27	65.55
111	18.20	169.67	15.00	154.67	67.02
112	7.95	169.54	25.00	144.54	62.63
113	140.80	181.70	20.00	161.70	70.07
114	33.00	163.55	20.00	143.55	62.21
115	80.85	162.18	20.00	142.18	61.61
116	73.80	161.70	20.00	141.70	61.40
117	43.00	161.34	20.00	141.34	61.25
118	50.00	161.32	20.00	141.32	61.24
119	31.85	161.16	20.00	141.16	61.17
120	31.85	161.14	20.00	141.14	61.16
121	22.40	161.16	20.00	141.16	61.17
122	54.25	161.14	20.00	141.14	61.16
123	71.00	161.19	20.00	141.19	61.18
124	6.65	159.12	20.00	139.12	60.28
125	220.85	148.47	20.00	128.47	55.67
126	69.05	138.42	20.00	118.42	51.31
127	95.40	138.41	20.00	118.41	51.31
128	97.30	121.96	20.00	101.96	44.18
129	19.35	113.79	20.00	93.79	40.64
130	4072.00	104.52	20.00	84.52	36.63
131	138.10	159.89	20.00	139.89	60.62
132	132.70	160.33	20.00	140.33	60.81
133	101.40	160.32	20.00	140.32	60.81
134	50.60	161.28	20.00	141.28	61.22
135	31.75	165.32	20.00	145.32	62.97
136	31.75	165.04	20.00	145.04	62.85
137	31.75	165.72	20.00	145.72	63.15
138	.00	168.81	20.00	148.81	64.48
139	.00	169.48	20.00	149.48	64.77
140	32.80	169.44	20.00	149.44	64.76
141	32.80	169.43	20.00	149.43	64.75
201	.00	226.75	70.00	156.75	67.92
202	.00	372.00	135.00	237.00	102.70
203	.00	228.05	130.00	98.05	42.49
204	.00	226.94	80.00	146.94	63.67
205	.00	224.51	102.00	122.51	53.09
206	.00	218.79	175.00	43.79	18.98
207	.00	224.58	175.00	49.58	21.48
208	.00	224.58	175.00	49.58	21.48
209	.00	218.71	175.00	43.71	18.94
210	.00	218.38	175.00	43.38	18.80
211	.00	226.75	208.00	18.75	8.12
212	.00	218.14	175.00	43.14	18.69
213	.00	273.89	175.00	98.89	42.85
214	.00	273.71	175.00	98.71	42.78
215	.00	273.47	175.00	98.47	42.67
216	.00	254.10	130.00	124.10	53.77
217	8333.00	252.61	215.00	37.61	16.30
218	12500.00	221.39	215.00	6.39	2.77

240	531.50	212.52	95.00	117.52	50.93

M A X I M U M   A N D   M I N I M U M   V A L U E S

P R E S S U R E S

JUNCTION NUMBER	MAXIMUM PRESSURES (psi)	JUNCTION NUMBER	MINIMUM PRESSURES (psi)
202	102.70	218	2.77
18	82.62	211	8.12
12	81.60	217	16.30
19	77.88	212	18.69
78	77.14	210	18.80
28	76.61	209	18.94
26	76.23	206	18.98
4	76.19	10	19.05
27	76.18	207	21.48
49	74.67	208	21.48

V E L O C I T I E S

PIPE NUMBER	MAXIMUM VELOCITY (ft/s)	PIPE NUMBER	MINIMUM VELOCITY (ft/s)
213	7.96	30	.00
214	7.96	165	.01
215	7.96	145	.01
221	7.39	172	.03
222	7.39	242	.07
174	7.30	166	.08
175	6.95	52	.09
177	6.68	98	.10
178	6.53	70	.11
179	6.50	71	.11

S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

(+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
(-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

PIPE NUMBER	FLOWRATE (gpm)
1	6984.69
6	1607.56
23	23696.32
203	.00
209	2952.00
240	2527.78

NET SYSTEM INFLOW = 37768.35
NET SYSTEM OUTFLOW = .00
NET SYSTEM DEMAND = 37768.35

D A T A   C H A N G E S   F O R   N E X T   S I M U L A T I O N

D E M A N D   C H A N G E S

DEMAND TYPE = 1 - GDF = .500

THE FOLLOWING SPECIFIC DEMAND CHANGES ARE MADE :

JUNCTION NUMBER	DEMAND (gpm)
217	8333.00
218	12500.00
133	4073.00

****
S I M U L A T I O N   R E S U L T S
****

THE RESULTS ARE OBTAINED AFTER 2 TRIALS WITH AN ACCURACY = .00386

P I P E L I N E   R E S U L T S

STATUS CODE: XX -CLOSED PIPE FG -FIXED GRADE NODE PU -PUMP LINE
CV -CHECK VALVE RV -REGULATING VALVE TK -STORAGE TANK

PIPE NUMBER	NODE NOS. #1	#2	FLOWRATE (gpm)	HEAD LOSS (ft)	PUMP HEAD (ft)	MINOR LOSS (ft)	LINE VELO. (ft/s)	HL/ 1000 (ft/ft)
1-FGPU	0	203	6984.64	.02	218.08	.00	2.20	.44
2	1	2	6267.06	.86	.00	.00	2.84	.88
3	1	2	476.53	.86	.00	.00	1.35	.88
4	2	3	4164.93	.42	.00	.00	1.31	.17
5	2	3	2578.66	.42	.00	.00	1.17	.17
6-FG	0	204	1610.12	1.06	.00	.00	1.64	.59
7	3	4	6358.96	.50	.00	.00	2.00	.37
8	3	4	3937.06	.50	.00	.00	1.79	.37
9	3	4	1251.30	.50	.00	.00	1.28	.37
10	4	5	6095.18	.56	.00	.00	1.92	.34
11	4	5	3773.74	.56	.00	.00	1.71	.34
12	4	5	1199.39	.56	.00	.00	1.22	.34
13	5	6	5801.04	.58	.00	.00	1.83	.31
14	5	6	3591.63	.58	.00	.00	1.63	.31
15	6	7	3397.13	.10	.00	.00	1.54	.28
16-XXPU	7	8						
17-XXPU	7	8						

18-XXPU	7	8						
19-CV	7	8	3397.13	.01	.00	.00	1.54	.28
20	8	9	.00	.00	.00	.00	.00	.00
21	9	208	.00	.00	.00	.00	.00	.00
22	205	10	9392.67	5.56	.00	.00	4.26	1.85
23-FG	0	10	23702.50	9.05	.00	.00	5.49	2.00
24	210	11	13569.12	5.87	.00	.00	3.14	.71
25-CV	5	12	1571.64	11.97	.00	.00	2.51	1.67
26	12	11	741.08	.79	.00	.00	1.18	.42
27	11	13	14468.69	3.00	.00	.00	3.35	.80
28	12	14	.00	.00	.00	.00	.00	.00
29-XX	14	15						
30	16	15	-1.07	.00	.00	.00	.00	.00
31	17	16	165.93	.02	.00	.00	.26	.03
32	13	17	228.43	.01	.00	.00	.36	.05
33	12	18	595.07	2.64	.00	.00	1.69	1.32
34	18	19	360.57	.94	.00	.00	1.02	.52
35	15	19	-126.07	.24	.00	.00	.36	.07
36	13	20	14084.25	2.02	.00	.00	4.44	1.61
37	20	21	13962.75	.37	.00	.00	4.40	1.59
38	21	22	13891.25	.31	.00	.00	4.38	1.57
39	22	23	13819.75	.31	.00	.00	4.36	1.56
40	23	24	13747.75	.59	.00	.00	4.33	1.54
41-XX	15	28						
42	24	25	12584.97	1.44	.00	.00	3.97	1.31
43	25	26	12584.97	.57	.00	.00	5.71	3.18
44	26	27	11558.16	.11	.00	.00	3.64	1.12
45	28	27	.00	.00	.00	.00	.00	.00
46-XX	28	35						
47	27	79	11558.16	2.74	.00	.00	3.64	1.12
48	24	29	1162.78	.11	.00	.00	1.86	.96
49	29	30	1063.28	2.83	.00	.00	3.02	3.87
50	30	31	876.78	2.63	.00	.00	2.49	2.71
51	31	32	662.28	2.74	.00	.00	1.88	1.61
52	33	32	-31.62	.00	.00	.00	.09	.01
53	34	33	67.38	.01	.00	.00	.19	.02
54	35	34	.00	.00	.00	.00	.00	.00
55-XX	35	48						
56	36	37	978.81	2.32	.00	.00	2.78	3.32
57	37	38	320.38	.15	.00	.00	.91	.42
58	38	34	158.88	.08	.00	.00	.45	.11
59	37	39	334.70	.59	.00	.00	.95	.46
60	32	39	315.20	.35	.00	.00	.89	.41
61	32	40	315.46	.46	.00	.00	.89	.41
62	40	41	164.96	.14	.00	.00	.47	.12
63	39	41	203.54	.25	.00	.00	.58	.18
64	39	42	542.00	1.64	.00	.00	1.54	1.11
65	42	44	521.00	.13	.00	.00	1.48	1.03
66	41	43	368.50	.10	.00	.00	.59	.11
67	37	54	323.73	.43	.00	.00	.92	.43
68	54	53	168.23	.13	.00	.00	.48	.13
69	53	39	95.64	.03	.00	.00	.27	.04
70	52	53	-37.59	.01	.00	.00	.11	.01
71	51	52	-37.59	.00	.00	.00	.11	.01
72	50	51	139.91	.05	.00	.00	.40	.09
73	50	49	75.00	.03	.00	.00	.21	.03
74	79	71	11558.16	.17	.00	.00	3.64	1.12
75-XX	48	36						

76	46	47	99.00	.48	.00	.00	.63	.34
77	45	46	208.50	.26	.00	.00	.59	.19
78	43	45	318.00	.58	.00	.00	.90	.41
79	55	50	303.91	.39	.00	.00	.86	.38
80	56	55	403.41	.64	.00	.00	1.14	.64
81	57	56	579.91	.59	.00	.00	1.64	1.26
82-XX	36	57						
83	71	77	10068.21	1.73	.00	.00	3.17	.87
84	77	57	579.91	.19	.00	.00	1.64	1.26
85	26	58	1026.81	1.31	.00	.00	2.91	3.63
86	58	59	801.27	1.44	.00	.00	2.27	2.29
87	58	60	225.54	1.03	.00	.00	1.44	1.58
88	60	61	142.54	.44	.00	.00	.91	.67
89	59	61	86.46	.02	.00	.00	.25	.04
90	61	62	225.00	.16	.00	.00	.64	.22
91	62	63	161.50	.11	.00	.00	.46	.12
92	59	64	714.81	.58	.00	.00	2.03	1.86
93	64	65	624.81	.61	.00	.00	1.77	1.45
94	65	66	457.81	.26	.00	.00	1.30	.81
95	66	67	195.31	.10	.00	.00	.55	.17
96	68	67	-142.31	.04	.00	.00	.40	.09
97	69	68	-89.31	.01	.00	.00	.25	.04
98	70	69	-36.31	.00	.00	.00	.10	.01
99	71	70	511.14	1.32	.00	.00	1.45	1.00
100	79	48	.00	.00	.00	.00	.00	.00
101	70	72	547.45	.46	.00	.00	1.55	1.13
102	72	73	336.45	.18	.00	.00	.95	.46
103	73	74	189.45	.12	.00	.00	.54	.16
104	75	74	-75.45	.01	.00	.00	.21	.03
105	76	75	188.05	.13	.00	.00	.53	.16
106	77	76	284.55	.24	.00	.00	.81	.34
107	77	78	9188.25	1.16	.00	.00	2.90	.73
108-XX	57	78						
109	71	36	978.81	.70	.00	.00	2.78	3.32
110	78	80	5725.87	5.57	.00	.00	5.85	6.19
111	78	80	1369.88	5.57	.00	.00	3.89	6.19
112	80	81	3181.14	2.54	.00	.00	3.25	2.08
113	80	82	3887.66	10.48	.00	.00	6.20	8.96
114	81	84	3146.74	4.24	.00	.00	5.02	6.05
115	82	83	207.42	.85	.00	.00	1.32	1.35
116	84	83	361.92	4.55	.00	.00	2.31	3.79
117	82	89	3539.44	6.78	.00	.00	5.65	7.53
118	83	85	83.28	.26	.00	.00	.53	.25
119	83	86	375.65	4.20	.00	.00	2.40	4.06
120	84	85	2706.23	4.81	.00	.00	4.32	4.58
121	89	91	3476.09	4.73	.00	.00	5.55	7.28
122	87	88	.00	.00	.00	.00	.00	.00
123	86	87	51.45	.07	.00	.00	.33	.10
124	85	86	342.82	3.94	.00	.00	2.19	3.43
125	85	94	2282.09	4.01	.00	.00	3.64	3.34
126	82	113	140.80	.18	.00	.00	.90	.66
127	91	90	153.35	.07	.00	.00	.43	.11
128	91	92	-64.37	.02	.00	.00	.18	.02
129	93	92	396.38	.59	.00	.00	1.12	.62
130	86	93	603.77	5.87	.00	.00	3.85	9.78
131	94	93	443.62	5.80	.00	.00	2.83	5.52
132	92	96	332.01	.90	.00	.00	2.12	3.23
133	93	103	634.12	1.55	.00	.00	1.80	1.49

134	94	104	1739.76	1.62	.00	.00	2.78	2.02
135	95	98	57.42	.07	.00	.00	.37	.13
136	96	95	78.32	.17	.00	.00	.50	.22
137	96	100	122.51	.27	.00	.00	.78	.51
138	97	101	67.62	.12	.00	.00	.43	.17
139	96	97	88.92	.22	.00	.00	.57	.28
140	98	99	36.52	.04	.00	.00	.23	.05
141	100	99	41.57	.02	.00	.00	.27	.07
142	101	100	-51.69	.08	.00	.00	.33	.10
143	99	112	49.24	.07	.00	.00	.31	.09
144	101	112	24.31	.02	.00	.00	.16	.03
145	102	101	-65.76	.02	.00	.00	.42	.16
146	103	102	185.88	.30	.00	.00	1.19	1.10
147	104	103	425.52	5.73	.00	.00	2.72	5.11
148	104	105	1265.35	1.34	.00	.00	3.59	5.34
149	102	108	251.64	2.11	.00	.00	1.61	1.93
150	103	107	824.85	2.18	.00	.00	2.34	2.42
151	105	106	1245.05	2.90	.00	.00	3.53	5.19
152	107	108	152.50	.22	.00	.00	.97	.76
153	106	107	371.64	3.66	.00	.00	2.37	3.98
154	108	109	385.89	2.13	.00	.00	2.46	4.27
155	107	110	1012.04	2.51	.00	.00	2.87	3.53
156	106	111	855.16	2.41	.00	.00	2.43	2.59
157	109	110	120.52	.15	.00	.00	.77	.49
158	111	110	497.91	3.76	.00	.00	3.18	6.84
159	91	114	3383.86	5.93	.00	.00	3.46	2.34
160	114	115	391.66	1.32	.00	.00	2.50	4.39
201-XXPU	0	211						
202	211	201	.00	.00	.00	.00	.00	.00
203-FGPU	0	202	.00	.00	362.00	.00	.00	.00
204-XX	202	201						
205	201	2	.00	.00	.00	.00	.00	.00
206	203	1	6984.64	.45	.00	.00	3.17	1.07
207	1	204	241.05	.67	.00	.00	.68	.25
208	204	3	1851.17	.61	.00	.00	1.89	.76
309-FG	0	3	2952.55	1.67	.00	.00	2.09	.64
210-XX	6	9						
211-CV	6	205	5995.54	.18	.00	.00	2.72	.81
212	8	205	3397.13	.07	.00	.00	1.54	.28
213	10	206	34402.13	.16	.00	.00	7.97	3.98
214	206	209	34402.13	.08	.00	.00	7.97	3.98
215	209	210	34402.13	.34	.00	.00	7.97	3.98
216-XX	207	206						
217-XX	207	209						
218	208	207	.00	.00	.00	.00	.00	.00
219	210	212	20833.00	.24	.00	.00	4.82	1.57
220-XXCV	212	213						
221-PU	212	213	10416.50	.33	56.08	.00	7.39	6.65
222-PU	212	213	10416.50	.33	56.08	.00	7.39	6.65
223-XXPU	212	213						
224-XXCV	208	215						
225	214	215	7933.44	.24	.00	.00	5.63	4.02
226	213	214	20833.00	.17	.00	.00	4.82	1.57
227	215	216	7933.44	19.38	.00	.00	3.60	1.36
228	214	216	12899.56	19.62	.00	.00	4.07	1.37
229	216	217	8333.00	1.48	.00	.00	2.63	.61
230	216	218	12500.00	32.71	.00	.00	5.67	3.15
231-XXFG	0	211						

161	115	116	166.38	.46	.00	.00	1.06	.90
162	116	117	92.58	.34	.00	.00	.59	.30
163	115	118	144.43	.80	.00	.00	.92	.69
164	114	123	2959.21	2.11	.00	.00	3.02	1.82
165	118	117	2.51	.00	.00	.00	.02	.00
166	123	118	-3.66	.00	.00	.00	.02	.00
167	117	121	52.09	.17	.00	.00	.33	.10
168	118	119	88.26	.17	.00	.00	.56	.28
169	119	120	28.63	.02	.00	.00	.18	.03
170	121	122	29.69	.02	.00	.00	.19	.04
171	119	122	27.78	.02	.00	.00	.18	.03
172	122	120	3.22	.00	.00	.00	.02	.00
173	123	124	2891.86	1.83	.00	.00	2.95	1.75
174	124	125	612.25	.26	.00	.00	.98	.29
175	125	126	391.40	.12	.00	.00	.62	.13
176	126	127	95.40	.01	.00	.00	.15	.01
177	126	128	226.95	.07	.00	.00	.36	.05
178	128	129	129.65	.01	.00	.00	.21	.02
179	129	130	110.30	.01	.00	.00	.18	.01
180	131	124	-2272.96	1.69	.00	.00	3.63	3.31
181	131	132	1955.40	16.03	.00	.00	5.55	11.96
182	132	133	4073.00	9.86	.00	.00	6.50	9.76
183	134	132	2250.30	15.83	.00	.00	6.38	15.52
184	134	131	-179.46	.03	.00	.00	.29	.03
185	136	134	2121.44	4.58	.00	.00	3.38	2.92
186	109	135	247.17	1.23	.00	.00	1.58	1.87
187	110	136	1630.47	1.49	.00	.00	2.60	1.79
188	138	137	339.04	3.49	.00	.00	2.16	3.36
189	135	136	215.42	.41	.00	.00	1.37	1.45
190	137	136	307.29	.78	.00	.00	1.96	2.80
191	111	138	339.04	.97	.00	.00	2.16	3.36
192	112	139	65.60	.06	.00	.00	.42	.16
193	139	140	32.80	.04	.00	.00	.21	.04
194	139	141	32.80	.05	.00	.00	.21	.04
240-FG	0	10	2528.44	9.05	.00	.00	4.03	3.48
241	10	240	1221.49	6.44	.00	.00	1.95	.90
242	240	11	46.92	.01	.00	.00	.07	.00
243	240	11	643.07	.01	.00	.00	.15	.00

J U N C T I O N   N O D E   R E S U L T S

JUNCTION NUMBER	JUNCTION TITLE	EXTERNAL DEMAND (gpm)	HYDRAULIC GRADE (ft)	JUNCTION ELEVATION (ft)	PRESSURE HEAD (ft)	JUNCTION PRESSURE (psi)
1		.00	227.61	120.00	107.61	46.63
2		.00	226.75	75.00	151.75	65.76
3		.00	226.33	77.00	149.33	64.71
4		479.00	225.83	50.00	175.83	76.19
5		104.00	225.26	85.00	140.26	60.78
6		.00	224.68	95.00	129.68	56.20
7		.00	224.58	98.00	126.58	54.85
8		.00	224.57	98.00	126.57	54.85
9		.00	224.57	102.00	122.57	53.12
10		.00	218.95	175.00	43.95	19.04
11		531.50	212.50	55.00	157.50	68.25

12	235.50	213.29	25.00	188.29	81.59
13	156.00	209.50	45.00	164.50	71.28
14	.00	213.29	45.00	168.29	72.93
15	125.00	209.47	45.00	164.47	71.27
16	167.00	209.47	45.00	164.47	71.27
17	62.50	209.49	45.00	164.49	71.28
18	234.50	210.65	20.00	190.65	82.62
19	234.50	209.71	30.00	179.71	77.87
20	121.50	207.48	38.00	169.48	73.44
21	71.50	207.12	37.00	170.12	73.72
22	71.50	206.80	36.00	170.80	74.01
23	72.00	206.49	35.00	171.49	74.31
24	.00	205.90	34.00	171.90	74.49
25	.00	204.46	33.00	171.46	74.30
26	.00	203.89	28.00	175.89	76.22
27	.00	203.78	28.00	175.78	76.17
28	.00	203.78	27.00	176.78	76.60
29	99.50	205.80	35.00	170.80	74.01
30	186.50	202.97	36.00	166.97	72.35
31	214.50	200.34	37.00	163.34	70.78
32	.00	197.61	34.00	163.61	70.90
33	99.00	197.60	33.00	164.60	71.33
34	91.50	197.62	31.00	166.62	72.20
35	.00	197.62	34.00	163.62	70.90
36	.00	200.17	34.00	166.17	72.01
37	.00	197.84	34.00	163.84	71.00
38	161.50	197.70	33.00	164.70	71.37
39	.00	197.25	33.00	164.25	71.18
40	150.50	197.14	33.00	164.14	71.13
41	.00	197.00	34.00	163.00	70.63
42	21.00	195.61	34.00	161.61	70.03
43	50.50	196.90	34.00	162.90	70.59
44	521.00	195.48	33.00	162.48	70.41
45	109.50	196.32	30.00	166.32	72.07
46	109.50	196.06	28.00	168.06	72.83
47	99.00	195.58	25.00	170.58	73.92
48	.00	201.03	35.00	166.03	71.95
49	75.00	197.30	25.00	172.30	74.66
50	89.00	197.33	26.00	171.33	74.24
51	177.50	197.27	27.00	170.27	73.79
52	.00	197.28	28.00	169.28	73.35
53	35.00	197.28	29.00	168.28	72.92
54	155.50	197.42	31.00	166.42	72.11
55	99.50	197.71	27.00	170.71	73.98
56	176.50	198.36	27.00	171.36	74.25
57	.00	198.94	28.00	170.94	74.08
58	.00	202.58	32.00	170.58	73.92
59	.00	201.14	31.00	170.14	73.73
60	83.00	201.56	31.00	170.56	73.91
61	4.00	201.12	31.00	170.12	73.72
62	63.50	200.96	32.00	168.96	73.22
63	161.50	200.85	38.00	162.85	70.57
64	90.00	200.56	30.00	170.56	73.91
65	167.00	199.95	30.00	169.95	73.65
66	262.50	199.69	30.00	169.69	73.53
67	53.00	199.60	30.00	169.60	73.49
68	53.00	199.56	30.00	169.56	73.48
69	53.00	199.55	30.00	169.55	73.47

70	.00	199.55	32.00	167.55	72.60
71	.00	200.87	34.00	166.87	72.31
72	211.00	199.09	32.00	167.09	72.40
73	147.00	198.91	31.00	167.91	72.76
74	114.00	198.78	30.00	168.78	73.14
75	263.50	198.77	30.00	168.77	73.13
76	96.50	198.90	29.00	169.90	73.62
77	15.50	199.13	28.00	171.13	74.16
78	2092.50	197.97	20.00	177.97	77.12
79	.00	201.03	35.00	166.03	71.95
80	26.95	192.40	25.00	167.40	72.54
81	34.40	189.86	25.00	164.86	71.44
82	.00	181.93	25.00	156.93	68.00
83	110.40	181.07	25.00	156.07	67.63
84	78.60	185.62	25.00	160.62	69.60
85	164.60	180.82	25.00	155.82	67.52
86	63.25	176.87	25.00	151.87	65.81
87	51.45	176.80	25.00	151.80	65.78
88	.00	176.80	25.00	151.80	65.78
89	63.35	175.15	25.00	150.15	65.06
90	153.35	170.35	25.00	145.35	62.99
91	3.25	170.42	20.00	150.42	65.18
92	.00	170.44	20.00	150.44	65.19
93	16.90	171.00	20.00	151.00	65.44
94	98.70	176.81	20.00	156.81	67.95
95	20.90	169.36	20.00	149.36	64.72
96	42.25	169.54	20.00	149.54	64.80
97	21.30	169.32	20.00	149.32	64.71
98	20.90	169.29	20.00	149.29	64.69
99	28.85	169.25	20.00	149.25	64.67
100	29.25	169.27	20.00	149.27	64.68
101	29.25	169.19	20.00	149.19	64.65
102	.00	169.16	15.00	154.16	66.80
103	48.90	169.46	15.00	154.46	66.93
104	48.90	175.19	15.00	160.19	69.42
105	20.30	173.86	15.00	158.86	68.84
106	18.25	170.95	15.00	155.95	67.58
107	31.95	167.28	15.00	152.28	65.99
108	18.25	167.05	15.00	152.05	65.89
109	18.20	164.92	15.00	149.92	64.97
110	.00	164.77	15.00	149.77	64.90
111	18.20	168.55	15.00	153.55	66.54
112	7.95	169.16	25.00	144.16	62.47
113	140.80	181.74	20.00	161.74	70.09
114	33.00	164.48	20.00	144.48	62.61
115	80.85	163.17	20.00	143.17	62.04
116	73.80	162.71	20.00	142.71	61.84
117	43.00	162.37	20.00	142.37	61.69
118	50.00	162.37	20.00	142.37	61.69
119	31.85	162.21	20.00	142.21	61.62
120	31.85	162.18	20.00	142.18	61.61
121	22.40	162.20	20.00	142.20	61.62
122	54.25	162.18	20.00	142.18	61.61
123	71.00	162.37	20.00	142.37	61.69
124	6.65	160.53	20.00	140.53	60.90
125	220.85	160.28	20.00	140.28	60.79
126	69.05	160.16	20.00	140.16	60.74
127	95.40	160.16	20.00	140.16	60.73

128	97.30	160.09	20.00	140.09	60.70
129	19.35	160.07	20.00	140.07	60.70
130	110.30	160.06	20.00	140.06	60.69
131	138.10	158.84	20.00	138.84	60.17
132	132.70	142.81	20.00	122.81	53.22
133	4073.00	132.95	20.00	112.95	48.95
134	50.60	158.81	20.00	138.81	60.15
135	31.75	163.69	20.00	143.69	62.26
136	31.75	163.29	20.00	143.29	62.09
137	31.75	164.07	20.00	144.07	62.43
138	.00	167.57	20.00	147.57	63.95
139	.00	169.10	20.00	149.10	64.61
140	32.80	169.06	20.00	149.06	64.59
141	32.80	169.06	20.00	149.06	64.59
201	.00	226.75	70.00	156.75	67.92
202	.00	372.00	135.00	237.00	102.70
203	.00	228.06	130.00	98.06	42.49
204	.00	226.94	80.00	146.94	63.67
205	.00	224.51	102.00	122.51	53.09
206	.00	218.79	175.00	43.79	18.98
207	.00	224.57	175.00	49.57	21.48
208	.00	224.57	175.00	49.57	21.48
209	.00	218.71	175.00	43.71	18.94
210	.00	218.37	175.00	43.37	18.79
211	.00	226.75	208.00	18.75	8.12
212	.00	218.13	175.00	43.13	18.69
213	.00	273.88	175.00	98.88	42.85
214	.00	273.71	175.00	98.71	42.77
215	.00	273.47	175.00	98.47	42.67
216	.00	254.09	130.00	124.09	53.77
217	8333.00	252.61	215.00	37.61	16.30
218	12500.00	221.38	215.00	6.38	2.77
240	531.50	212.51	95.00	117.51	50.92

M A X I M U M   A N D   M I N I M U M   V A L U E S

P R E S S U R E S

JUNCTION NUMBER	MAXIMUM PRESSURES (psi)	JUNCTION NUMBER	MINIMUM PRESSURES (psi)
202	102.70	218	2.77
18	82.62	211	8.12
12	81.59	217	16.30
19	77.87	212	18.69
78	77.12	210	18.79
28	76.60	209	18.94
26	76.22	206	18.98
4	76.19	10	19.04
27	76.17	207	21.48
49	74.66	208	21.48

V E L O C I T I E S

PIPE NUMBER	MAXIMUM VELOCITY (ft/s)	PIPE NUMBER	MINIMUM VELOCITY (ft/s)
213	7.97	30	.00
214	7.97	165	.02
215	7.97	172	.02
221	7.39	166	.02
222	7.39	242	.07
182	6.50	52	.09
183	6.38	98	.10
113	6.20	70	.11
110	5.85	71	.11
43	5.71	243	.15

S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

(+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
(-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

PIPE NUMBER	FLOWRATE (gpm)
1	6984.64
6	1610.12
23	23702.50
203	.00
209	2952.55
240	2528.44

NET SYSTEM INFLOW = 37778.26
NET SYSTEM OUTFLOW = .00
NET SYSTEM DEMAND = 37778.25

D A T A   C H A N G E S   F O R   N E X T   S I M U L A T I O N

D E M A N D   C H A N G E S

DEMAND TYPE = 1 - GDF = .500

THE FOLLOWING SPECIFIC DEMAND CHANGES ARE MADE :

JUNCTION NUMBER	DEMAND (gpm)
217	8333.00
218	12500.00
141	1033.00

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S I M U L A T I O N   R E S U L T S

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THE RESULTS ARE OBTAINED AFTER 3 TRIALS WITH AN ACCURACY = .00116

P I P E L I N E   R E S U L T S

STATUS CODE: XX -CLOSED PIPE CV -CHECK VALVE FG -FIXED GRADE NODE RV -REGULATING VALVE PU -PUMP LINE TK -STORAGE TANK

PIPE NUMBER	NODE NOS. #1	#2	FLOWRATE (gpm)	HEAD LOSS (ft)	PUMP HEAD (ft)	MINOR LOSS (ft)	LINE VELO. (ft/s)	HL/ 1000 (ft/ft)
1-FGPU	0	203	6973.67	.02	218.54	.00	2.20	.44
2	1	2	6232.88	.85	.00	.00	2.83	.87
3	1	2	473.94	.85	.00	.00	1.34	.87
4	2	3	4142.22	.42	.00	.00	1.31	.17
5	2	3	2564.60	.42	.00	.00	1.16	.17
6-FG	0	204	1320.45	.74	.00	.00	1.35	.41
7	3	4	5923.32	.44	.00	.00	1.87	.32
8	3	4	3667.34	.44	.00	.00	1.66	.32
9	3	4	1165.58	.44	.00	.00	1.19	.32
10	4	5	5659.54	.49	.00	.00	1.78	.30
11	4	5	3504.02	.49	.00	.00	1.59	.30
12	4	5	1113.67	.49	.00	.00	1.14	.30
13	5	6	5427.83	.51	.00	.00	1.71	.28
14	5	6	3360.56	.51	.00	.00	1.53	.28
15	6	7	3178.58	.09	.00	.00	1.44	.25
16-XXPU	7	8						
17-XXPU	7	8						
18-XXPU	7	8						
19-CV	7	8	3178.58	.00	.00	.00	1.44	.25
20	8	9	.00	.00	.00	.00	.00	.00
21	9	208	.00	.00	.00	.00	.00	.00
22	205	10	8788.39	4.91	.00	.00	3.99	1.64
23-FG	0	10	21732.33	7.71	.00	.00	5.03	1.70
24	210	11	11002.21	3.98	.00	.00	2.55	.48
25-CV	5	12	1384.85	9.47	.00	.00	2.21	1.32
26	12	11	634.78	.59	.00	.00	1.01	.31
27	11	13	11577.78	1.99	.00	.00	2.68	.53
28	12	14	.00	.00	.00	.00	.00	.00
29-XX	14	15						
30	16	15	79.43	.01	.00	.00	.13	.01
31	17	16	246.43	.04	.00	.00	.39	.05
32	13	17	308.93	.02	.00	.00	.49	.08
33	12	18	514.57	2.02	.00	.00	1.46	1.01
34	18	19	280.07	.59	.00	.00	.79	.33
35	15	19	-45.57	.04	.00	.00	.13	.01
36	13	20	11112.85	1.30	.00	.00	3.50	1.04
37	20	21	10991.35	.23	.00	.00	3.46	1.02
38	21	22	10919.85	.20	.00	.00	3.44	1.01
39	22	23	10848.35	.20	.00	.00	3.42	1.00
40	23	24	10776.35	.37	.00	.00	3.40	.98
41-XX	15	28						
42	24	25	9715.90	.89	.00	.00	3.06	.81
43	25	26	9715.90	.36	.00	.00	4.41	1.97

44	26	27	8808.38	.07	.00	.00	2.78	.68
45	28	27	.00	.00	.00	.00	.00	.00
46-XX	28	35						
47	27	79	8808.38	1.66	.00	.00	2.78	.68
48	24	29	1060.45	.09	.00	.00	1.69	.81
49	29	30	960.95	2.34	.00	.00	2.73	3.21
50	30	31	774.45	2.09	.00	.00	2.20	2.15
51	31	32	559.95	2.01	.00	.00	1.59	1.18
52	33	32	5.08	.00	.00	.00	.01	.00
53	34	33	104.08	.03	.00	.00	.30	.05
54	35	34	.00	.00	.00	.00	.00	.00
55-XX	35	48						
56	36	37	996.37	2.40	.00	.00	2.83	3.43
57	37	38	357.08	.18	.00	.00	1.01	.51
58	38	34	195.58	.12	.00	.00	.55	.17
59	37	39	332.34	.58	.00	.00	.94	.45
60	32	39	264.54	.26	.00	.00	.75	.29
61	32	40	300.49	.42	.00	.00	.85	.37
62	40	41	149.99	.12	.00	.00	.43	.10
63	39	41	218.51	.29	.00	.00	.62	.21
64	39	42	542.00	1.64	.00	.00	1.54	1.11
65	42	44	521.00	.13	.00	.00	1.48	1.03
66	41	43	368.50	.10	.00	.00	.59	.11
67	37	54	306.95	.39	.00	.00	.87	.39
68	54	53	151.45	.11	.00	.00	.43	.10
69	53	39	163.63	.09	.00	.00	.46	.12
70	52	53	47.18	.01	.00	.00	.13	.01
71	51	52	47.18	.00	.00	.00	.13	.01
72	50	51	224.68	.13	.00	.00	.64	.22
73	50	49	75.00	.03	.00	.00	.21	.03
74	79	71	8808.38	.10	.00	.00	2.78	.68
75-XX	48	36						
76	46	47	99.00	.48	.00	.00	.63	.34
77	45	46	208.50	.26	.00	.00	.59	.19
78	43	45	318.00	.58	.00	.00	.90	.41
79	55	50	388.68	.61	.00	.00	1.10	.60
80	56	55	488.18	.92	.00	.00	1.38	.92
81	57	56	664.68	.75	.00	.00	1.89	1.62
82-XX	36	57						
83	71	77	7299.40	.96	.00	.00	2.30	.48
84	77	57	664.68	.24	.00	.00	1.89	1.62
85	26	58	907.52	1.04	.00	.00	2.57	2.89
86	58	59	704.14	1.14	.00	.00	2.00	1.80
87	58	60	203.39	.85	.00	.00	1.30	1.30
88	60	61	120.39	.32	.00	.00	.77	.49
89	59	61	108.61	.03	.00	.00	.31	.06
90	61	62	225.00	.16	.00	.00	.64	.22
91	62	63	161.50	.11	.00	.00	.46	.12
92	59	64	595.52	.41	.00	.00	1.69	1.32
93	64	65	505.52	.41	.00	.00	1.43	.98
94	65	66	338.52	.15	.00	.00	.96	.46
95	66	67	76.02	.02	.00	.00	.22	.03
96	68	67	-23.02	.00	.00	.00	.07	.00
97	69	68	29.98	.00	.00	.00	.09	.01
98	70	69	82.98	.01	.00	.00	.24	.03
99	71	70	512.61	1.32	.00	.00	1.45	1.00
100	79	48	.00	.00	.00	.00	.00	.00
101	70	72	429.63	.30	.00	.00	1.22	.72

102	72	73	218.63	.08	.00	.00	.62	.21
103	73	74	71.63	.02	.00	.00	.20	.03
104	75	74	42.37	.00	.00	.00	.12	.01
105	76	75	305.87	.31	.00	.00	.87	.39
106	77	76	402.37	.45	.00	.00	1.14	.64
107	77	78	6216.85	.56	.00	.00	1.96	.36
108-XX	57	78						
109	71	36	996.37	.72	.00	.00	2.83	3.43
110	78	80	3328.12	2.04	.00	.00	3.40	2.27
111	78	80	796.23	2.04	.00	.00	2.26	2.27
112	80	81	1898.19	.98	.00	.00	1.94	.80
113	80	82	2199.21	3.65	.00	.00	3.51	3.12
114	81	84	1863.79	1.61	.00	.00	2.97	2.30
115	82	83	173.15	.61	.00	.00	1.11	.97
116	84	83	211.00	1.67	.00	.00	1.35	1.40
117	82	89	1885.27	2.11	.00	.00	3.01	2.34
118	83	85	46.15	.09	.00	.00	.29	.08
119	83	86	227.59	1.66	.00	.00	1.45	1.61
120	84	85	1574.19	1.76	.00	.00	2.51	1.68
121	89	91	1821.92	1.43	.00	.00	2.91	2.20
122	87	88	.00	.00	.00	.00	.00	.00
123	86	87	51.45	.07	.00	.00	.33	.10
124	85	86	208.74	1.57	.00	.00	1.33	1.37
125	85	94	1247.00	1.31	.00	.00	1.99	1.09
126	82	113	140.80	.18	.00	.00	.90	.66
127	91	90	153.35	.07	.00	.00	.43	.11
128	91	92	418.04	.74	.00	.00	1.19	.69
129	93	92	207.53	.18	.00	.00	.59	.19
130	86	93	321.63	1.83	.00	.00	2.05	3.05
131	94	93	255.74	2.09	.00	.00	1.63	1.99
132	92	96	625.57	2.92	.00	.00	3.99	10.44
133	93	103	352.94	.52	.00	.00	1.00	.50
134	94	104	892.56	.47	.00	.00	1.42	.59
135	95	98	184.93	.60	.00	.00	1.18	1.09
136	96	95	205.83	1.04	.00	.00	1.31	1.33
137	96	100	262.22	1.08	.00	.00	1.67	2.09
138	97	101	93.97	.23	.00	.00	.60	.31
139	96	97	115.27	.35	.00	.00	.74	.46
140	98	99	164.03	.70	.00	.00	1.05	.88
141	100	99	376.48	1.26	.00	.00	2.40	4.08
142	101	100	143.51	.55	.00	.00	.92	.68
143	99	112	511.66	5.68	.00	.00	3.27	7.20
144	101	112	562.09	7.45	.00	.00	3.59	8.56
145	102	101	640.88	1.64	.00	.00	4.09	10.92
146	103	102	446.65	1.51	.00	.00	2.85	5.60
147	104	103	250.26	2.14	.00	.00	1.60	1.91
148	104	105	593.40	.33	.00	.00	1.68	1.31
149	102	108	-194.22	1.30	.00	.00	1.24	1.20
150	103	107	107.65	.05	.00	.00	.31	.06
151	105	106	573.10	.69	.00	.00	1.63	1.23
152	107	108	147.10	.21	.00	.00	.94	.72
153	106	107	200.83	1.17	.00	.00	1.28	1.27
154	108	109	-65.37	.08	.00	.00	.42	.16
155	107	110	129.43	.06	.00	.00	.37	.08
156	106	111	354.02	.47	.00	.00	1.00	.50
157	109	110	-81.58	.07	.00	.00	.52	.24
158	111	110	209.52	.76	.00	.00	1.34	1.38
159	91	114	1247.27	.93	.00	.00	1.27	.37

160	114	115	264.52	.64	.00	.00	1.69	2.12
201-XXPU	0	211						
202	211	201	.00	.00	.00	.00	.00	.00
203-FGPU	0	202	.00	.00	362.00	.00	.00	.00
204-XX	202	201						
205	201	2	.00	.00	.00	.00	.00	.00
206	203	1	6973.67	.45	.00	.00	3.17	1.07
207	1	204	266.85	.81	.00	.00	.76	.30
208	204	3	1587.30	.46	.00	.00	1.62	.58
209-FG	0	3	2462.12	1.20	.00	.00	1.75	.46
210-XX	6	9						
211-CV	6	205	5609.81	.16	.00	.00	2.55	.71
212	8	205	3178.58	.06	.00	.00	1.44	.25
213	10	206	31835.21	.14	.00	.00	7.37	3.45
214	206	209	31835.21	.07	.00	.00	7.37	3.45
215	209	210	31835.21	.29	.00	.00	7.37	3.45
216-XX	207	206						
217-XX	207	209						
218	208	207	.00	.00	.00	.00	.00	.00
219	210	212	20833.00	.24	.00	.00	4.82	1.57
220-XXCV	212	213						
221-PU	212	213	10416.50	.33	56.08	.00	7.39	6.65
222-PU	212	213	10416.50	.33	56.08	.00	7.39	6.65
223-XXPU	212	213						
224-XXCV	208	215						
225	214	215	7933.44	.24	.00	.00	5.63	4.02
226	213	214	20833.00	.17	.00	.00	4.82	1.57
227	215	216	7933.44	19.38	.00	.00	3.60	1.36
228	214	216	12899.56	19.62	.00	.00	4.07	1.37
229	216	217	8333.00	1.48	.00	.00	2.63	.61
230	216	218	12500.00	32.71	.00	.00	5.67	3.15
231-XXFG	0	211						
161	115	116	111.36	.22	.00	.00	.71	.43
162	116	117	37.56	.06	.00	.00	.24	.06
163	115	118	72.31	.22	.00	.00	.46	.19
164	114	123	949.76	.26	.00	.00	.97	.22
165	118	117	52.54	.06	.00	.00	.34	.11
166	123	118	123.48	.60	.00	.00	.79	.52
167	117	121	47.10	.14	.00	.00	.30	.09
168	118	119	93.25	.18	.00	.00	.60	.31
169	119	120	30.95	.03	.00	.00	.20	.04
170	121	122	24.70	.02	.00	.00	.16	.03
171	119	122	30.45	.03	.00	.00	.19	.04
172	122	120	.90	.00	.00	.00	.01	.00
173	123	124	755.27	.15	.00	.00	.77	.15
174	124	125	612.25	.26	.00	.00	.98	.29
175	125	126	391.40	.12	.00	.00	.62	.13
176	126	127	95.40	.01	.00	.00	.15	.01
177	126	128	226.95	.07	.00	.00	.36	.05
178	128	129	129.65	.01	.00	.00	.21	.02
179	129	130	110.30	.01	.00	.00	.18	.01
180	131	124	-136.37	.01	.00	.00	.22	.02
181	131	132	103.38	.07	.00	.00	.29	.05
182	132	133	101.40	.01	.00	.00	.16	.01
183	134	132	130.72	.08	.00	.00	.37	.08
184	134	131	105.11	.01	.00	.00	.17	.01
185	136	134	286.43	.11	.00	.00	.46	.07
186	109	135	-1.99	.00	.00	.00	.01	.00

187	110	136	257.36	.05	.00	.00	.41	.06
188	138	137	126.30	.56	.00	.00	.81	.54
189	135	136	-33.74	.01	.00	.00	.22	.05
190	137	136	94.55	.09	.00	.00	.60	.32
191	111	138	126.30	.16	.00	.00	.81	.54
192	112	139	1065.80	10.64	.00	.00	6.80	28.01
193	139	140	32.80	.04	.00	.00	.21	.04
194	139	141	1033.00	27.23	.00	.00	6.59	26.43
240-FG	0	10	2318.29	7.71	.00	.00	3.70	2.96
241	10	240	1003.80	4.48	.00	.00	1.60	.63
242	240	11	32.12	.00	.00	.00	.05	.00
243	240	11	440.18	.00	.00	.00	.10	.00

J U N C T I O N   N O D E   R E S U L T S

JUNCTION NUMBER	JUNCTION TITLE	EXTERNAL DEMAND (gpm)	HYDRAULIC GRADE (ft)	JUNCTION ELEVATION (ft)	PRESSURE HEAD (ft)	JUNCTION PRESSURE (psi)
1		.00	228.07	120.00	108.07	46.83
2		.00	227.22	75.00	152.22	65.96
3		.00	226.80	77.00	149.80	64.91
4		479.00	226.37	50.00	176.37	76.43
5		104.00	225.87	85.00	140.87	61.05
6		.00	225.36	95.00	130.36	56.49
7		.00	225.27	98.00	127.27	55.15
8		.00	225.27	98.00	127.27	55.15
9		.00	225.27	102.00	123.27	53.42
10		.00	220.29	175.00	45.29	19.63
11		531.50	215.81	55.00	160.81	69.69
12		235.50	216.41	25.00	191.41	82.94
13		156.00	213.82	45.00	168.82	73.16
14		.00	216.41	45.00	171.41	74.28
15		125.00	213.76	45.00	168.76	73.13
16		167.00	213.77	45.00	168.77	73.13
17		62.50	213.81	45.00	168.81	73.15
18		234.50	214.39	20.00	194.39	84.23
19		234.50	213.80	30.00	183.80	79.65
20		121.50	212.52	38.00	174.52	75.63
21		71.50	212.29	37.00	175.29	75.96
22		71.50	212.09	36.00	176.09	76.30
23		72.00	211.89	35.00	176.89	76.65
24		.00	211.51	34.00	177.51	76.92
25		.00	210.62	33.00	177.62	76.97
26		.00	210.27	28.00	182.27	78.98
27		.00	210.20	28.00	182.20	78.95
28		.00	210.20	27.00	183.20	79.39
29		99.50	211.43	35.00	176.43	76.45
30		186.50	209.08	36.00	173.08	75.00
31		214.50	207.00	37.00	170.00	73.66
32		.00	204.99	34.00	170.99	74.09
33		99.00	204.99	33.00	171.99	74.53
34		91.50	205.02	31.00	174.02	75.41
35		.00	205.02	34.00	171.02	74.11
36		.00	207.72	34.00	173.72	75.28
37		.00	205.32	34.00	171.32	74.24

38	161.50	205.14	33.00	172.14	74.59
39	.00	204.73	33.00	171.73	74.42
40	150.50	204.56	33.00	171.56	74.34
41	.00	204.44	34.00	170.44	73.86
42	21.00	203.09	34.00	169.09	73.27
43	50.50	204.34	34.00	170.34	73.82
44	521.00	202.96	33.00	169.96	73.65
45	109.50	203.77	30.00	173.77	75.30
46	109.50	203.50	28.00	175.50	76.05
47	99.00	203.03	25.00	178.03	77.15
48	.00	208.54	35.00	173.54	75.20
49	75.00	204.93	25.00	179.93	77.97
50	89.00	204.96	26.00	178.96	77.55
51	177.50	204.83	27.00	177.83	77.06
52	.00	204.83	28.00	176.83	76.63
53	35.00	204.82	29.00	175.82	76.19
54	155.50	204.93	31.00	173.93	75.37
55	99.50	205.57	27.00	178.57	77.38
56	176.50	206.49	27.00	179.49	77.78
57	.00	207.24	28.00	179.24	77.67
58	.00	209.23	32.00	177.23	76.80
59	.00	208.09	31.00	177.09	76.74
60	83.00	208.38	31.00	177.38	76.86
61	4.00	208.06	31.00	177.06	76.73
62	63.50	207.90	32.00	175.90	76.22
63	161.50	207.79	38.00	169.79	73.58
64	90.00	207.68	30.00	177.68	76.99
65	167.00	207.27	30.00	177.27	76.82
66	262.50	207.12	30.00	177.12	76.75
67	53.00	207.10	30.00	177.10	76.75
68	53.00	207.10	30.00	177.10	76.74
69	53.00	207.10	30.00	177.10	76.75
70	.00	207.12	32.00	175.12	75.88
71	.00	208.44	34.00	174.44	75.59
72	211.00	206.82	32.00	174.82	75.76
73	147.00	206.74	31.00	175.74	76.15
74	114.00	206.72	30.00	176.72	76.58
75	263.50	206.72	30.00	176.72	76.58
76	96.50	207.04	29.00	178.04	77.15
77	15.50	207.48	28.00	179.48	77.78
78	2092.50	206.92	20.00	186.92	81.00
79	.00	208.54	35.00	173.54	75.20
80	26.95	204.88	25.00	179.88	77.95
81	34.40	203.91	25.00	178.91	77.53
82	.00	201.23	25.00	176.23	76.37
83	110.40	200.63	25.00	175.63	76.10
84	78.60	202.30	25.00	177.30	76.83
85	164.60	200.54	25.00	175.54	76.07
86	63.25	198.96	25.00	173.96	75.38
87	51.45	198.90	25.00	173.90	75.35
88	.00	198.90	25.00	173.90	75.35
89	63.35	199.12	25.00	174.12	75.45
90	153.35	197.63	25.00	172.63	74.81
91	3.25	197.69	20.00	177.69	77.00
92	.00	196.96	20.00	176.96	76.68
93	16.90	197.14	20.00	177.14	76.76
94	98.70	199.23	20.00	179.23	77.67
95	20.90	193.00	20.00	173.00	74.97

96	42.25	194.04	20.00	174.04	75.42
97	21.30	193.68	20.00	173.68	75.26
98	20.90	192.40	20.00	172.40	74.70
99	28.85	191.69	20.00	171.69	74.40
100	29.25	192.95	20.00	172.95	74.95
101	29.25	193.47	20.00	173.47	75.17
102	.00	195.10	15.00	180.10	78.04
103	48.90	196.61	15.00	181.61	78.70
104	48.90	198.76	15.00	183.76	79.63
105	20.30	198.43	15.00	183.43	79.49
106	18.25	197.74	15.00	182.74	79.19
107	31.95	196.56	15.00	181.56	78.68
108	18.25	196.41	15.00	181.41	78.61
109	18.20	196.49	15.00	181.49	78.64
110	.00	196.51	15.00	181.51	78.65
111	18.20	197.27	15.00	182.27	78.98
112	7.95	186.01	25.00	161.01	69.77
113	140.80	201.05	20.00	181.05	78.46
114	33.00	196.76	20.00	176.76	76.60
115	80.85	196.12	20.00	176.12	76.32
116	73.80	195.91	20.00	175.91	76.23
117	43.00	195.84	20.00	175.84	76.20
118	50.00	195.90	20.00	175.90	76.22
119	31.85	195.72	20.00	175.72	76.14
120	31.85	195.69	20.00	175.69	76.13
121	22.40	195.70	20.00	175.70	76.14
122	54.25	195.69	20.00	175.69	76.13
123	71.00	196.50	20.00	176.50	76.48
124	6.65	196.35	20.00	176.35	76.42
125	220.85	196.09	20.00	176.09	76.31
126	69.05	195.98	20.00	175.98	76.26
127	95.40	195.97	20.00	175.97	76.25
128	97.30	195.90	20.00	175.90	76.22
129	19.35	195.89	20.00	175.89	76.22
130	110.30	195.88	20.00	175.88	76.21
131	138.10	196.34	20.00	176.34	76.41
132	132.70	196.27	20.00	176.27	76.38
133	101.40	196.26	20.00	176.26	76.38
134	50.60	196.35	20.00	176.35	76.42
135	31.75	196.49	20.00	176.49	76.48
136	31.75	196.46	20.00	176.46	76.47
137	31.75	196.55	20.00	176.55	76.50
138	.00	197.11	20.00	177.11	76.75
139	.00	175.37	20.00	155.37	67.33
140	32.80	175.33	20.00	155.33	67.31
141	1033.00	148.14	20.00	128.14	55.53
201	.00	227.22	70.00	157.22	68.13
202	.00	372.00	135.00	237.00	102.70
203	.00	228.52	130.00	98.52	42.69
204	.00	227.26	80.00	147.26	63.81
205	.00	225.21	102.00	123.21	53.39
206	.00	220.15	175.00	45.15	19.57
207	.00	225.27	175.00	50.27	21.78
208	.00	225.27	175.00	50.27	21.78
209	.00	220.08	175.00	45.08	19.54
210	.00	219.79	175.00	44.79	19.41
211	.00	227.22	208.00	19.22	8.33
212	.00	219.56	175.00	44.56	19.31

213	.00	275.30	175.00	100.30	43.46
214	.00	275.13	175.00	100.13	43.39
215	.00	274.89	175.00	99.89	43.29
216	.00	255.51	130.00	125.51	54.39
217	8333.00	254.03	215.00	39.03	16.91
218	12500.00	222.80	215.00	7.80	3.38
240	531.50	215.82	95.00	120.82	52.35

M A X I M U M   A N D   M I N I M U M   V A L U E S

P R E S S U R E S

JUNCTION NUMBER	MAXIMUM PRESSURES (psi)	JUNCTION NUMBER	MINIMUM PRESSURES (psi)
202	102.70	218	3.38
18	84.23	211	8.33
12	82.94	217	16.91
78	81.00	212	19.31
19	79.65	210	19.41
104	79.63	209	19.54
105	79.49	206	19.57
28	79.39	10	19.63
106	79.19	207	21.78
111	78.98	208	21.78

V E L O C I T I E S

PIPE NUMBER	MAXIMUM VELOCITY (ft/s)	PIPE NUMBER	MINIMUM VELOCITY (ft/s)
221	7.39	172	.01
222	7.39	186	.01
213	7.37	52	.01
214	7.37	242	.05
215	7.37	96	.07
192	6.80	97	.09
194	6.59	243	.10
230	5.67	104	.12
225	5.63	30	.13
23	5.03	35	.13

S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

(+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
(-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

PIPE NUMBER	FLOWRATE (gpm)
1	6973.67
6	1320.45
23	21732.33
203	.00
209	2462.12
240	2318.29

NET SYSTEM INFLOW = 34806.85
NET SYSTEM OUTFLOW = .00
NET SYSTEM DEMAND = 34806.85

**** KYPIPE SIMULATION COMPLETED ****

DATE: 11/16/2006
TIME: 8:47: 0

Appendix D

Water Line Tunnel Under H-1 Freeway
For the
Hoopili Project

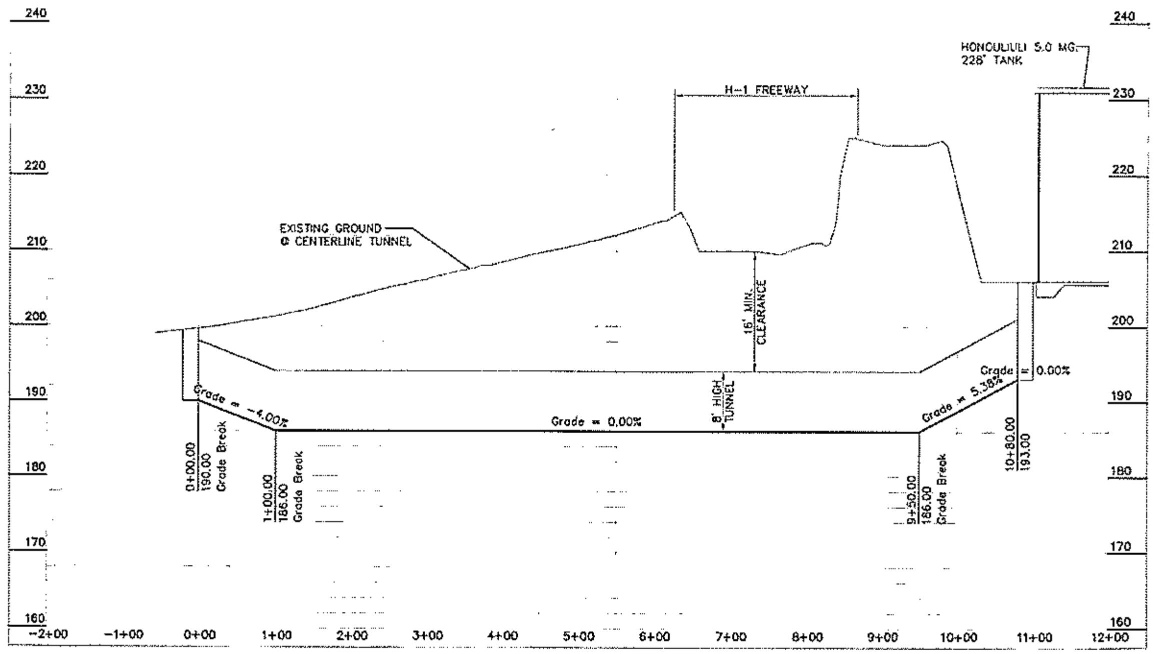
The Hoopili project proposes to construct a tunnel under the H-1 Freeway to deliver water from both the 228 and 440 storage systems to the Hoopili project boundaries. This corridor will be used if there is insufficient space within the Honouliuli Gulch crossing. The Honouliuli Gulch crossing contains BWS water lines delivering water from the existing BWS 228 and 440 storage systems.

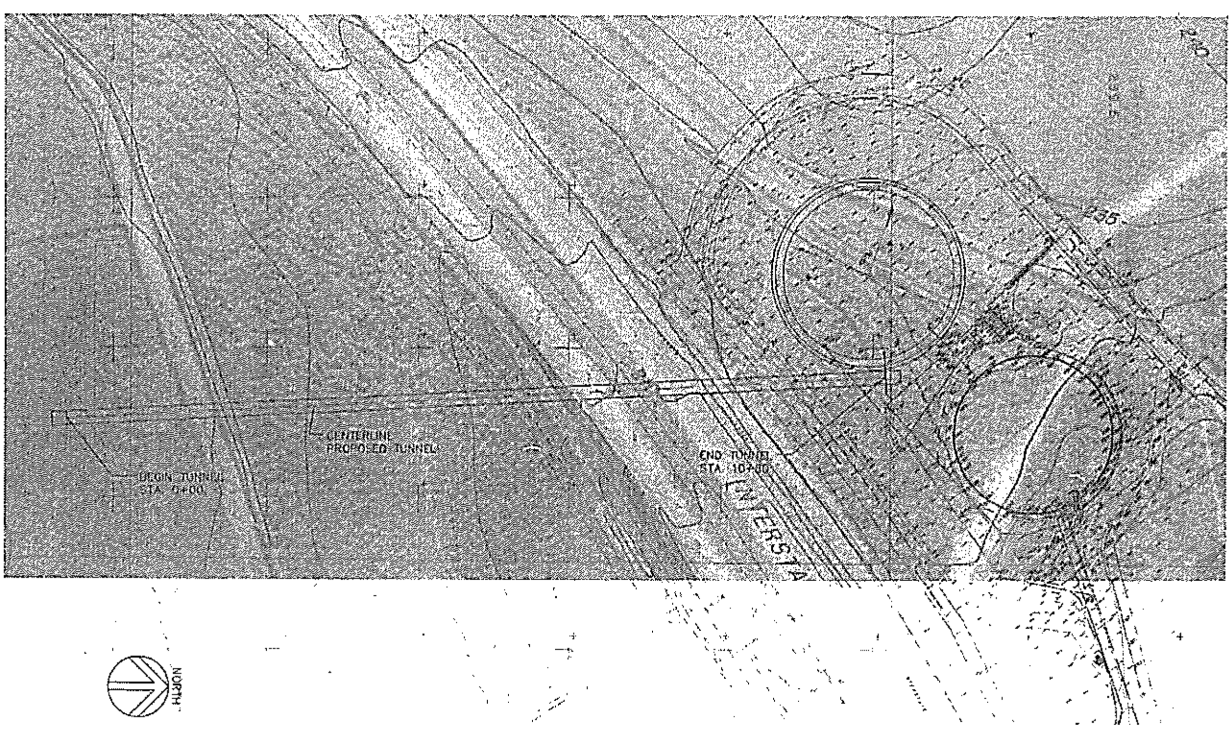
A plan and profile of the tunnel is contained on the exhibits within this appendix. The tunnel will have a mauka terminus in the existing Honouliuli 228 Reservoir site and the makai terminus in the mixed use industrial area of the Hoopili project. A typical section is also shown.

Two options exist for construction. One would be micro-tunneling and the other would be conventional well construction.

Once constructed, the water system (including the tunnel) would be dedicated to the Board of Water Supply.

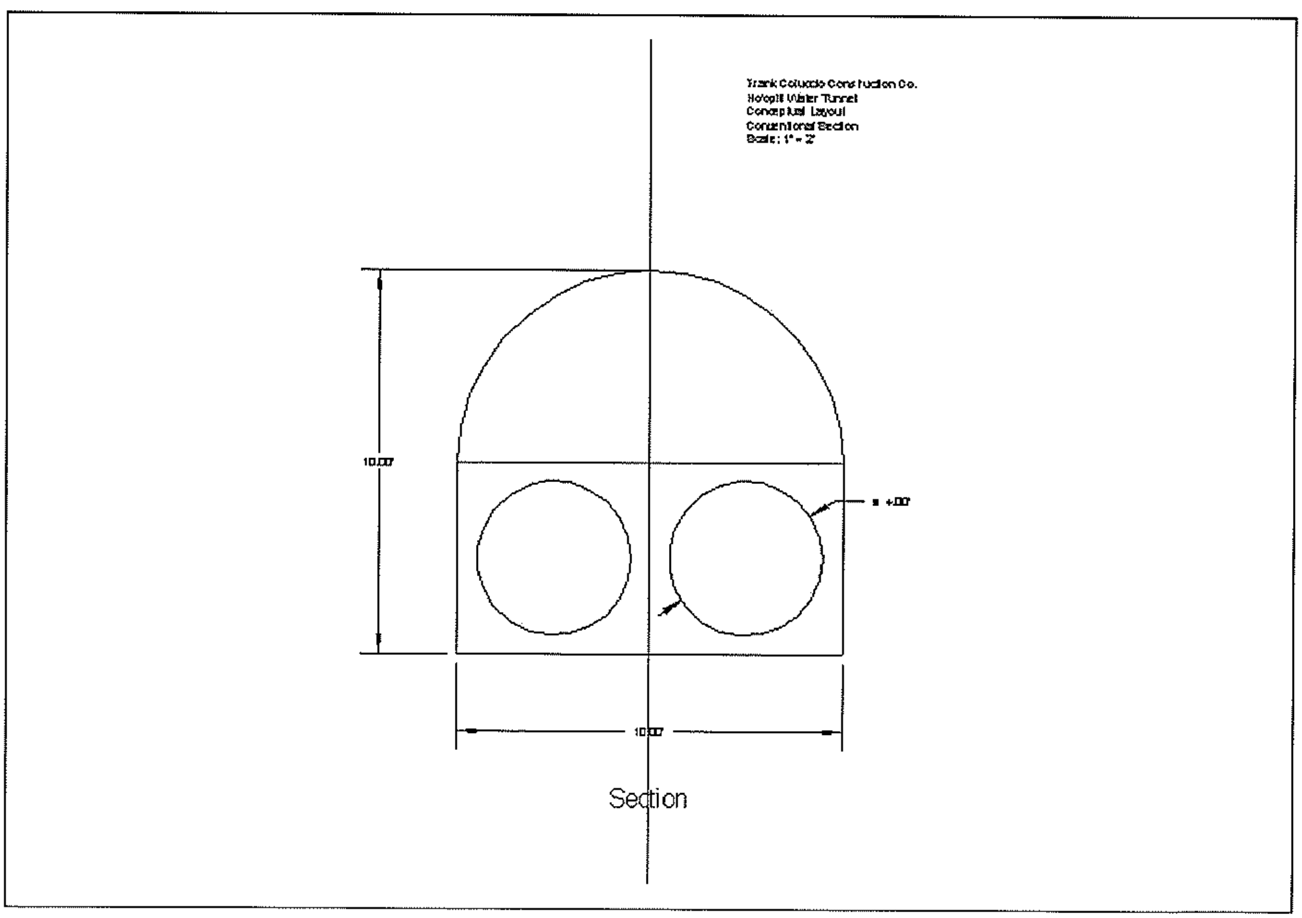
An easement or access permitted designation would be required form the State of Hawaii Department of Transportation. Ongoing discussions exploring the easement/access permitted designation have been occurring.





PLAN

POSSIBLE TUNNEL ALIGNMENT FROM HONOULIULI 228' TANK BENEATH H-1 FREEWAY


Frank Coluccio Construction Co.
Holopili Water Tunnel
Conceptual Layout
Conventional Section
Scale: 1" = 2'
10.00'
± 4.00'
10.00'
Section

Appendix N
Preliminary Wastewater Collection System Master Plan

PRELIMINARY WASTEWATER COLLECTION SYSTEM MASTER PLAN

FOR

HO'OPILI

HONOULIULI, 'EWA, O'AHU, HAWAI'I
TMK: (1)9-1-017: POR. 004, 059, 072;
(1)9-1-018: 001, 004

NOVEMBER 2007

BILLS ENGINEERING INC.
Civil/Environmental Engineering
1124 Fort Street Mall, Suite 200
Honolulu, Hawai'i 96813-2715
Telephone No: 808.792.2022
Fax No: 808.792.2033
General Email: info@BillsEngineering.com
www.BillsEngineering.com

PRELIMINARY WASTEWATER COLLECTION SYSTEM MASTER PLAN

FOR

HO'OPILI

TMK: (1) 9-1-017: POR. 004, 059, 072;
(1)9-1-018: 001, 004
HONOULIULI, 'EWA, O'AHU, HAWAI'I

NOVEMBER 2007

DAVID B. BILLS
LICENSED PROFESSIONAL ENGINEER
No. 4516-C
HAWAII, USA

THIS WORK WAS PREPARED
BY ME OR UNDER MY SUPERVISION.

SIGNATURE
Expiration Date: 4-30-08

PREPARED BY:

BILLS ENGINEERING INC.
Civil/Environmental Engineering
1124 Fort Street Mall, Suite 200
Honolulu, Hawai'i 96813

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LIST OF FIGURES

APPENDICES

SECTION 1. BACKGROUND INFORMATION

D. R. Horton-Schuler Division ("Schuler") intends to develop approximately 1,555 acres of land in 'Ewa over the next 25 to 30 years. The project will be called Ho'opili. The Ho'opili project is generally bound by the H-1 Freeway to the north, proposed North-South Road to the west, Ewa Villages to the south and Old Fort Weaver Road/Fort Weaver Road to the east. Figure 1 - Ho'opili Site Plan illustrates the project and how it is situated on the Ewa plain. The other notable projects being developed in the immediate vicinity are Department of Hawaiian Homeland ("DHHL") properties and the University of Hawai'i West Oahu ("UHWO") campus. Ho'opili and other neighboring projects in the area are shown on Figure 1.

The Ho'opili project is anticipated to provide housing and commercial space as listed below:

Housing Units:	11,750 (Single Family, Multi-Family and Apartment)
Commercial Space:	
Retail	2,240,000 Square Feet
Office	720,000 Square Feet
Industrial	800,000 Square Feet
Developable Acres (Minus Schools/Parks/ Roads/Open Space)	1,130 Acres

The Ho'opili project is at the beginning of the development path. The current State land use designation is agricultural and a petition will be processed with the State Land Use Commission to change the designation of the land from agricultural to urban. Subsequent steps in the development process will be the submittal and processing of a change of zone application with the City and County of Honolulu. Upon successful completion of the State Land Use petition process and change of zoning, actual development (subdivision work and physical improvements) could commence. A general time frame for the project is outlined below:

State Land Use Petition and City Change of Zone	3-5 years (Starting in 4th Quarter 2006 ending 2010)
Incremental Development initiated through subdivision actions	20-25 years (Starting 2010 and ending 2035)

This wastewater collection system master plan has been prepared for the Ho'opili project in order to support the development process and to assist reviewing technical agencies (Department of Planning and Permitting and the Department of Wastewater Management).

SECTION 2. EXISTING CONDITIONS

The major municipal sewage system features that exist in the project area are the Honouliuli Wastewater Treatment Plant (WWTP) and trunk sewers transmitting sewage from points farther west to the Honouliuli WWTP. The existing treatment plant capacity is 35 MGD. The current average daily flows are approximately 27 MGD. The trunk sewer system is made up of the Makakilo Interceptor Sewer and the recently completed Kapolei Interceptor Sewer. Figure 2 - Existing Sewer System Plan shows these municipal sewage system features in relation to the project site and proposed development in the immediate vicinity.

It should be pointed out that development in the immediate project area has been contemplated in various forms over the past decade. This portion of the Ewa Plain has long been the designated site for the University of Hawai'i West Oahu campus as well as for DHHL property development. In the mid 1990's Schuler explored development of 660 acres of the Ho'opili property (East Kapolei Project) and prepared an EIS to support a Land Use petition.

Because of that earlier planning, the existing conditions plan, as shown on Figure 2, shows a sewer stub on the recently completed Kapolei Interceptor at the proposed North/South Road intersection. This stub was to accommodate future growth to the north and, particularly, DHHL and UHWO lands. The Kapolei Interceptor was designed to accept a "future" flow having an equivalent population of 38,975 people, encompassing an area of 1,409 acres and a peak flow of 9.45 million gallons per day (MGD).

There are other existing municipal sewage collection features in the area. These include trunk sewers in Fort Weaver Road/Geiger Road delivering sewage from properties to the east and south into the Honouliuli WWTP. However, since there are no planned connections to this part of the existing sewage collection infrastructure, these systems have been omitted from the existing conditions plan (Figure 2).

SECTION 3. PROPOSED CONDITIONS

Ho'opili, UHWO and DHHL plan to develop a sewer corridor extending from the existing sewer stub on the Kapolei Interceptor at North/South Road (see Figure 2) and extending the gravity sewer system in a northerly direction generally following North/South Road to collect sewage from all three projects and deliver the sewage to the Honouliuli WWTP. The proposed system is shown on Figure 3 - DHHL Sewer System.

Transmission to the Honouliuli WWTP will require one of two upgrades to the existing sewer corridor:

1. Construct a third interceptor, alongside the 30" Makakilo Interceptor and 42" Kapolei Interceptor. Figure 4 - Sewer Corridor Typical Section shows a preliminary location for the new interceptor. The three lines will be connected to create a manifold system capable of distributing flow between the lines. Size and actual location of the line will be determined as planning progresses.

2. Construct a third interceptor, alongside the 30" Makakilo Interceptor and 42" Kapolei Interceptor, with the intention of abandoning the 30" Makakilo Interceptor. This line would be larger than that proposed in option 1 above, and would be sized to accommodate the additional flows from DHHL, UHWO, Ho'opili and other future projects, such as Makaiwa Hills. Size of the line will be determined as planning progresses.

The Ho'opili project is made up of three sewer zones as shown on Figure 5 - Ho'opili Sewer Zones. Sewer Zone 1 is approximately 925 acres and is located on the site's west side. Zone 2 is approximately 375 acres and borders the east side of Zone 1 and Old Fort Weaver Road. Zone 3 is located on the project's northeastern corner, east of Honouliuli Stream and is approximately 205 acres. See Appendix A - Preliminary Wastewater Calculations for computed flows for each of the three zones.

Zone 1 will gravity flow to the Main Trunk Sewer to Honouliuli WWTP with a design peak flow of 9.2 MGD. This main trunk sewer is a part of the DHHL sewer system shown on Figure 3. See Appendix B - Wastewater Calculations from "Wastewater Master Plan for East Kapolei" dated June 2006.

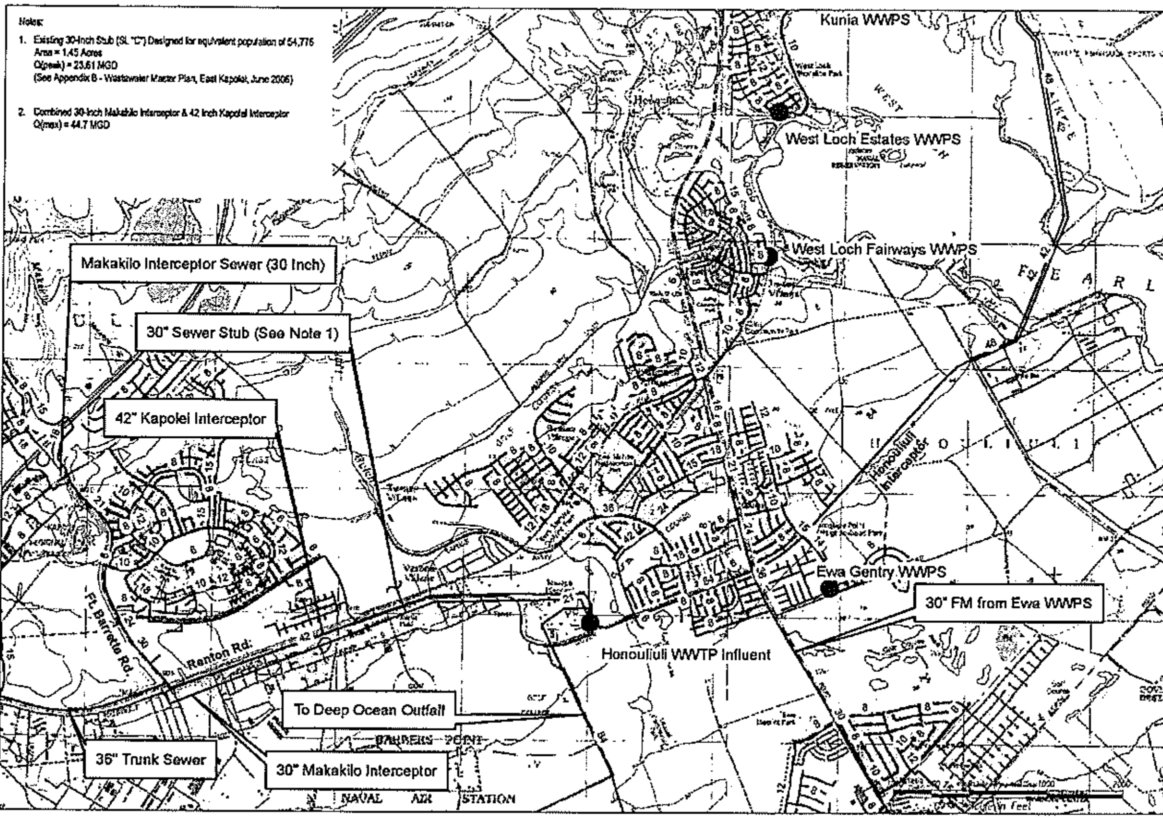
Zone 2 sewage will gravity flow to the proposed Ho'opili SPS, where it will then be lifted to Zone 1. Peak design flow is approximately 2.0 MGD.

Zone 3 has a design peak flow of 1.6 MGD. This area will gravity flow to the Kunia SPS, eventually connecting to the Waipahu SPS. Adequacy of the existing infrastructure will be determined as planning progresses.

An alternative option to provide sewer service for Zone 3 is to install a sewage pump station and lift sewage to the mauka end of Zone 2. The Zone 2 gravity system would be sized to transport all sewage to the Zone 2 sewage pump station and subsequently lifted to the main trunk sewer in Zone 1.

SECTION 4. ULTIMATE TREATMENT AND DISPOSAL

The project area is within the service limits of the City's Honouliuli Wastewater Treatment Plant service (WWTP) area. The "West Mamala Bay Facilities Plan" prepared for the City and County of Honolulu (Wilson Okamoto and Associates, Inc. and Brown and Caldwell Consultants, 2001) identifies the future flows from the total service area identified in Figure 1. The 2020 capacity of the Honolululi is anticipated to be 51 MGD. The project will be contributing funds towards planned expansions to the treatment plant facilities by payment of Sewer Facility Charges.

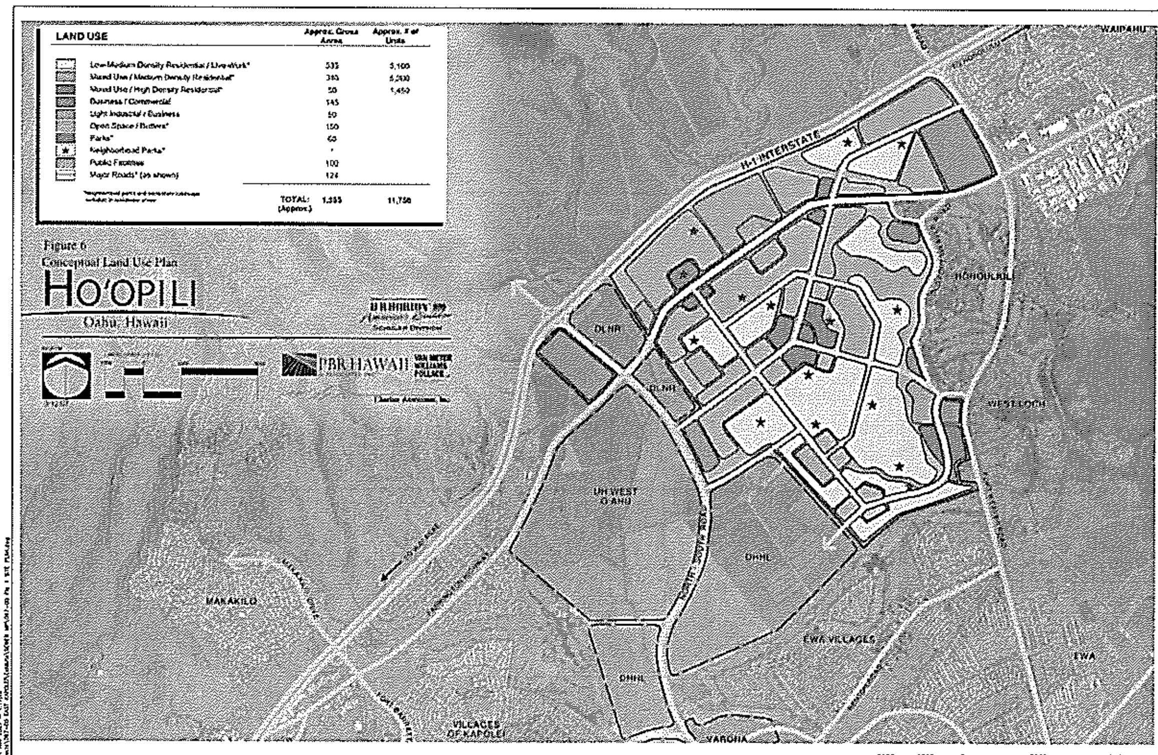


HO'OPILI
SEWER MASTER PLAN
EXISTING SEWER SYTEM PLAN

Bills Engineering Inc.
Civil/Environmental Engineering
1124 Fort Street Mall, Suite 200
Honolulu, HI 96813

CADD: 057-00
SCALE: 1" = 1000'
DATE: Oct 16, 2006

FIGURE
2



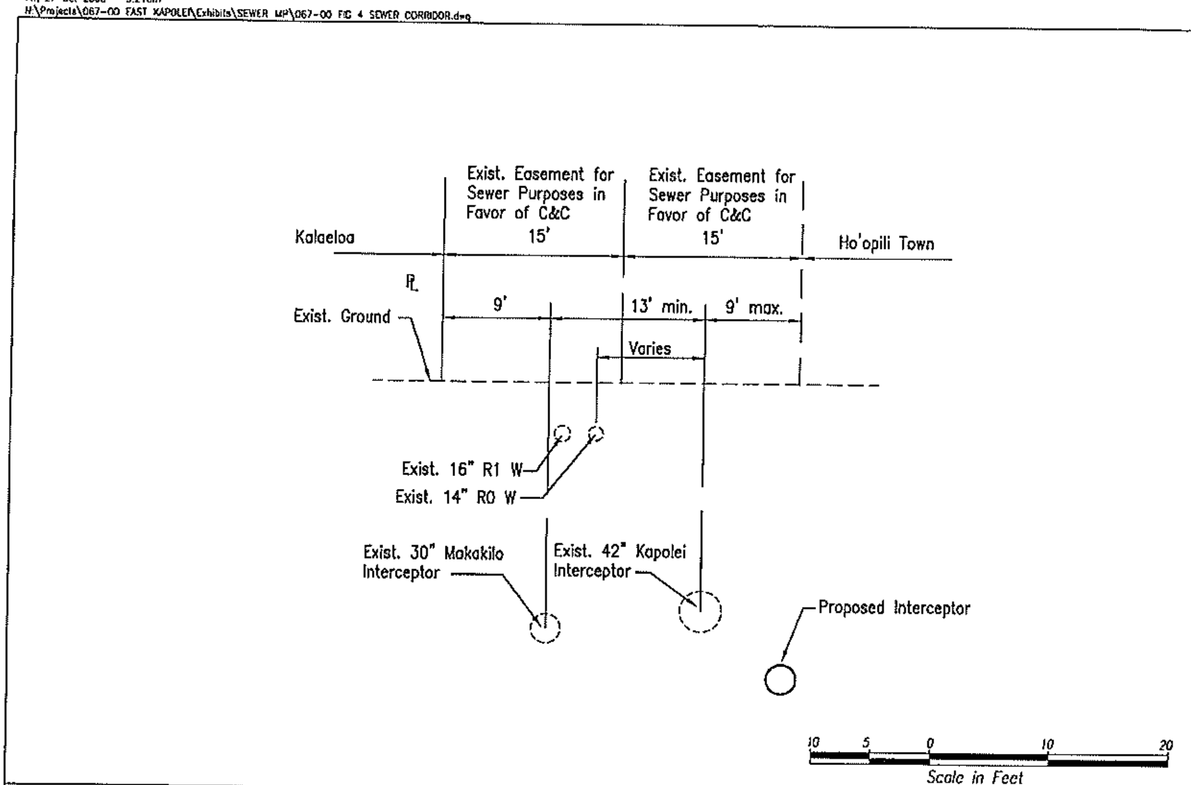
HO'OPILI
SEWER MASTER PLAN
SITE PLAN

Bills Engineering Inc.
Civil/Environmental Engineering
1124 Fort Street Mall, Suite 200
Honolulu, HI 96813

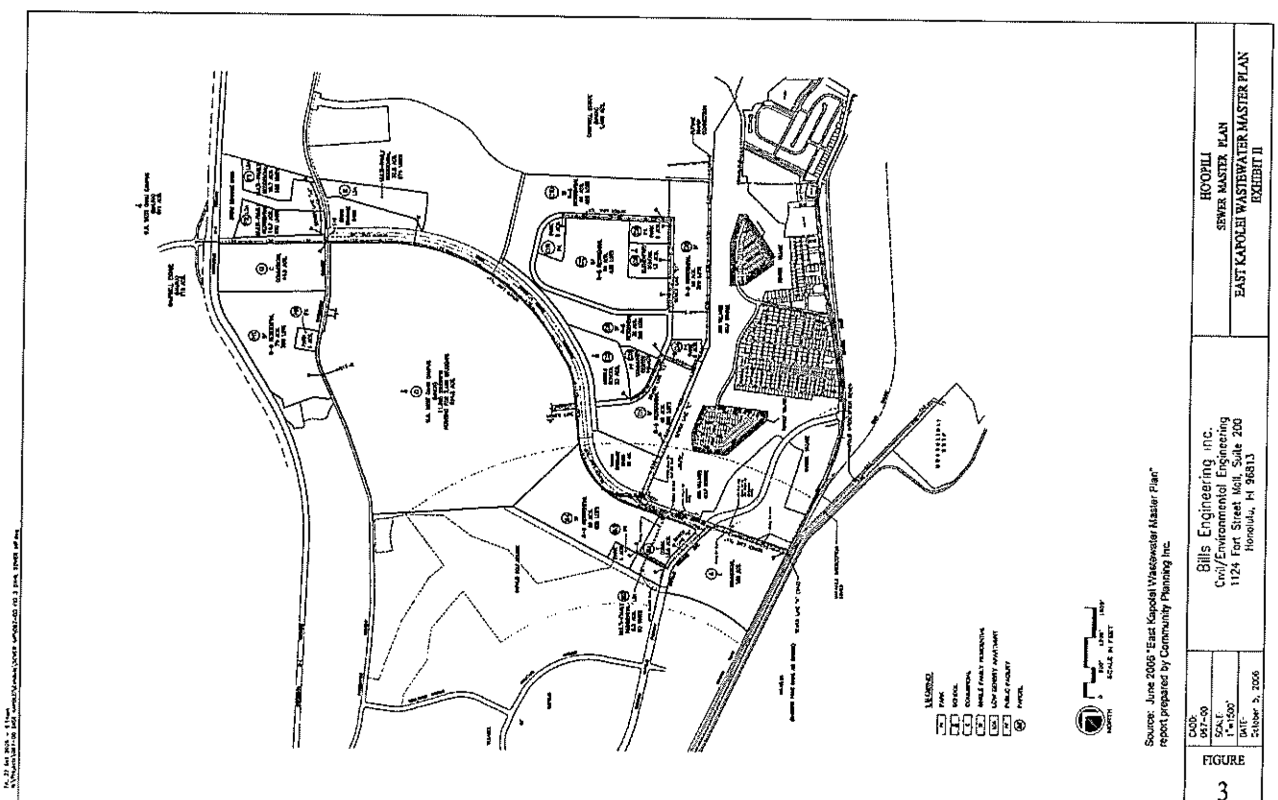
CADD: 057-00
SCALE: 1"=2000'
DATE: November 2007

FIGURE
1

Fri, 27 Oct 2006 - 9:21am
H:\Projects\067-00 EAST KAPOLEI\Exhibits\SEWER MP\067-00 FIG 4 SEWER CORRIDOR.dwg



CADD: 067-00	Bills Engineering Inc.	HO'OPILI	FIGURE
SCALE: 1"=10'	Civil/Environmental Engineering	SEWER MASTER PLAN	4
DATE: Oct. 5, 2006	1124 Fort Street Mall, Suite 200 Honolulu, HI 96813	SEWER CORRIDOR TYPICAL SECTION	



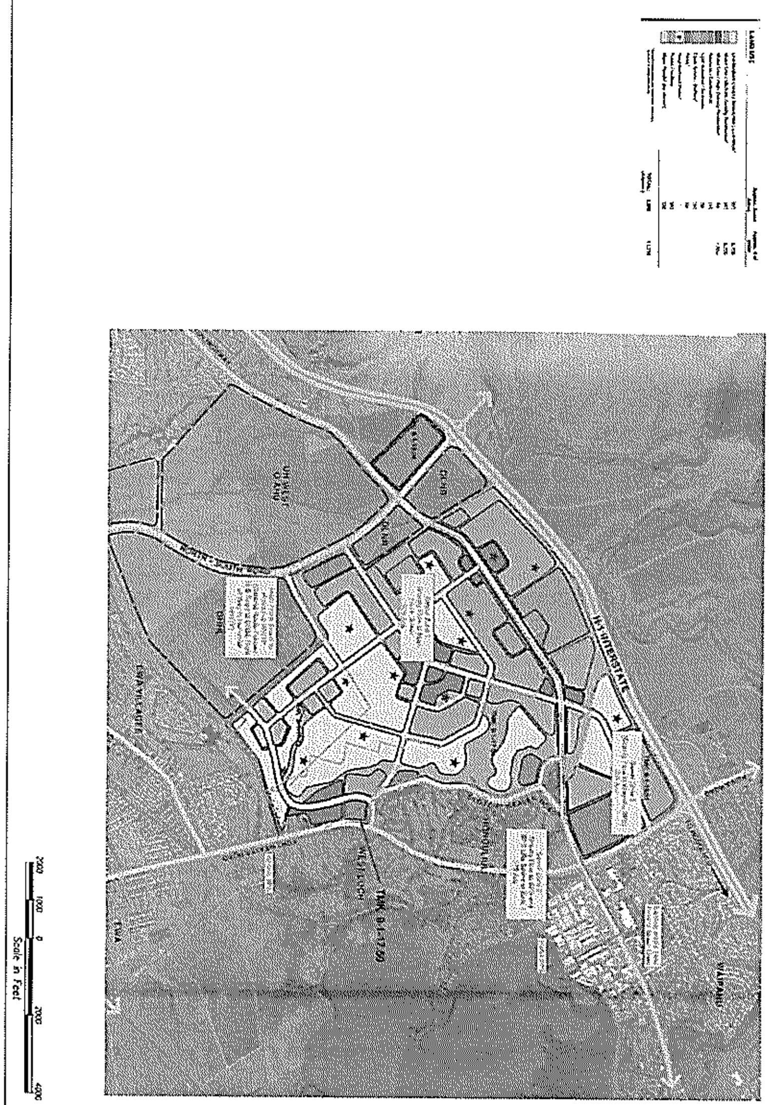


FIGURE 5	CADD: 067-00 SCALE: AS NOTED DATE: November 2007	Bills Engineering Inc. Civil/Environmental Engineering 1124 Fort Street Mall, Suite 200 Honolulu, HI 96813
		HO'OPILI SEWER MASTER PLAN SEWER ZONES

APPENDIX A
Preliminary Wastewater Calculations

Sewer Location: District Zone or Street	Point	Unit	Multiplier	Tributary Area (Acres): Incr.	Tributary Area (Acres): Total	Tributary Equivalent Population: Residential 1/ Incr.	Residential 1/ Total	Other 2/ 3/ Incr.	Other 2/ 3/ Total	Total Incr.	Total Total	Ave. WWF (MGD)	Maximum Flow Factor	Maximum Flow (mgd)	Dry Weather Infiltration (mgd)	Design Average Flow (mgd)	Design Maximum Flow (mgd)	Wet Weather Infiltration (mgd)	Design Peak Flow (mgd)	Design Peak Flow (cfs)
ZONE 2	RESIDENTIAL (1,243 UNITS)	1,243	4			4972	4,972					0.398								
	RETAIL (327,034 SF)	327,934	0.007					2,186				0.055								
	OFFICE (215,285 SF)	215,285	0.007					1,435				0.036								
	INDUSTRIAL (0 SF)	-	0.005					-				-								
				317.00	317.00	4,972	4,972	3,621	3,621	8,593	8,593	0.488	3.2519	1.5879	0.0430	0.5313	1.6309	0.3963	2.0271	3.1362

1. RESIDENTIAL - 4 PN/UNIT * 80 GPCD
2. RETAIL/OFFICE - 150 SF/PN 25 GPCD
3. INDUSTRIAL - 200 SF/PN 25 GPCD

Sewer Location: District Zone or Street	Point	Unit	Multiplier	Tributary Area (Acres): Incr.	Tributary Area (Acres): Total	Tributary Equivalent Population: Residential 1/ Incr.	Residential 1/ Total	Other 2/ 3/ Incr.	Other 2/ 3/ Total	Total Incr.	Total Total	Ave. WWF (MGD)	Maximum Flow Factor	Maximum Flow (mgd)	Dry Weather Infiltration (mgd)	Design Average Flow (mgd)	Design Maximum Flow (mgd)	Wet Weather Infiltration (mgd)	Design Peak Flow (mgd)	Design Peak Flow (cfs)
ZONE 1	RESIDENTIAL (9,747 UNITS)	9,747	4			38988	38,988					3.119								
	RETAIL (1,249,136 SF)	1,249,136	0.007					8,328				0.208								
	OFFICE (81,437 SF)	81,437	0.007					543				0.014								
	INDUSTRIAL (800,000 SF)	800,000	0.005					4,000				0.100								
				906.00	906.00	38,988	38,988	12,870	12,870	51,858	51,858	3.441	2.2699	7.8103	0.2593	3.7001	8.0696	1.1325	9.2021	14.2367

1. RESIDENTIAL - 4 PN/UNIT * 80 GPCD
2. RETAIL/OFFICE - 150 SF/PN 25 GPCD
3. INDUSTRIAL - 200 SF/PN 25 GPCD

APPENDIX B
Wastewater Calculations from "Wastewater Master Plan for East Kapolei" dated June 2006

Sewer Location: District Zone or Street	Sewer Location: Point	Unit	Multiplier	Tributary Area (Acres): Incr.	Tributary Area (Acres): Total	Tributary Equivalent Population: Residential 1/ Incr.	Residential 1/ Total	Other 2/ 3/ Incr.	Other 2/ 3/ Total	Total Incr.	Total Total	Ave. WWF (MGD)	Maximum Flow Factor	Maximum Flow (mgd)	Dry Weather Infiltration (mgd)	Design Average Flow (mgd)	Design Maximum Flow (mgd)	Wet Weather Infiltration (mgd)	Design Peak Flow (mgd)	Design Peak Flow (cfs)
ZONE 3	RESIDENTIAL (760 UNITS)	760	4			3040	3,040					0.243								
	RETAIL (642,930 SF)	642,930	0.007					4,286				0.107								
	OFFICE (423,278 SF)	423,278	0.007					2,822				0.071								
	INDUSTRIAL (0 SF)	-	0.005					-				-								
				187.00	187.00	3,040	3,040	7,108	7,108	10,148	10,148	0.421	3.1455	1.3240	0.0507	0.4716	1.3747	0.2330	1.6084	2.4685
	1. RESIDENTIAL - 4 PN/UNIT * 80 GPCD																			
	2. RETAIL/OFFICE - 150 SF/PN 25 GPCD																			
	3. INDUSTRIAL - 200 SF/PN 25 GPCD																			

COMPUTATION OF WASTEWATER FLOW

SEWER: EAST KAPOLEI
DISTRICT: SEWERLINE "B" AND "C"
REFERENCE MAPS:

PAGE: 2 OF 3
COMPUTED BY: DKM
DATE: 5/18/2005

SEWER LOCATION		TRIBUTARY AREA (ACRES)		TRIBUTARY EQUIVALENT POPULATION						WASTEWATER FLOW COMPUTATION								AVERAGE FLOW			MAXIMUM FLOW		SEWER STUDY ___ EXISTING X ULTIMATE					
				RESIDENTIAL		OTHER		TOTAL																				
DISTRICT ZONE OR STREET	PARCEL	INCREMENT	TOTAL	INCREMENT	TOTAL	INCREMENT *	TOTAL	INCREMENT	TOTAL	AVERAGE WWF @ 80 GPCD (MGD)	MAXIMUM FLOW FACTOR	MAXIMUM FLOW (MGD)	DRY WEATHER INFIL (MGD)	DESIGN AVERAGE FLOW (MGD)	DESIGN MAXIMUM FLOW (MGD)	WET WEATHER INFIL (MGD)	DESIGN PEAK FLOW (MGD)	VELOCITY (FPS)	DEPTH (IN)	% FULL	VELOCITY (FPS)	DEPTH (IN)	PIPE DIA. (IN.)	ROUGHNESS	SLOPE (%)	VELOCITY (FPS)	CAPACITY (MGD)	PEAK FLOW CAPACITY (%)
SEWERLINE "B"																												
Single-Family Res.	B4	69	69	1,600	1,600			1,600	1,600	0.128	4.55	0.583	0.008	0.135	0.591	0.066	0.66	1.45	2.86	24%	2.16	6.36	12	0.015	0.28	2.1	1.06	64%
Park	B3	4	73		1,600	20/6		6	1,606	0.128	4.55	0.584	0.008	0.137	0.592	0.091	0.68	1.46	2.86	24%	2.14	6.42	12	0.015	0.28	2.1	1.06	65%
Low-Density Res.	B2	5.3	78.3	168	1,768			168	1,774	0.142	4.46	0.633	0.009	0.151	0.642	0.098	0.74	1.48	3.06	26%	2.19	6.72	12	0.015	0.28	2.1	1.06	70%
Community/Business	B1	13.8	92.1		1,768	1932		1,932	3,706	0.298	3.85	1.141	0.019	0.315	1.159	0.115	1.27	2.46	3.60	30%	3.38	7.68	12	0.015	0.81	3.1	1.56	82%
Sewer "B"			92.1		1,768				3,706	0.298	3.88	1.141	0.019	0.315	1.159	0.115	1.27	2.46	3.60	30%	3.38	7.66	12	0.015	0.81	3.1	1.56	82%
SEWERLINE "C"																												
Single-Family Res.	C6	58	58	1,460	1,460			1,460	1,460	0.116	4.62	0.547	0.007	0.126	0.555	0.075	0.63	1.43	2.76	23%	2.16	6.18	12	0.015	0.28	2.1	1.06	59%
"C1" carry over		167	225	3,400	4,860			3,787	5,267	0.421	3.59	1.511	0.026	0.448	1.537	0.281	1.82	1.75	4.95	28%	2.41	9.81	18	0.015	0.20	2.3	2.63	69%
"C2" carry over		73	298	800	5,660			1,261	6,528	0.522	3.44	1.794	0.033	0.558	1.827	0.373	2.20	1.84	5.58	31%	2.50	10.56	18	0.015	0.20	2.3	2.63	84%
Single-Family Res.	C1	45	343	1,120	6,900			1,120	7,648	0.612	3.33	2.037	0.036	0.650	2.075	0.429	2.50	2.26	5.40	30%	3.02	10.44	18	0.015	0.30	2.8	3.22	78%
Campbell-Makai (FUTURE)		1485	1828	54,775	61,575			54,776	62,423	4.994	2.19	10.923	0.312	5.306	11.235	2.285	13.52	4.21	11.52	32%	5.11	17.46	36	0.013	0.30	5.2	23.81	57%
Sewer "C"			1828		61,575			-	62,423	4.994	2.19	10.923	0.312	5.306	11.235	2.285	13.52	4.21	11.52	32%	5.11	17.46	36	0.013	0.30	5.2	23.81	57%
Park	C11	6	6		-	20/6		6	6	0.000	5.00	0.002	0.000	0.001	0.002	0.010	0.01	0.33	0.20	3%	0.60	0.44	6	0.015	0.28	1.6	0.38	3%
Single-Family Res.	C10	69	77	1,680	1,680			1,680	1,686	0.135	4.50	0.607	0.008	0.143	0.616	0.098	0.71	1.49	2.94	25%	2.18	6.54	12	0.015	0.28	2.1	1.06	67%
Park	C9	8	85		1,680	20/6		6	1,692	0.135	4.50	0.609	0.008	0.144	0.618	0.106	0.72	1.49	2.94	25%	2.18	6.54	12	0.015	0.28	2.1	1.06	69%
Elementary School	C8	13	98		1,680	1200/375		375	2,067	0.165	4.32	0.715	0.010	0.178	0.725	0.123	0.84	1.55	3.30	28%	2.26	7.26	12	0.015	0.28	2.1	1.06	80%
Single-Family Res.	C7	69	167	1,720	3,400			1,720	3,787	0.303	3.83	1.161	0.019	0.322	1.180	0.209	1.39	1.82	4.13	28%	2.55	8.48	15	0.015	0.28	2.4	1.91	73%
Sewer "C1"			167		3,400				3,787	0.303	3.83	1.161	0.019	0.322	1.180	0.209	1.39	1.82	4.13	28%	2.55	8.48	15	0.015	0.28	2.4	1.91	73%
Middle School	C2	23	23		-	1200/375		375	375	0.030	5.00	0.150	0.002	0.032	0.152	0.022	0.18	1.31	1.32	17%	2.04	2.52	8	0.015	0.60	2.3	0.52	34%
Community Center	C3	10	33		-	256/80		80	455	0.036	5.00	0.182	0.002	0.039	0.184	0.041	0.23	1.40	1.44	18%	2.15	3.24	8	0.015	0.60	2.3	0.52	43%
Single-Family Res.	C5	32	65	800	800			800	1,255	0.100	4.78	0.480	0.006	0.107	0.486	0.061	0.57	1.46	2.60	26%	2.14	6.15	10	0.015	0.32	2.0	0.69	82%
Park	C4	8	73		800	20/6		6	1,261	0.101	4.77	0.482	0.003	0.107	0.488	0.091	0.58	1.43	2.65	27%	2.14	6.15	10	0.015	0.32	2.0	0.69	83%
Sewer "C2"			73		800				1,261	0.101	4.77	0.482	0.003	0.107	0.488	0.091	0.58	1.43	2.65	27%	2.14	6.15	10	0.015	0.32	2.0	0.69	83%

REMARKS: * Design criteria population (generating 25 gpcd) converted to an equivalent population (generating 80 gpcd) by multiplying the number in the column by 0.3125
(Example: 1200/375 => 1200 x 0.3125 = 375 equivalent population)

Appendix O

Drainage Master Plan

DRAINAGE MASTER PLAN

FOR

HO'OPILI

HONOULIULI, 'EWA, O'AHU, HAWAI'I
TMK: (1)9-1-017: POR. 004, 059, 072;
9-1-018: 001, 004

NOVEMBER 2007

BILLS ENGINEERING INC.
Civil/Environmental Engineering
1124 Fort Street Mall, Suite 200
Honolulu, Hawai'i 96813-2715
Telephone No: 808.792.2022
Fax No: 808.792.2033
General Email: info@BillsEngineering.com
www.BillsEngineering.com

DRAINAGE MASTER PLAN

FOR

HO'OPILI

TMK: (1)9-1-017: POR. 004, 059, 072;
9-1-018: 001, 004
HONOULIULI, 'EWA, O'AHU, HAWAI'I

NOVEMBER 2007

DAVID B. BILLS
LICENSED PROFESSIONAL ENGINEER
No. 4516-C
HAWAII, U.S.A.

THIS WORK WAS PREPARED
BY ME OR UNDER MY SUPERVISION.

SIGNATURE
Expiration Date: 4-30-08

PREPARED BY:

BILLS ENGINEERING INC.
Civil/Environmental Engineering
1124 Fort Street Mall, Suite 200
Honolulu, Hawai'i 96813

067-00

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APPENDICES

SECTION 1. INTRODUCTION

1.1 Project Location

The Ho'opili project by D. R. Horton-Schuler Division ("Schuler") is located in Honouliuli, 'Ewa, O'ahu. The project site is between 'Ewa Villages and H-1 Freeway, west of Fort Weaver Road, and east of the proposed North-South Road. The development includes TMK: (1)9-1-017: por. 004, 059, 072 and 9-1-018: 001, 004, for a total area of approximately 1,586 acres. (See Figure 1 - Location Map & Project Site Plan.)

The proposed Ho'opili project is a master-planned community with approximately 11,750 residential units. The project will also include commercial and medical office space, parks, and schools.

1.2 Purpose

The purpose of this report is to present the existing and proposed hydrology affecting the project site and to develop a conceptual drainage plan that will demonstrate that storm water can adequately be accommodated to pass through the project site, in conformance with the City and County of Honolulu Drainage Standards.

The second purpose of this report is to present a conceptual plan for compliance with the Water Quality component of the City and County of Honolulu Drainage Standards. All projects in excess of 10 acres must demonstrate that it has reduced the discharge of pollutants to the "maximum extent practicable". Physical methods to demonstrate compliance (detention based water quality control) are proposed.

More detailed drainage studies will be done, as appropriate, to support the various stages of project planning and development.

SECTION 2. EXISTING CONDITIONS

2.1 Existing Topography

The project site is located within the 'Ewa Plain of Leeward O'ahu. The land is presently in agricultural production. The property is relatively flat with elevations ranging from 220 feet above Mean Sea Level (MSL) at the mauka boundary at H-1, to elevation 55 MSL at Fort Weaver Road. The site has an average slope of 1.6% from mauka to makai.

2.2 Flood Insurance Rate Map

The majority of the project site is located in an area designated as Zone D on the Flood Insurance Rate Map (Map No. 15003C220 & 310 F, effective September 30, 2004), where flood hazards are undetermined but possible. Portions of the site are subject to flooding from Honouliuli Stream and are within Zones A, AE and X. (See Figure 2 - Flood Insurance Rate Map.)

2.3 Existing Drainage

The Ho'opili project is within three drainage basins - West Loch, Kalo'i Gulch and Honouliuli. The "Ewa District Runoff Map - Drainage Areas and Peak Flows" prepared by Engineering Concepts, Inc. dated April 3, 1991, identifies the extent of each of these drainage basins. Figure 3 – Ho'opili/'Ewa District Runoff Map shows the map with the proposed Ho'opili project limits superimposed. Figure 4 – Project Drainage Areas, shows how the site is divided between these basins.

West Loch

Approximately 849 acres of the project area lies within the West Loch drainage basin, extending from H-1 Freeway, across Farrington Highway, and down toward the northeast boundary with 'Ewa Village. Runoff within the basin flows along the cane haul road, crossing under Fort Weaver Road, or over Fort Weaver Road in the vicinity just mauka of the Elderly Housing Project (see Figure 4).

The cane haul road is within Easement "2680" and runs through the Asing Park owned by the City and County of Honolulu (TMK: 9-1-17:66). A 54" inlet, located at the low-point takes water through the West Loch Fairways project (design area, A = 31 acres, design discharge, Q = 93 cfs) and discharges through an 84" outlet into the West Loch Fairways golf course (A = 80 acres, Q = 239 cfs). Runoff in excess of the 93 cfs is forced out toward West Loch along the cane haul road. The cane haul road terminates at an existing detention basin built in Schuler's 31-acre parcel (TMK: (1)9-1-010: 002).

The basin was built just southeast of the West Loch subdivision in conjunction with the 'Ewa by Gentry – East project. The basin collects runoff from the Elderly Housing site, a portion of 'Ewa Villages (via two- 54" pipe culverts under Fort Weaver Road), and the site of the future Ho'opili project. The basin is owned and maintained by the City and County of Honolulu. Overflow from the basin sheet-flows toward the West Loch basin of Pearl Harbor.

Onsite storm water basins have been defined from H-1 Freeway as the mauka extent and the basins have been drawn to the exit point of the proposed project (see Figure 4). Basins W1 and W2 represent the drainage areas contributing to West Loch via the Cane Haul Road. The City and County of Honolulu Drainage Standard (Plate 6) was used for this basin since it is over 100 acres. The basins listed as W1A and W1B represent subareas of basin W1 used in the analysis of developed conditions.

Kalo'i Gulch

The entire Kalo'i basin extends from the Wai'anae Range above H-1 Freeway and terminates at the coast in the vicinity of the Ocean Pointe marina. Approximately 102 acres of the project area (areas K8 and K9, on Figure 4) lie within the Kalo'i drainage basin. The areas are adjacent to the proposed North-South Road (TMK: (1)9-1-018: 004 and portion of TMK: (1)9-1-017: 004). Runoff flows in a mauka to makai direction from H-1 Freeway.

Honouliuli

The entire Honouliuli drainage basin is approximately 12.13 square miles in area. It extends from the south slopes of the Wai'anae Range above H-1 Freeway and drains into West Loch, Pearl Harbor. The Honouliuli Stream system is made up of two main branches, the East and West forks, with a confluence just above H-1 Freeway. Below H-1, the flow is confined to Honouliuli Stream.

The "Honouliuli Stream Flood Study for the West Loch Development" dated May 1992, prepared by the R. M. Towill Corporation, established flood boundaries and elevations along the lower Honouliuli Stream floodplain. The study mentioned that the area is prone to relatively frequent flooding due to an accumulation of debris along the stream's narrow and winding course. Channel improvements and clearing done in conjunction with the development of the golf course increased capacity of Honouliuli Stream to carry the 10-year flood. The Fort Weaver Road twin bridges have a 100-year design capacity. (See Figure 2 – Flood Insurance Rate Map.)

Approximately 632 acres of the Ho'opili project (portion of TMK: (1)9-1-018: 001 and portion of (1)9-1-017: 004) are within the Honouliuli drainage basin. The majority of the area is within Zone D, where flood hazards are undetermined but possible. Within TMK: (1)9-1-018: 001 (portions of areas H3 and H4), a strip along Honouliuli Stream is within Zone A and Zone X, areas where no base flood elevations have been determined, and areas of 0.2% annual chance of flood or with 1% annual chance of flood with average depths less than 1 foot, respectively.

The offsite drainage basin, mauka of H-1 Freeway, entering the site is approximately 6,896 acres with a Plate 6 design discharge of 11,200 cfs. The Flood Insurance Study lists a Q_{100} of 7,730 cfs at Farrington Highway.

The onsite basins are shown as H3 – H7 on Figure 4. Areas H5A, H5B, H7A and H7B are subareas used in the analysis of developed conditions.

2.4 Existing Hydrology

The following table summarizes the hydrologic calculations for each onsite basin shown on Figure 4.

TABLE 1. ONSITE DRAINAGE BASIN SUMMARY

Basin	*Area (acres)*	*Q (cfs)*	*Method/comments*
West Loch			
W1	809.5	2,400	Plate 6, Q_{peak}/A = 3 cfs/ac
W2	9.1	11.2	Rational Method Q_{50}/A = 1.2 cfs/ac
	30.8		Detention area (TMK: 9-1-10:02)
	849.4		
Honouliuli			
H3	94.8	83.4	Rational Method Q_{50}/A = 0.9 cfs/ac
H4	78.1	82.5	Rational Method Q_{50}/A = 1.1 cfs/ac
H5	137.8	750	Plate 6, Q_{peak}/A = 5.4 cfs/ac
H6	173.5	750	Plate 6, Q_{peak}/A = 4.3 cfs/ac
H7	148.2	700	Plate 6, Q_{peak}/A = 4.7 cfs/ac
	632.4		
Kalo'i			
K8	50.5	48	Rational Method Q_{50}/A = 0.92 cfs/ac
K9	52.0	48.9	Rational Method Q_{50}/A = 0.97 cfs/ac
	102.5		
Totals	1,584.3*	4,874	*Drainage area exceeds project area due to area contributed by Farrington Hwy.

Rational Method
(See Appendix A – Rational Method, for Tables and Plates)

Basin W2 – 9.1 Acres

Q_{50} = CIA, where
C = 0.2 (Table 1, Band 4, flat farmlands)
I = TM_{50} x Correction Factor for Time of Concentration
TM_{50} = 2.2 in/hr (Plate 2)

Correction Factor = Use Plate 5 for Small Agricultural Basins, where:

Length (L) = 450 Feet
H (Height) = Elevation 62- Elevation 58 = 4 Feet
Slope (S) = 4/450 = 0.89 Ft/Ft

$K = L/S^{1/2}$ = $450/0.0089^{1/2}$ = 4,770

For K = 4,770 and Upper Curve Plate 5,
Time of Concentration = 5.3 Minutes
Correction Factor = 2.8 (Plate 4)

Q_{50} /A = (0.2)(2.8 In/Hr.)(2.2) = 1.2 cfs/ac
Q_{50} = (9.1 ac)(1.2) = 11 cfs

Basin H3 – 94.8 Acres

Q_{50} = CIA, where
C = 0.2 (Table 1, Band 4, flat farmlands)
I = TM_{50} x Correction Factor for Time of Concentration
TM_{50} = 2.2 in/hr (Plate 2)

Correction Factor = Use Plate 5 for Small Agricultural Basins, where:

Length (L) = 3,200 Feet
H (Height) = Elevation 212 - Elevation 107 = 105 Feet
Slope (S) = 105/3,200 = 3.28 Ft/Ft

$K = L/S^{1/2}$ = $3,200 /0.0328^{1/2}$ = 17,669

For K = 17,669 and Upper Curve, Plate 5
Time of Concentration = 14.5 Minutes
Correction Factor = 2.0 (Plate 4)

Q_{50}/A = (0.2) (2.0 in/hr)(2.2)/(A) = 0.88 cfs/ac
Q_{50} = (94.8 ac)(0.88) = 83.4 cfs

Basin H4 – 78.1 Acres

Q_{50} = CIA, where
C = 0.2 (Table 1, Band 4, flat farmlands)
I = TM_{50} x Correction Factor for Time of Concentration
TM_{50} = 2.2 in/hr (Plate 2)

Correction Factor = Use Plate 5 for Small Agricultural Basins, where:

Length (L) = 2,100 Feet
H (Height) = Elevation 189.6 - Elevation 96 = 93.6 Feet
Slope (S) = 93.6/2,100 = 4.46 Ft/Ft

$K = L/S^{1/2}$ = $2,100 /0.0446^{/2}$ = 9,947

For K = 9,947 and Upper Curve, Plate 5
Time of Concentration = 9.3 Minutes
Correction Factor = 2.4 (Plate 4)

Q_{50}/A = (0.2) (2.2 in/hr)(2.4)/(A) = 1.06 cfs/ac
Q_{50} = (78.1 ac)(1.06) = 82.8 cfs

Basin K8 – 50.5 Acres

Q_{50} = CIA, where
C = 0.2 (Table 1, Band 4, flat farmlands)
I = TM_{50} x Correction Factor for Time of Concentration
TM_{50} = 2.2 in/hr (Plate 2)

Correction Factor = Use Plate 5 for Small Agricultural Basins, where:

Length (L) = 2,200 Feet
H (Height) = Elevation 200 - Elevation 150 = 50 Feet
Slope (S) = 50/2,200 = .0227 Ft/Ft

$K = L/S^{1/2}$ = $2,200 /0.0227^{/2}$ = 14,602

For K = 14,602 and Upper Curve, Plate 5
Time of Concentration = 12.6 Minutes
Correction Factor = 2.1 (Plate 4)

Q_{50}/A = (0.2) (2.2 in/hr)(2.1)/(A) = 0.92 cfs/ac
Q_{50} = (50.5 ac)(0.92) = 46.5 cfs

SECTION 3. PROPOSED CONDITIONS

3.1 Increased Runoff from Development

The master plan for the proposed "Ho'opili" project is shown on Figure 5 – Ho'opili Master Plan. The individual basins and sub-basins that were analyzed to create the Master Plan are identified on Figure 4 - Project Drainage Areas. Figure 5 - Drainage Master Plan summarizes the total "after development" conditions. Increased runoff resulting from development has been determined for all areas using the NRCS Method TR-20. Existing and peak flows were calculated for each drainage basin assuming 24-hour rainfall. (See Table 2 - Runoff Increase Summary.)

Runoff will "be limited to predevelopment conditions", in accordance with Section 1-4.1B.3 of the City and County of Honolulu Drainage Standards. Individual developments will be required to provide detention/retention facilities to address both peak storm water runoff rates as well as water quality requirements of the Drainage Standards. The location of the retention/detention basin facilities will be determined during the site planning stage for each area. The one exception to this design criteria will be that runoff that can be directly routed to West Loch and not cause downstream aggravation to property will be allowed to pass at a "fully developed" discharge flow with detention for water quality requirements only. See Table 2 for comparison of runoff for existing and developed conditions. Figure 5 shows preliminary locations for detention/retention areas discussed below.

<u>Kalo'i Basin</u>
For Kalo'i drainage basins (Areas K8 and K9), any increase in runoff will be collected in retention/detention facilities within the two development areas. The retention/detention basin for the K-8 area will discharge to Farrington Highway and the UHWO campus areas at pre-development rates. The discharge from the retention/detention basin for the K9 area will be connected to the North-South Road drainage channel system.

<u>Honouliuli Stream Basin</u>
Area H5 at the corner of Farrington Highway and Fort Weaver Road presently drains to a low point at the southeast corner of TMK: (1)9-1-018: 001. It appears that the runoff ponds within this area until it rises and eventually crosses Fort Weaver Road towards West Loch, Pearl Harbor. Under developed conditions, portions of the Honouliuli drainage basin will be diverted to Honouliuli Stream to alleviate this potential problem, resulting in a decrease in runoff for area H5B. Area H5B is identified as the Waipahu Drainage Basin on the Master Plan (Figure 5).

Under existing and proposed conditions, runoff from Areas H3 and H4 drain towards Honouliuli Stream. Any increase in runoff will need to be addressed by providing onsite detention/retention facilities, with overflow going into Honouliuli Stream.

Runoff from area H6 flows along an existing gully and then sheet flows across existing lots along the West Loch Golf Course (Mauka Phase 1). The runoff gets into Honouliuli Stream once it reaches the golf course. It is proposed that a detention/retention area be created within the existing gully. Overflow will be released at a rate not to exceed the 10-year recurrence interval storm. (This is the recognized capacity of the Honouliuli Stream channel.)

Under existing conditions, the majority of the runoff from area H7 sheet flows across Fort Weaver Road, with a portion of the runoff allowed to pass under Fort Weaver Road via a 48-inch pipe culvert to West Loch Estates. Under developed conditions, runoff from Area H7A (approximately 148 acres) will be collected within the roadway drainage system and piped to the Cane Haul Road, eventually discharging into West Loch. Runoff from Area H7B (approximately 23 acres) will continue to sheet flow across Fort Weaver Road. The net result of drainage improvements proposed by Ho'opili will be a reduction in storm water flow (46 cfs) crossing Fort Weaver Road, passing through West Loch Estates and crossing the Golf Course before ultimately entering the West Loch.

<u>West Loch</u>
Runoff from the West Loch areas (Areas H7A, W1A and W1B) will flow from the project's onsite drainage system into the Cane Haul Road drainage ditch and then into an enlarged detention area near West Loch Fairways Subdivision. The existing detention basin will need to be expanded to cover the 31-acre site to accept flow from the "developed" Ho'opili project. Discharge from the detention basin facilities would then be routed across Navy property to ultimately discharge into the West Loch of Pearl Harbor. The stormwater routing from the detention basin to West Loch would consist of an earth lined trapezoidal channel approximately 80 to 100 feet wide. The channel (from the detention basin to West Loch) would have a maintenance roadway and security fencing.

A plan was developed by Gentry in the mid 1990's to allow a similar detention basin and overflow channel to West Loch. Gentry entered discussions with the Navy but no agreements were made. The Gentry 1990's plan is shown on Figure 6 – Proposed West Loch Detention Area as the background of the current plan. The current plan minimizes the amount of Navy land potentially impacted. A Figure 6A is also presented that provides for a concrete channel overflow. The concrete channel overflow is being considered as a "lowest maintenance" option that would be more attractive to the City for dedication purposes.

The plan presented in this drainage analysis shows storm water runoff from the West Loch drainage basin entering the makai detention area with an overflow to West Loch across Navy property. The concept can readily be expanded to also include Gentry properties to the west of Fort Weaver Road by adding detention on Gentry property adjacent to the 31 acre makai detention area and widening the overflow channel. Consultation with Gentry has confirmed this option may be explored. The current Gentry plan to meet City and County of Honolulu Drainage standards for their properties west of Fort Weaver Road is to excavate depressions capable of storing 100-year 24-hour rainfall events. This plan reduces the land Gentry's land area available for development and encumbers it with large depressions.

Crossing Navy property will require approval of the U. S. Navy. Resolving issues regarding security and maintenance (private vs. City and County) will be paramount. The alternative to the concept shown on Figure 6 is complete retention of a 100-year 24-hour storm on the Ho'opili project property. This would include the 31-acre detention site shown on Figure 6 as well as a portion of the project currently planned for residential housing. The volume required to retain a 100-year 24-hour storm is 34 acre-feet.

TABLE 2. RUNOFF INCREASE SUMMARY

Basin	Area (acres)	Developed Area (acres)	Existing Peak Runoff (cfs)	Developed Peak Runoff (cfs)	Change (cfs)	Storm Water Quality Requirement WQDV = C(1")A(3,630) (Acre-ft)	Preliminary Basin Design Dimensions/ Peak flow /Vol (cfs/Acre-ft)
West Loch							
W1							
W1 (Exist.)	809.5		306.52				
W1A & W1B		809.5		1201.53	895.01	33.7	
W2	9.1	9.1	11.0	21.35	10.35	0.4	
TMK: 9-1-010:2	30.8	30.8	-	-	-	Detention area	700'x400'x8.4'/ 195 cfs/57 AF
Total (West Loch)	849.4	849.4	317.52	1222.88	905.36	35.4	
Honouliuli							
H3	94.8	94.8	83.81	217.59	133.78	4.0	140'x100'x9.3'/ 68 cfs/8 AF
H4							
H4 (Exist.)	78.1		91.12				
H4 & H5A		183.1		357.19	266.07	7.6	300'x300'x7.8'/ 74 cfs/18 AF
H5							
H5A & H5B (Exist.)	137.8		114.4				
H5B		32.8		75.48	-38.92	1.4	100'x100'x7.9'/ 36 cfs/3 AF
H6	173.5	173.5	144.92	217.07	72.15	7.2	250'x250'x7.8'/ 142 cfs/13 AF
H7							
H7 (Exist.)	148.2		99.05				
H7A		125.2		236.87		5.2	250'x250'x7.8'/ 71 cfs/11 AF
H7B		23		52.93	190.75	1.0	100'x100'x6.3'/ 23 cfs/2 AF
Total (Honouliuli)	632.4	632.4	533.3	1134.59	601.29	26.4	
Kalo'i							
K8	50.5	50.5	49.31	108.13	58.62	2.2	150'x150'x6.9'/ 45 cfs/4 AF
K9	52.0	52.0	48.36	110.32	61.96	2.1	150'x150'x6.7'/ 48 cfs/4 AF
Total (Kalo'i)	102.5	102.5			120.78	4.3	
Totals	1,584.3	1,584.3					

3.2 Onsite Drainage System

All runoff from the project lots and roadway system will be collected by swales and roadway catch basins. The drainage system will include catch basins, drain manholes and drain lines. All improvements will be designed and constructed in accordance with City and County of Honolulu "Rules Relating to Storm Drainage Standards" dated January 2000.

Hydraulic calculations for the onsite drainage system will be submitted with the construction plans.

3.3 Retention/Detention Facility

The project's detention/retention facilities have two purposes: to reduce the project's peak flow to predevelopment conditions and to provide water quality detention.

The size of the water quality detention facilities will be based on Section 1-5.1C of the Storm Drainage Standards the required volume of runoff to be detained through the water quality detention basin is calculated as follows:

WQDV = C x 1" x A x 3,630

Where, C = 0.05 + (0.009) x (IMP)

Where, IMP = Impervious Area of project expressed as percentage where little or no infiltration occurs. For the purpose of this study, a paved percentage factor of 50 has been used.

C = 0.05 + (0.009) x 50 = 0.50

WQVD = 0.5 x 1" x Area x 3,630 = 1,815 Cubic Feet/Acre (.0417 Acre-feet/Acre)
Table 2 - Runoff Increase Summary identifies the water quality storage requirement for each of the development areas shown of Figure 4.

In addition to the water quality aspect of the project's retention/detention facility, the facility utilizes storage to dampen the project's peak flow. Inflow and outflow hydrographs have been created to size both the basin and the basin's outflow structure, to demonstrate that the basin adequately dampens the peak flow to predevelopment conditions. (See Appendix B – Preliminary TR-20 Calculations.)

3.4 Maintenance of Drainage Facilities

<u>Piped Systems</u>
Piped systems (i.e., drain pipes, catch basins, concrete drainage structures, etc.) will be constructed to meet the requirements of the Drainage Standards and will be dedicated to the City and County oh Honolulu. Drainage features within roadways will be part of the dedicated roadway system. Piped drainage systems created outside the roadway area will be constructed to City and County standards and easements will be created for the piped systems as a part of dedication.

Retention/Detention Basins
Retention/detention basins will be constructed to meet hydraulic requirements of the Drainage Standards. It is the project's intention to dedicate the facilities to the City and County of Honolulu. However, it is recognized that the City may require maintenance of these facilities to be retained by the homeowners or property owner associations. Flowage easements will be created for the basins.

The West Loch drainage basin and the makai detention facility may require special consideration. The discharge from the basin is proposed to cross Navy property and the Navy will be particularly concerned about the entity responsible for maintenance. Maintenance by a private company or a property owner association may be unacceptable to the Navy.

Commercial lots, such as Areas K8 and K9, will most likely have their own property owner association(s) and these retention/detention basins will be privately maintained.

SECTION 4. SUMMARY & CONCLUSIONS

1. The Drainage Master Plan for the Ho'opili project demonstrates that proposed development will not adversely affect adjacent property owners and/or existing or proposed downstream development in accordance with the City and County of Honolulu Drainage Standards.

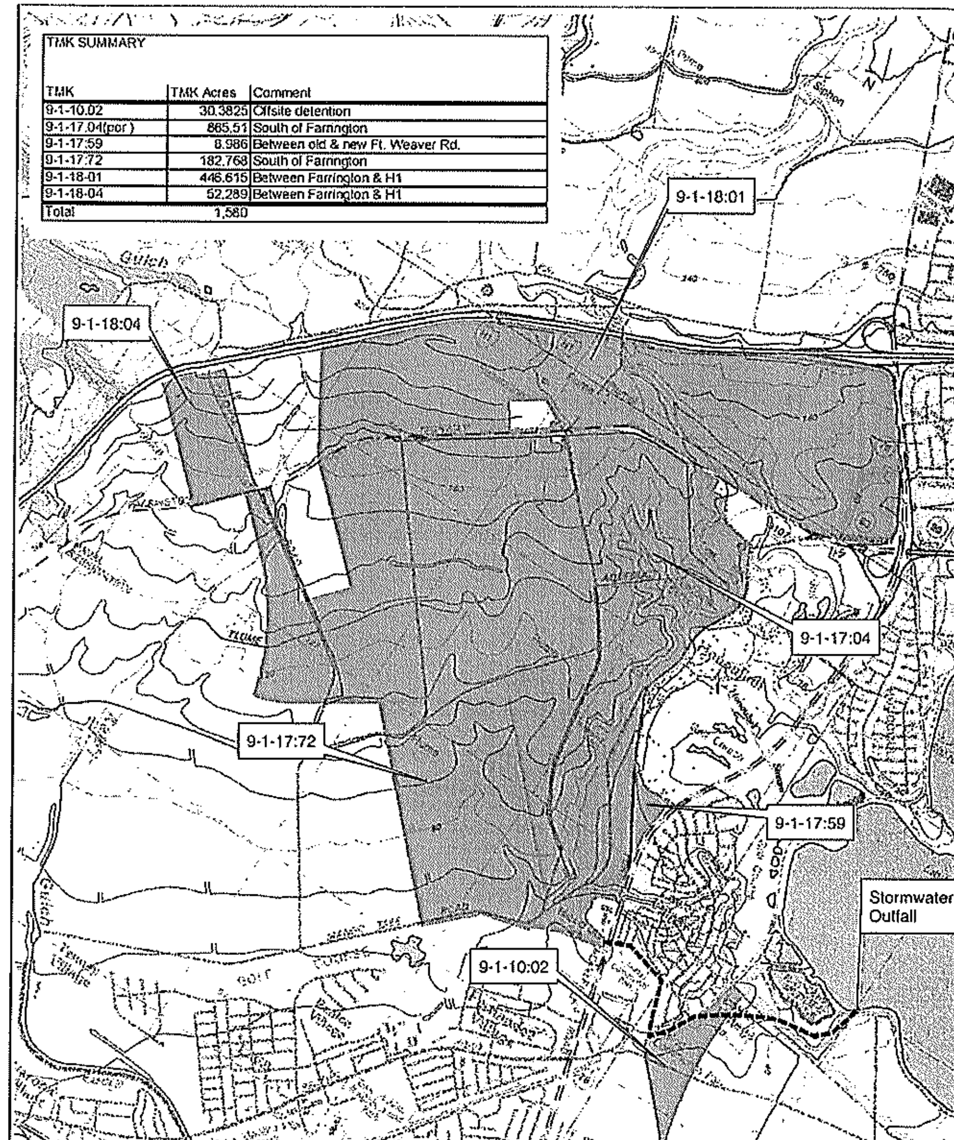
2. This Drainage Master Plan identifies the major components of the overall Ho'opili drainage system with emphasis on the methods and means to address downstream runoff created through urbanization. The master plan will evolve to add more detailed site specific analysis of on-site piping structures at a later date as the plan becomes more developed. However, the methods to address increased runoff will not change significantly.

3. There will be no adverse drainage impacts resulting from development if the principles in this Drainage Master Plan are followed.

4. The Navy has been consulted with respect to the preferred option of having the ultimate discharge enter West Loch. As of this date the Navy has rejected the plan. Therefore, unless the Navy's position can be altered, the primary ultimate drainage solution will be the creation of on-site retention basins capable of storing the 100-year, 24-hour rainfall event.

TMK SUMMARY

TMK	TMK Acres	Comment
9-1-10:02	30.3825	Offsite detention
9-1-17:04(por)	865.51	South of Farrington
9-1-17:59	8.986	Between old & new Ft. Weaver Rd.
9-1-17:72	182.768	South of Farrington
9-1-18:01	446.615	Between Farrington & H1
9-1-18:04	52.289	Between Farrington & H1
Total	1,580	



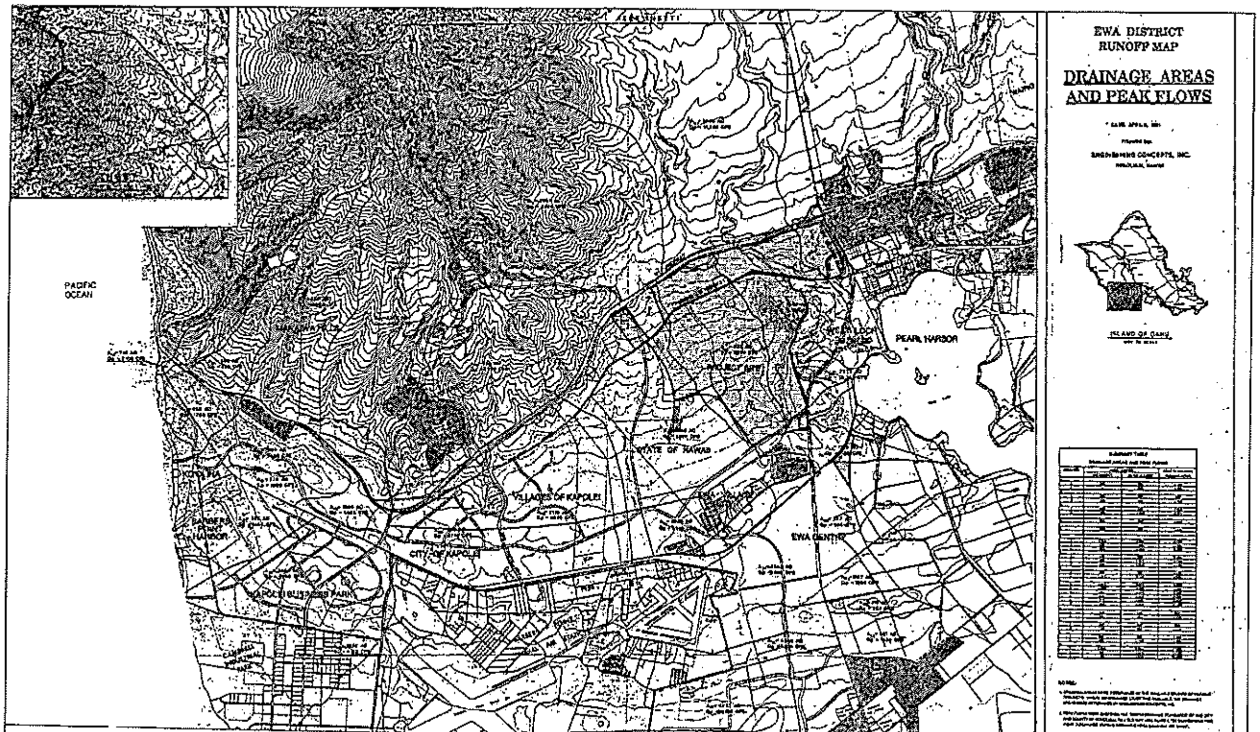
CADD: 067-00
SCALE: 1" = 2000'
DATE: 8/9/6

Bills Engineering Inc.
Civil/Enviromental Engineering
1124 Fort Street Mall, Suite 200
Honolulu, Hi 96813

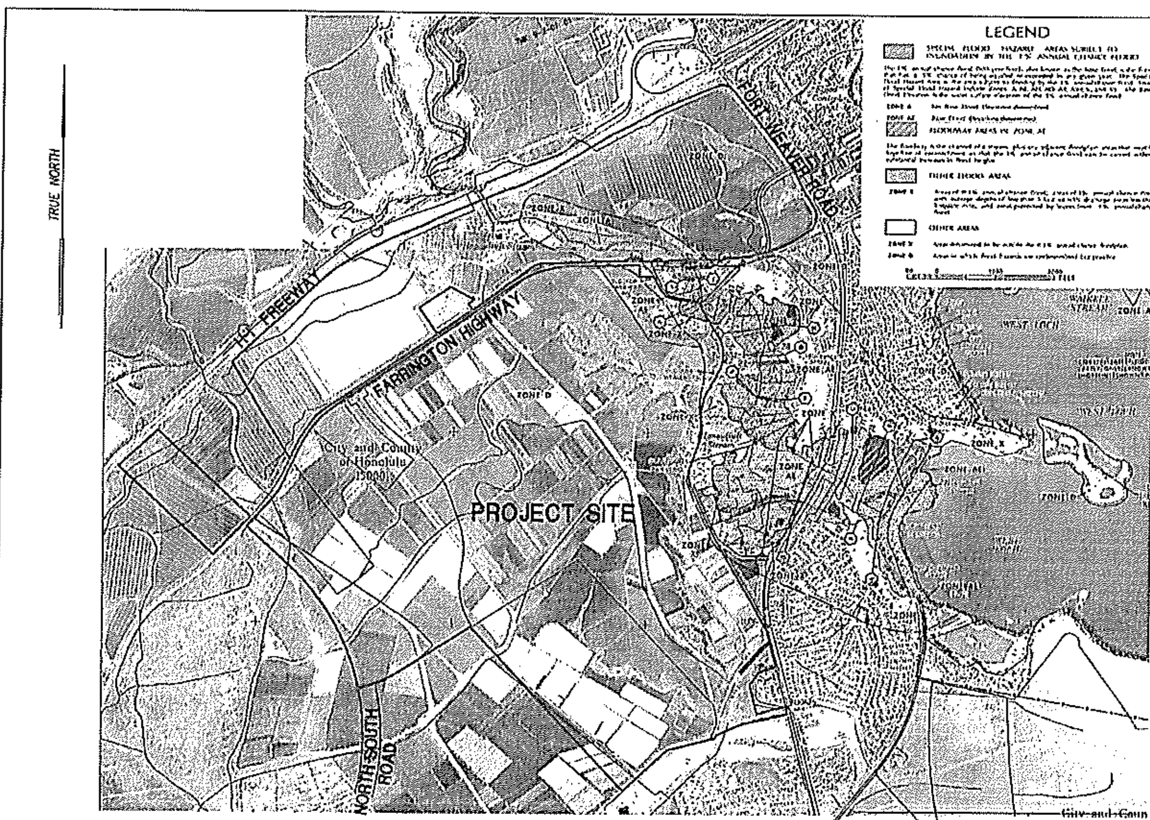
Ho'opili
Drainage Master Plan

Location Map

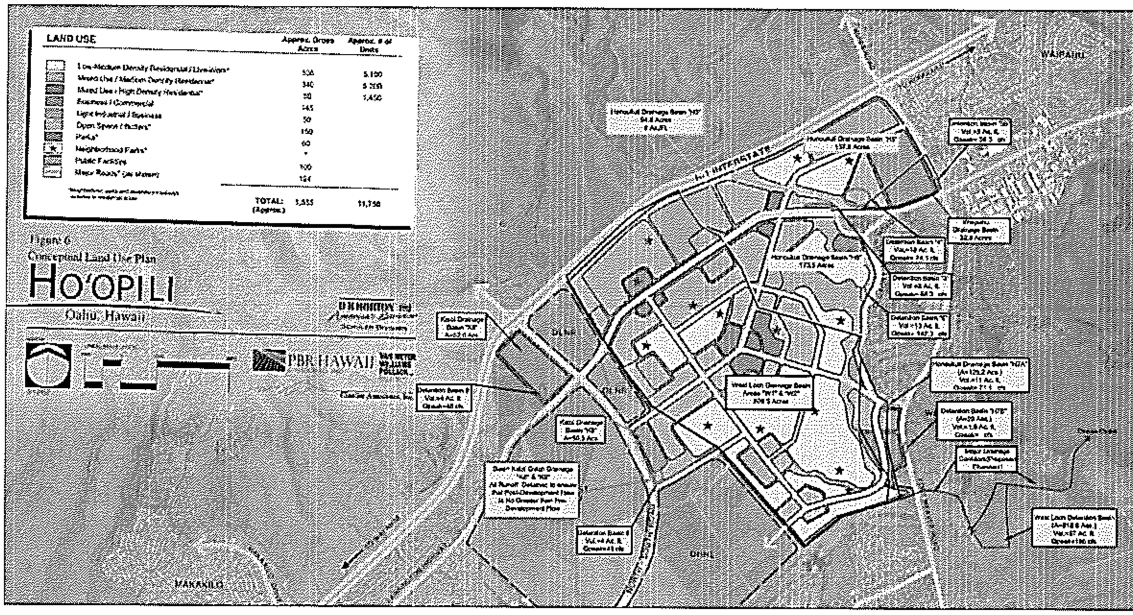
FIGURE 1



	CADD: 067-Figure 3	**Bills Engineering Inc.** Civil/Environmental Engineering 1124 Fort Street Mall, Suite 200 Honolulu, HI 96813	HO'OPILI DRAINAGE MASTER PLAN	FIGURE
	SCALE: SCALE AS SHOWN		HO'OPILI/EWA DISTRICT RUNOFF MAP	3
Fri. 27 Oct 2006 - 10:57am K:\Projects\067-00 EAST KAPOLEI\Exhibits\DRAINAGE MP\FIG 3 Runoff Map.dwg	DATE: Aug 31, 2006			



CADD: 067-00 FIRM	Bills Engineering Inc. Civil/Environmental Engineering 1124 Fort Street Mall, Suite 200 Honolulu, HI 96813	HO'OPILI	FIGURE
SCALE: 1" = 2000'			
DATE: Oct. 27, 2006		FLOOD INSURANCE RATE MAP (FIRM)	2



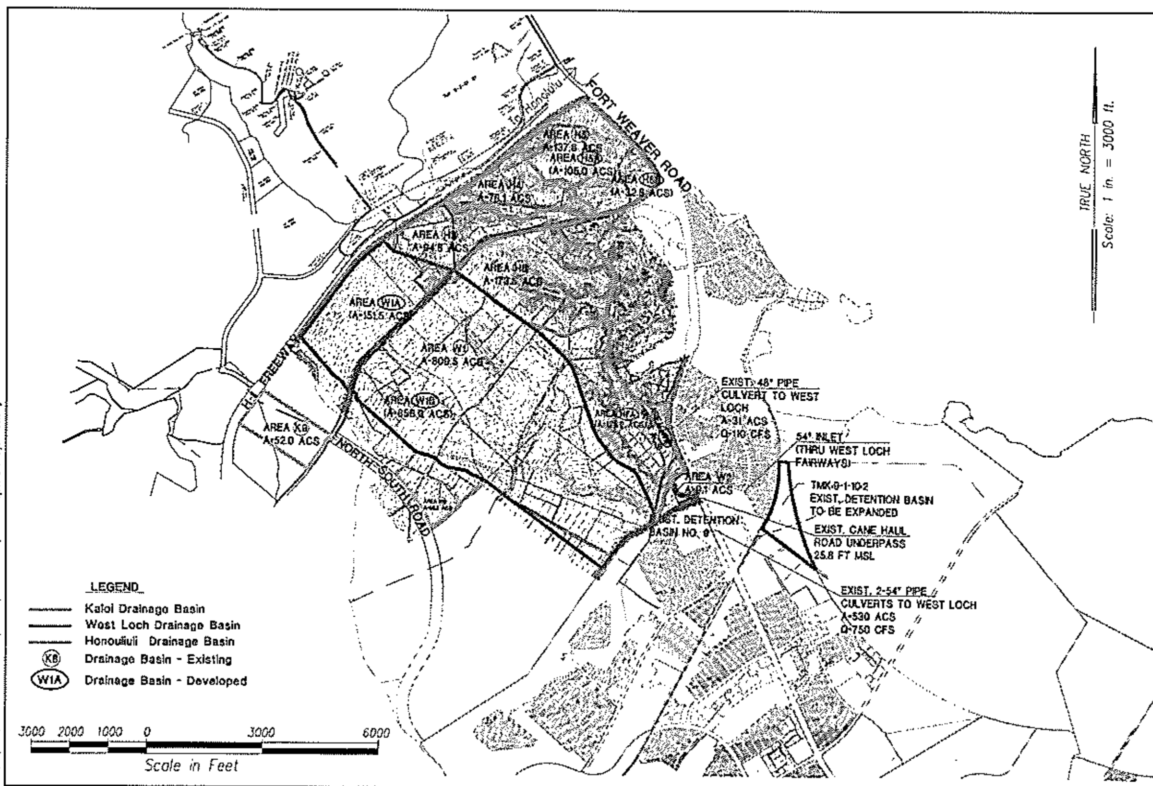
HO'OPILI
DRAINAGE MASTER PLAN

DRAINAGE MASTER PLAN

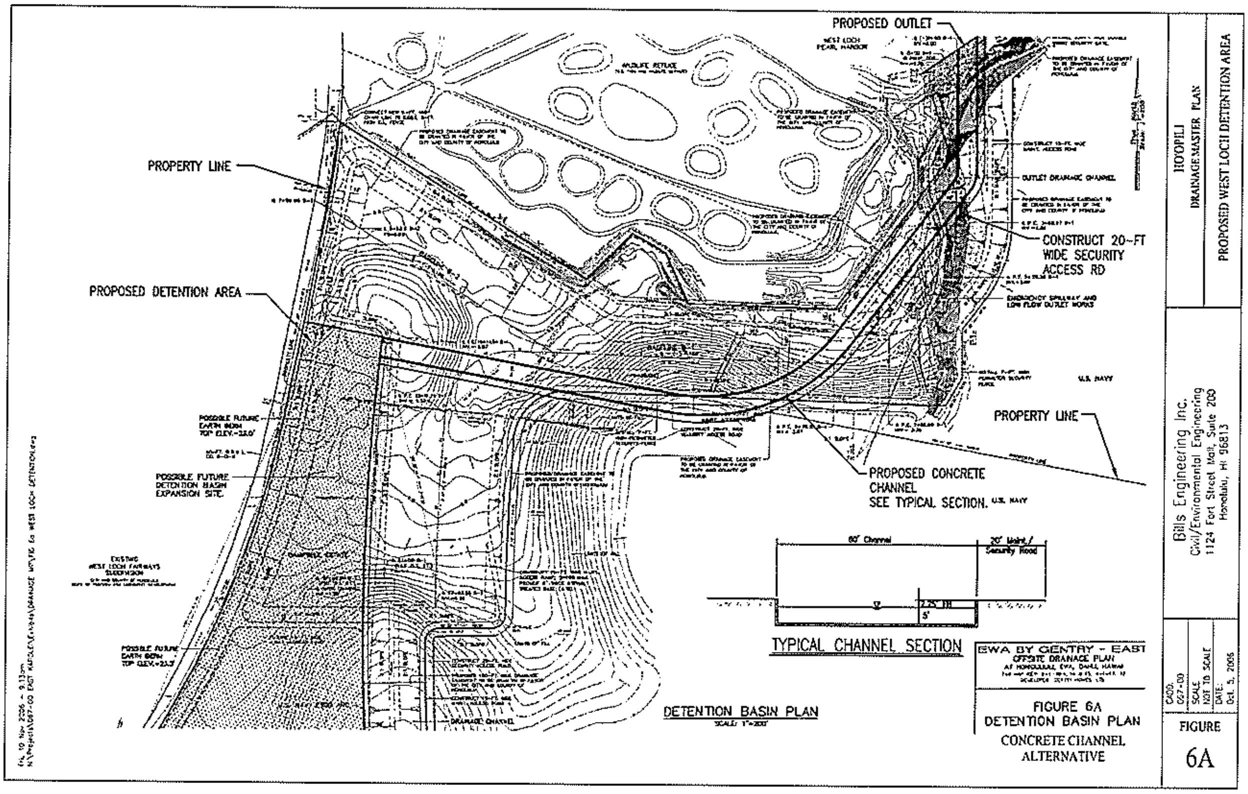
Bills Engineering Inc.
Civil/Environmental Engineering
1124 Fort Street Mall, Suite 200
Honolulu, HI 96813

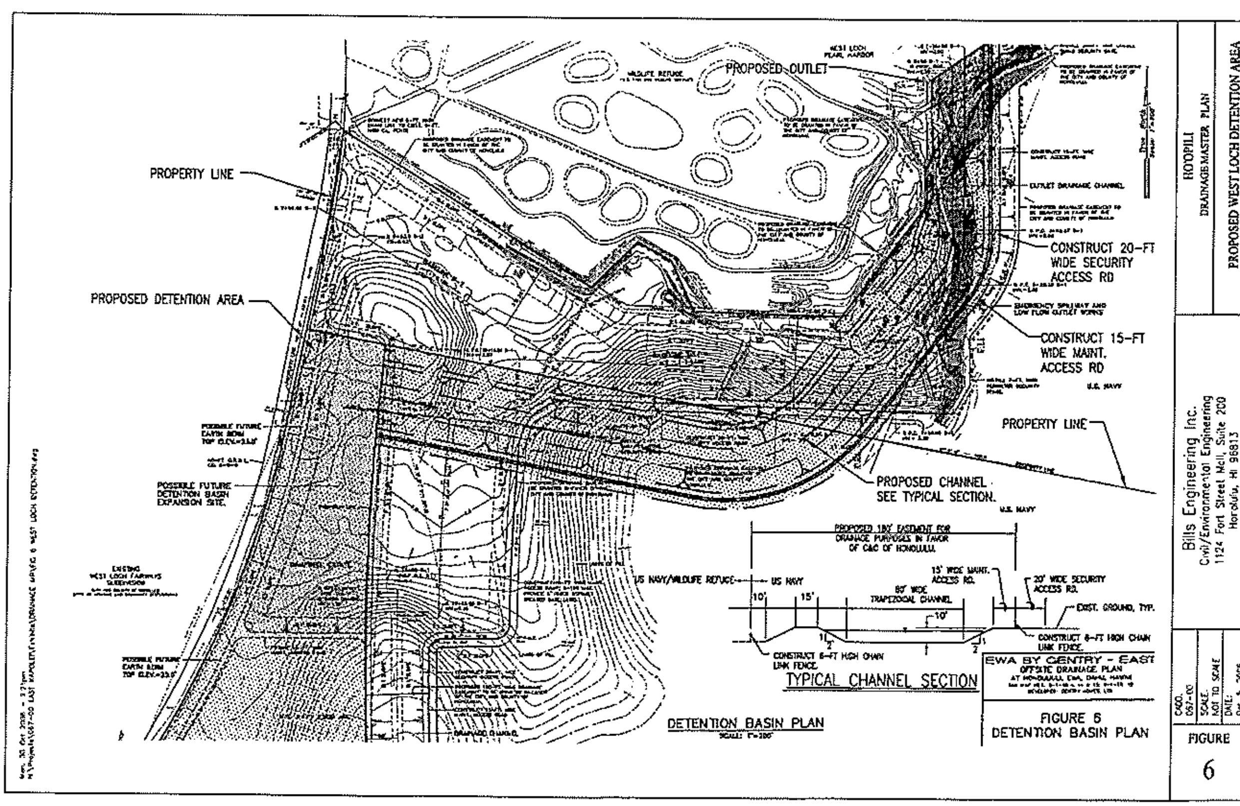
CADD: 067-00
SCALE: AS NOTED
DATE: November 2007

FIGURE
5



CADD:	Bills Engineering Inc.	HO'OPILI DRAINAGE MASTER PLAN	FIGURE
SCALE: 1" = 3000'	Civil/Environmental Engineering		
DATE: NOVEMBER 2007	1124 Fort Street Mall, Suite 200 Honolulu, HI 96813	PROJECT DRAINAGE AREAS	4


PROPOSED OUTLET
PROPERTY LINE
PROPOSED DETENTION AREA
CONSTRUCT 20-FT WIDE SECURITY ACCESS RD
PROPERTY LINE
PROPOSED CONCRETE CHANNEL SEE TYPICAL SECTION.
U.S. NAVY
60' Channel
20' Maint./ Security Road
TYPICAL CHANNEL SECTION
DETENTION BASIN PLAN
EWA BY GENTRY - EAST
OFFSITE DRAINAGE PLAN
FIGURE 6A
DETENTION BASIN PLAN
CONCRETE CHANNEL ALTERNATIVE
HO'OPILI
DRAINAGE MASTER PLAN
PROPOSED WEST LOCH DETENTION AREA
Bills Engineering Inc.
Civil/Environmental Engineering
1124 Fort Street Mall, Suite 200
Honolulu, HI 96813
NOT TO SCALE
Oct. 5, 2006
FIGURE
6A

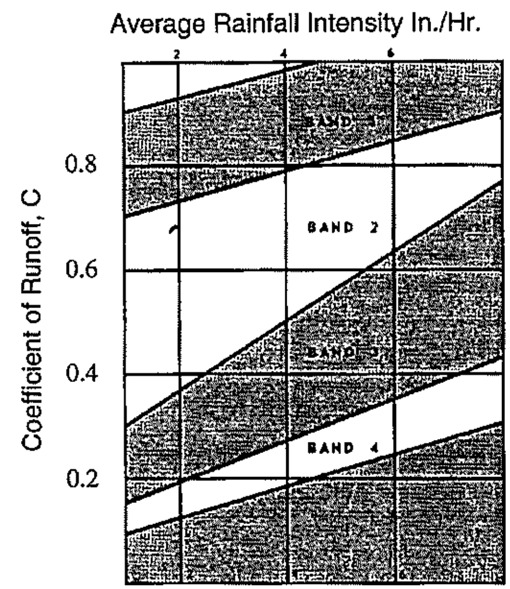

PROPOSED OUTLET
PROPERTY LINE
PROPOSED DETENTION AREA
CONSTRUCT 20-FT WIDE SECURITY ACCESS RD
CONSTRUCT 15-FT WIDE MAINT. ACCESS RD
U.S. NAVY
PROPERTY LINE
PROPOSED CHANNEL SEE TYPICAL SECTION.
US NAVY/WILDLIFE REFUGE
US NAVY
15' WIDE MAINT. ACCESS RD.
20' WIDE SECURITY ACCESS RD.
EXIST. GROUND, TYP.
80' WIDE TRAPEZOIDAL CHANNEL
CONSTRUCT 6-FT HIGH CHAIN LINK FENCE
TYPICAL CHANNEL SECTION
DETENTION BASIN PLAN
EWA BY GENTRY - EAST
OFFSITE DRAINAGE PLAN
FIGURE 6
DETENTION BASIN PLAN
HO'OPILI
DRAINAGE MASTER PLAN
PROPOSED WEST LOCH DETENTION AREA
Bills Engineering Inc.
Civil/Environmental Engineering
1124 Fort Street Mall, Suite 200
Honolulu, HI 96813
NOT TO SCALE
Oct. 5, 2006
FIGURE
6

APPENDIX A
Rational Method Tables and Plates

§1-4.3 DESIGN CHARTS

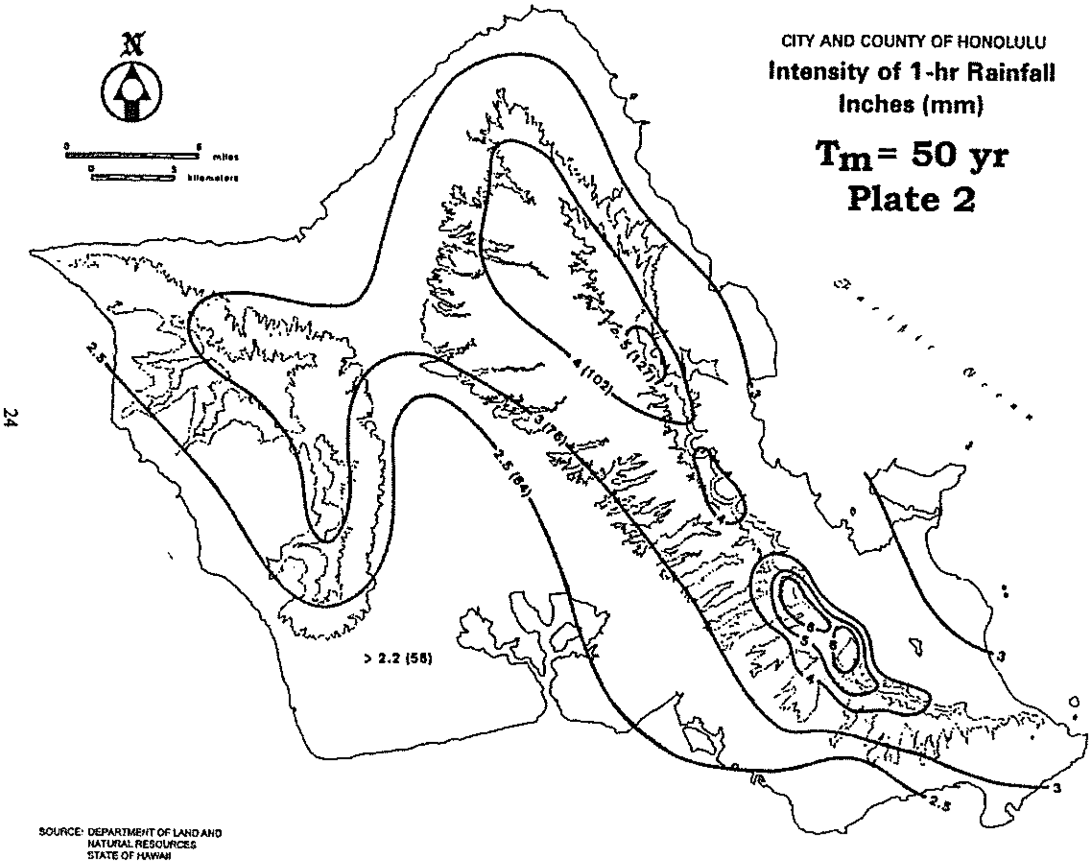
Table 1

RUNOFF COEFFICIENT FOR AGRICULTRUAL AND OPEN AREAS



Band 1	Steep, barren, impervious surfaces
Band 2	Rolling barren in upper band values, flat barren in lower part of band, steep forested and steep grass meadows
Band 3	Timber lands of moderate to steep slopes, mountainous, farming
Band 4	Flat pervious surface, flat farmlands, wooded areas and meadows

24


CITY AND COUNTY OF HONOLULU
Intensity of 1-hr Rainfall
Inches (mm)
Tm = 50 yr
Plate 2
miles
kilometers
> 2.2 (56)
2.5
3
SOURCE: DEPARTMENT OF LAND AND NATURAL RESOURCES STATE OF HAWAII

23

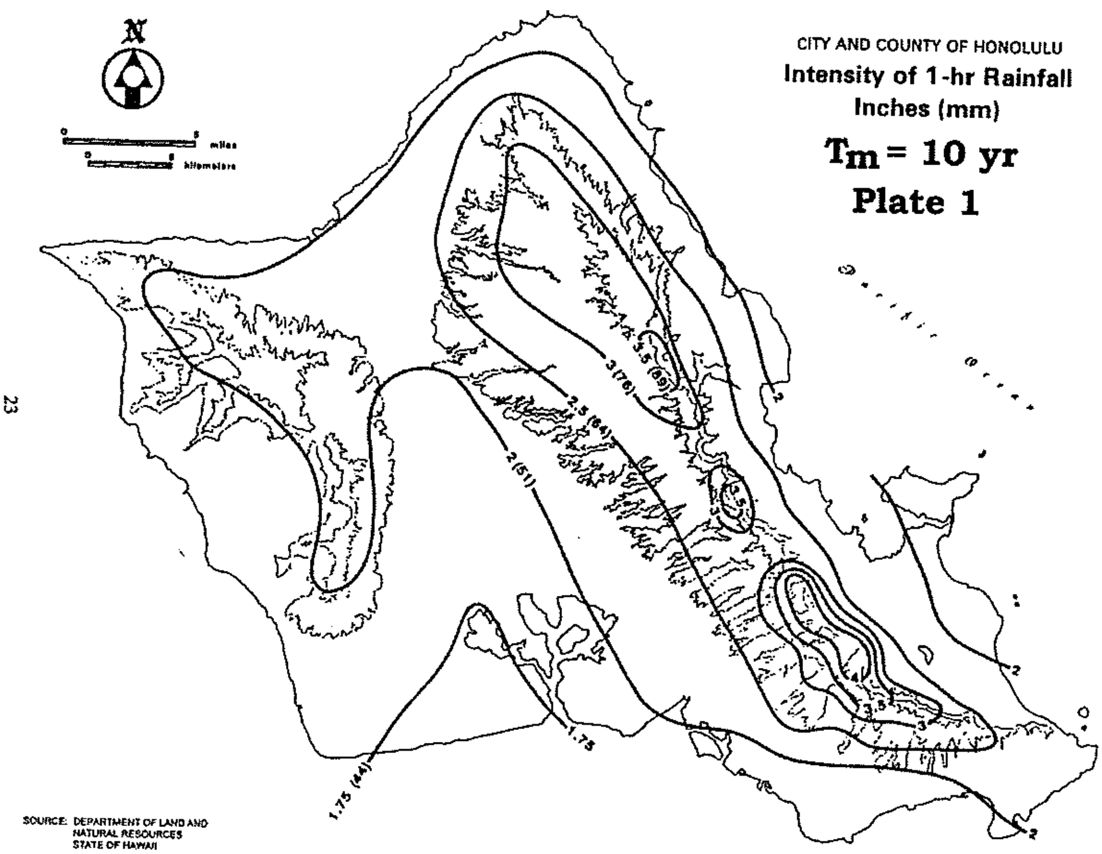
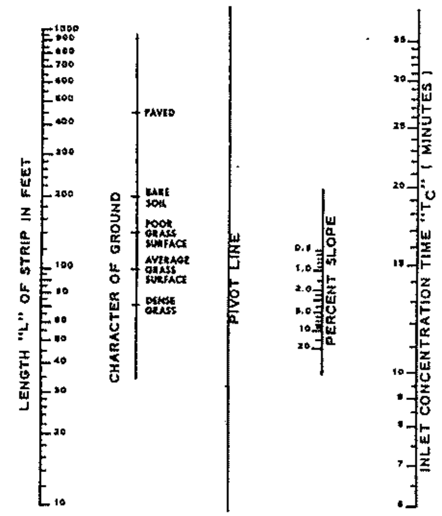

CITY AND COUNTY OF HONOLULU
Intensity of 1-hr Rainfall
Inches (mm)
Tm = 10 yr
Plate 1
miles
kilometers
1.75
2
SOURCE: DEPARTMENT OF LAND AND NATURAL RESOURCES STATE OF HAWAII

Plate 3

Overland Flow Chart



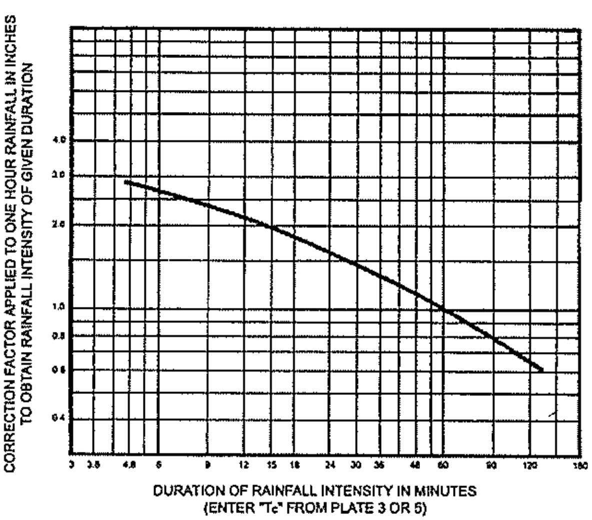
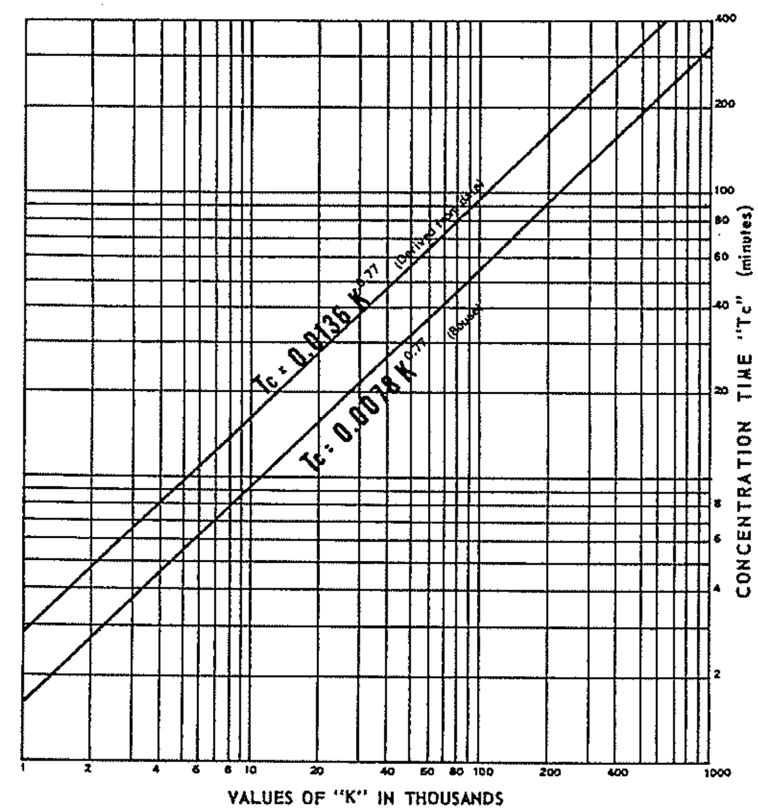


Plate 4

CORRECTION FACTOR
FOR CONVERTING 1 HR. RAINFALL TO RAINFALL INTENSITY OF VARIOUS DURATIONS

TO BE USED FOR AREA LESS THAN 100 ACRES

(See Plate 6 for area more than 100 acres)



L = Maximum length of travel in feet
H = Difference in elevation between most remote point and outlet in feet.
S = Slope H/L

$K = \frac{L}{\sqrt{S}} = \sqrt{\frac{L^3}{H}}$

Use upper curve for well forested areas
Use lower curve for areas with little or no cover.

SOURCE: CITY PLANNING COMMISSION
graph from Hunter Rouse "Engineering Hydraulics."

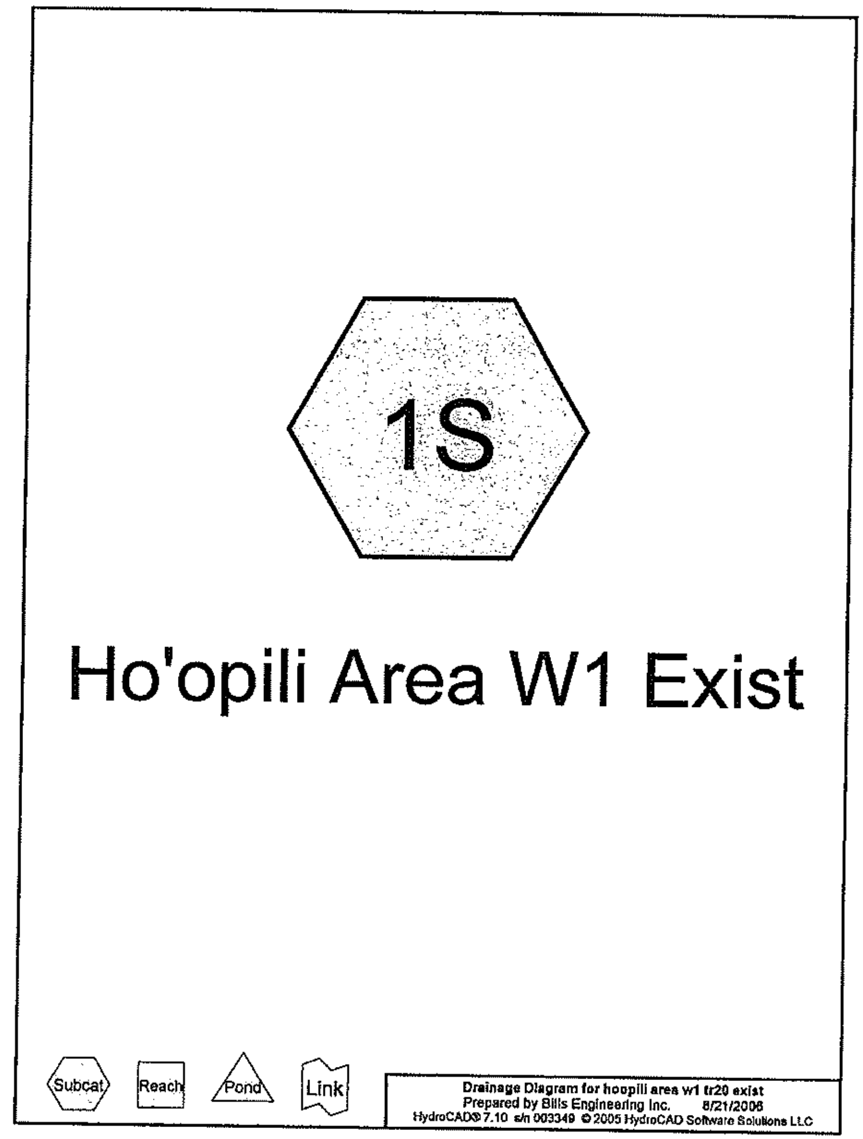
NOTE: Use 5 minutes if Tc is 5 minutes or less.

Plate 5

Time of Concentration

(OF SMALL AGRICULTURAL DRAINAGE BASIN)

APPENDIX B
Preliminary TR-20 Calculations



Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Ho'opili Area W1 Exist Runoff Area=809.500 ac Runoff Depth=2.46"
Flow Length=11,000' Tc=176.7 min CN=80 Runoff=306.52 cfs 166.051 af

Total Runoff Area = 809.500 ac Runoff Volume = 166.051 af Average Runoff Depth = 2.46"

Subcatchment 1S: Ho'opili Area W1 Exist

Subcatchment area W1 east of NS Rd

Runoff = 306.52 cfs @ 12.36 hrs, Volume= 166.051 af, Depth= 2.46"

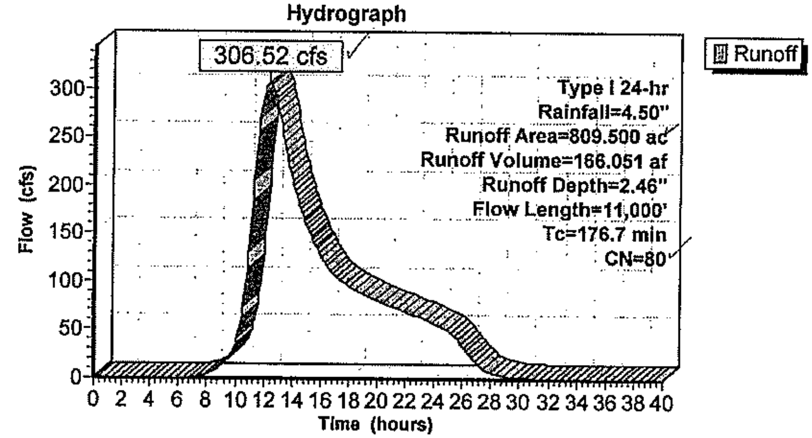
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type I 24-hr Rainfall=4.50"

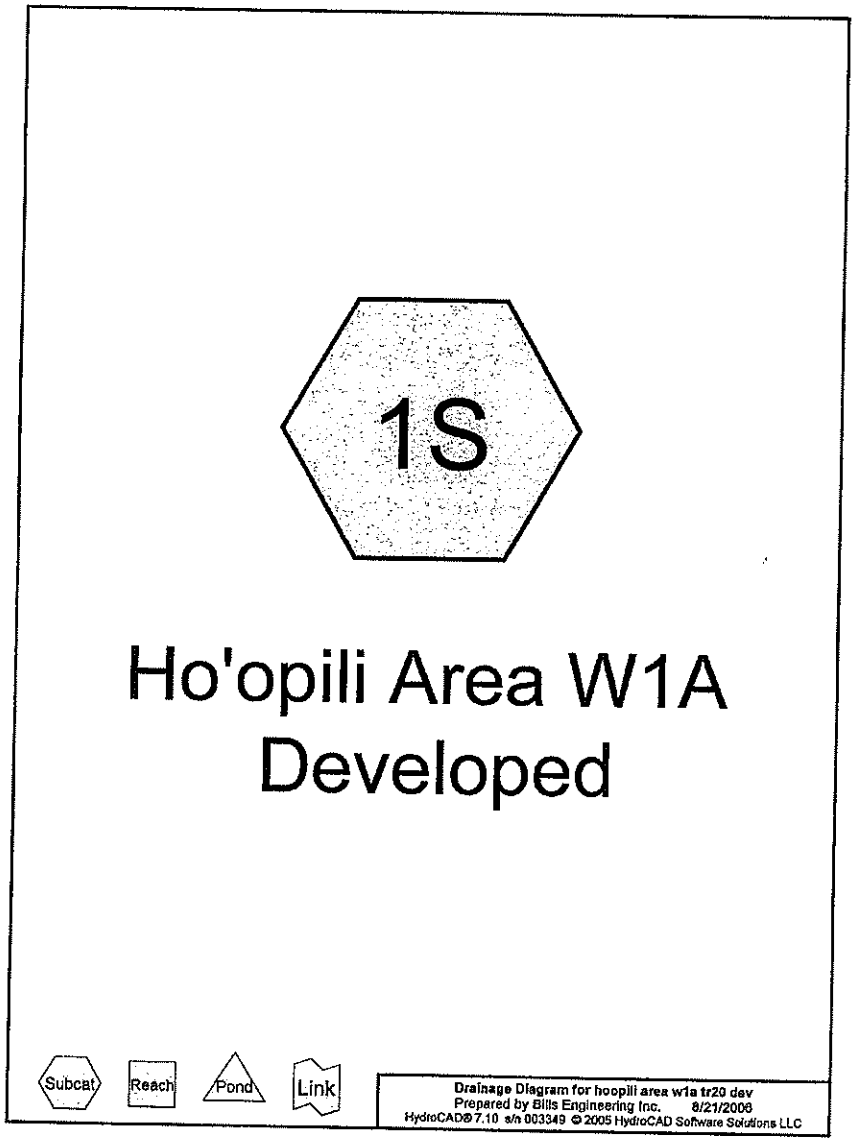
Area (ac)	CN	Description
809.500	80	CN entered directly

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
176.7	11,000	0.0150	1.0		Lag/CN Method, Existing condition

Subcatchment 1S: Ho'opili Area W1 Exist

Hydrograph





Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Ho'opili Area W1A Developed Runoff Area=151.500 ac Runoff Depth=3.10"
Flow Length=5,400' Tc=17.7 min CN=87 Runoff=281.85 cfs 39.124 af

Total Runoff Area = 151.500 ac Runoff Volume = 39.124 af Average Runoff Depth = 3.10"

Subcatchment 1S: Ho'opili Area W1A Developed

Subcatchment area W1A east of NS Rd above Farrington

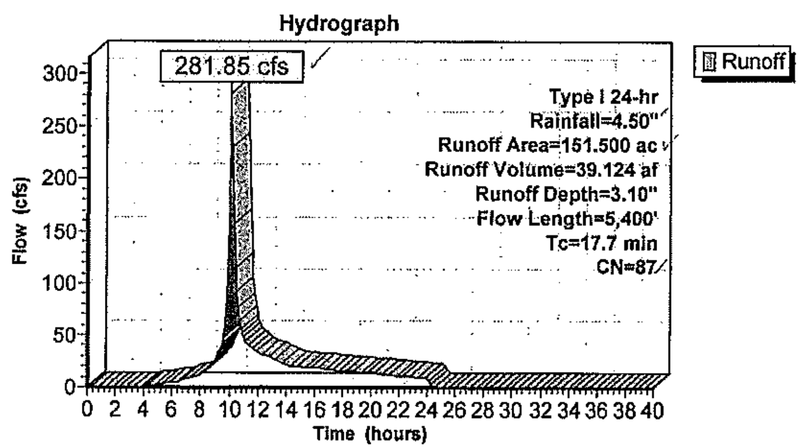
Runoff = 281.85 cfs @ 10.10 hrs, Volume= 39.124 af, Depth= 3.10"

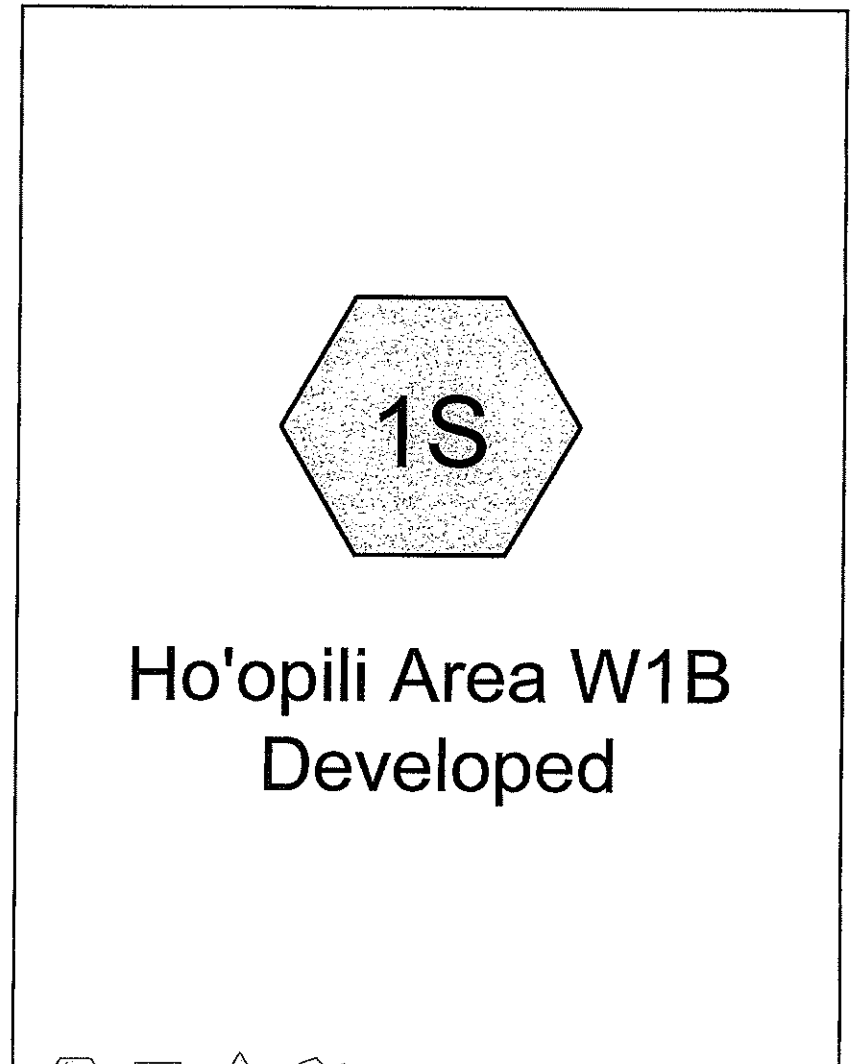
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type I 24-hr Rainfall=4.50"

Area (ac)	CN	Description
151.500	87	CN entered directly

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.9	200	0.0100	0.5		Lag/CN Method, Overland
2.9	1,800	0.0200	10.2	31.99	Circular Channel (pipe), Piped Diam= 24.0" Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
7.9	3,400	0.0100	7.2	22.62	Circular Channel (pipe), Piped within Farrington Diam= 24.0" Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
17.7	5,400	Total			

Subcatchment 1S: Ho'opili Area W1A Developed





Drainage Diagram for hoopili area w1b tr20 dev
Prepared by Bills Engineering Inc. 8/21/2006
HydroCAD® 7.10 s/n 003349 © 2005 HydroCAD Software Solutions LLC

Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Ho'opili Area W1B Developed Runoff Area=658.000 ac Runoff Depth=3.10"
Flow Length=12,000' Tc=31.4 min CN=87 Runoff=919.68 cfs 169.925 af

Total Runoff Area = 658.000 ac Runoff Volume = 169.925 af Average Runoff Depth = 3.10"

Subcatchment 1S: Ho'opili Area W1B Developed

Subcatchment area W1B east of NS Rd belowFarrington

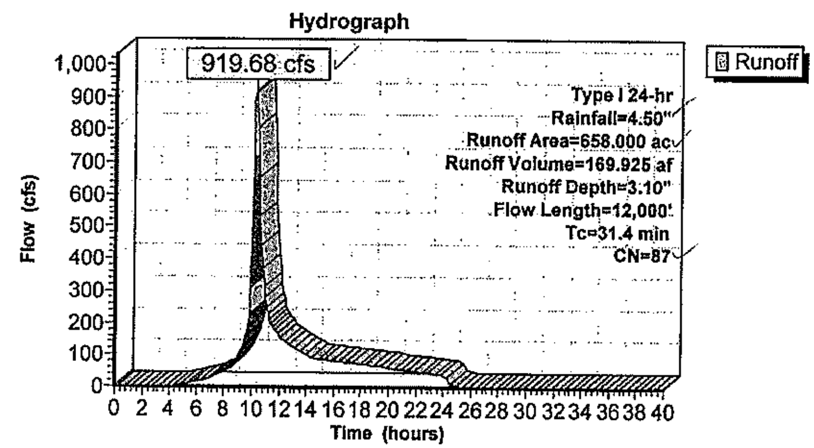
Runoff = 919.68 cfs @ 10.27 hrs, Volume= 169.925 af, Depth= 3.10"

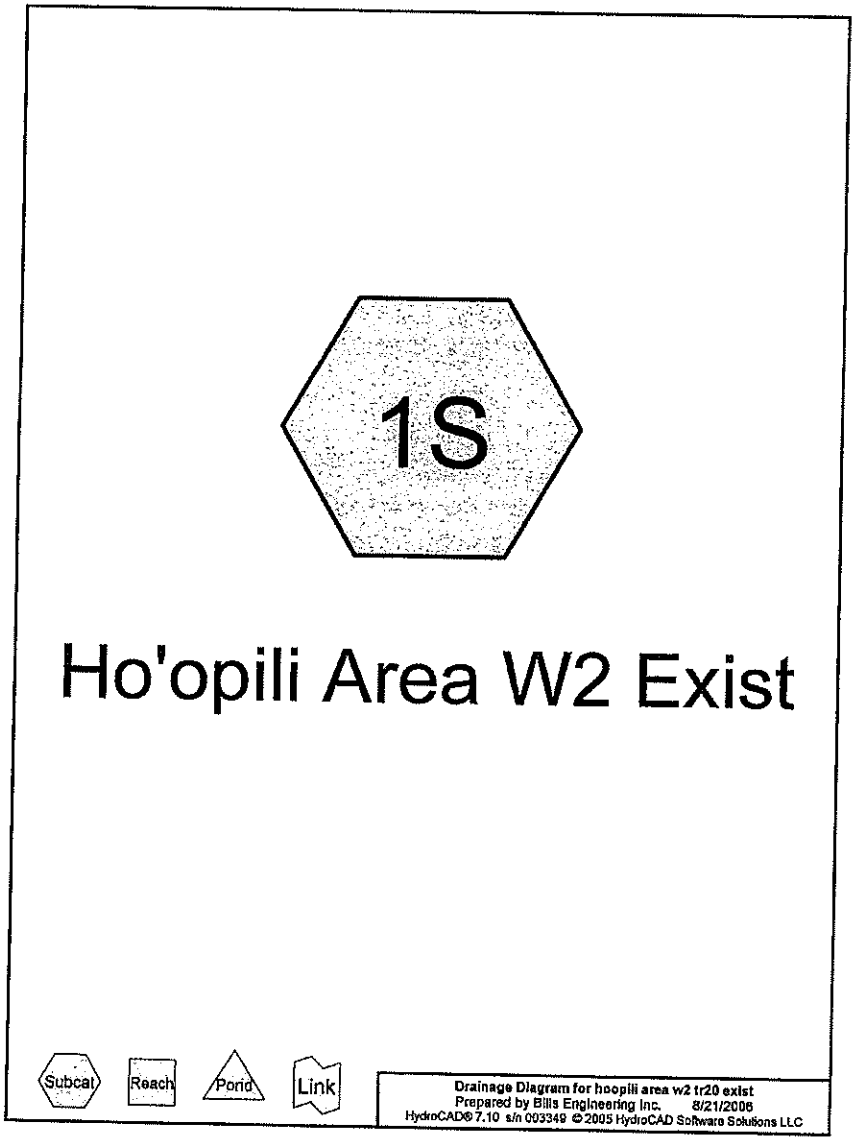
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type I 24-hr Rainfall=4.50"

Area (ac)	CN	Description
658.000	87	CN entered directly

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.9	200	0.0100	0.5		Lag/CN Method, Overland
19.9	9,800	0.0130	8.2	25.79	Circular Channel (pipe), Piped Diam= 24.0" Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
4.6	2,000	0.0100	7.2	22.62	Circular Channel (pipe), Piped Diam= 24.0" Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
31.4	12,000	Total			

Subcatchment 1S: Ho'opili Area W1B Developed





Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Ho'opili Area W2 Exist Runoff Area=9.100 ac Runoff Depth=2.46"
Flow Length=600' Tc=25.2 min CN=80 Runoff=11.00 cfs 1.867 af

Total Runoff Area = 9.100 ac Runoff Volume = 1.867 af Average Runoff Depth = 2.46"

Subcatchment 1S: Ho'opili Area W2 Exist

Subcatchment area W2 north of Cane Haul Rd.

Runoff = 11.00 cfs @ 10.20 hrs, Volume= 1.867 af, Depth= 2.46"

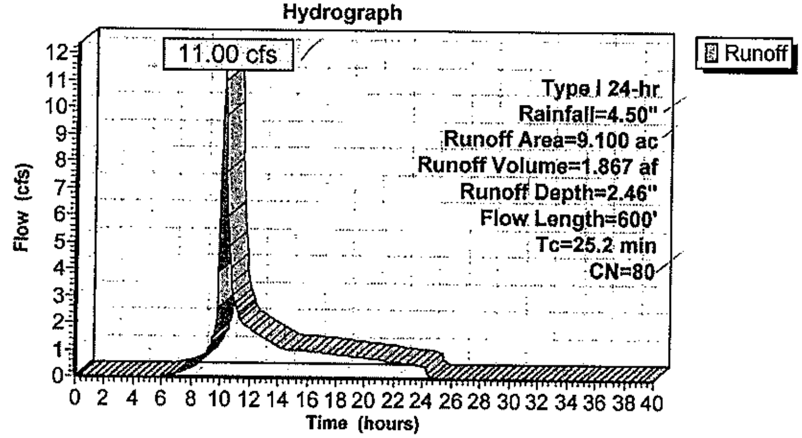
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type I 24-hr Rainfall=4.50"

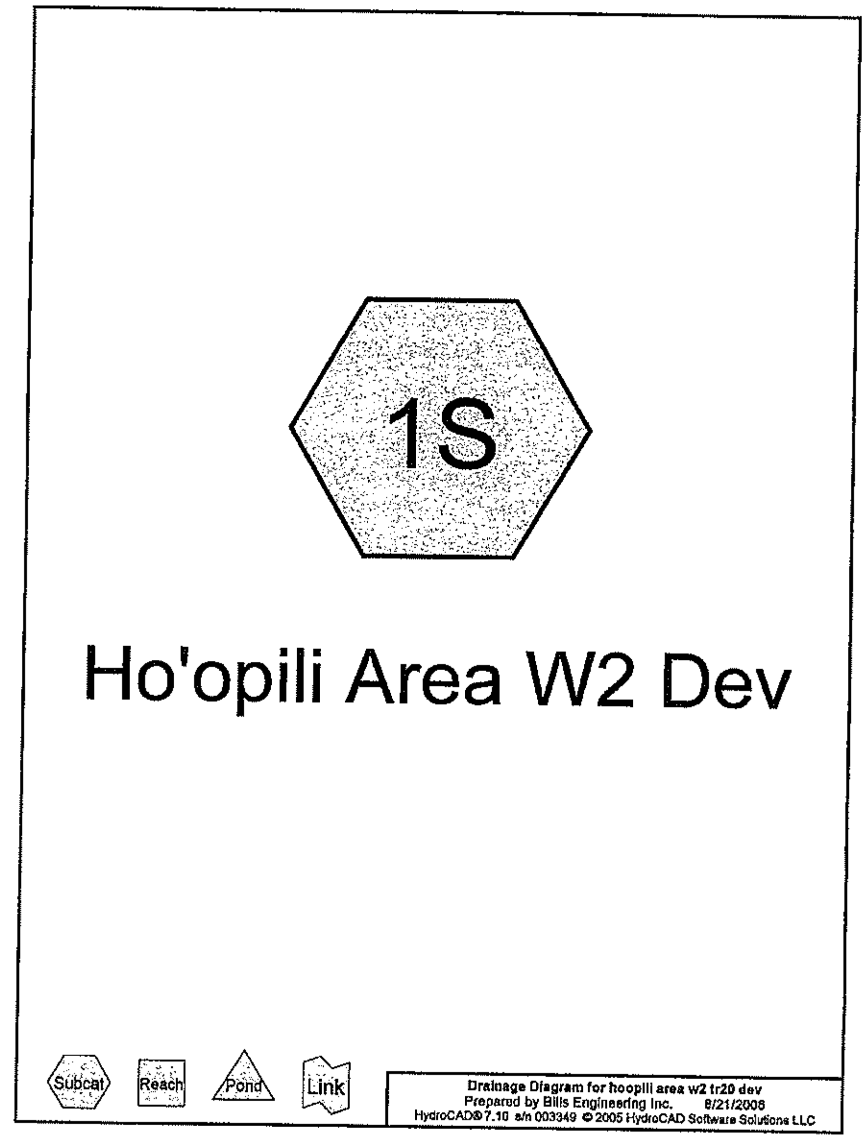
Area (ac)	CN	Description
9.100	80	CN entered directly

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.2	600	0.0070	0.4		Lag/CN Method, Existing condition

Subcatchment 1S: Ho'opili Area W2 Exist

Hydrograph





Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Ho'opili Area W2 Dev Runoff Area=9.100 ac Runoff Depth=3.10"
Flow Length=800' Tc=8.3 min CN=87 Runoff=21.35 cfs 2.350 af

Total Runoff Area = 9.100 ac Runoff Volume = 2.350 af Average Runoff Depth = 3.10"

Subcatchment 1S: Ho'opili Area W2 Dev

Subcatchment area W2 north of Cane Haul Rd.

[49] Hint: Tc<2dt may require smaller dt

Runoff = 21.35 cfs @ 9.99 hrs, Volume= 2.350 af, Depth= 3.10"

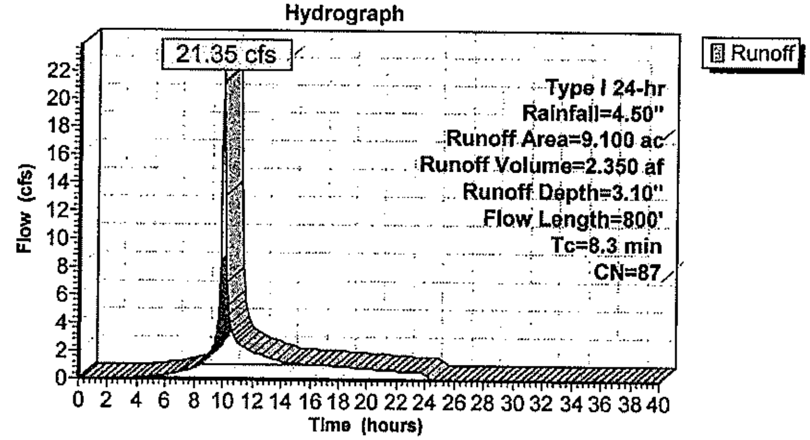
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type I 24-hr Rainfall=4.50"

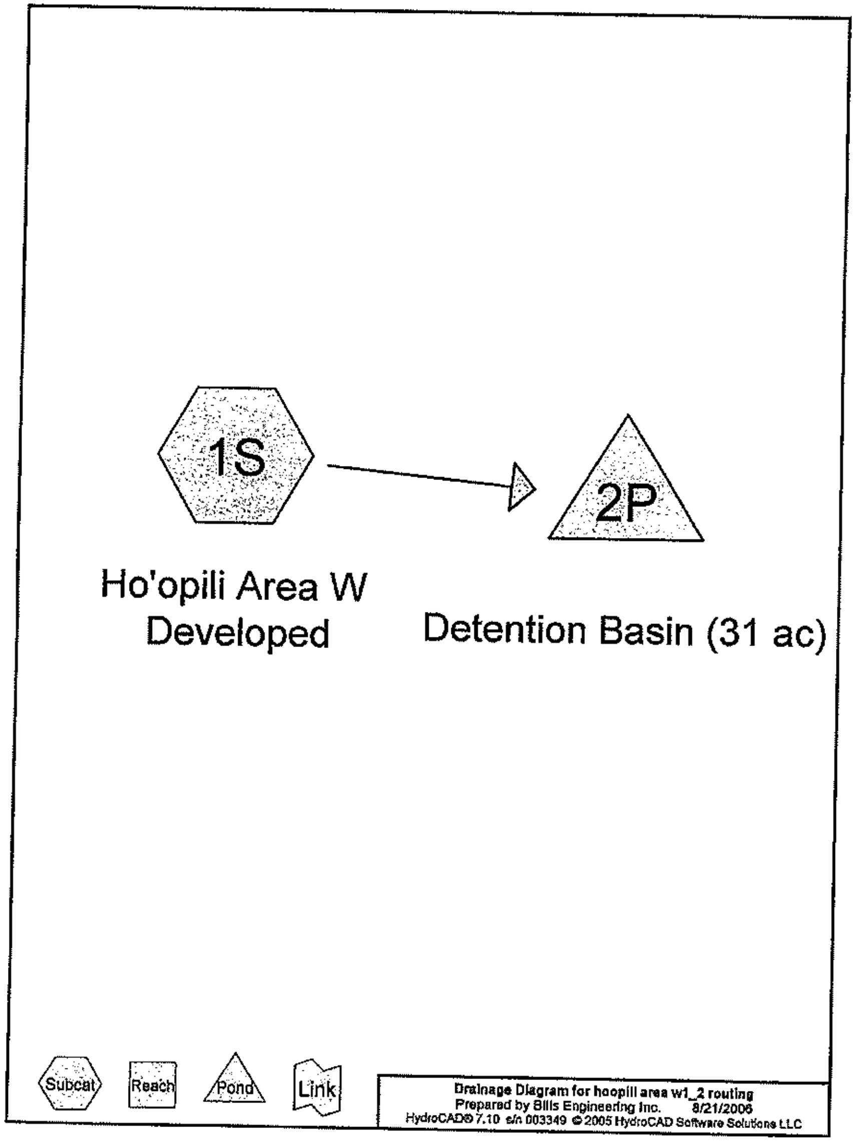
Area (ac)	CN	Description
9.100	87	CN entered directly

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.9	200	0.0100	0.5		Lag/CN Method, Overland
1.4	600	0.0100	7.2	22.62	Circular Channel (pipe), Piped within rd Diam= 24.0" Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
8.3	800	Total			

Subcatchment 1S: Ho'opili Area W2 Dev

Hydrograph





Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Ho'opili Area W Developed Runoff Area=818.600 ac Runoff Depth=2.18"
Flow Length=12,000' Tc=31.4 min CN=87 Runoff=796.88 cfs 148.878 af

Pond 2P: Detention Basin (31 ac) Peak Elev=8.35' Storage=57.243 af Inflow=796.88 cfs 148.878 af
48.0" x 20.0' Culvert Outflow=195.01 cfs 113.468 af

Total Runoff Area = 818.600 ac Runoff Volume = 148.878 af Average Runoff Depth = 2.18"

Subcatchment 1S: Ho'opili Area W Developed

West Loch drainage basins W1 and W2

Runoff = 796.88 cfs @ 10.27 hrs, Volume= 148.878 af, Depth= 2.18"

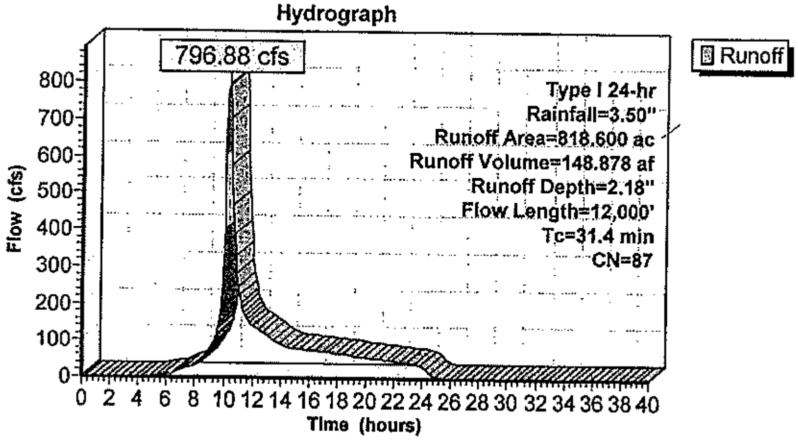
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type I 24-hr Rainfall=3.50"

Area (ac)	CN	Description
818.600	87	CN entered directly

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.9	200	0.0100	0.5		Lag/CN Method, Overland
19.9	9,800	0.0130	8.2	25.79	Circular Channel (pipe), Piped Diam= 24.0" Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
4.6	2,000	0.0100	7.2	22.62	Circular Channel (pipe), Piped Diam= 24.0" Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
31.4	12,000	Total			

Subcatchment 1S: Ho'opili Area W Developed

Hydrograph



Pond 2P: Detention Basin (31 ac)

Inflow Area = 818.600 ac, Inflow Depth = 2.18"
Inflow = 796.88 cfs @ 10.27 hrs, Volume= 148.878 af
Outflow = 195.01 cfs @ 11.26 hrs, Volume= 113.468 af, Atten= 76%, Lag= 59.6 min
Primary = 195.01 cfs @ 11.26 hrs, Volume= 113.468 af

Routing by Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Peak Elev= 8.35' @ 11.26 hrs Surf.Area= 7.297 ac Storage= 57.243 af
Plug-Flow detention time=307.1 min calculated for 113.185 af (76% of inflow)
Center-of-Mass det. time= 187.2 min (994.4 - 807.2)

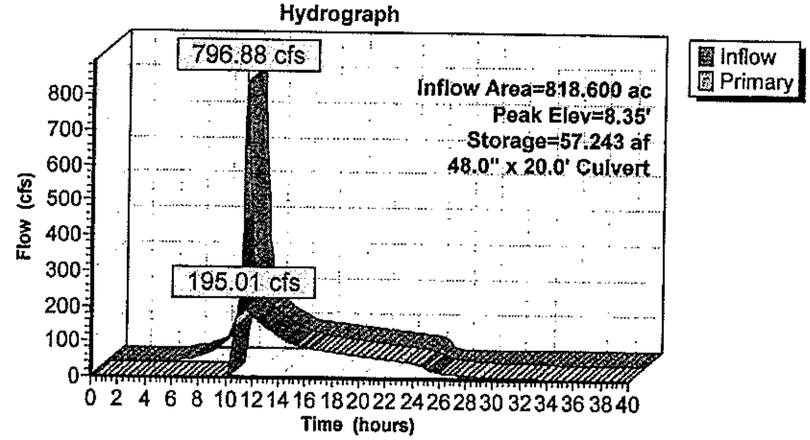
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	84.619 af	700.00'W x 400.00'L x 12.00'H Prismatoid Z=2.0

Device	Routing	Invert	Outlet Devices
#1	Primary	5.10'	48.0" x 20.0' long Culvert X 4.00 RCP, square edge headwall, Ke= 0.500 Outlet Invert= 5.00' S= 0.0050 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=194.83 cfs @ 11.26 hrs HW=8.35' (Free Discharge)
↑—1=Culvert (Barrel Controls 194.83 cfs @ 6.1 fps)

Pond 2P: Detention Basin (31 ac)

Hydrograph



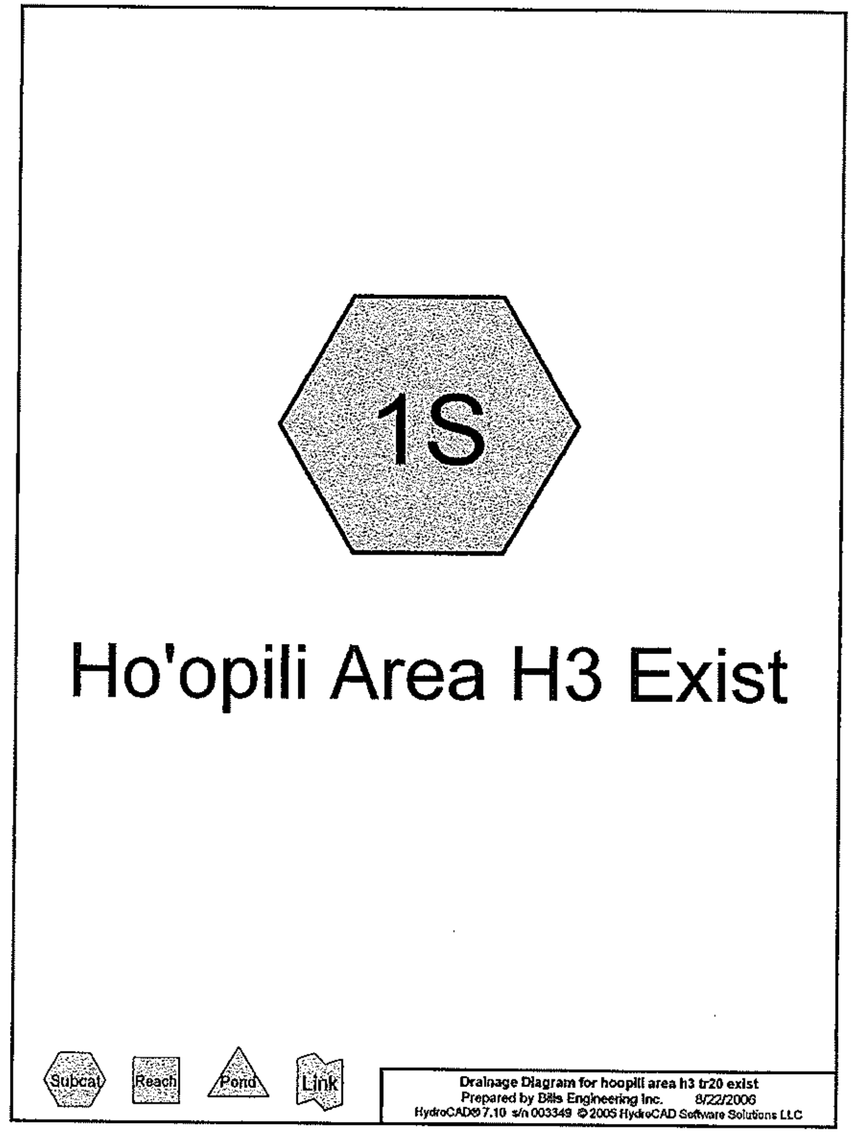
Stage-Discharge for Pond 2P: Detention Basin (31 ac)

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
0.00	0.00	3.18	0.00	6.36	35.81	9.54	314.43
0.06	0.00	3.24	0.00	6.42	39.06	9.60	320.11
0.12	0.00	3.30	0.00	6.48	42.43	9.66	325.70
0.18	0.00	3.36	0.00	6.54	45.92	9.72	331.21
0.24	0.00	3.42	0.00	6.60	49.52	9.78	336.61
0.30	0.00	3.48	0.00	6.66	53.24	9.84	341.89
0.36	0.00	3.54	0.00	6.72	57.08	9.90	347.04
0.42	0.00	3.60	0.00	6.78	61.02	9.96	352.04
0.48	0.00	3.66	0.00	6.84	65.08	10.02	356.88
0.54	0.00	3.72	0.00	6.90	69.23	10.08	361.53
0.60	0.00	3.78	0.00	6.96	73.50	10.14	365.96
0.66	0.00	3.84	0.00	7.02	77.86	10.20	370.14
0.72	0.00	3.90	0.00	7.08	82.33	10.26	374.01
0.78	0.00	3.96	0.00	7.14	86.89	10.32	377.51
0.84	0.00	4.02	0.00	7.20	91.54	10.38	380.46
0.90	0.00	4.08	0.00	7.26	96.29	10.44	382.81
0.96	0.00	4.14	0.00	7.32	101.12	10.50	390.70
1.02	0.00	4.20	0.00	7.38	106.04	10.56	398.44
1.08	0.00	4.26	0.00	7.44	111.05	10.62	406.03
1.14	0.00	4.32	0.00	7.50	116.13	10.68	413.48
1.20	0.00	4.38	0.00	7.56	121.30	10.74	420.80
1.26	0.00	4.44	0.00	7.62	126.54	10.80	427.99
1.32	0.00	4.50	0.00	7.68	131.86	10.86	435.06
1.38	0.00	4.56	0.00	7.74	137.24	10.92	442.03
1.44	0.00	4.62	0.00	7.80	142.70	10.98	448.88
1.50	0.00	4.68	0.00	7.86	148.21	11.04	455.63
1.56	0.00	4.74	0.00	7.92	153.79	11.10	462.28
1.62	0.00	4.80	0.00	7.98	159.43	11.16	468.84
1.68	0.00	4.86	0.00	8.04	165.13	11.22	475.31
1.74	0.00	4.92	0.00	8.10	170.87	11.28	481.69
1.80	0.00	4.98	0.00	8.16	176.67	11.34	487.98
1.86	0.00	5.04	0.00	8.22	182.51	11.40	494.20
1.92	0.00	5.10	0.00	8.28	188.39	11.46	500.34
1.98	0.00	5.16	0.08	8.34	194.31	11.52	506.40
2.04	0.00	5.22	0.34	8.40	200.27	11.58	512.27
2.10	0.00	5.28	0.80	8.46	206.26	11.64	515.69
2.16	0.00	5.34	1.44	8.52	212.28	11.70	519.09
2.22	0.00	5.40	2.25	8.58	218.32	11.76	522.46
2.28	0.00	5.46	3.23	8.64	224.38	11.82	525.82
2.34	0.00	5.52	4.38	8.70	230.45	11.88	529.15
2.40	0.00	5.58	5.68	8.76	236.54	11.94	532.46
2.46	0.00	5.64	7.14	8.82	242.64	12.00	**535.75**
2.52	0.00	5.70	8.76	8.88	248.73		
2.58	0.00	5.76	10.52	8.94	254.83		
2.64	0.00	5.82	12.43	9.00	260.91		
2.70	0.00	5.88	14.48	9.06	266.99		
2.76	0.00	5.94	16.67	9.12	273.05		
2.82	0.00	6.00	19.01	9.18	279.08		
2.88	0.00	6.06	21.48	9.24	285.08		
2.94	0.00	6.12	24.08	9.30	291.05		
3.00	0.00	6.18	26.82	9.36	296.98		
3.06	0.00	6.24	29.69	9.42	302.85		
3.12	0.00	6.30	32.69	9.48	308.67		

Stage-Area-Storage for Pond 2P: Detention Basin (31 ac)

Elevation (feet)	Storage (acre-feet)	Elevation (feet)	Storage (acre-feet)	Elevation (feet)	Storage (acre-feet)	Elevation (feet)	Storage (acre-feet)
0.00	0.000	3.18	20.955	6.36	42.956	9.54	66.025
0.06	0.386	3.24	21.361	6.42	43.381	9.60	66.471
0.12	0.772	3.30	21.767	6.48	43.807	9.66	66.917
0.18	1.159	3.36	22.173	6.54	44.233	9.72	67.363
0.24	1.546	3.42	22.579	6.60	44.659	9.78	67.810
0.30	1.933	3.48	22.986	6.66	45.086	9.84	68.258
0.36	2.321	3.54	23.393	6.72	45.513	9.90	68.705
0.42	2.709	3.60	23.801	6.78	45.941	9.96	69.153
0.48	3.097	3.66	24.209	6.84	46.369	10.02	69.602
0.54	3.486	3.72	24.617	6.90	46.797	10.08	70.050
0.60	3.875	3.78	25.026	6.96	47.226	10.14	70.500
0.66	4.264	3.84	25.435	7.02	47.655	10.20	70.949
0.72	4.654	3.90	25.844	7.08	48.085	10.26	71.399
0.78	5.045	3.96	26.254	7.14	48.515	10.32	71.850
0.84	5.435	4.02	26.664	7.20	48.945	10.38	72.300
0.90	5.826	4.08	27.075	7.26	49.376	10.44	72.751
0.96	6.217	4.14	27.486	7.32	49.807	10.50	73.203
1.02	6.609	4.20	27.897	7.38	50.238	10.56	73.655
1.08	7.001	4.26	28.309	7.44	50.670	10.62	74.107
1.14	7.394	4.32	28.721	7.50	51.102	10.68	74.560
1.20	7.786	4.38	29.133	7.56	51.534	10.74	75.013
1.26	8.180	4.44	29.546	7.62	51.967	10.80	75.467
1.32	8.573	4.50	29.960	7.68	52.401	10.86	75.921
1.38	8.967	4.56	30.373	7.74	52.834	10.92	76.375
1.44	9.361	4.62	30.787	7.80	53.269	10.98	76.829
1.50	9.756	4.68	31.201	7.86	53.703	11.04	77.285
1.56	10.151	4.74	31.616	7.92	54.138	11.10	77.740
1.62	10.546	4.80	32.031	7.98	54.573	11.16	78.196
1.68	10.942	4.86	32.447	8.04	55.009	11.22	78.652
1.74	11.338	4.92	32.862	8.10	55.445	11.28	79.109
1.80	11.735	4.98	33.279	8.16	55.881	11.34	79.566
1.86	12.131	5.04	33.695	8.22	56.318	11.40	80.023
1.92	12.529	5.10 ✓	34.112 ✓	8.28	56.755	11.46	80.481
1.98	12.926	5.16	34.530	8.34	57.193	11.52	80.939
2.04	13.324	5.22	34.947	8.40	57.631	11.58	81.398
2.10	13.722	5.28	35.365	8.46	58.069	11.64	81.857
2.16	14.121	5.34	35.784	8.52	58.508	11.70	82.316
2.22	14.520	5.40	36.203	8.58	58.947	11.76	82.776
2.28	14.920	5.46	36.622	8.64	59.386	11.82	83.236
2.34	15.319	5.52	37.042	8.70	59.826	11.88	83.697
2.40	15.720	5.58	37.462	8.76	60.266	11.94	84.158
2.46	16.120	5.64	37.882	8.82	60.707	12.00	**84.619**
2.52	16.521	5.70	38.303	8.88	61.148		
2.58	16.922	5.76	38.724	8.94	61.590		
2.64	17.324	5.82	39.145	9.00	62.031		
2.70	17.726	5.88	39.567	9.06	62.474		
2.76	18.128	5.94	39.989	9.12	62.916		
2.82	18.531	6.00	40.412	9.18	63.359		
2.88	18.934	6.06	40.835	9.24	63.803		
2.94	19.338	6.12	41.259	9.30	64.246		
3.00	19.742	6.18	41.682	9.36	64.690		
3.06	20.146	6.24	42.106	9.42	65.135		
3.12	20.550	6.30	42.531	9.48	65.580		

Q = 1.486 AR^2/3 S^1/2 N^(-1)					Cane Haul Rd Channel
SECTION	Rectangular	Input width		30	
DESIRED Q	2600				
ASSUMED D	5.1		R =		3.81
INPUT S	0.005		Q =		2614.49
INPUT N	0.015				
A	153	TOTAL REQ'D DEPTH			7.84
P	40.2				
V	17.08818				
FB*	2.73535				



Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Ho'opili Area H3 Exist Runoff Area=94.800 ac Runoff Depth=2.46"
Flow Length=3,200' Tc=44.4 min CN=80 Runoff=83.81 cfs 19.446 af

Total Runoff Area = 94.800 ac Runoff Volume = 19.446 af Average Runoff Depth = 2.46"

Subcatchment 1S: Ho'opili Area H3 Exist

Subcatchment area 3 west of Honouliuli Stream

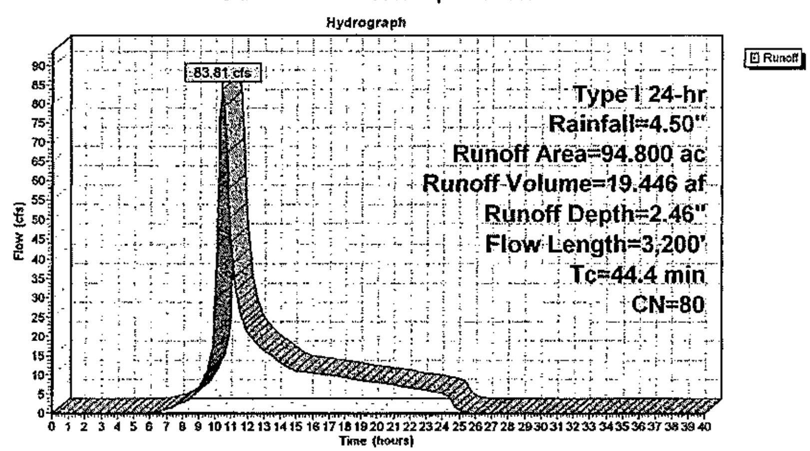
Runoff = 83.81 cfs @ 10.44 hrs, Volume= 19.446 af, Depth= 2.46"

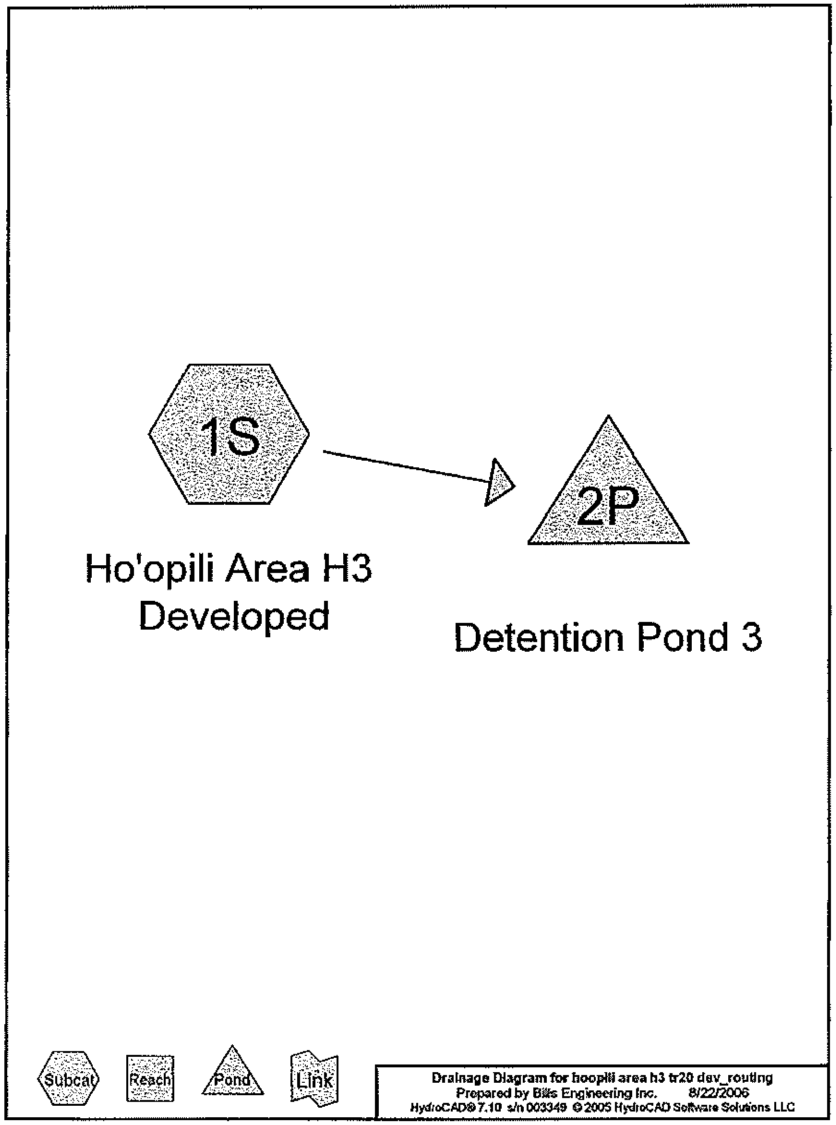
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type I 24-hr Rainfall=4.50"

Area (ac)	CN	Description
94.800	80	CN entered directly

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
44.4	3,200	0.0330	1.2		Lag/CN Method, Existing condition

Subcatchment 1S: Ho'opili Area H3 Exist





Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Ho'opili Area H3 Developed Runoff Area=94.800 ac Runoff Depth=3.10"
Flow Length=2,000' Tc=9.3 min CN=87 Runoff=217.59 cfs 24.482 af

Pond 2P: Detention Pond 3 Peak Elev=90.32' Storage=8.108 af Inflow=217.59 cfs 24.482 af
30.0" x 100.0' Culvert Outflow=68.33 cfs 20.187 af

Total Runoff Area = 94.800 ac Runoff Volume = 24.482 af Average Runoff Depth = 3.10"

Subcatchment 1S: Ho'opili Area H3 Developed

Subcatchment area 3 Honouliuli Stream

[49] Hint: Tc<2dt may require smaller dt

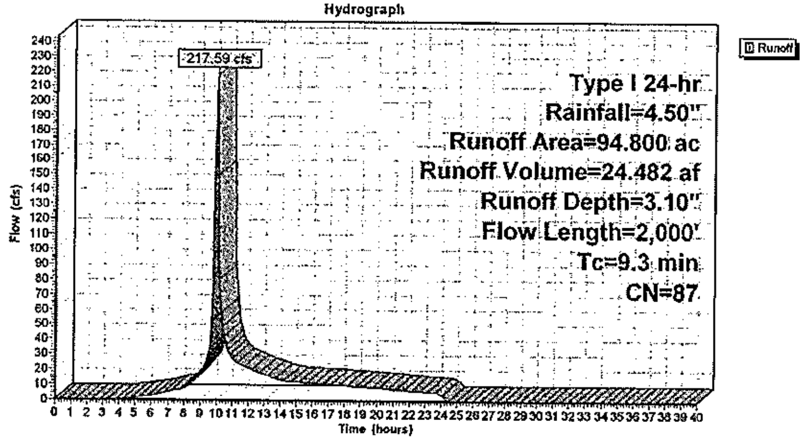
Runoff = 217.59 cfs @ 10.00 hrs, Volume= 24.482 af, Depth= 3.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type I 24-hr Rainfall=4.50"

Area (ac)	CN	Description
94.800	87	CN entered directly

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.9	200	0.0100	0.5		Lag/CN Method, OVERLAND
2.4	1,800	0.0300	12.5	39.18	Circular Channel (pipe), PIPED DRAIN SYSTEM Diam= 24.0" Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Concrete pipe, bends & connections
9.3	2,000	Total			

Subcatchment 1S: Ho'opili Area H3 Developed



Pond 2P: Detention Pond 3

Inflow Area = 94.800 ac, Inflow Depth = 3.10"
Inflow = 217.59 cfs @ 10.00 hrs, Volume= 24.482 af
Outflow = 68.33 cfs @ 10.26 hrs, Volume= 20.187 af, Atten= 69%, Lag= 15.6 min
Primary = 68.33 cfs @ 10.26 hrs, Volume= 20.187 af

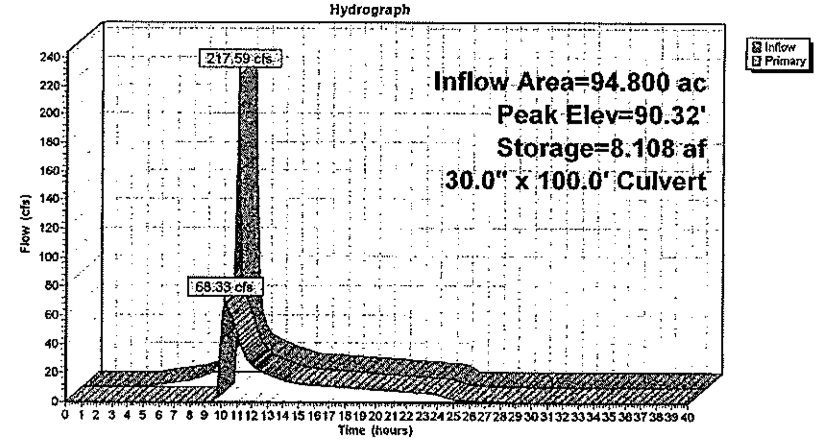
Routing by Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Peak Elev= 90.32' @ 10.26 hrs Surf.Area= 1.118 ac Storage= 8.108 af
Plug-Flow detention time= 204.9 min calculated for 20.137 af (82% of inflow)
Center-of-Mass det. time= 110.7 min (882.5 - 771.8)

Volume	Invert	Avail.Storage	Storage Description
#1	81.00'	8.877 af	**140.00'W x 100.00'L x 10.00'H Prismatoid Z=2.0 x 2**

Device	Routing	Invert	Outlet Devices
#1	Primary	86.50'	**30.0" x 100.0' long Culvert X 2.00** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 86.00' S= 0.0050 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=68.08 cfs @ 10.26 hrs HW=90.31' (Free Discharge)
└─**1=Culvert** (Barrel Controls 68.08 cfs @ 6.9 fps)

Pond 2P: Detention Pond 3

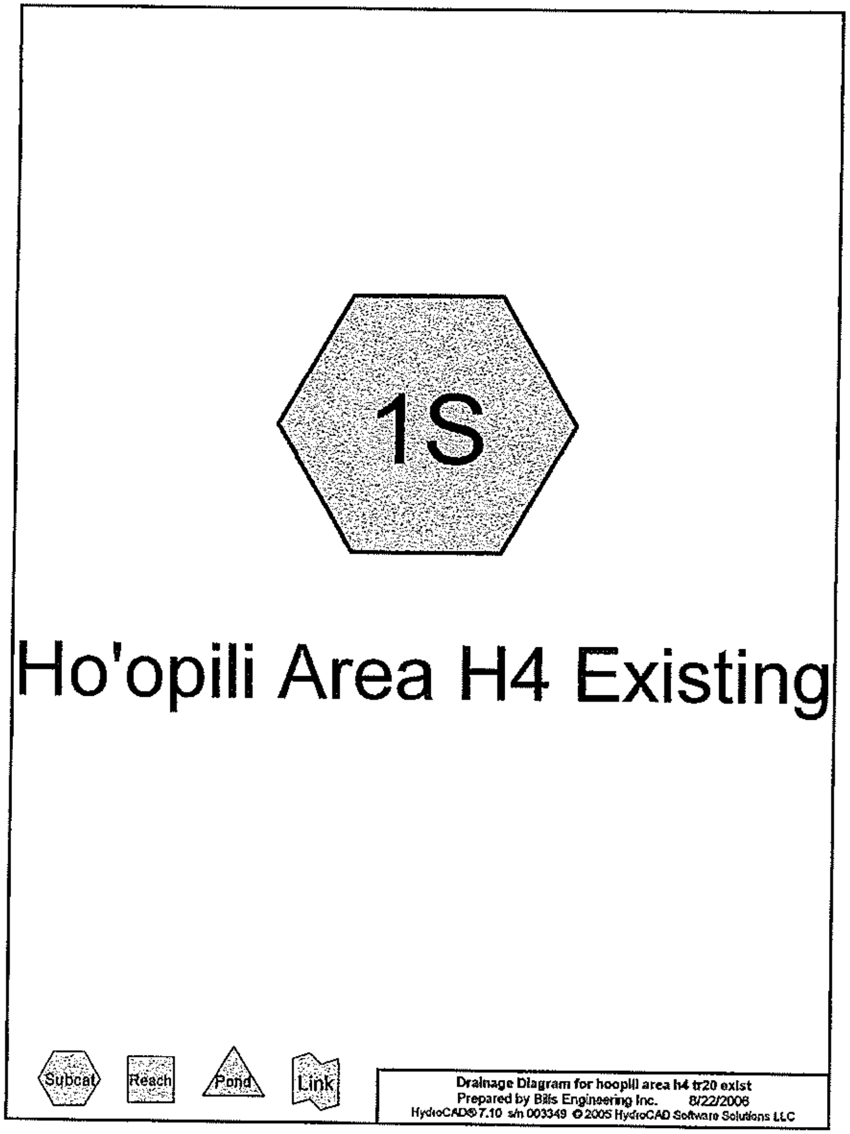


Stage-Discharge for Pond 2P: Detention Pond 3

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
81.00	0.00	86.40	0.00
81.10	0.00	86.50	0.00
81.20	0.00	86.60	0.09
81.30	0.00	86.70	0.40
81.40	0.00	86.80	0.94
81.50	0.00	86.90	1.68
81.60	0.00	87.00	2.63
81.70	0.00	87.10	3.76
81.80	0.00	87.20	5.06
81.90	0.00	87.30	6.53
82.00	0.00	87.40	8.13
82.10	0.00	87.50	9.88
82.20	0.00	87.60	11.75
82.30	0.00	87.70	13.74
82.40	0.00	87.80	15.82
82.50	0.00	87.90	18.01
82.60	0.00	88.00	20.28
82.70	0.00	88.10	22.62
82.80	0.00	88.20	25.02
82.90	0.00	88.30	27.48
83.00	0.00	88.40	29.98
83.10	0.00	88.50	32.51
83.20	0.00	88.60	35.06
83.30	0.00	88.70	37.60
83.40	0.00	88.80	40.14
83.50	0.00	88.90	42.65
83.60	0.00	89.00	45.11
83.70	0.00	89.10	47.51
83.80	0.00	89.20	49.82
83.90	0.00	89.30	52.01
84.00	0.00	89.40	54.05
84.10	0.00	89.50	55.89
84.20	0.00	89.60	57.45
84.30	0.00	89.70	58.63
84.40	0.00	89.80	59.06
84.50	0.00	89.90	59.85
84.60	0.00	90.00	61.95
84.70	0.00	90.10	63.99
84.80	0.00	90.20	65.96
84.90	0.00	90.30	67.87
85.00	0.00	90.40	69.73
85.10	0.00	90.50	71.54
85.20	0.00	90.60	73.31
85.30	0.00	90.70	75.03
85.40	0.00	90.80	76.72
85.50	0.00	90.90	78.37
85.60	0.00	91.00	79.98
85.70	0.00		
85.80	0.00		
85.90	0.00		
86.00	0.00		
86.10	0.00		
86.20	0.00		
86.30	0.00		

Stage-Area-Storage for Pond 2P: Detention Pond 3

Elevation (feet)	Storage (acre-feet)	Elevation (feet)	Storage (acre-feet)
81.00	0.000	86.40	4.152
81.10	0.064	86.50	4.243
81.20	0.129	86.60	4.334
81.30	0.195	86.70	4.425
81.40	0.261	86.80	4.517
81.50	0.327	86.90	4.610
81.60	0.394	87.00	4.703
81.70	0.461	87.10	4.797
81.80	0.528	87.20	4.891
81.90	0.597	87.30	4.986
82.00	0.665	87.40	5.081
82.10	0.734	87.50	5.177
82.20	0.804	87.60	5.273
82.30	0.873	87.70	5.370
82.40	0.944	87.80	5.467
82.50	1.015	87.90	5.565
82.60	1.086	88.00	5.663
82.70	1.158	88.10	5.762
82.80	1.230	88.20	5.862
82.90	1.303	88.30	5.962
83.00	1.376	88.40	6.063
83.10	1.449	88.50	6.164
83.20	1.523	88.60	6.266
83.30	1.598	88.70	6.368
83.40	1.673	88.80	6.471
83.50	1.749	88.90	6.574
83.60	1.825	89.00	6.678
83.70	1.901	89.10	6.783
83.80	1.978	89.20	6.888
83.90	2.055	89.30	6.993
84.00	2.133	89.40	7.100
84.10	2.212	89.50	7.206
84.20	2.291	89.60	7.314
84.30	2.370	89.70	7.422
84.40	2.450	89.80	7.530
84.50	2.530	89.90	7.639
84.60	2.611	90.00	7.749
84.70	2.692	90.10	7.859
84.80	2.774	90.20	7.970
84.90	2.857	90.30	8.081
85.00	2.939	90.40	8.193
85.10	3.023	90.50	8.305
85.20	3.107	90.60	8.419
85.30	3.191	90.70	8.532
85.40	3.276	90.80	8.646
85.50	3.361	90.90	8.761
85.60	3.447	91.00	8.877
85.70	3.533		
85.80	3.620		
85.90	3.708		
86.00	3.796		
86.10	3.884		
86.20	3.973		
86.30	4.062		



Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Ho'opili Area H4 Existing Runoff Area=78.100 ac Runoff Depth=2.46"
Flow Length=2,100' Tc=27.1 min CN=80 Runoff=91.12 cfs 16.021 af

Total Runoff Area = 78.100 ac Runoff Volume = 16.021 af Average Runoff Depth = 2.46"

Subcatchment 1S: Ho'opili Area H4 Existing

Subcatchment area 4 Honouliuli Stream

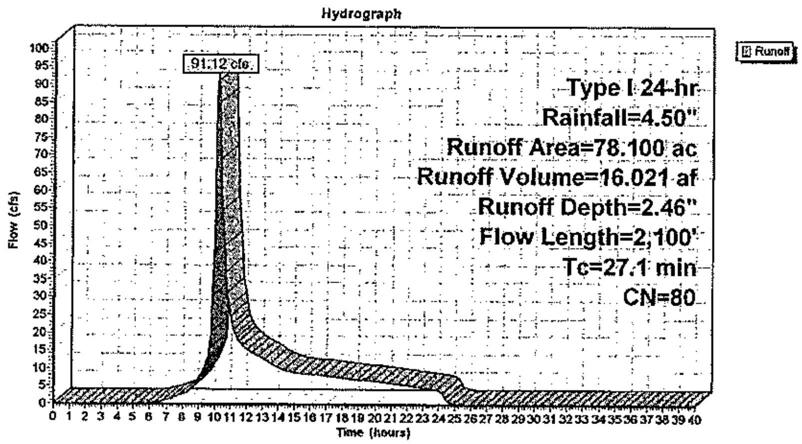
Runoff = 91.12 cfs @ 10.22 hrs, Volume= 16.021 af, Depth= 2.46"

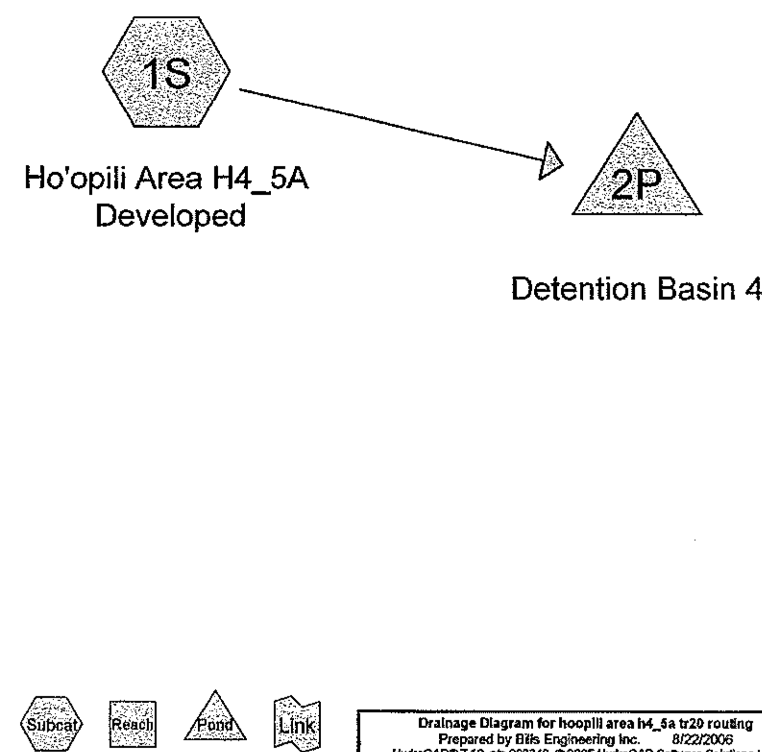
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type I 24-hr Rainfall=4.50"

Area (ac)	CN	Description
78.100	80	CN entered directly

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
27.1	2,100	0.0450	1.3		**Lag/CN Method, Existing condition**

Subcatchment 1S: Ho'opili Area H4 Existing





Drainage Diagram for hoopili area h4_5a tr20 routing
Prepared by Bills Engineering Inc. 8/22/2006
HydroCAD® 7.10 s/n 003349 © 2005 HydroCAD Software Solutions LLC

Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Ho'opili Area H4_5A Developed Runoff Area=183.100 ac Runoff Depth=3.10"
Flow Length=3,800' Tc=15.2 min CN=87 Runoff=357.19 cfs 47.285 af

Pond 2P: Detention Basin 4 Peak Elev=87.75' Storage=17.715 af Inflow=357.19 cfs 47.285 af
30.0" x 100.0' Culvert Outflow=74.10 cfs 39.155 af

Total Runoff Area = 183.100 ac Runoff Volume = 47.285 af Average Runoff Depth = 3.10"

Subcatchment 1S: Ho'opili Area H4_5A Developed

Subcatchment area 4 Honouliuli Stream, including area 5A (105 acs).

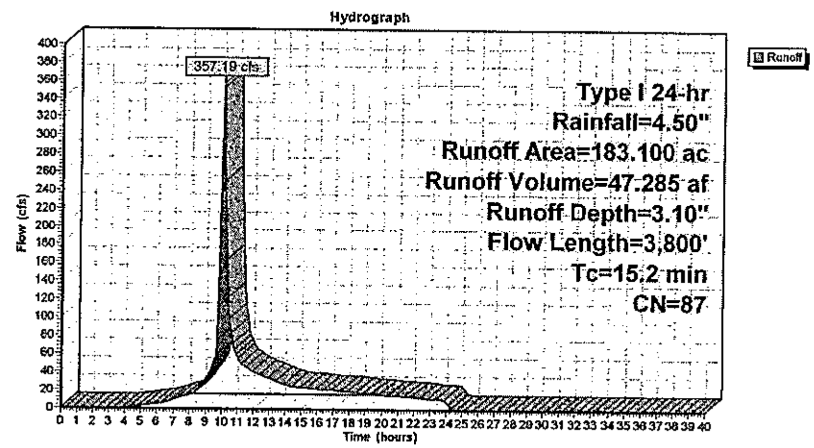
Runoff = 357.19 cfs @ 10.07 hrs, Volume= 47.285 af, Depth= 3.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type I 24-hr Rainfall=4.50"

Area (ac)	CN	Description
183.100	87	CN entered directly

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.9	200	0.0100	0.5		Lag/CN Method, Overland
8.3	3,600	0.0100	7.2	22.62	Circular Channel (pipe), Piped Diam= 24.0" Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
15.2	3,800	Total			

Subcatchment 1S: Ho'opili Area H4_5A Developed



Pond 2P: Detention Basin 4

Inflow Area =	183.100 ac, Inflow Depth = 3.10"		
Inflow =	357.19 cfs @ 10.07 hrs, Volume=	47.285 af	
Outflow =	74.10 cfs @ 10.69 hrs, Volume=	39.155 af,	Atten= 79%, Lag= 36.8 min
Primary =	74.10 cfs @ 10.69 hrs, Volume=	39.155 af	

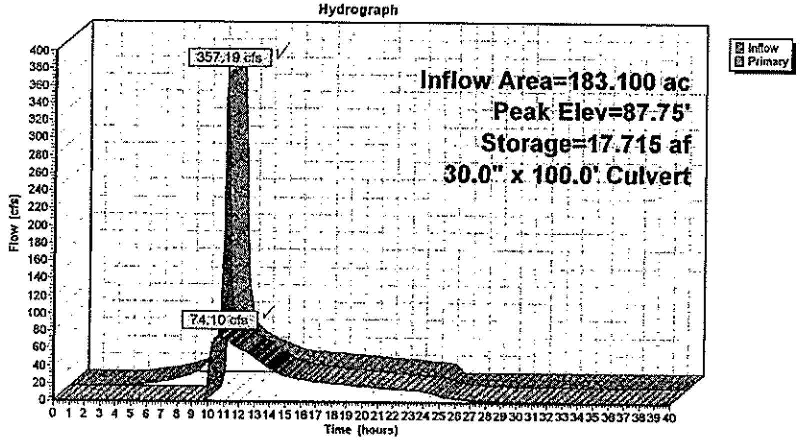
Routing by Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Peak Elev= 87.75' @ 10.69 hrs Surf.Area= 2.515 ac Storage= 17.715 af
Plug-Flow detention time= 255.5 min calculated for 39.155 af (83% of inflow)
Center-of-Mass det. time= 160.6 min (937.9 - 777.3)

Volume	Invert	Avail.Storage	Storage Description
#1	80.00'	23.538 af	**300.00'W x 300.00'L x 10.00'H Prismatoid Z=2.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	83.60'	**30.0" x 100.0' long Culvert X 2.00** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 83.10' S= 0.0050 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=74.08 cfs @ 10.69 hrs HW=87.74' (Free Discharge)
↑—1=Culvert (Barrel Controls 74.08 cfs @ 7.5 fps)

Pond 2P: Detention Basin 4

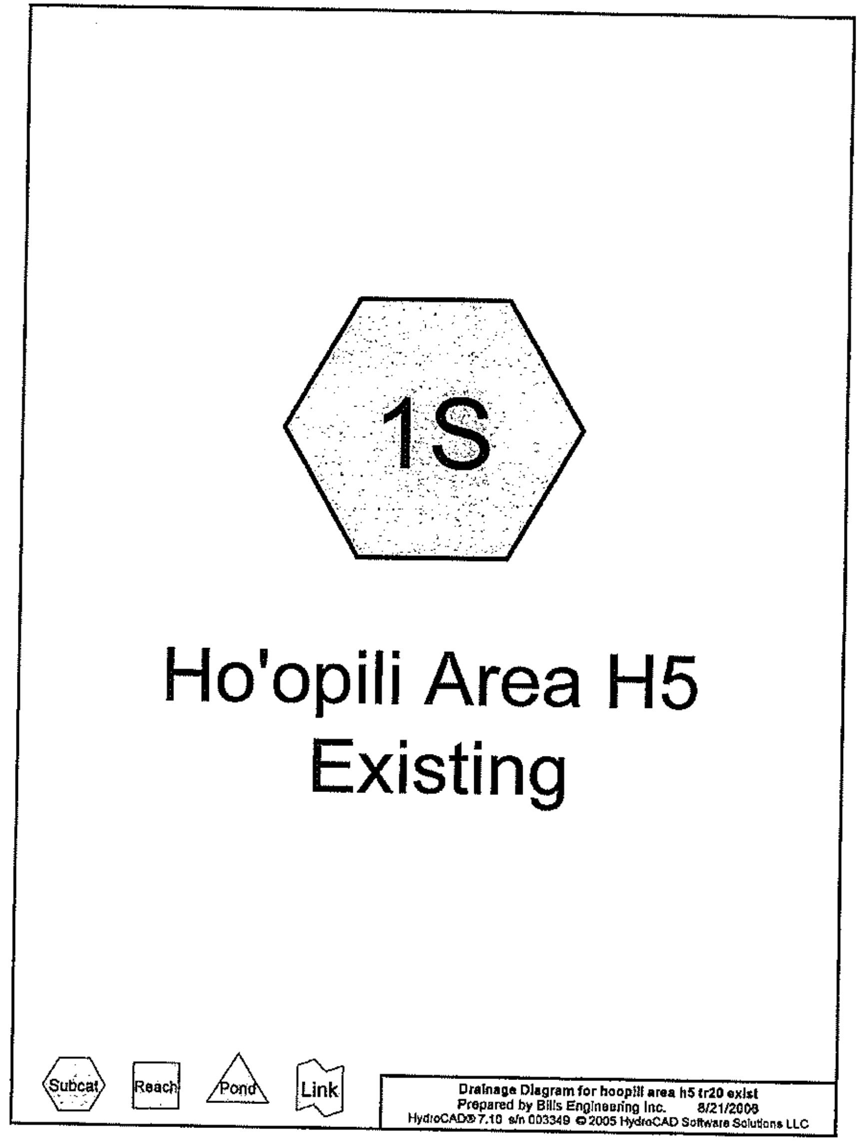


Stage-Discharge for Pond 2P: Detention Basin 4

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
80.00	0.00	85.40	27.48
80.10	0.00	85.50	29.98
80.20	0.00	85.60	32.51
80.30	0.00	85.70	35.06
80.40	0.00	85.80	37.60
80.50	0.00	85.90	40.14
80.60	0.00	86.00	42.65
80.70	0.00	86.10	45.11
80.80	0.00	86.20	47.51
80.90	0.00	86.30	49.82
81.00	0.00	86.40	52.01
81.10	0.00	86.50	54.05
81.20	0.00	86.60	55.89
81.30	0.00	86.70	57.45
81.40	0.00	86.80	58.63
81.50	0.00	86.90	59.06
81.60	0.00	87.00	59.85
81.70	0.00	87.10	61.95
81.80	0.00	87.20	63.99
81.90	0.00	87.30	65.96
82.00	0.00	87.40	67.87
82.10	0.00	87.50	69.73
82.20	0.00	87.60	71.54
82.30	0.00	87.70	73.31
82.40	0.00	87.80	75.03
82.50	0.00	87.90	76.72
82.60	0.00	88.00	78.37
82.70	0.00	88.10	79.98
82.80	0.00	88.20	81.57
82.90	0.00	88.30	83.12
83.00	0.00	88.40	84.65
83.10	0.00	88.50	86.14
83.20	0.00	88.60	87.62
83.30	0.00	88.70	89.07
83.40	0.00	88.80	90.49
83.50	0.00	88.90	91.89
83.60	0.00	89.00	93.28
83.70	0.09	89.10	94.64
83.80	0.40	89.20	95.98
83.90	0.94	89.30	97.30
84.00	1.68	89.40	98.61
84.10	2.63	89.50	99.90
84.20	3.76	89.60	101.17
84.30	5.06	89.70	102.43
84.40	6.53	89.80	103.67
84.50	8.13	89.90	104.90
84.60	9.88	90.00	106.11
84.70	11.75		
84.80	13.74		
84.90	15.82		
85.00	18.01		
85.10	20.28		
85.20	22.62		
85.30	25.02		

Stage-Area-Storage for Pond 2P: Detention Basin 4

Elevation (feet)	Storage (acre-feet)	Elevation (feet)	Storage (acre-feet)
80.00	0.000	85.40	11.980
80.10	0.207	85.50	12.217
80.20	0.414	85.60	12.456
80.30	0.622	85.70	12.695
80.40	0.831	85.80	12.934
80.50	1.040	85.90	13.174
80.60	1.250	86.00	13.415
80.70	1.460	86.10	13.656
80.80	1.671	86.20	13.898
80.90	1.882	86.30	14.141
81.00	2.094	86.40	14.384
81.10	2.306	86.50	14.627
81.20	2.519	86.60	14.872
81.30	2.733	86.70	15.116
81.40	2.947	86.80	15.362
81.50	3.162	86.90	15.608
81.60	3.377	87.00	15.855
81.70	3.593	87.10	16.102
81.80	3.809	87.20	16.350
81.90	4.026	87.30	16.598
82.00	4.243	87.40	16.847
82.10	4.461	87.50	17.097
82.20	4.680	87.60	17.347
82.30	4.899	87.70	17.598
82.40	5.119	87.80	17.850
82.50	5.339	87.90	18.102
82.60	5.560	88.00	18.355
82.70	5.782	88.10	18.608
82.80	6.004	88.20	18.862
82.90	6.226	88.30	19.117
83.00	6.450	88.40	19.372
83.10	6.673	88.50	19.628
83.20	6.898	88.60	19.884
83.30	7.123	88.70	20.141
83.40	7.348	88.80	20.399
83.50	7.574	88.90	20.657
83.60	7.801	89.00	20.916
83.70	8.028	89.10	21.175
83.80	8.256	89.20	21.435
83.90	8.484	89.30	21.696
84.00	8.713	89.40	21.957
84.10	8.943	89.50	22.219
84.20	9.173	89.60	22.482
84.30	9.403	89.70	22.745
84.40	9.635	89.80	23.009
84.50	9.867	89.90	23.273
84.60	10.099	90.00	23.538
84.70	10.332		
84.80	10.566		
84.90	10.800		
85.00	11.035		
85.10	11.270		
85.20	11.506		
85.30	11.742		



Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Ho'opili Area H5 Existing Runoff Area=137.800 ac Runoff Depth=2.46"
Flow Length=3,800' Tc=49.4 min CN=80 Runoff=114.40 cfs 28.267 af

Total Runoff Area = 137.800 ac Runoff Volume = 28.267 af Average Runoff Depth = 2.46"

Subcatchment 1S: Ho'opili Area H5 Existing

Subcatchment area 5 Honouliuli Stream

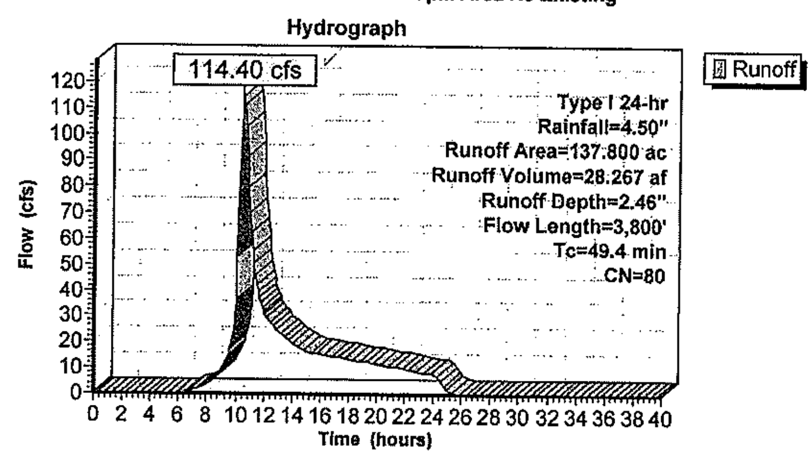
Runoff = 114.40 cfs @ 10.51 hrs, Volume= 28.267 af, Depth= 2.46"

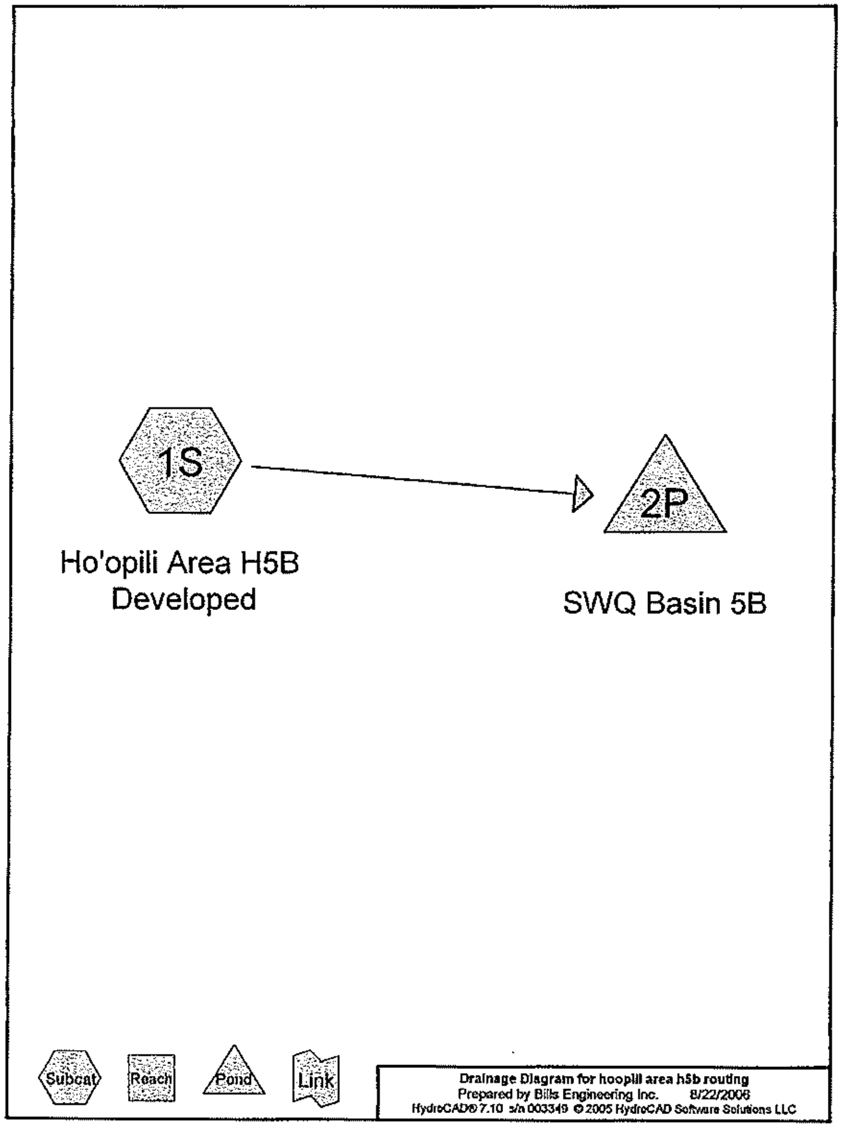
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type I 24-hr Rainfall=4.50"

Area (ac)	CN	Description
137.800	80	CN entered directly

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
49.4	3,800	0.0350	1.3		Lag/CN Method, Existing condition

Subcatchment 1S: Ho'opili Area H5 Existing





Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Ho'opili Area H5B Developed Runoff Area=32.800 ac Runoff Depth=3.10"
Flow Length=1,200' Tc=9.2 min CN=87 Runoff=75.48 cfs 8.470 af

Pond 2P: SWQ Basin 5B Peak Elev=7.93' Storage=2.458 af Inflow=75.48 cfs 8.470 af
24.0" x 100.0' Culvert Outflow=36.33 cfs 7.075 af

Total Runoff Area = 32.800 ac Runoff Volume = 8.470 af Average Runoff Depth = 3.10"

Subcatchment 1S: Ho'opili Area H5B Developed

Subcatchment area 5B Honouliuli Stream

[49] Hint: Tc<2dt may require smaller dt

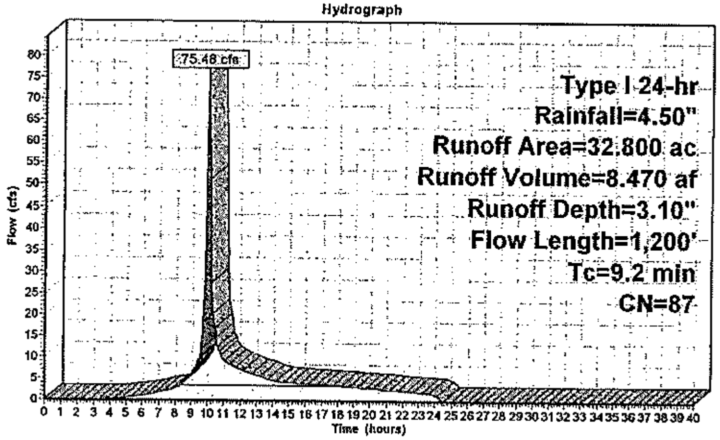
Runoff = 75.48 cfs @ 10.00 hrs, Volume= 8.470 af, Depth= 3.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type I 24-hr Rainfall=4.50"

Area (ac)	CN	Description
32.800	87	CN entered directly

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.9	200	0.0100	0.5		Lag/CN Method, Overland
2.3	1,000	0.0100	7.2	22.62	Circular Channel (pipe), Piped Diam= 24.0" Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
9.2	1,200	Total			

Subcatchment 1S: Ho'opili Area H5B Developed



Pond 2P: SWQ Basin 5B

Inflow Area =	32.800 ac,	Inflow Depth = 3.10"		
Inflow =	75.48 cfs @	10.00 hrs, Volume=	8.470 af	
Outflow =	36.33 cfs @	10.18 hrs, Volume=	7.075 af,	Atten= 52%, Lag= 10.7 min
Primary =	36.33 cfs @	10.18 hrs, Volume=	7.075 af	

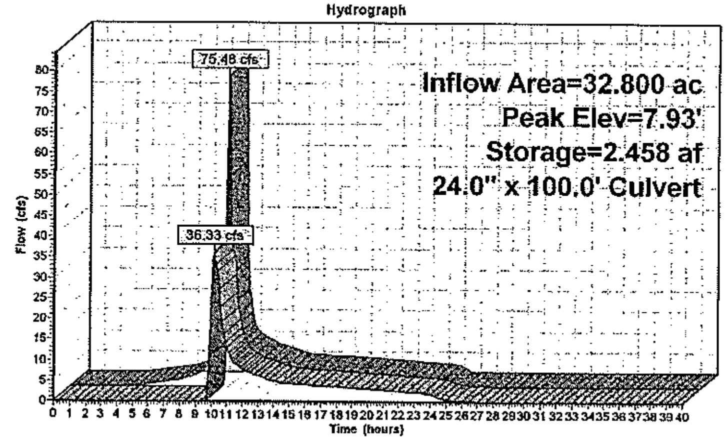
Routing by Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Peak Elev= 7.93' @ 10.18 hrs Surf.Area= 0.398 ac Storage= 2.458 af
Plug-Flow detention time= 179.0 min calculated for 7.075 af (84% of inflow)
Center-of-Mass det. time= 87.2 min (858.9 - 771.7)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	3.336 af	100.00'W x 100.00'L x 10.00'H Prismatoid Z=2.0

Device	Routing	Invert	Outlet Devices
#1	Primary	5.00'	24.0" x 100.0' long Culvert X 2.00 RCP, square edge headwall, Ke= 0.500 Outlet Invert= 4.50' S= 0.0050 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=35.98 cfs @ 10.18 hrs HW=7.90' (Free Discharge)
↑—1=Culvert (Barrel Controls 35.98 cfs @ 5.7 fps)

Pond 2P: SWQ Basin 5B

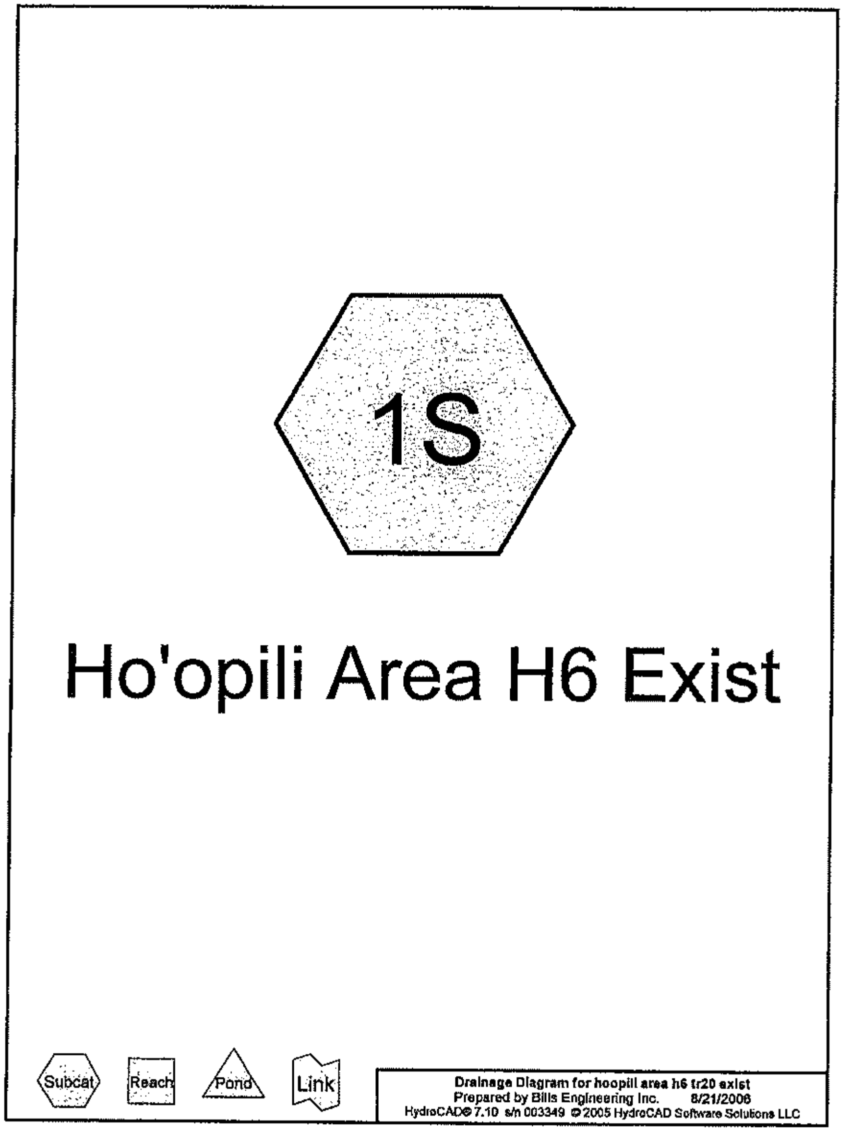


Stage-Discharge for Pond 2P: SWQ Basin 5B

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
0.00	0.00	5.40	1.48
0.10	0.00	5.50	2.30
0.20	0.00	5.60	3.28
0.30	0.00	5.70	4.39
0.40	0.00	5.80	5.63
0.50	0.00	5.90	6.99
0.60	0.00	6.00	8.45
0.70	0.00	6.10	10.00
0.80	0.00	6.20	11.62
0.90	0.00	6.30	13.31
1.00	0.00	6.40	15.05
1.10	0.00	6.50	16.84
1.20	0.00	6.60	18.64
1.30	0.00	6.70	20.46
1.40	0.00	6.80	22.27
1.50	0.00	6.90	24.06
1.60	0.00	7.00	25.81
1.70	0.00	7.10	27.49
1.80	0.00	7.20	29.07
1.90	0.00	7.30	30.53
2.00	0.00	7.40	31.79
2.10	0.00	7.50	32.80
2.20	0.00	7.60	33.37
2.30	0.00	7.70	33.33
2.40	0.00	7.80	34.69
2.50	0.00	7.90	36.00
2.60	0.00	8.00	37.26
2.70	0.00	8.10	38.49
2.80	0.00	8.20	39.67
2.90	0.00	8.30	40.82
3.00	0.00	8.40	41.94
3.10	0.00	8.50	43.03
3.20	0.00	8.60	44.09
3.30	0.00	8.70	45.13
3.40	0.00	8.80	46.14
3.50	0.00	8.90	47.14
3.60	0.00	9.00	48.11
3.70	0.00	9.10	49.06
3.80	0.00	9.20	50.00
3.90	0.00	9.30	50.91
4.00	0.00	9.40	51.81
4.10	0.00	9.50	52.70
4.20	0.00	9.60	53.57
4.30	0.00	9.70	54.43
4.40	0.00	9.80	55.27
4.50	0.00	9.90	56.10
4.60	0.00	10.00	56.92
4.70	0.00		
4.80	0.00		
4.90	0.00		
5.00	0.00		
5.10	0.08		
5.20	0.36		
5.30	0.83		

Stage-Area-Storage for Pond 2P: SWQ Basin 5B

Elevation (feet)	Storage (acre-feet)	Elevation (feet)	Storage (acre-feet)
0.00	0.000	5.40	1.527
0.10	0.023	5.50	1.561
0.20	0.046	5.60	1.595
0.30	0.070	5.70	1.630
0.40	0.093	5.80	1.664
0.50	0.117	5.90	1.699
0.60	0.141	6.00	1.734
0.70	0.165	6.10	1.770
0.80	0.190	6.20	1.805
0.90	0.214	6.30	1.841
1.00	0.239	6.40	1.877
1.10	0.264	6.50	1.914
1.20	0.289	6.60	1.950
1.30	0.314	6.70	1.987
1.40	0.340	6.80	2.024
1.50	0.365	6.90	2.061
1.60	0.391	7.00	2.099
1.70	0.417	7.10	2.137
1.80	0.444	7.20	2.175
1.90	0.470	7.30	2.213
2.00	0.497	7.40	2.251
2.10	0.524	7.50	2.290
2.20	0.551	7.60	2.329
2.30	0.578	7.70	2.368
2.40	0.606	7.80	2.407
2.50	0.633	7.90	2.447
2.60	0.661	8.00	2.487
2.70	0.689	8.10	2.527
2.80	0.717	8.20	2.567
2.90	0.746	8.30	2.608
3.00	0.775	8.40	2.649
3.10	0.804	8.50	2.690
3.20	0.833	8.60	2.731
3.30	0.862	8.70	2.773
3.40	0.891	8.80	2.815
3.50	0.921	8.90	2.857
3.60	0.951	9.00	2.899
3.70	0.981	9.10	2.942
3.80	1.012	9.20	2.985
3.90	1.042	9.30	3.028
4.00	1.073	9.40	3.071
4.10	1.104	9.50	3.115
4.20	1.135	9.60	3.158
4.30	1.167	9.70	3.203
4.40	1.198	9.80	3.247
4.50	1.230	9.90	3.292
4.60	1.262	10.00	3.336
4.70	1.295		
4.80	1.327		
4.90	1.360		
5.00	1.393		
5.10	1.426		
5.20	1.459		
5.30	1.493		



Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Ho'opili Area H6 Exist Runoff Area=173.500 ac Runoff Depth=2.46"
Flow Length=3,800' Tc=48.7 min CN=80 Runoff=144.92 cfs 35.590 af

Total Runoff Area = 173.500 ac Runoff Volume = 35.590 af Average Runoff Depth = 2.46"

Subcatchment 1S: Ho'opili Area H6 Exist

Subcatchment area 6 west of Honouliuli Stream

Runoff = 144.92 cfs @ 10.50 hrs, Volume= 35.590 af, Depth= 2.46"

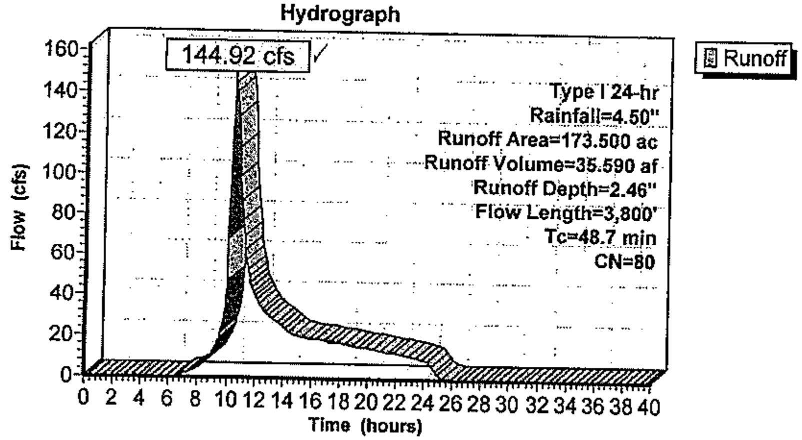
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type I 24-hr Rainfall=4.50"

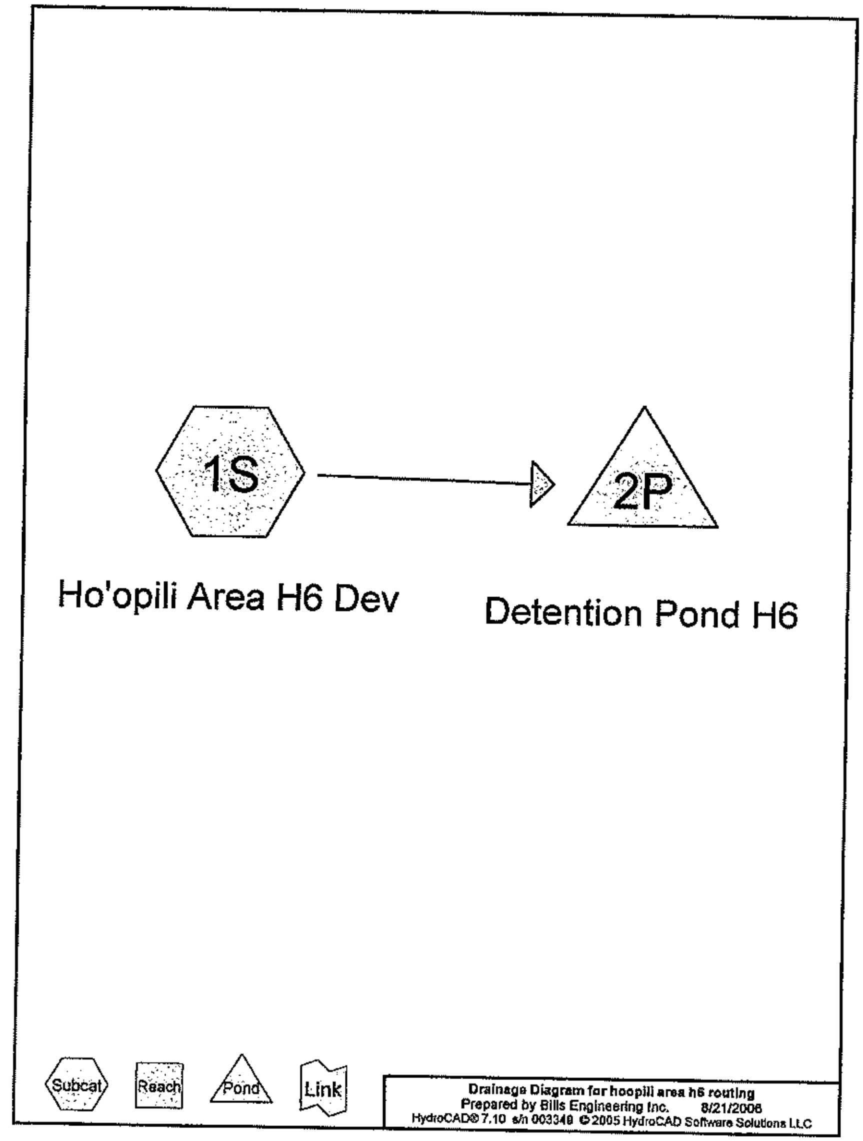
Area (ac)	CN	Description
173.500	80✓	CN entered directly

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
48.7	3,800	0.0360	1.3		Lag/CN Method, Existing condition

Subcatchment 1S: Ho'opili Area H6 Exist

Hydrograph





Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Ho'opili Area H6 Dev Runoff Area=173.500 ac Runoff Depth=3.10"
Flow Length=3,800' Tc=38.4 min CN=87 Runoff=217.07 cfs 44.805 af

Pond 2P: Detention Pond H6 Peak Elev=7.83' Storage=12.693 af Inflow=217.07 cfs 44.805 af
48.0" x 100.0' Culvert Outflow=142.26 cfs 37.285 af

Total Runoff Area = 173.500 ac Runoff Volume = 44.805 af Average Runoff Depth = 3.10"

Subcatchment 1S: Ho'opili Area H6 Dev

Subcatchment area 6 west of Honouliuli Stream

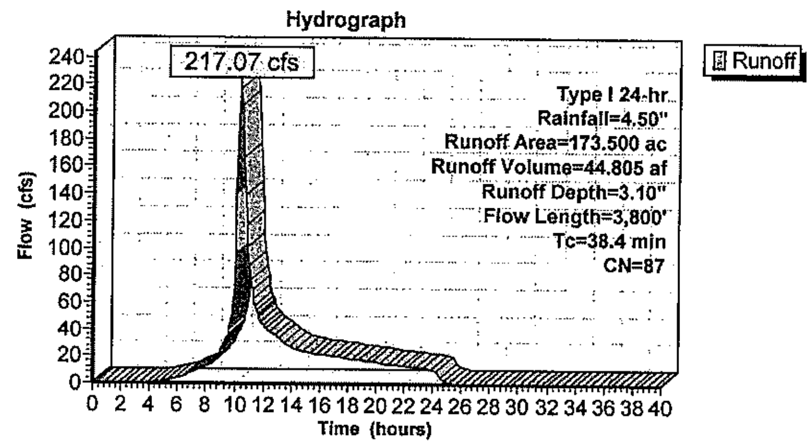
Runoff = 217.07 cfs @ 10.35 hrs, Volume= 44.805 af, Depth= 3.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type I 24-hr Rainfall=4.50"

Area (ac)	CN	Description
173.500	87	CN entered directly

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
38.4	3,800	0.0360	1.6		Lag/CN Method, Developed condition

Subcatchment 1S: Ho'opili Area H6 Dev



Pond 2P: Detention Pond H6

Inflow Area = 173.500 ac, Inflow Depth = 3.10"
Inflow = 217.07 cfs @ 10.35 hrs, Volume= 44.805 af
Outflow = 142.26 cfs @ 10.70 hrs, Volume= 37.285 af, Atten= 34%, Lag= 20.9 min
Primary = 142.26 cfs @ 10.70 hrs, Volume= 37.285 af

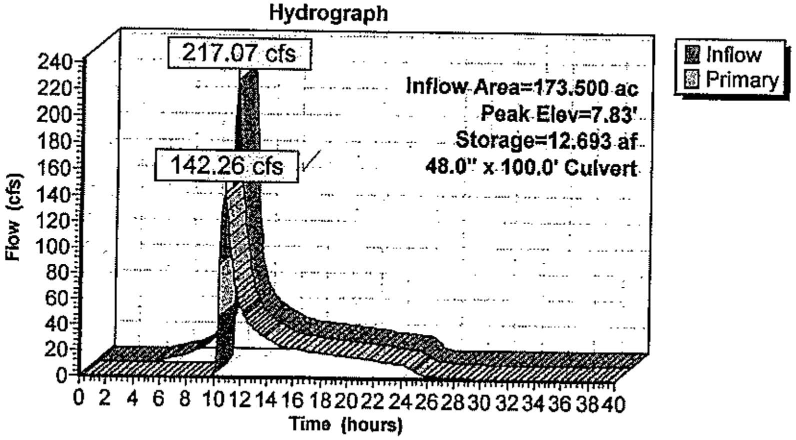
Routing by Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Peak Elev= 7.83' @ 10.70 hrs Surf.Area= 1.817 ac Storage= 12.693 af
Plug-Flow detention time= 193.7 min calculated for 37.192 af (83% of inflow)
Center-of-Mass det. time= 102.7 min (901.5 - 798.8)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	16.766 af	**250.00'W x 250.00'L x 10.00'H Prismatoid Z=2.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	4.80'	**48.0" x 100.0' long Culvert X 3.00** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 4.30' S= 0.0050 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=142.24 cfs @ 10.70 hrs HW=7.83' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 142.24 cfs @ 6.4 fps)

Pond 2P: Detention Pond H6

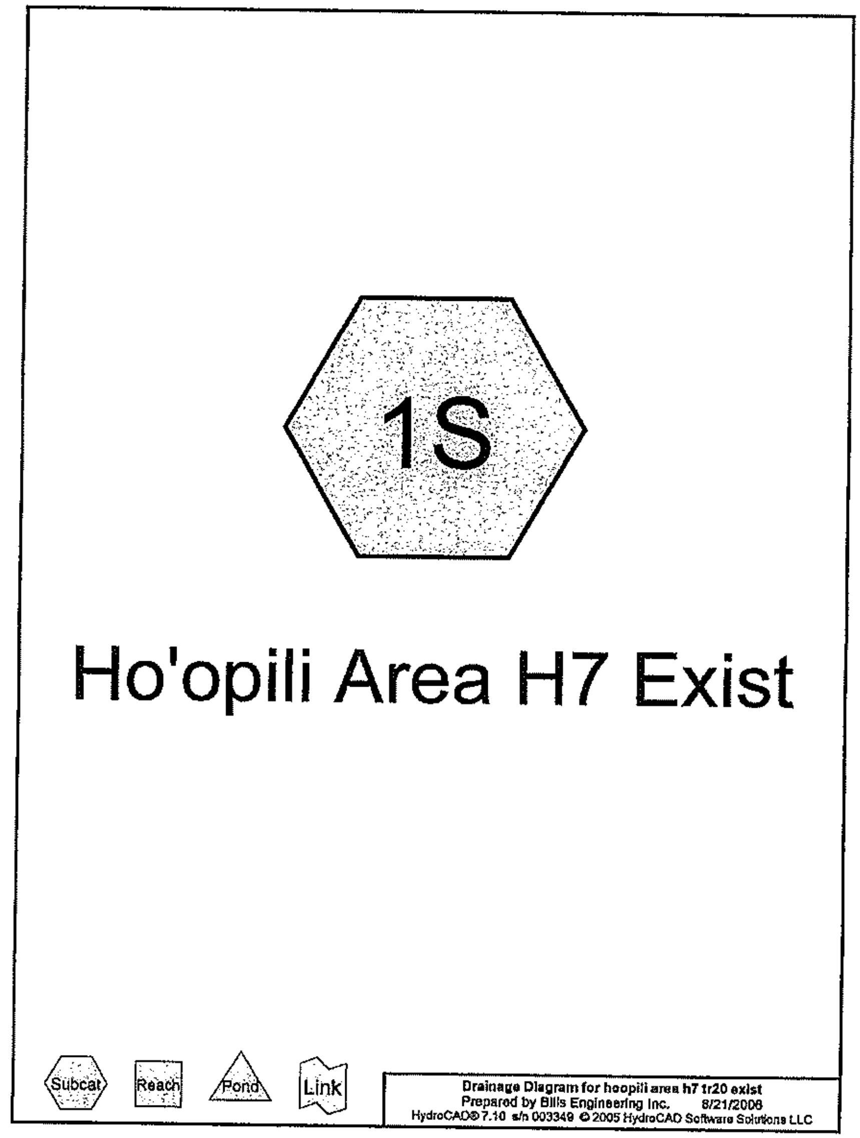


Stage-Discharge for Pond 2P: Detention Pond H6

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
0.00	0.00	5.30	5.15
0.10	0.00	5.40	7.41
0.20	0.00	5.50	10.03
0.30	0.00	5.60	13.00
0.40	0.00	5.70	16.31
0.50	0.00	5.80	19.93
0.60	0.00	5.90	23.85
0.70	0.00	6.00	28.06
0.80	0.00	6.10	32.54
0.90	0.00	6.20	37.29
1.00	0.00	6.30	42.29
1.10	0.00	6.40	47.53
1.20	0.00	6.50	53.00
1.30	0.00	6.60	58.70
1.40	0.00	6.70	64.60
1.50	0.00	6.80	70.70
1.60	0.00	6.90	76.99
1.70	0.00	7.00	83.45
1.80	0.00	7.10	90.09
1.90	0.00	7.20	96.88
2.00	0.00	7.30	103.82
2.10	0.00	7.40	110.90
2.20	0.00	7.50	118.10
2.30	0.00	7.60	125.41
2.40	0.00	7.70	132.82
2.50	0.00	7.80	140.32
2.60	0.00	7.90	147.90
2.70	0.00	8.00	155.54
2.80	0.00	8.10	163.23
2.90	0.00	8.20	170.95
3.00	0.00	8.30	178.70
3.10	0.00	8.40	186.44
3.20	0.00	8.50	194.18
3.30	0.00	8.60	201.88
3.40	0.00	8.70	209.53
3.50	0.00	8.80	217.11
3.60	0.00	8.90	224.60
3.70	0.00	9.00	231.97
3.80	0.00	9.10	239.19
3.90	0.00	9.20	246.24
4.00	0.00	9.30	253.08
4.10	0.00	9.40	259.66
4.20	0.00	9.50	265.96
4.30	0.00	9.60	271.89
4.40	0.00	9.70	277.40
4.50	0.00	9.80	282.38
4.60	0.00	9.90	286.67
4.70	0.00	10.00	**289.99**
4.80	0.00		
4.90	0.18		
5.00	0.78		
5.10	1.81		
5.20	3.28		

Stage-Area-Storage for Pond 2P: Detention Pond H6

Elevation (feet)	Storage (acre-feet)	Elevation (feet)	Storage (acre-feet)
0.00	0.000	5.30	8.268
0.10	0.144	5.40	8.437
0.20	0.288	5.50	8.606
0.30	0.433	5.60	8.776
0.40	0.578	5.70	8.947
0.50	0.723	5.80	9.118
0.60	0.869	5.90	9.290
0.70	1.016	6.00	9.462
0.80	1.163	6.10	9.634
0.90	1.310	6.20	9.807
1.00	1.458	6.30	9.981
1.10	1.606	6.40	10.155
1.20	1.755	6.50	10.330
1.30	1.904	6.60	10.505
1.40	2.054	6.70	10.681
1.50	2.204	6.80	10.857
1.60	2.355	6.90	11.033
1.70	2.506	7.00	11.210
1.80	2.658	7.10	11.388
1.90	2.810	7.20	11.566
2.00	2.962	7.30	11.745
2.10	3.115	7.40	11.924
2.20	3.269	7.50	12.104
2.30	3.423	7.60	12.284
2.40	3.577	7.70	12.465
2.50	3.732	7.80	12.646
2.60	3.888	7.90	12.828
2.70	4.044	8.00	13.010
2.80	4.200	8.10	13.193
2.90	4.357	8.20	13.377
3.00	4.514	8.30	13.560
3.10	4.672	8.40	13.745
3.20	4.830	8.50	13.930
3.30	4.989	8.60	14.115
3.40	5.149	8.70	14.301
3.50	5.308	8.80	14.487
3.60	5.469	8.90	14.674
3.70	5.629	9.00	14.862
3.80	5.790	9.10	15.050
3.90	5.952	9.20	15.239
4.00	6.114	9.30	15.428
4.10	6.277	9.40	15.617
4.20	6.440	9.50	15.807
4.30	6.604	9.60	15.998
4.40	6.768	9.70	16.189
4.50	6.933	9.80	16.381
4.60	7.098	9.90	16.573
4.70	7.263	10.00	**16.766**
4.80 ✓	7.430 ✓		
4.90	7.596		
5.00	7.763		
5.10	7.931		
5.20	8.099		



Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Ho'opili Area H7 Exist Runoff Area=148.200 ac Runoff Depth=2.46"
Flow Length=4,800' Tc=70.5 min CN=80 Runoff=99.05 cfs 30.400 af

Total Runoff Area = 148.200 ac Runoff Volume = 30.400 af Average Runoff Depth = 2.46"

Subcatchment 1S: Ho'opili Area H7 Exist

Subcatchment area 7 west of Honouliuli Stream

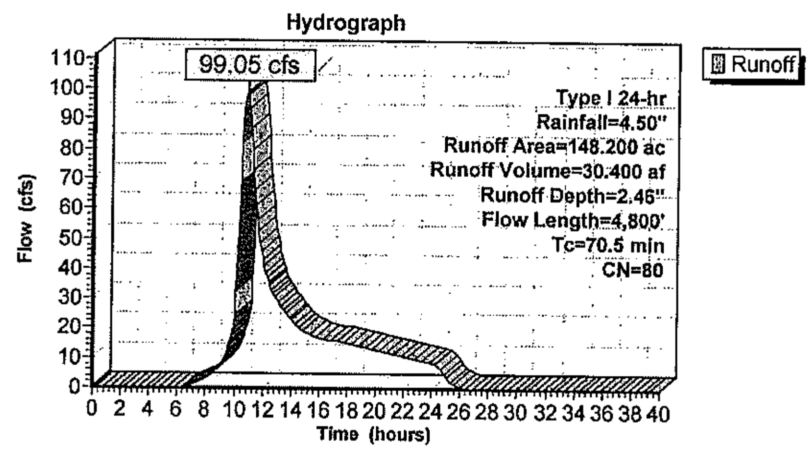
Runoff = 99.05 cfs @ 10.80 hrs, Volume= 30.400 af, Depth= 2.46"

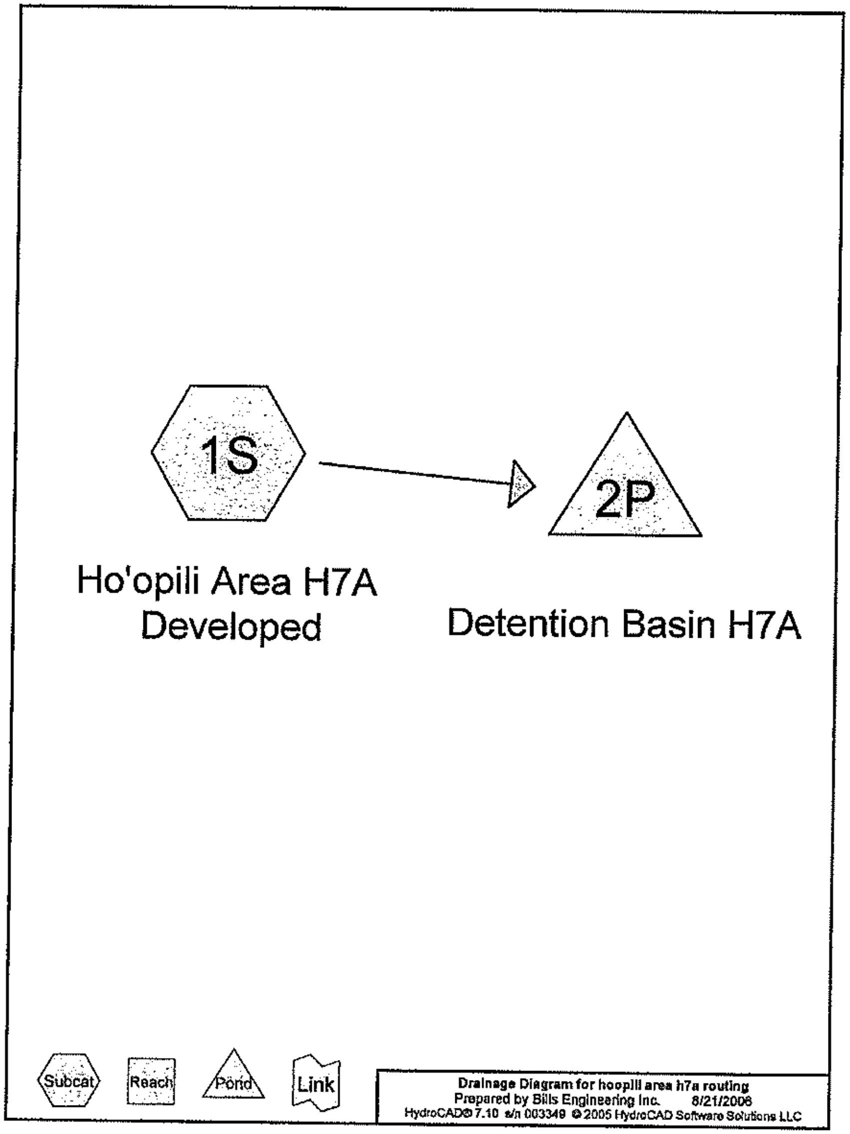
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type I 24-hr Rainfall=4.50"

Area (ac)	CN	Description
148.200	80	CN entered directly

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
70.5	4,800	0.0250	1.1		**Lag/CN Method, Existing condition**

Subcatchment 1S: Ho'opili Area H7 Exist





Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Ho'opili Area H7A Developed Runoff Area=125.200 ac Runoff Depth=3.10"
Flow Length=4,000' Tc=16.9 min CN=87 Runoff=236.87 cfs 32.332 af

Pond 2P: Detention Basin H7A Peak Elev=7.78' Storage=11.157 af Inflow=236.87 cfs 32.332 af
30.0" x 100.0' Culvert Outflow=71.10 cfs 26.745 af

Total Runoff Area = 125.200 ac Runoff Volume = 32.332 af Average Runoff Depth = 3.10"

Subcatchment 1S: Ho'opili Area H7A Developed

Subcatchment area 7 west of Honouliuli Stream

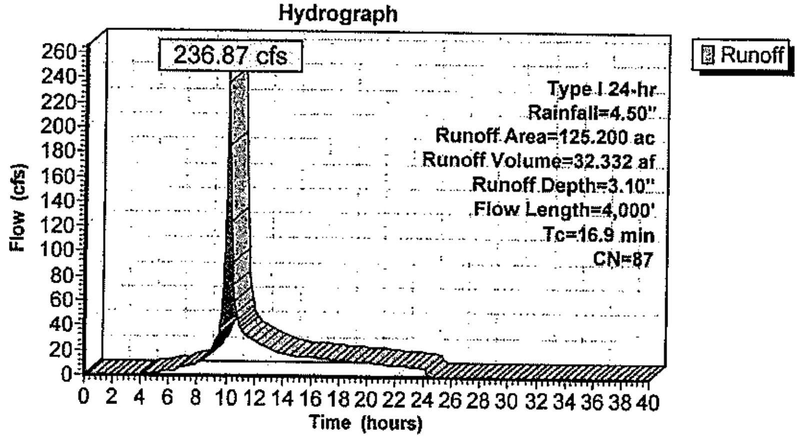
Runoff = 236.87 cfs @ 10.09 hrs, Volume= 32.332 af, Depth= 3.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type I 24-hr Rainfall=4.50"

Area (ac)	CN	Description
125.200	87	CN entered directly

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.9	200	0.0100	0.5		Lag/CN Method, Overland
2.5	1,500	0.0200	10.2	31.99	Circular Channel (pipe), Piped Diam= 24.0" Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
7.5	2,300	0.0050	5.1	16.00	Circular Channel (pipe), Piped-in road Diam= 24.0" Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
16.9	4,000	Total			

Subcatchment 1S: Ho'opili Area H7A Developed



Pond 2P: Detention Basin H7A

Inflow Area = 125.200 ac, Inflow Depth = 3.10"
Inflow = 236.87 cfs @ 10.09 hrs, Volume= 32.332 af
Outflow = 71.10 cfs @ 10.52 hrs, Volume= 26.745 af, Atten= 70%, Lag= 25.9 min
Primary = 71.10 cfs @ 10.52 hrs, Volume= 26.745 af

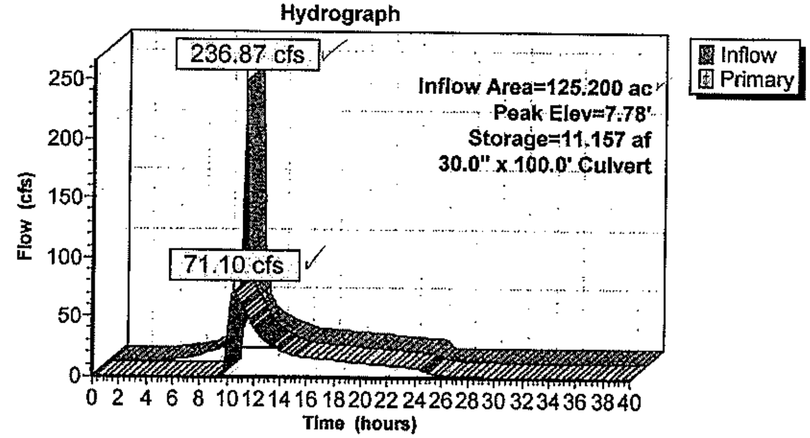
Routing by Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Peak Elev= 7.78' @ 10.52 hrs Surf.Area= 1.435 ac Storage= 11.157 af
Plug-Flow detention time=222.0 min calculated for 26.679 af (83% of inflow)
Center-of-Mass det. time= 129.0 min (907.9 - 778.9)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	14.348 af	250.00'W x 250.00'L x 10.00'H Prismatoid

Device	Routing	Invert	Outlet Devices
#1	Primary	3.80'	30.0" x 100.0' long Culvert X 2.00 RCP, square edge headwall, Ke= 0.500 Outlet Invert= 3.30' S= 0.0050 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=70.95 cfs @ 10.52 hrs HW=7.77' (Free Discharge)
└1=Culvert (Barrel Controls 70.95 cfs @ 7.2 fps)

Pond 2P: Detention Basin H7A

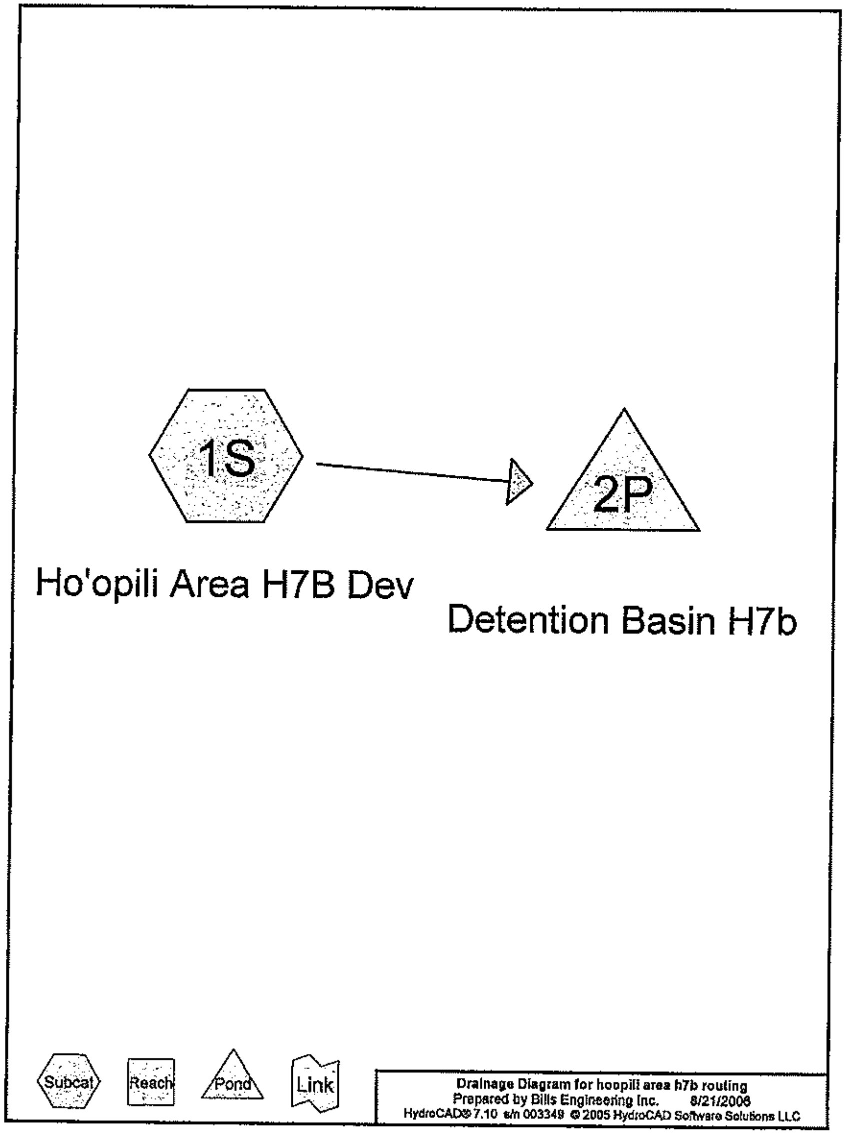


Stage-Discharge for Pond 2P: Detention Basin H7A

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
0.00	0.00	5.30	20.28
0.10	0.00	5.40	22.62
0.20	0.00	5.50	25.02
0.30	0.00	5.60	27.48
0.40	0.00	5.70	29.98
0.50	0.00	5.80	32.51
0.60	0.00	5.90	35.06
0.70	0.00	6.00	37.60
0.80	0.00	6.10	40.14
0.90	0.00	6.20	42.65
1.00	0.00	6.30	45.11
1.10	0.00	6.40	47.51
1.20	0.00	6.50	49.82
1.30	0.00	6.60	52.01
1.40	0.00	6.70	54.05
1.50	0.00	6.80	55.89
1.60	0.00	6.90	57.45
1.70	0.00	7.00	58.63
1.80	0.00	7.10	59.06
1.90	0.00	7.20	59.85
2.00	0.00	7.30	61.95
2.10	0.00	7.40	63.99
2.20	0.00	7.50	65.96
2.30	0.00	7.60	67.87
2.40	0.00	7.70	69.73
2.50	0.00	7.80	71.54
2.60	0.00	7.90	73.31
2.70	0.00	8.00	75.03
2.80	0.00	8.10	76.72
2.90	0.00	8.20	78.37
3.00	0.00	8.30	79.98
3.10	0.00	8.40	81.57
3.20	0.00	8.50	83.12
3.30	0.00	8.60	84.65
3.40	0.00	8.70	86.14
3.50	0.00	8.80	87.62
3.60	0.00	8.90	89.07
3.70	0.00	9.00	90.49
3.80	0.00	9.10	91.89
3.90	0.09	9.20	93.28
4.00	0.40	9.30	94.64
4.10	0.94	9.40	95.98
4.20	1.68	9.50	97.30
4.30	2.63	9.60	98.61
4.40	3.76	9.70	99.90
4.50	5.06	9.80	101.17
4.60	6.53	9.90	102.43
4.70	8.13	10.00	**103.67**
4.80	9.88		
4.90	11.75		
5.00	13.74		
5.10	15.82		
5.20	18.01		

Stage-Area-Storage for Pond 2P: Detention Basin H7A

Elevation (feet)	Storage (acre-feet)	Elevation (feet)	Storage (acre-feet)
0.00	0.000	5.30	7.604
0.10	0.143	5.40	7.748
0.20	0.287	5.50	7.891
0.30	0.430	5.60	8.035
0.40	0.574	5.70	8.178
0.50	0.717	5.80	8.322
0.60	0.861	5.90	8.465
0.70	1.004	6.00	8.609
0.80	1.148	6.10	8.752
0.90	1.291	6.20	8.896
1.00	1.435	6.30	9.039
1.10	1.578	6.40	9.183
1.20	1.722	6.50	9.326
1.30	1.865	6.60	9.470
1.40	2.009	6.70	9.613
1.50	2.152	6.80	9.757
1.60	2.296	6.90	9.900
1.70	2.439	7.00	10.044
1.80	2.583	7.10	10.187
1.90	2.726	7.20	10.331
2.00	2.870	7.30	10.474
2.10	3.013	7.40	10.618
2.20	3.157	7.50	10.761
2.30	3.300	7.60	10.904
2.40	3.444	7.70	11.048
2.50	3.587	7.80	11.191
2.60	3.730	7.90	11.335
2.70	3.874	8.00	11.478
2.80	4.017	8.10	11.622
2.90	4.161	8.20	11.765
3.00	4.304	8.30	11.909
3.10	4.448	8.40	12.052
3.20	4.591	8.50	12.196
3.30	4.735	8.60	12.339
3.40	4.878	8.70	12.483
3.50	5.022	8.80	12.626
3.60	5.165	8.90	12.770
3.70	5.309	9.00	12.913
3.80 ✓	5.452 ✓	9.10	13.057
3.90	5.596	9.20	13.200
4.00	5.739	9.30	13.344
4.10	5.883	9.40	13.487
4.20	6.026	9.50	13.631
4.30	6.170	9.60	13.774
4.40	6.313	9.70	13.918
4.50	6.457	9.80	14.061
4.60	6.600	9.90	14.205
4.70	6.744	10.00	**14.348**
4.80	6.887		
4.90	7.031		
5.00	7.174		
5.10	7.317		
5.20	7.461		



Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Ho'opili Area H7B Dev Runoff Area=23.000 ac Runoff Depth=3.10"
Flow Length=1,200' Tc=9.2 min CN=87 Runoff=52.93 cfs 5.940 af

Pond 2P: Detention Basin H7b Peak Elev=6.33' Storage=1.852 af Inflow=52.93 cfs 5.940 af
30.0" x 100.0' Culvert Outflow=22.91 cfs 4.919 af

Total Runoff Area = 23.000 ac Runoff Volume = 5.940 af Average Runoff Depth = 3.10"

Subcatchment 1S: Ho'opili Area H7B Dev

Subcatchment area 7B west of Honouliuli Stream

[49] Hint: Tc<2dt may require smaller dt

Runoff = 52.93 cfs @ 10.00 hrs, Volume= 5.940 af, Depth= 3.10"

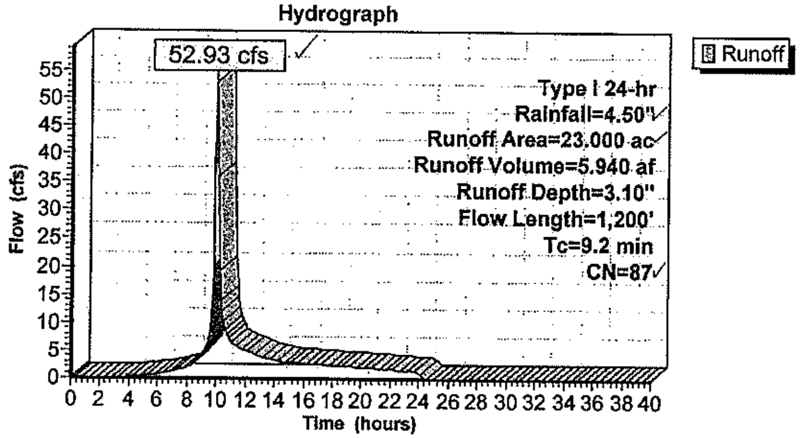
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type I 24-hr Rainfall=4.50"

Area (ac)	CN	Description
23.000	87	CN entered directly

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.9	200	0.0100	0.5		Lag/CN Method, Overland
2.3	1,000	0.0100	7.2	22.62	Circular Channel (pipe), Piped Diam= 24.0" Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
9.2	1,200	Total			

Subcatchment 1S: Ho'opili Area H7B Dev

Hydrograph



Pond 2P: Detention Basin H7b

Inflow Area = 23.000 ac, Inflow Depth = 3.10"
Inflow = 52.93 cfs @ 10.00 hrs, Volume= 5.940 af
Outflow = 22.91 cfs @ 10.20 hrs, Volume= 4.919 af, Atten= 57%, Lag= 12.2 min
Primary = 22.91 cfs @ 10.20 hrs, Volume= 4.919 af

Routing by Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Peak Elev= 6.33' @ 10.20 hrs Surf.Area= 0.361 ac Storage= 1.852 af
Plug-Flow detention time=199.3 min calculated for 4.919 af (83% of inflow)
Center-of-Mass det. time= 104.4 min (876.1 - 771.7)

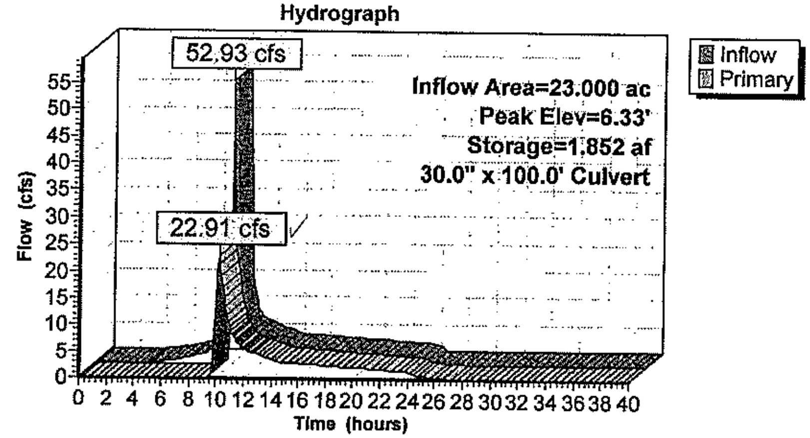
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	3.336 af	100.00'W x 100.00'L x 10.00'H Prismatoid Z=2.0

Device	Routing	Invert	Outlet Devices
#1	Primary	3.80'	30.0" x 100.0' long Culvert CPP, square edge headwall, Ke= 0.500 Outlet Invert= 3.30' S= 0.0050 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=22.91 cfs @ 10.20 hrs HW=6.33' (Free Discharge)
└1=Culvert (Barrel Controls 22.91 cfs @ 5.7 fps)

Pond 2P: Detention Basin H7b

Hydrograph

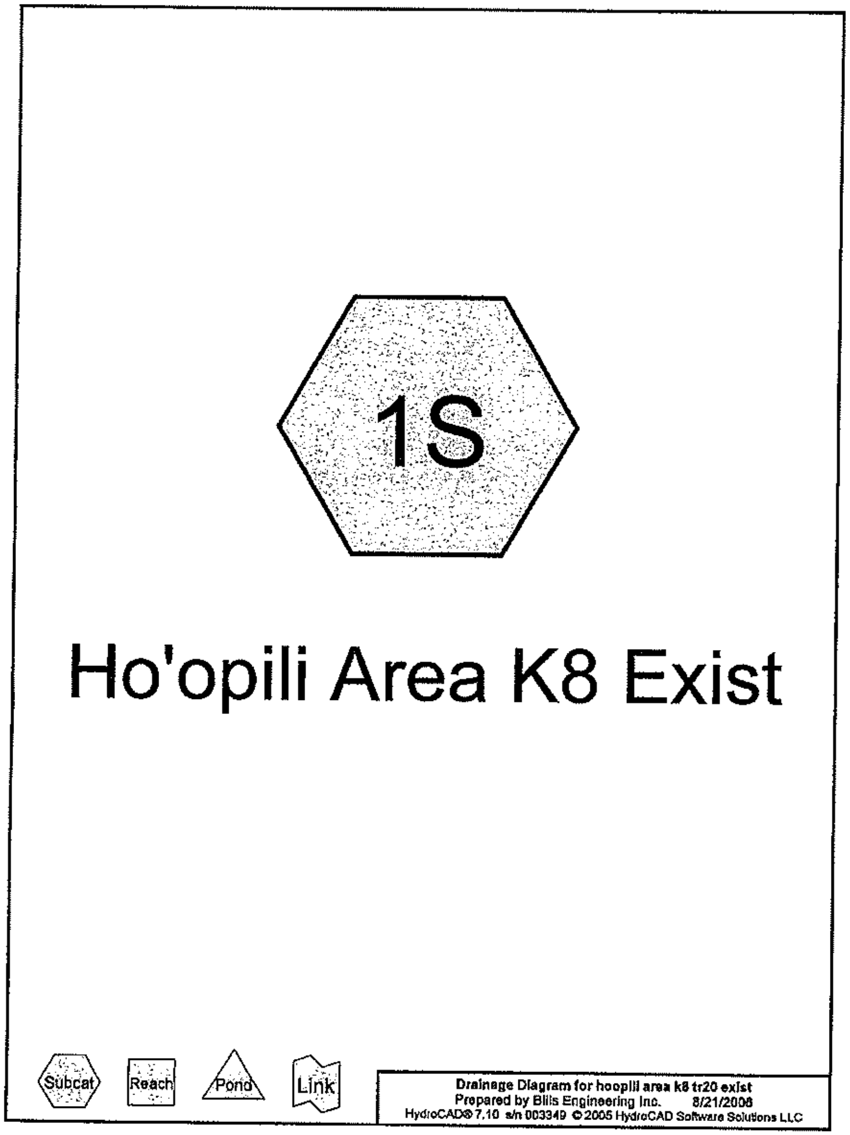


Stage-Discharge for Pond 2P: Detention Basin H7b

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
0.00	0.00	5.30	10.14
0.10	0.00	5.40	11.31
0.20	0.00	5.50	12.51
0.30	0.00	5.60	13.74
0.40	0.00	5.70	14.99
0.50	0.00	5.80	16.26
0.60	0.00	5.90	17.53
0.70	0.00	6.00	18.80
0.80	0.00	6.10	20.07
0.90	0.00	6.20	21.33
1.00	0.00	6.30	22.56
1.10	0.00	6.40	23.76
1.20	0.00	6.50	24.91
1.30	0.00	6.60	26.01
1.40	0.00	6.70	27.02
1.50	0.00	6.80	27.94
1.60	0.00	6.90	28.73
1.70	0.00	7.00	29.31
1.80	0.00	7.10	29.53
1.90	0.00	7.20	29.93
2.00	0.00	7.30	30.98
2.10	0.00	7.40	31.99
2.20	0.00	7.50	32.98
2.30	0.00	7.60	33.93
2.40	0.00	7.70	34.86
2.50	0.00	7.80	35.77
2.60	0.00	7.90	36.65
2.70	0.00	8.00	37.52
2.80	0.00	8.10	38.36
2.90	0.00	8.20	39.18
3.00	0.00	8.30	39.99
3.10	0.00	8.40	40.78
3.20	0.00	8.50	41.56
3.30	0.00	8.60	42.32
3.40	0.00	8.70	43.07
3.50	0.00	8.80	43.81
3.60	0.00	8.90	44.53
3.70	0.00	9.00	45.25
3.80	0.00	9.10	45.95
3.90	0.05	9.20	46.64
4.00	0.20	9.30	47.32
4.10	0.47	9.40	47.99
4.20	0.84	9.50	48.65
4.30	1.31	9.60	49.31
4.40	1.88	9.70	49.95
4.50	2.53	9.80	50.59
4.60	3.26	9.90	51.21
4.70	4.07	10.00	**51.84**
4.80	4.94		
4.90	5.87		
5.00	6.87		
5.10	7.91		
5.20	9.00		

Stage-Area-Storage for Pond 2P: Detention Basin H7b

Elevation (feet)	Storage (acre-feet)	Elevation (feet)	Storage (acre-feet)
0.00	0.000	5.30	1.493
0.10	0.023	5.40	1.527
0.20	0.046	5.50	1.561
0.30	0.070	5.60	1.595
0.40	0.093	5.70	1.630
0.50	0.117	5.80	1.664
0.60	0.141	5.90	1.699
0.70	0.165	6.00	1.734
0.80	0.190	6.10	1.770
0.90	0.214	6.20	1.805
1.00	0.239	6.30	1.841
1.10	0.264	6.40	1.877
1.20	0.289	6.50	1.914
1.30	0.314	6.60	1.950
1.40	0.340	6.70	1.987
1.50	0.365	6.80	2.024
1.60	0.391	6.90	2.061
1.70	0.417	7.00	2.099
1.80	0.444	7.10	2.137
1.90	0.470	7.20	2.175
2.00	0.497	7.30	2.213
2.10	0.524	7.40	2.251
2.20	0.551	7.50	2.290
2.30	0.578	7.60	2.329
2.40	0.606	7.70	2.368
2.50	0.633	7.80	2.407
2.60	0.661	7.90	2.447
2.70	0.689	8.00	2.487
2.80	0.717	8.10	2.527
2.90	0.746	8.20	2.567
3.00	0.775	8.30	2.608
3.10	0.804	8.40	2.649
3.20	0.833	8.50	2.690
3.30	0.862	8.60	2.731
3.40	0.891	8.70	2.773
3.50	0.921	8.80	2.815
3.60	0.951	8.90	2.857
3.70	0.981	9.00	2.899
3.80 ✓	1.012 ✓	9.10	2.942
3.90	1.042	9.20	2.985
4.00	1.073	9.30	3.028
4.10	1.104	9.40	3.071
4.20	1.135	9.50	3.115
4.30	1.167	9.60	3.158
4.40	1.198	9.70	3.203
4.50	1.230	9.80	3.247
4.60	1.262	9.90	3.292
4.70	1.295	10.00	**3.338**
4.80	1.327		
4.90	1.360		
5.00	1.393		
5.10	1.426		
5.20	1.459		



Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Ho'opili Area K8 Exist Runoff Area=52.000 ac Runoff Depth=2.46"
Flow Length=2,000' Tc=39.1 min CN=80 Runoff=49.31 cfs 10.667 af

Total Runoff Area = 52.000 ac Runoff Volume = 10.667 af Average Runoff Depth = 2.46"

Subcatchment 1S: Ho'opili Area K8 Exist

Subcatchment area K8 west of NS Rd above Farrington

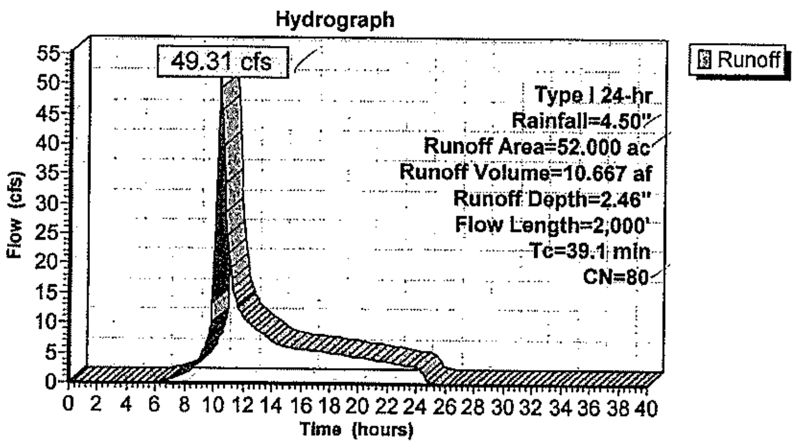
Runoff = 49.31 cfs @ 10.38 hrs, Volume= 10.667 af, Depth= 2.46"

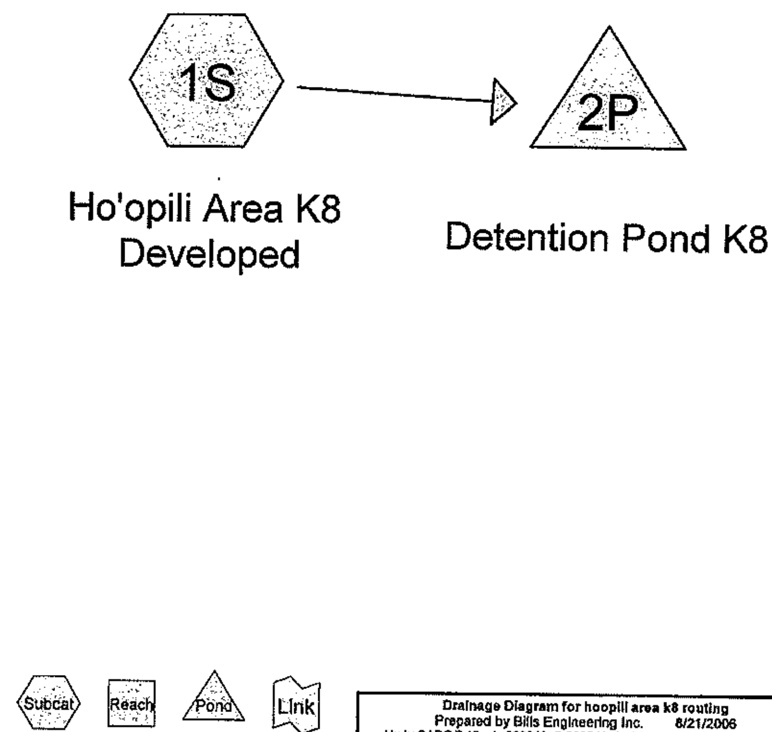
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type I 24-hr Rainfall=4.50"

Area (ac)	CN	Description
52.000	80	CN entered directly

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
39.1	2,000	0.0200	0.9		Lag/CN Method, Existing condition

Subcatchment 1S: Ho'opili Area K8 Exist





Drainage Diagram for hoopili area k8 routing
Prepared by Bills Engineering Inc. 8/21/2006
HydroCAD® 7.10 s/n 003349 © 2005 HydroCAD Software Solutions LLC

Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Ho'opili Area K8 Developed Runoff Area=52.000 ac Runoff Depth=3.10"
Flow Length=3,200' Tc=12.5 min CN=87 Runoff=108.13 cfs 13.429 af

Pond 2P: Detention Pond K8 Peak Elev=6.94' Storage=4.291 af Inflow=108.13 cfs 13.429 af
48.0" x 100.0' Culvert Outflow=45.35 cfs 11.092 af

Total Runoff Area = 52.000 ac Runoff Volume = 13.429 af Average Runoff Depth = 3.10"

Subcatchment 1S: Ho'opili Area K8 Developed

Subcatchment area K8 west of NS Rd above Farrington

Runoff = 108.13 cfs @ 10.03 hrs, Volume= 13.429 af, Depth= 3.10"

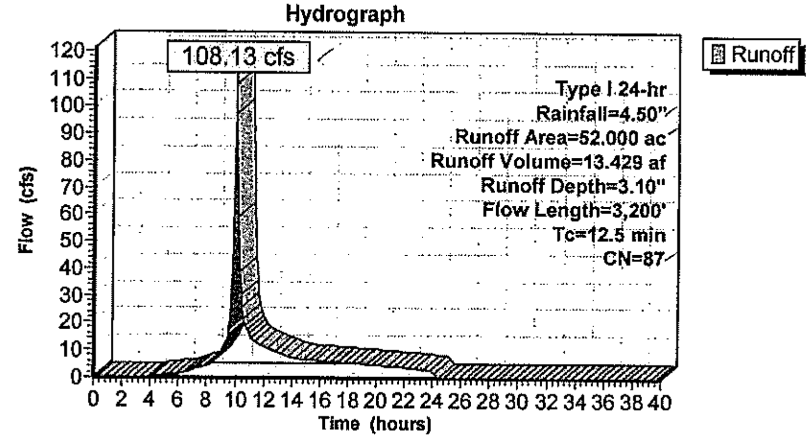
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type I 24-hr Rainfall=4.50"

Area (ac)	CN	Description
52.000	87	CN entered directly

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.9	200	0.0100	0.5		Lag/CN Method, overland
2.3	1,000	0.0100	7.2	22.62	Circular Channel (pipe), Piped Diam= 24.0" Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
3.3	2,000	0.0200	10.2	31.99	Circular Channel (pipe), Diam= 24.0" Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
12.5	3,200	Total			

Subcatchment 1S: Ho'opili Area K8 Developed

Hydrograph



Pond 2P: Detention Pond K8

Inflow Area =	52.000 ac, Inflow Depth = 3.10"		
Inflow =	108.13 cfs @ 10.03 hrs, Volume=	13.429 af	
Outflow =	45.35 cfs @ 10.28 hrs, Volume=	11.092 af,	Atten= 58%, Lag= 15.0 min
Primary =	45.35 cfs @ 10.28 hrs, Volume=	11.092 af	

Routing by Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Peak Elev= 6.94' @ 10.28 hrs Surf.Area= 0.726 ac Storage= 4.291 af
Plug-Flow detention time=209.7 min calculated for 11.092 af (83% of inflow)
Center-of-Mass det. time= 113.8 min (888.5 - 774.8)

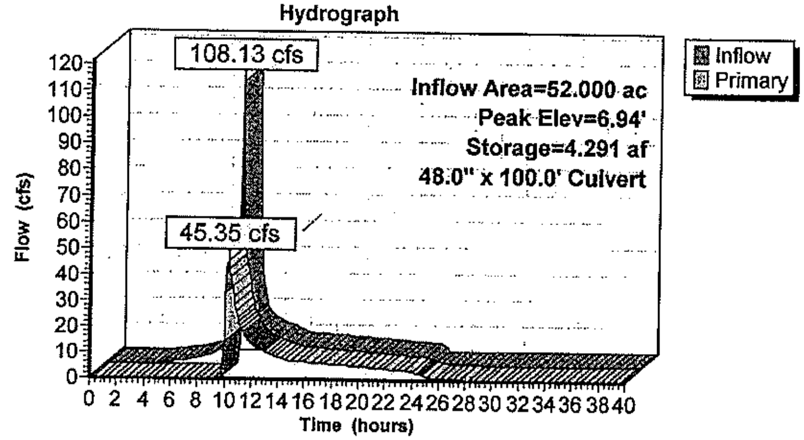
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	5.076 af	**150.00'W x 150.00'L x 8.00'H Prismatoid Z=2.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	4.00'	**48.0" x 100.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 3.50' S= 0.0050 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=45.07 cfs @ 10.28 hrs HW=6.93' (Free Discharge)
↑**1=Culvert** (Barrel Controls 45.07 cfs @ 6.4 fps)

Pond 2P: Detention Pond K8

Hydrograph

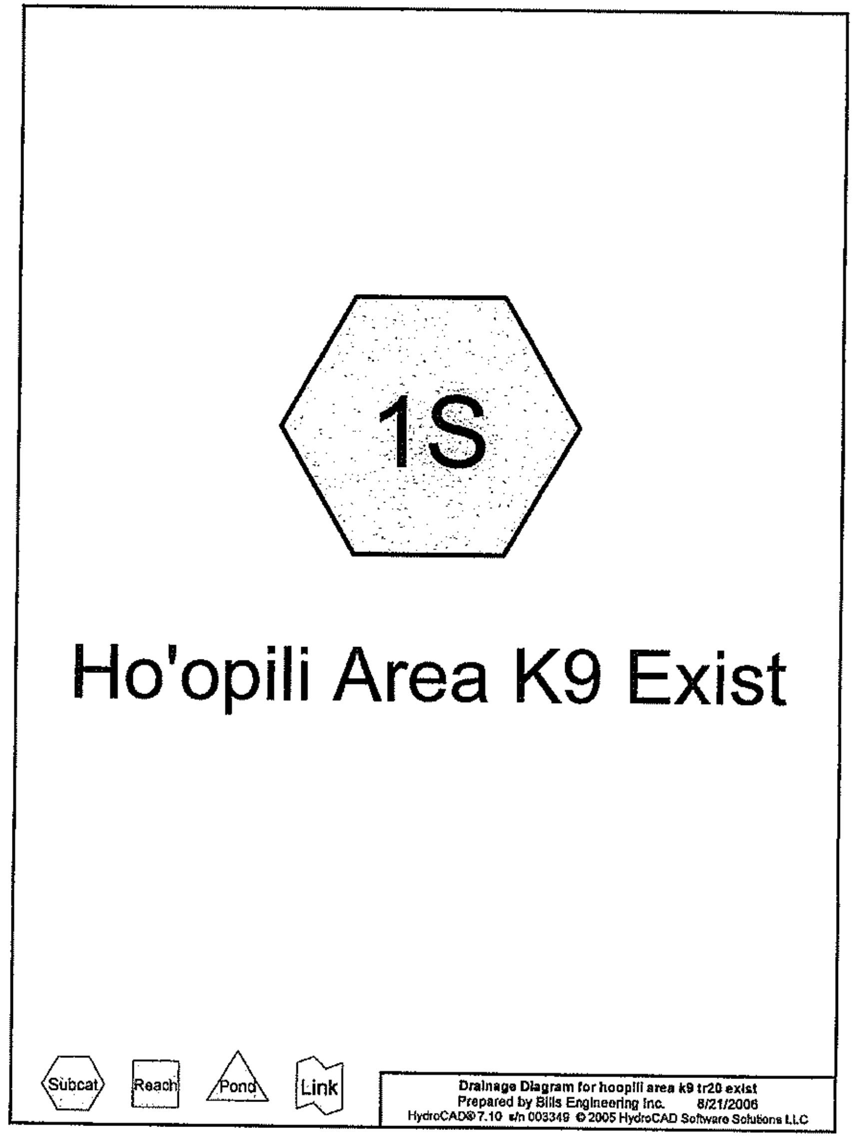


Stage-Discharge for Pond 2P: Detention Pond K8

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
0.00	0.00	2.12	0.00	4.24	0.38	6.36	31.38
0.04	0.00	2.16	0.00	4.28	0.52	6.40	32.29
0.08	0.00	2.20	0.00	4.32	0.69	6.44	33.21
0.12	0.00	2.24	0.00	4.36	0.88	6.48	34.14
0.16	0.00	2.28	0.00	4.40	1.09	6.52	35.08
0.20	0.00	2.32	0.00	4.44	1.33	6.56	36.02
0.24	0.00	2.36	0.00	4.48	1.58	6.60	36.97
0.28	0.00	2.40	0.00	4.52	1.86	6.64	37.92
0.32	0.00	2.44	0.00	4.56	2.15	6.68	38.88
0.36	0.00	2.48	0.00	4.60	2.47	6.72	39.85
0.40	0.00	2.52	0.00	4.64	2.80	6.76	40.82
0.44	0.00	2.56	0.00	4.68	3.16	6.80	41.80
0.48	0.00	2.60	0.00	4.72	3.53	6.84	42.79
0.52	0.00	2.64	0.00	4.76	3.92	6.88	43.78
0.56	0.00	2.68	0.00	4.80	4.33	6.92	44.77
0.60	0.00	2.72	0.00	4.84	4.76	6.96	45.77
0.64	0.00	2.76	0.00	4.88	5.21	7.00	46.77
0.68	0.00	2.80	0.00	4.92	5.67	7.04	47.78
0.72	0.00	2.84	0.00	4.96	6.15	7.08	48.79
0.76	0.00	2.88	0.00	5.00	6.64	7.12	49.81
0.80	0.00	2.92	0.00	5.04	7.15	7.16	50.83
0.84	0.00	2.96	0.00	5.08	7.68	7.20	51.85
0.88	0.00	3.00	0.00	5.12	8.22	7.24	52.87
0.92	0.00	3.04	0.00	5.16	8.78	7.28	53.90
0.96	0.00	3.08	0.00	5.20	9.35	7.32	54.92
1.00	0.00	3.12	0.00	5.24	9.94	7.36	55.95
1.04	0.00	3.16	0.00	5.28	10.54	7.40	56.98
1.08	0.00	3.20	0.00	5.32	11.16	7.44	58.02
1.12	0.00	3.24	0.00	5.36	11.79	7.48	59.05
1.16	0.00	3.28	0.00	5.40	12.43	7.52	60.08
1.20	0.00	3.32	0.00	5.44	13.09	7.56	61.12
1.24	0.00	3.36	0.00	5.48	13.76	7.60	62.15
1.28	0.00	3.40	0.00	5.52	14.44	7.64	63.18
1.32	0.00	3.44	0.00	5.56	15.14	7.68	64.21
1.36	0.00	3.48	0.00	5.60	15.84	7.72	65.24
1.40	0.00	3.52	0.00	5.64	16.56	7.76	66.27
1.44	0.00	3.56	0.00	5.68	17.30	7.80	67.29
1.48	0.00	3.60	0.00	5.72	18.04	7.84	68.32
1.52	0.00	3.64	0.00	5.76	18.80	7.88	69.33
1.56	0.00	3.68	0.00	5.80	19.57	7.92	70.35
1.60	0.00	3.72	0.00	5.84	20.34	7.96	71.36
1.64	0.00	3.76	0.00	5.88	21.13	8.00	**72.37**
1.68	0.00	3.80	0.00	5.92	21.93		
1.72	0.00	3.84	0.00	5.96	22.74		
1.76	0.00	3.88	0.00	6.00	23.57		
1.80	0.00	3.92	0.00	6.04	24.40		
1.84	0.00	3.96	0.00	6.08	25.24		
1.88	0.00	4.00	0.00	6.12	26.09		
1.92	0.00	4.04	0.01	6.16	26.95		
1.96	0.00	4.08	0.04	6.20	27.82		
2.00	0.00	4.12	0.09	6.24	28.70		
2.04	0.00	4.16	0.16	6.28	29.58		
2.08	0.00	4.20	0.26	6.32	30.48		

Stage-Area-Storage for Pond 2P: Detention Pond K8

Elevation (feet)	Storage (acre-feet)	Elevation (feet)	Storage (acre-feet)	Elevation (feet)	Storage (acre-feet)	Elevation (feet)	Storage (acre-feet)
0.00	0.000	2.12	1.158	4.24	2.447	6.36	3.874
0.04	0.021	2.16	1.181	4.28	2.473	6.40	3.902
0.08	0.041	2.20	1.204	4.32	2.498	6.44	3.930
0.12	0.062	2.24	1.228	4.36	2.524	6.48	3.959
0.16	0.083	2.28	1.251	4.40	2.550	6.52	3.987
0.20	0.104	2.32	1.274	4.44	2.576	6.56	4.016
0.24	0.125	2.36	1.297	4.48	2.602	6.60	4.044
0.28	0.146	2.40	1.321	4.52	2.627	6.64	4.073
0.32	0.167	2.44	1.344	4.56	2.653	6.68	4.102
0.36	0.188	2.48	1.368	4.60	2.679	6.72	4.130
0.40	0.209	2.52	1.391	4.64	2.705	6.76	4.159
0.44	0.230	2.56	1.415	4.68	2.732	6.80	4.188
0.48	0.251	2.60	1.438	4.72	2.758	6.84	4.217
0.52	0.272	2.64	1.462	4.76	2.784	6.88	4.246
0.56	0.294	2.68	1.486	4.80	2.810	6.92	4.275
0.60	0.315	2.72	1.509	4.84	2.837	6.96	4.304
0.64	0.336	2.76	1.533	4.88	2.863	7.00	4.333
0.68	0.358	2.80	1.557	4.92	2.889	7.04	4.362
0.72	0.379	2.84	1.581	4.96	2.916	7.08	4.391
0.76	0.401	2.88	1.605	5.00	2.942	7.12	4.420
0.80	0.422	2.92	1.629	5.04	2.969	7.16	4.449
0.84	0.444	2.96	1.653	5.08	2.995	7.20	4.479
0.88	0.465	3.00	1.677	5.12	3.022	7.24	4.508
0.92	0.487	3.04	1.701	5.16	3.049	7.28	4.538
0.96	0.509	3.08	1.725	5.20	3.076	7.32	4.567
1.00	0.530	3.12	1.749	5.24	3.102	7.36	4.597
1.04	0.552	3.16	1.774	5.28	3.129	7.40	4.626
1.08	0.574	3.20	1.798	5.32	3.156	7.44	4.656
1.12	0.596	3.24	1.822	5.36	3.183	7.48	4.686
1.16	0.618	3.28	1.847	5.40	3.210	7.52	4.715
1.20	0.640	3.32	1.871	5.44	3.237	7.56	4.745
1.24	0.662	3.36	1.896	5.48	3.264	7.60	4.775
1.28	0.684	3.40	1.920	5.52	3.292	7.64	4.805
1.32	0.706	3.44	1.945	5.56	3.319	7.68	4.835
1.36	0.728	3.48	1.969	5.60	3.346	7.72	4.865
1.40	0.750	3.52	1.994	5.64	3.373	7.76	4.895
1.44	0.773	3.56	2.019	5.68	3.401	7.80	4.925
1.48	0.795	3.60	2.044	5.72	3.428	7.84	4.955
1.52	0.817	3.64	2.069	5.76	3.456	7.88	4.985
1.56	0.840	3.68	2.093	5.80	3.483	7.92	5.016
1.60	0.862	3.72	2.118	5.84	3.511	7.96	5.046
1.64	0.885	3.76	2.143	5.88	3.538	8.00	**5.076**
1.68	0.907	3.80	2.168	5.92	3.566		
1.72	0.930	3.84	2.194	5.96	3.594		
1.76	0.952	3.88	2.219	6.00	3.621		
1.80	0.975	3.92	2.244	6.04	3.649		
1.84	0.998	3.96	2.269	6.08	3.677		
1.88	1.021	4.00	2.294	6.12	3.705		
1.92	1.043	4.04	2.320	6.16	3.733		
1.96	1.066	4.08	2.345	6.20	3.761		
2.00	1.089	4.12	2.370	6.24	3.789		
2.04	1.112	4.16	2.396	6.28	3.817		
2.08	1.135	4.20	2.421	6.32	3.848		



Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Ho'opili Area K9 Exist Runoff Area=50.500 ac Runoff Depth=2.46"
Flow Length=1,700' Tc=38.4 min CN=80 Runoff=48.36 cfs 10.359 af

Total Runoff Area = 50.500 ac Runoff Volume = 10.359 af Average Runoff Depth = 2.46"

Subcatchment 1S: Ho'opili Area K9 Exist

Subcatchment area K9 east of NS Rd below Farrington

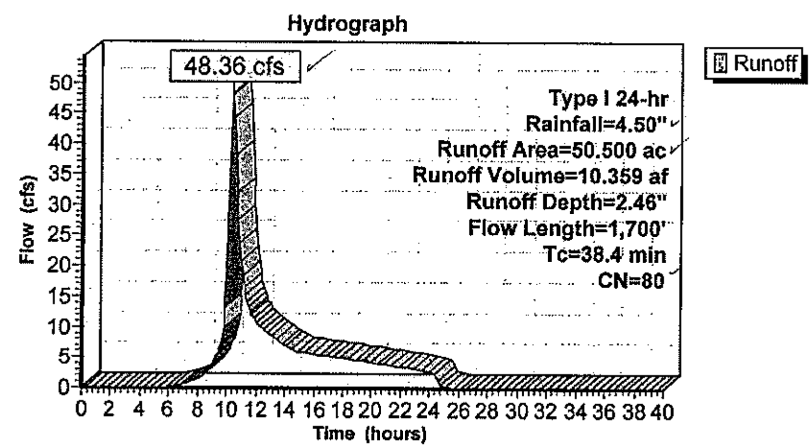
Runoff = 48.36 cfs @ 10.37 hrs, Volume= 10.359 af, Depth= 2.46"

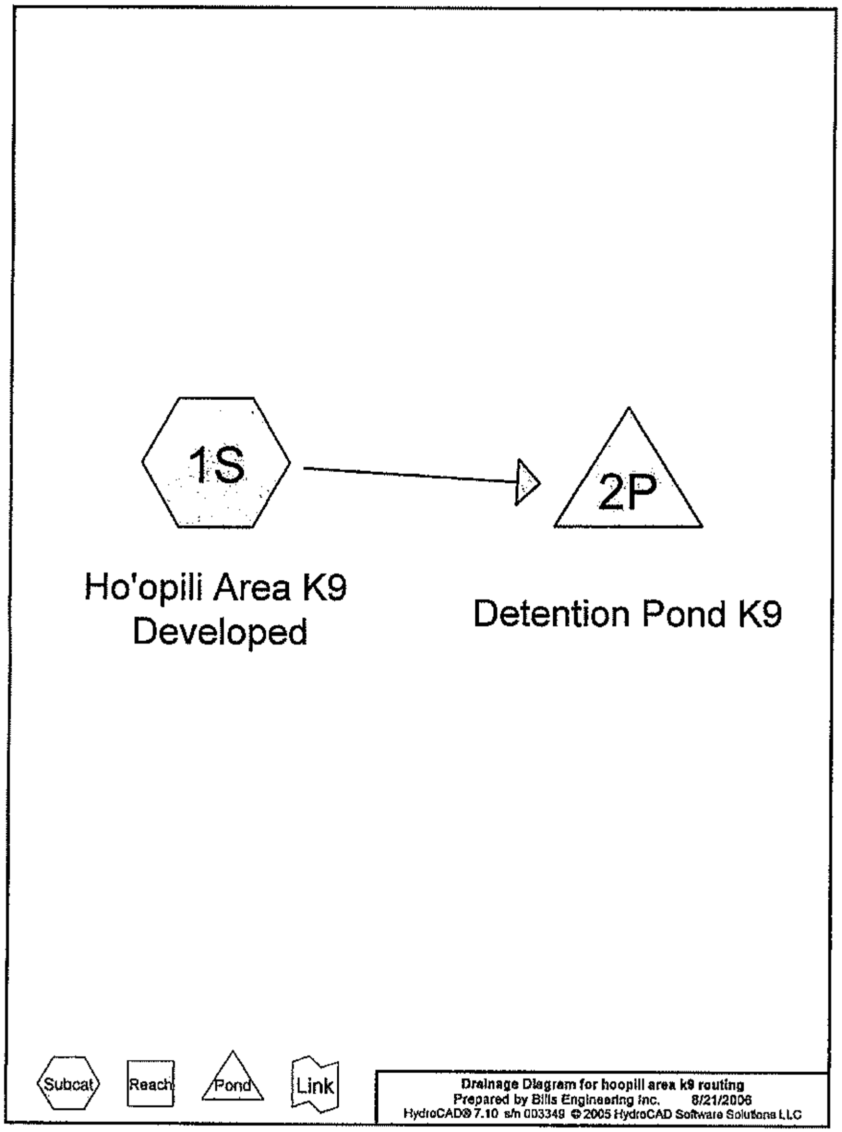
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type I 24-hr Rainfall=4.50"

Area (ac)	CN	Description
50.500	80	CN entered directly

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
38.4	1,700	0.0160	0.7		Lag/CN Method, Existing condition

Subcatchment 1S: Ho'opili Area K9 Exist





Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Ho'opili Area K9 Developed Runoff Area=50.500 ac Runoff Depth=3.10"
Flow Length=2,300' Tc=11.0 min CN=87 Runoff=110.32 cfs 13.041 af

Pond 2P: Detention Pond K9 Peak Elev=8.66' Storage=4.084 af Inflow=110.32 cfs 13.041 af
48.0" x 100.0' Culvert Outflow=48.16 cfs 10.960 af

Total Runoff Area = 50.500 ac Runoff Volume = 13.041 af Average Runoff Depth = 3.10"

Subcatchment 1S: Ho'opili Area K9 Developed

Subcatchment area K9 east of NS Rd below Farrington

[49] Hint: Tc<2dt may require smaller dt

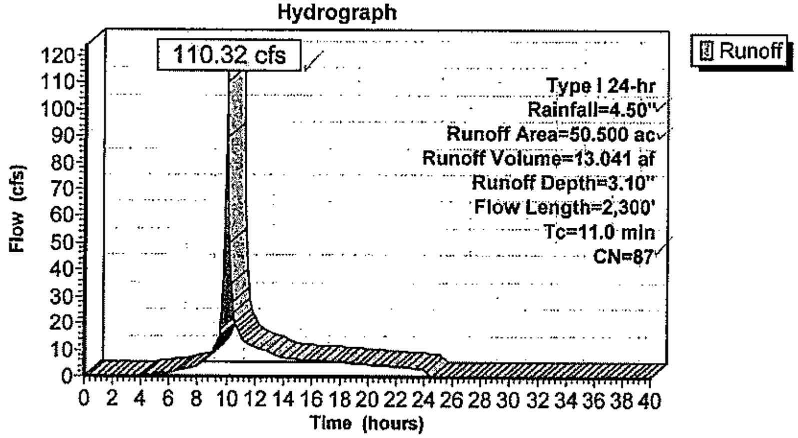
Runoff = 110.32 cfs @ 10.01 hrs, Volume= 13.041 af, Depth= 3.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type I 24-hr Rainfall=4.50"

Area (ac)	CN	Description
50.500	87	CN entered directly

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.9	200	0.0100	0.5		**Lag/CN Method, Overland**
3.2	1,700	0.0150	8.8	27.71	**Circular Channel (pipe), Piped in road** Diam= 24.0" Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
0.9	400	0.0100	7.2	22.62	**Circular Channel (pipe), Piped** Diam= 24.0" Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
11.0	2,300	Total			

Subcatchment 1S: Ho'opili Area K9 Developed



Pond 2P: Detention Pond K9

Inflow Area = 50.500 ac, Inflow Depth = 3.10"
Inflow = 110.32 cfs @ 10.01 hrs, Volume= 13.041 af
Outflow = 48.16 cfs @ 10.23 hrs, Volume= 10.960 af, Atten= 56%, Lag= 13.2 min
Primary = 48.16 cfs @ 10.23 hrs, Volume= 10.960 af

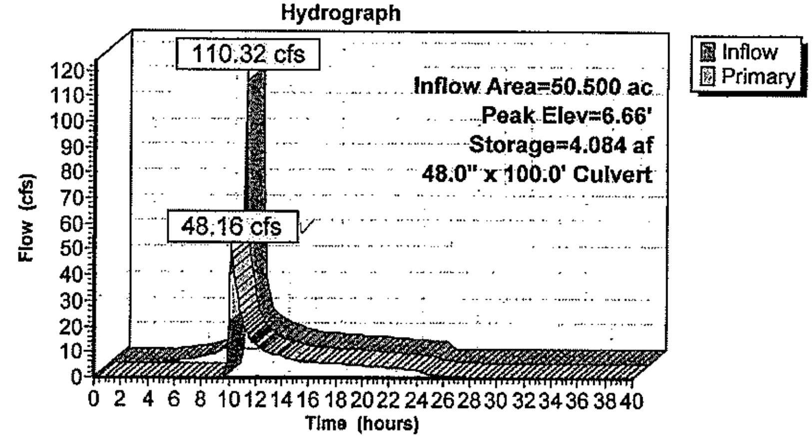
Routing by Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Peak Elev= 6.66' @ 10.23 hrs Surf.Area= 0.716 ac Storage= 4.084 af
Plug-Flow detention time= 196.0 min calculated for 10.933 af (84% of inflow)
Center-of-Mass det. time= 109.1 min (882.5 - 773.4)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	6.665 af	**150.00'W x 150.00'L x 10.00'H Prismatoid Z=2.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	3.60'	**48.0" x 100.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 3.10' S= 0.0050 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=47.16 cfs @ 10.23 hrs HW=6.62' (Free Discharge)
↑1=Culvert (Barrel Controls 47.16 cfs @ 6.4 fps)

Pond 2P: Detention Pond K9



Stage-Discharge for Pond 2P: Detention Pond K9

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
0.00	0.00	5.30	17.67
0.10	0.00	5.40	19.57
0.20	0.00	5.50	21.53
0.30	0.00	5.60	23.57
0.40	0.00	5.70	25.66
0.50	0.00	5.80	27.82
0.60	0.00	5.90	30.03
0.70	0.00	6.00	32.29
0.80	0.00	6.10	34.61
0.90	0.00	6.20	36.97
1.00	0.00	6.30	39.37
1.10	0.00	6.40	41.80
1.20	0.00	6.50	44.27
1.30	0.00	6.60	46.77
1.40	0.00	6.70	49.30
1.50	0.00	6.80	51.85
1.60	0.00	6.90	54.41
1.70	0.00	7.00	56.98
1.80	0.00	7.10	59.57
1.90	0.00	7.20	62.15
2.00	0.00	7.30	64.73
2.10	0.00	7.40	67.29
2.20	0.00	7.50	69.84
2.30	0.00	7.60	72.37
2.40	0.00	7.70	74.87
2.50	0.00	7.80	77.32
2.60	0.00	7.90	79.73
2.70	0.00	8.00	82.08
2.80	0.00	8.10	84.36
2.90	0.00	8.20	86.55
3.00	0.00	8.30	88.65
3.10	0.00	8.40	90.63
3.20	0.00	8.50	92.47
3.30	0.00	8.60	94.13
3.40	0.00	8.70	95.56
3.50	0.00	8.80	96.66
3.60	0.00	8.90	97.17
3.70	0.08	9.00	98.42
3.80	0.26	9.10	100.98
3.90	0.60	9.20	103.47
4.00	1.09	9.30	105.91
4.10	1.72	9.40	108.29
4.20	2.47	9.50	110.62
4.30	3.34	9.60	112.90
4.40	4.33	9.70	115.13
4.50	5.44	9.80	117.33
4.60	6.64	9.90	119.48
4.70	7.95	10.00	**121.59**
4.80	9.35		
4.90	10.85		
5.00	12.43		
5.10	14.10		
5.20	15.84		

Stage-Area-Storage for Pond 2P: Detention Pond K9

Elevation (feet)	Storage (acre-feet)	Elevation (feet)	Storage (acre-feet)
0.00	0.000	5.30	3.143
0.10	0.052	5.40	3.210
0.20	0.104	5.50	3.278
0.30	0.156	5.60	3.346
0.40	0.209	5.70	3.414
0.50	0.262	5.80	3.483
0.60	0.315	5.90	3.552
0.70	0.368	6.00	3.621
0.80	0.422	6.10	3.691
0.90	0.476	6.20	3.761
1.00	0.530	6.30	3.831
1.10	0.585	6.40	3.902
1.20	0.640	6.50	3.973
1.30	0.695	6.60	4.044
1.40	0.750	6.70	4.116
1.50	0.806	6.80	4.188
1.60	0.862	6.90	4.260
1.70	0.919	7.00	4.333
1.80	0.975	7.10	4.406
1.90	1.032	7.20	4.479
2.00	1.089	7.30	4.552
2.10	1.147	7.40	4.626
2.20	1.204	7.50	4.700
2.30	1.262	7.60	4.775
2.40	1.321	7.70	4.850
2.50	1.379	7.80	4.925
2.60	1.438	7.90	5.001
2.70	1.497	8.00	5.076
2.80	1.557	8.10	5.153
2.90	1.617	8.20	5.229
3.00	1.677	8.30	5.306
3.10	1.737	8.40	5.383
3.20	1.798	8.50	5.461
3.30	1.859	8.60	5.539
3.40	1.920	8.70	5.617
3.50	1.982	8.80	5.696
3.60	2.044	8.90	5.774
3.70	2.106	9.00	5.854
3.80	2.168	9.10	5.933
3.90	2.231	9.20	6.013
4.00	2.294	9.30	6.094
4.10	2.358	9.40	6.174
4.20	2.421	9.50	6.255
4.30	2.485	9.60	6.336
4.40	2.550	9.70	6.418
4.50	2.614	9.80	6.500
4.60	2.679	9.90	6.582
4.70	2.745	10.00	**6.665**
4.80	2.810		
4.90	2.876		
5.00	2.942		
5.10	3.009		
5.20	3.076		

APPENDIX P

Preliminary Electrical & Communications Master Plan

PRELIMINARY ELECTRICAL AND COMMUNICATIONS MASTER PLAN

FOR

HO'OPILI

EWA, OAHU, HAWAII

Prepared for:

D.R. Horton - Schuler Homes, LLC

Honolulu, Hawaii

Prepared by:

MK Engineers, Ltd.
286 Kalihi Street
Honolulu, Hawaii 96819

February, 2008

PRELIMINARY ELECTRICAL AND COMMUNICATIONS MASTER PLAN
Prepared by MK Engineers, Ltd. for
D.R. Horton – Schuler Homes, LLC
November, 2007

I. INTRODUCTION

D.R. Horton – Schuler Homes, LLC is preparing conceptual plans for the Ho'opili project that will provide residential homes, schools, parks, commercial, and light industrial facilities on about 1,555 acres in an area approximately bounded by the H-1 Freeway to the north, the new North-South Road to the west, Fort Weaver Road to the east, and Ewa Villages Golf Course to the south. This preliminary master plan document provides the results of meetings with the various electrical and communication utilities who have facilities being impacted by the development, what efforts will be required to relocate or remove the existing utilities, and what will be required to provide new electrical and communication services to the development.

II. HAWAIIAN ELECTRIC COMPANY (HECO)

A meeting was held with several HECO representatives on May 3, 2006 (see Attachment A for the meeting minutes). At the meeting and with follow-up correspondence, the following items were determined:

A. Existing Facilities (see Attachment B)

HECO's facilities currently consist of a major transmission steel pole line supporting two 138 kV circuits following the North-South Road alignment to Farrington Highway, then along the mauka side of Farrington Highway with a 12.47 kV circuit below to its Ewa Nui Transmission Substation. From the Ewa Nui Transmission Substation, two 138 kV circuits and a 46 kV circuit on a steel pole line, and a 12.47 kV circuit traverse the property mauka towards the H-1 Freeway on a perpetual easement with no relocation clause. From the Ewa Nui Transmission Substation, a 46 kV circuit on wood poles with 12.47 kV underbuild traverses east along Farrington Highway to the Waipahu Interchange and up Fort Weaver Road to the Kunia Interchange. The 46 kV and 12.47 kV lines also continue down the Old Fort Weaver Road to the intersection with the new Fort Weaver Road. Finally, a 12.47 kV line traverses the property in the makai direction on an easement to the Old Fort Weaver Road that serves the West Loch area as well as some irrigation wells that used to belong to the Oahu Sugar Company. This easement has a relocation clause. HECO also provided all the easement documents and maps for existing HECO facilities that currently encumber the properties within the project boundary.

Each of these easements will need to be researched during the preliminary engineering phase of the project to determine whether the existing facility can remain or must be relocated, and if so, to where, at what cost, at who's expense, and when required.

B. Proposed Substation Sites and 46 kV Subtransmission Lines

Three distribution substations will be required for the development at a minimum. The existing transmission substation is mainly for transmission and subtransmission switching, with expansion plans for only transmission and subtransmission. There is currently one distribution transformer in the transmission substation that serves as a backup to nearby distribution substations, as well as to provide station power for the transmission substation. The requirements for the new distribution substations are as follows:

1. The first new distribution substation will be located on the mauka side of Farrington Highway between the Ewa Nui Transmission Substation and Fort Weaver Road; the second new distribution substation will be located near the main road running through Ho'opili and perpendicular to the North-South Road; and the third new distribution substation will be located between the North-South Road and the Ewa Nui Transmission Substation. See Attachment C for tentative areas that these new distribution substations may be located. Other factors such as proximity to existing 46 kV subtransmission lines, use of open spaces, etc., should be taken into consideration in locating these substation sites.
2. The new substation sites will likely be low profile type and may be square or rectangular with a size of about 20,000 SF. This size lot will be suitable for a four-unit substation. See Attachment D (four sheets) for various substation layouts based on different lot configurations.
3. Substation land will be owned by HECO. HECO does not want the substations located in flood zone areas.
4. Each substation will require the 46 kV feeders to be underground. There will initially be two 46 kV feeders to each substation and one or two transformers, with a third 46 kV feeder required for full build-out of the substation (four transformers).
5. Since there is no ordinance mandating that the 46 kV lines within a subdivision be placed underground, any 46 kV underground lines within the subdivision will need to be paid for by the developer. The developer would be required to install the underground infrastructure at his cost and the developer's share of 46 kV line extension costs will be the difference between the underground cable installation cost and an equivalent overhead line cost.
6. HECO will have two 46 kV lines running overhead on the 138 kV steel poles along the new North-South Road. If substations are placed near North-South Road, the cost of the underground 46 kV line extensions may be minimized.

C. Proposed Distribution Lines

By City ordinance, all new primary and secondary distribution lines within Ho'opili must be placed underground.

1. The distribution system voltage will be 12.47 kV and the distribution system will include primary and secondary cables in a concrete-encased duct system within the streets and sidewalks and with handholes in the sidewalk area, primary padmounted switchgears, and padmounted transformers.
2. Easements will be required for the padmounted switchgears, padmounted transformers, and cables crossing private property to serve other customers.
3. Service tails will be provided at the property line for service to the individual property owners.
4. Each substation will require the 46 kV feeders to be underground. There will initially be two 46 kV feeders to each substation and one or two transformers, with a third 46 kV feeder required for full build-out of the substation (four transformers).

D. Miscellaneous

1. The new North-South Road will be constructed of concrete and any future trenching across the roadway will not be allowed. Accordingly, D.R. Horton – Schuler Homes, LLC is coordinating duct requirements with R.M. Towill along North-South Road.
2. The final alignment of the Honolulu High Capacity Transit Corridor (HHCTC) project has not yet been determined. An Environmental Impact Statement (EIS) will be prepared for the HHCTC project that will address impacts on existing and new electrical and communication facilities within the new Ho'opili project.
3. There is a 30-foot wide Energy Corridor along the mauka side of Farrington Highway that contains a 10-inch Hawaiian Independent Refinery, Inc. fuel oil pipeline and a 16-inch Gas Company gas pipeline. This Energy Corridor is currently under the jurisdiction of the State Department of Transportation (Harbors Division). Any utility lines crossing this Energy Corridor will require a permit from the Harbors Division and construction plans must satisfy the requirements of the Harbors Division and of its tenants.

III. HAWAIIAN TELCOM (HTCOM)

A meeting was held with several HTCOM representatives on April 25, 2006 (see Attachment E for the meeting minutes). At the meeting and with follow-up correspondence, the following items were determined:

A. Existing Facilities (see Attachment B)

HTCOM's facilities currently consist of a several major telephone cables on overhead wooden poles along Farrington Highway, Old Fort Weaver Road, and Kunia Road.

B. Proposed HTCOM Lines

1. One source of telephone service may be from Kapolei.
2. North-South Road design is underway and there are 6-way ducts on the mauka side and 8-way ducts on the makai side of the North-South Road. Service to Ho'opili could be routed along the North-South Road. Coordination should be done with Ron Ho and Associates, the electrical design consultant for the North-South Road.
3. HTCOM has not been contacted about the UH West Oahu Campus. They would like to know what the timing of that project is.
4. The size of the Ho'opili project suggests that multiple hubs may be required for telephone service. HTCOM would prefer to have a lot near the center of area served for the hub.
5. The telephone distribution system from the hubs will include copper or fiber optic cables in a concrete-encased duct system within the streets and sidewalks and with handholes in the sidewalk area.
6. Easements will be required for the cables crossing private property to serve other customers.
7. Service tails will be provided at the property line for service to the individual property owners.
8. HTCOM requested the electronic file of the subdivision plan so that they can begin planning and engineering.

IV. OCEANIC TIME WARNER CABLE (TW)

The following items were determined:

A. Existing Facilities (see Attachment B)

TW's facilities currently consist of fiber optic cables on overhead wooden poles along Farrington Highway, Old Fort Weaver Road, and Kunia Road.

B. Proposed TW Lines

1. The project will need to provide 6'x6' easements for TW's cable television (CATV) Power Supply Pedestal Equipment cabinets adjacent to HECO's padmounted switchgear (see Attachment F).
2. The CATV distribution system will include fiber optic cables in a concrete-encased duct system within the streets and sidewalks and with handholes in the

sidewalk area.

3. Easements will be required for the power supply cabinets and for cables crossing private property to serve other customers.
4. Service tails will be provided at the property line for service to the individual property owners.

V. OTHER COMMUNICATION FACILITIES

There may be other private or governmental communication facilities within the Ho'opili project such as Pacific LightNet, Inc., Sandwich Isles Communication, Inc, and Army Signal Corps. These entities will need to be contacted as part of the infrastructure design phase of the project to coordinate any relocation of existing facilities.

Attachment A

HECO Conference Memo

MK Engineers, Ltd.

Consulting Electrical Engineers
286 Kalihi St. $ Honolulu, Hawaii 96819
Telephone # (808) 848-8622 $ Fax # (808) 848-5574
e-mail address: ron@mkhawaii.com

CONFERENCE MEMORANDUM

Project:	Ho'opili Development (East Kapolei) for D. R. Horton, Schuler Division
Project No.:	06040
Location:	HECO Ward Avenue Conf Rm 300
Date of Conf:	5-3-06
Prepared By:	Ron Katahara
Attenders:	See attendance sheet

Items of Discussion

1. See Agenda. Mr. Hirakami described the project and displayed phasing drawings.
2. Discussion:
   a. The new development will have all-electric residential units (SF and MF), schools, medical facilities, commercial and light industrial facilities, and parks. Overall project development is expected to span 25 to 30 years. Developer needs to seek land rezoning and permitting from both the State and City governments. Construction of the first phase is expected to start within 4 to 5 years, with first home projected to be sold in 2012. The second, third and fourth phases of the project will be approximately 5 years each thereafter. A spreadsheet showing tentative zoning calculations of acreage and number of units within each Land Use Ordinance zone was provided.
   b. There are several other design projects that may impact this project.
      i. North South Road designs are underway. Ron Ho & Associates is doing the electrical design for the State DOT.
      ii. The UH West Oahu Campus will be on the western boundary of this project. HECO is working with the consultant on the location of a new substation to serve this development.
      iii. The Dept. of Hawaiian Home Lands is developing a parcel of land just below the UH West Oahu Campus. HECO is in contact with the DHHL, but haven't received definite plans to date.
      iv. The City's High-Capacity Transit project has two alternative routes that may impact this project: one along the North-South Road and Farrington Highway; and the other along Fort Weaver Road. MKE previously met with HECO engineers on the City's transit project and requested information on HECO's facilities along each of the alternative routes.
      v. The State DOT is widening Fort Weaver Road from about the Waipahu Interchange down to Geiger Road. MKE previously informed HECO on the DOT's project and requested information on HECO's existing facilities.
   c. There is an existing energy corridor along the mauka side of Farrington Highway.
   d. HECO's facilities currently consist of a major transmission steel pole line supporting two 138 kV circuits following the North-South Road alignment to Farrington Highway, then along the

mauka side of Farrington Highway to its Ewa Nui Transmission Substation. From the Ewa Nui Transmission Substation, two 138 kV circuits and a 46 kV circuit on a steel pole line traverses the property mauka towards the H-1 Freeway on an perpetual easement with no relocation clause. From the Ewa Nui Transmission Substation, a 46 kV circuit on wood poles with 12 kV underbuild traverses east along Farrington Highway to the Waipahu Interchange and up Kunia Road to the Kunia Interchange. The 46 kV and 12 kV lines also continue down the Old Fort Weaver Road to the intersection with the new Fort Weaver Road. Finally, a 12 kV line traverses the property in the makai direction on an easement to the Old Fort Weaver Road that serves the West Loch area as well as some irrigation wells that used to belong to the Oahu Sugar Company. This easement may have a relocation clause.

e. Two distribution substations will probably be required for the development as a minimum. The existing transmission substation is mainly for transmission and subtransmission switching, with expansion plans for only transmission and subtransmission. There is currently one distribution transformer in the transmission substation that serves as a backup to nearby distribution substations as well as to provide station power for the transmission substation.
   i. The new substation sites may be square or rectangular with size of about 20,000 SF. This size lot will be suitable for a four-unit substation.
   ii. Substation land will be owned by HECO. HECO does not want the substations located in flood zone areas.
   iii. The substation will likely be low profile type and will require 46 kV in-feed to be underground. There will initially be two 46 kV feeders to each substation and one or two transformers, with a third 46 kV feeder required for full build-out of the substation (four transformers).
   iv. Since there is no ordinance mandating that the 46 kV lines within a subdivision be placed underground, any 46 kV underground lines within the subdivision will need to be paid for by the developer. The developer would be required to install the underground infrastructure at his cost and the developer's share of 46 kV line extension costs will be the difference between the underground cable installation cost and an equivalent overhead line cost.
   v. HECO will have two 46 kV lines running overhead on the 138 kV steel poles along the new North-South Road. If substations are placed near North-South Road, the cost of the underground 46 kV line extensions may be minimized.

f. The distribution system voltage will be 12 kV and will be all underground.

g. The new North-South Road will be constructed of concrete and any future trenching across the roadway will not be allowed. Accordingly, HECO suggested that MKE contact D.R. Horton and ask them to see if the State would be willing to provide North-South Road duct crossings for HECO at the West Oahu UH main roadway that will extend into the Phase 1B portion of the Ho'opili Town Development. This will provide some flexibility in the event that the new substation in the UH West Oahu Campus might have some spare capacity to initially serve Phase 1B.

h. It is uncertain whether the High Capacity Transit project or the new Ho'opili Town Development project will provide for the widening of Farrington Highway. It is currently a two-lane highway, but there is room for widening on the makai side. Distribution duct requirements will need to be coordinated with whichever project initiates the widening of Farrington Highway.

3. MKE will provide a load estimate based on the planned uses of the land. This information will be used by HECO to determine the number of substations required for the development and their suggested locations.
4. ACTION ITEMS:
   a. HECO will request that MKE sign a waiver and hold harmless agreement form for copies of HECO documents (easement maps and documents, transmission and distribution line maps, and preliminary substation layout plans).
   b. Upon receipt of signed waiver and hold harmless agreement form, HECO will provide the requested documents.
   c. MKE will provide estimated loads for each of the planned zoning parcels so that the total number of substations and potential substation sites can be determined.
   d. Upon receipt of the estimated loads, HECO will provide the number of substations required to serve the development and potential substation sites within the development.

END

MK Engineers, Ltd.

Consulting Electrical Engineers
286 Kalihi St. • Honolulu, Hawaii 96819
Telephone # (808) 848-8622 • Fax # (808) 848-5574
e-mail address: info@mkhawaii.com

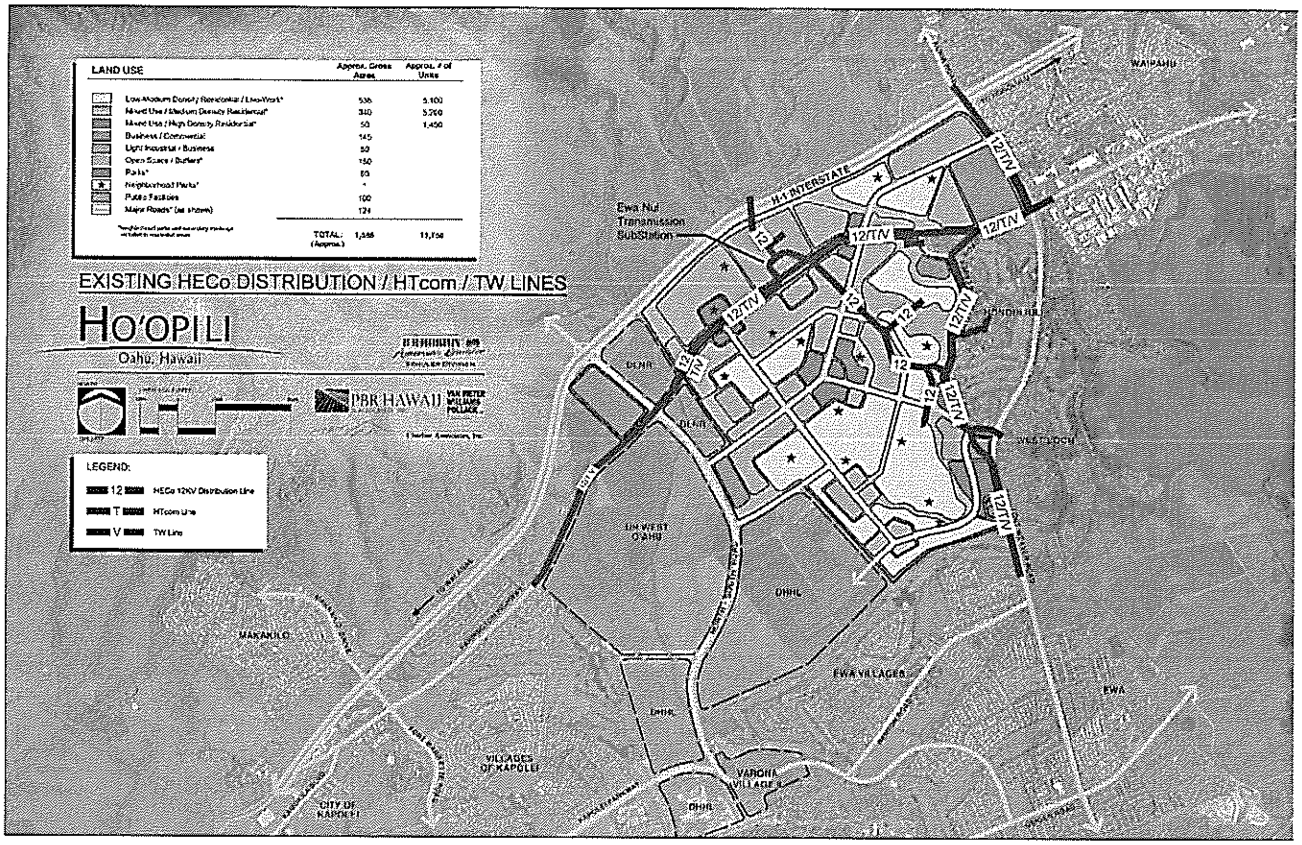
ATTENDANCE SHEET

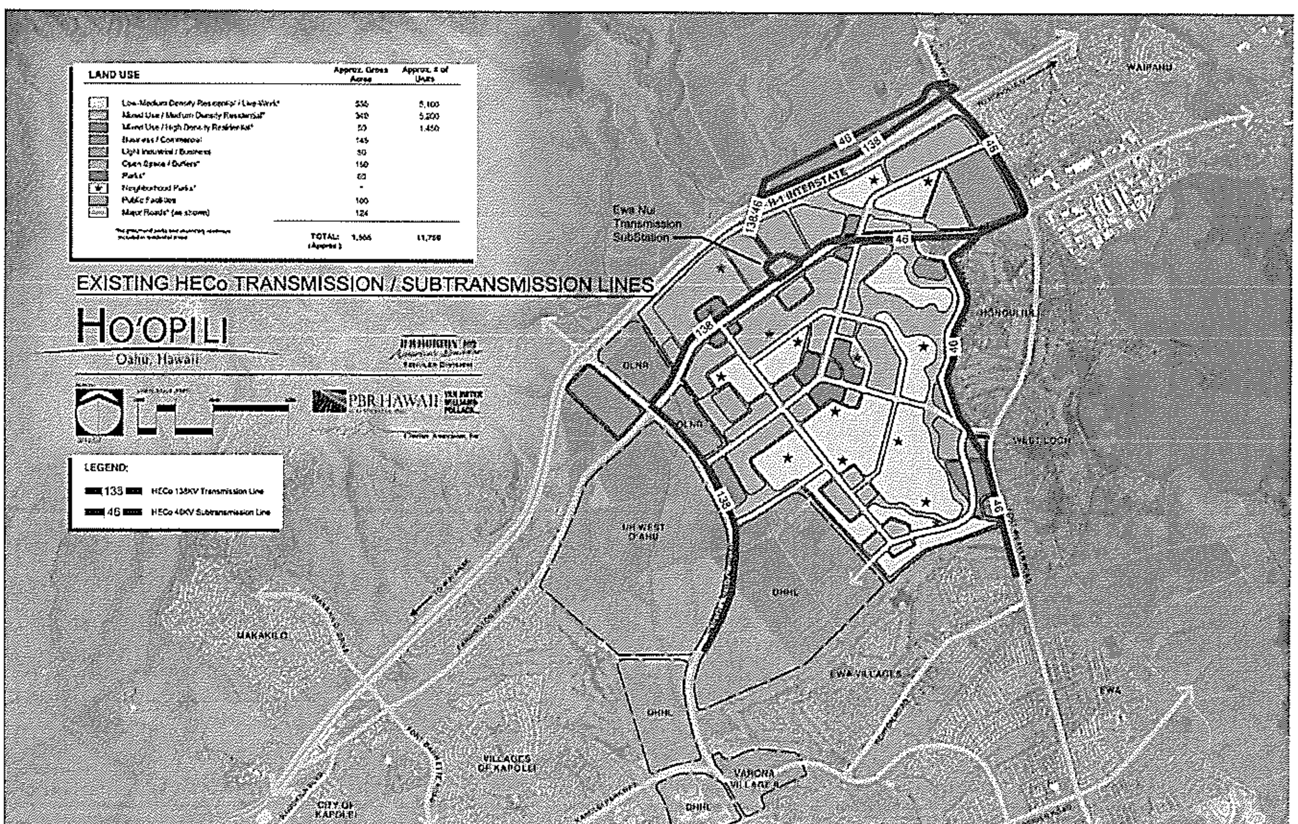
PROJECT: HO'OPILI TOWN DEVELOPMENT
DATE: 5/3/06
LOCATION OF CONFERENCE: HECO CONF RM 300

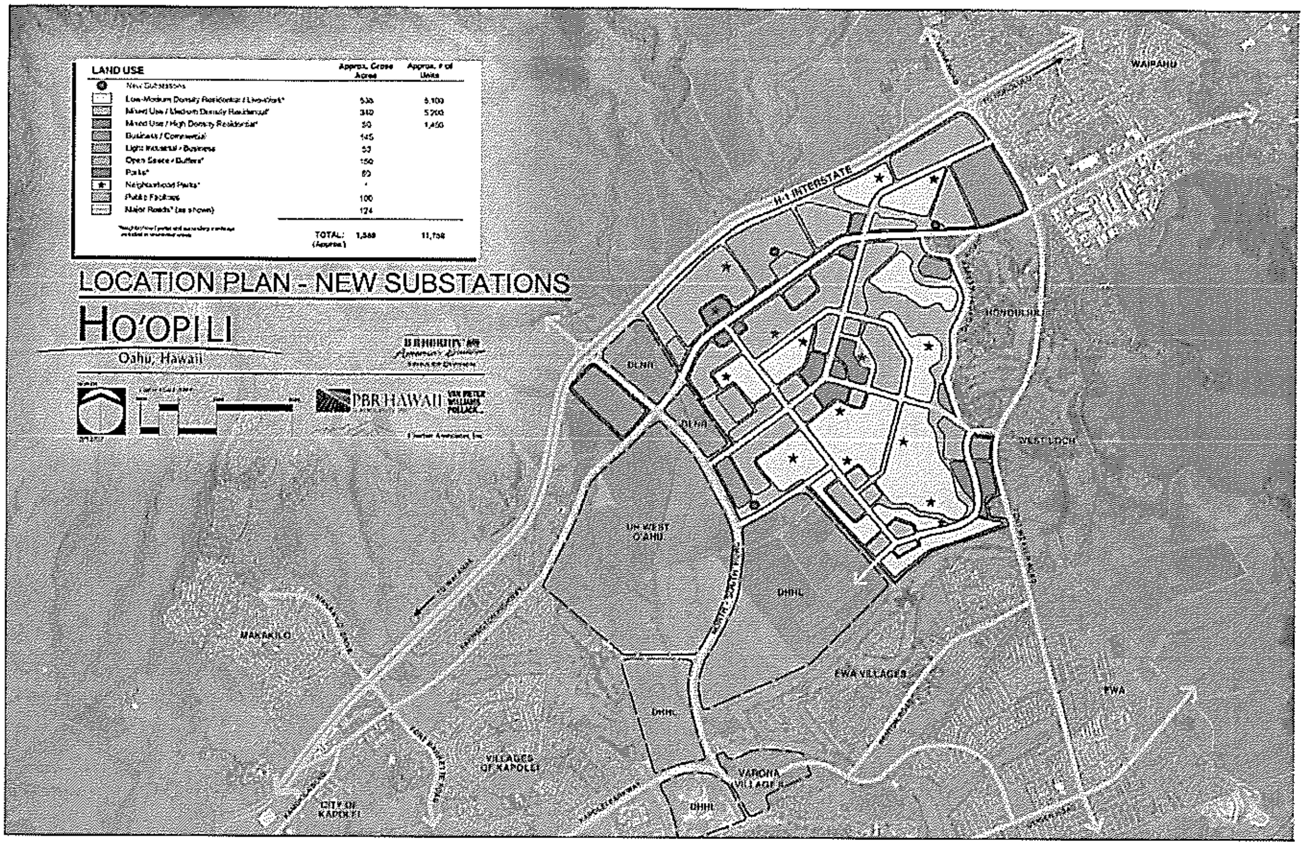
NAME	COMPANY/ACTIVITY	PHONE/FAX/E-MAIL
Francis Hirakami	MK Engineers, Ltd.	(808)848-8622/(808) 848-5574 francis@mkhawaii.com
RON KATAHARA	"	RON@mkhawaii.com
Phil Hauret	HECO	543-4735/4726 phil.hauret@heco.com
Ruby Shimabukuro	"	543-4617 Ruby.Shimabukuro@heco.com
Jimmy Lum	✓	543-7553 jimmy.lum@heco.com
Susan Chow	HECO	543-7766 susan.chow@heco.com
Rudy Tamayo	HECO	543-7999 rudy.Tamayo@heco.com
Nathan Liang	HECO	543-7978 NATHAN.LIANG@HECO.COM
PAUL NAKAGAWA	HECO	543-7062 paul.nakagawa@heco.com

Attachment B

Maps of Existing Utility Lines


LAND USE
Approx. Gross Acres
Approx. # of Units
Low-Medium Density Residential / Live-Work* 536 5,100
Mixed Use / Medium Density Residential* 340 5,200
Mixed Use / High Density Residential* 50 1,450
Business / Commercial 145
Light Industrial / Business 50
Open Space / Buffers* 150
Parks* 60
Neighborhood Parks*
Public Facilities 100
Major Roads* (as shown) 124
TOTAL: (Approx.)
EXISTING HECo DISTRIBUTION / HTcom / TW LINES
HO'OPILI
Oahu, Hawaii
PBR HAWAII
LEGEND:
12 HECo 12KV Distribution Line
T HTcom Line
V TW Line
Ewa Nui Transmission SubStation
H-1 INTERSTATE
12/T/V
12
WAIPAHU
HONOULIULI
WEST LOCH
DLNR
UH WEST O'AHU
DHHL
MAKAKILO
EWA VILLAGES
EWA
VILLAGES OF KAPOLEI
VARONA VILLAGE
CITY OF KAPOLEI


LAND USE
Approx. Gross Acres
Approx. # of Units
Low-Medium Density Residential / Live-Work* 536 5,100
Mixed Use / Medium Density Residential* 340 5,200
Mixed Use / High Density Residential* 50 1,450
Business / Commercial 145
Light Industrial / Business 50
Open Space / Buffers* 150
Parks* 60
Neighborhood Parks*
Public Facilities 100
Major Roads* (as shown) 124
TOTAL: (Approx.) 11,750
EXISTING HECo TRANSMISSION / SUBTRANSMISSION LINES
HO'OPILI
Oahu, Hawaii
PBR HAWAII
LEGEND:
138 HECo 138KV Transmission Line
46 HECo 46KV Subtransmission Line
Ewa Nui Transmission SubStation
H-1 INTERSTATE
138
46
138/46
WAIPAHU
HONOULIULI
WEST LOCH
DLNR
UH WEST O'AHU
DHHL
MAKAKILO
EWA VILLAGES
EWA
VILLAGES OF KAPOLEI
VARONA VILLAGE
CITY OF KAPOLEI

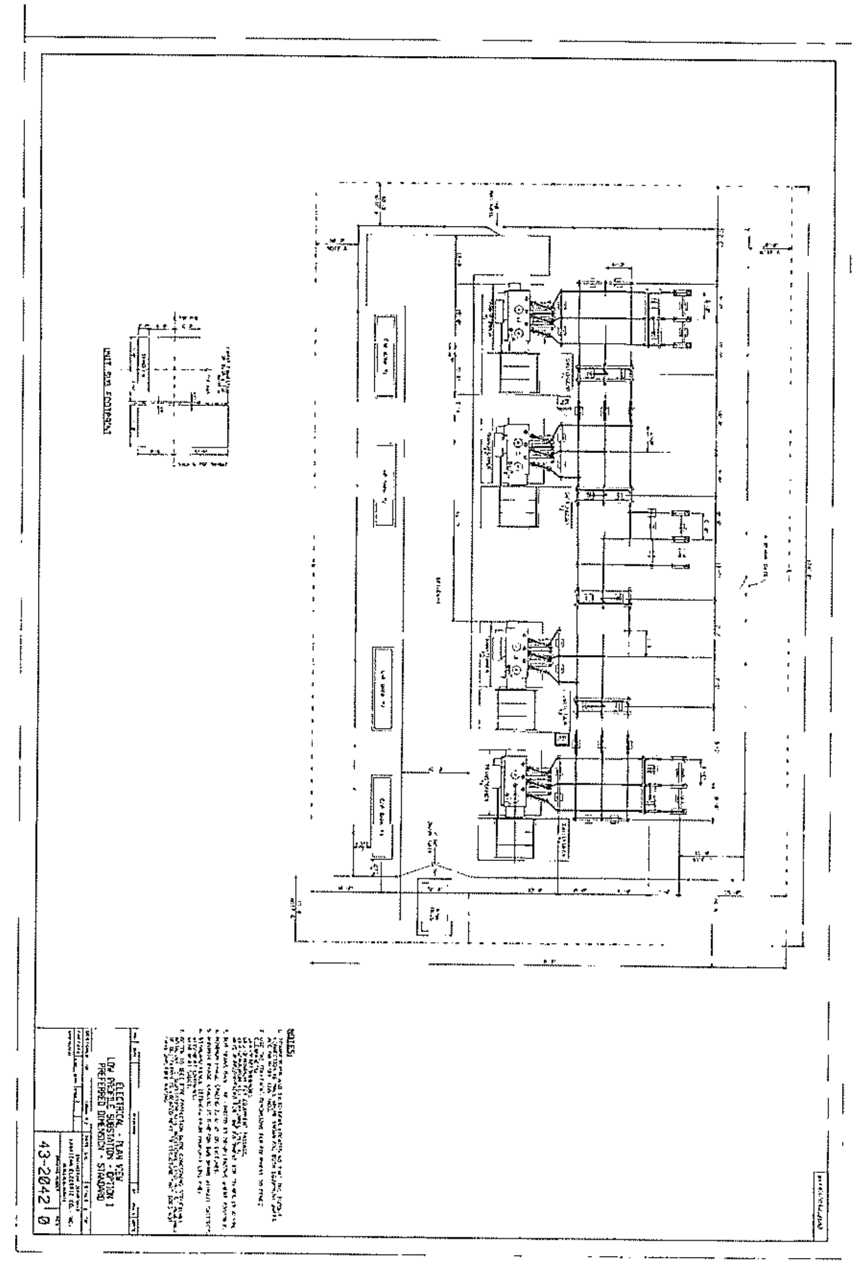


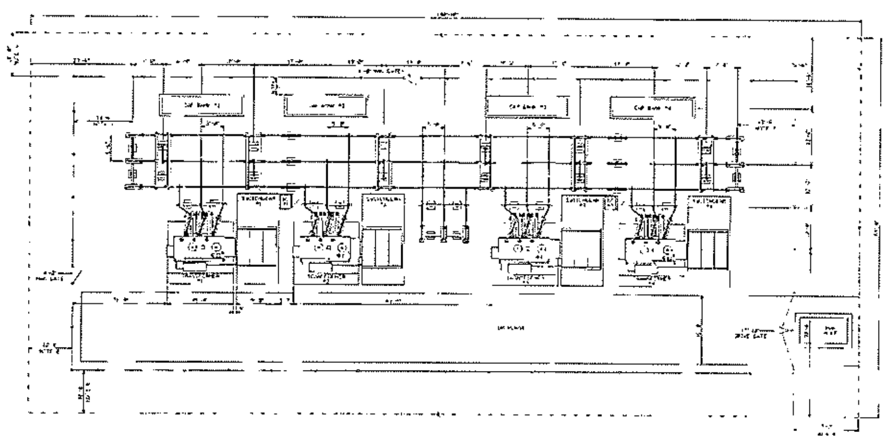
Attachment C

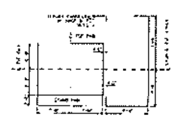
Distribution Substation Sites

Attachment D

Distribution Substation Layouts







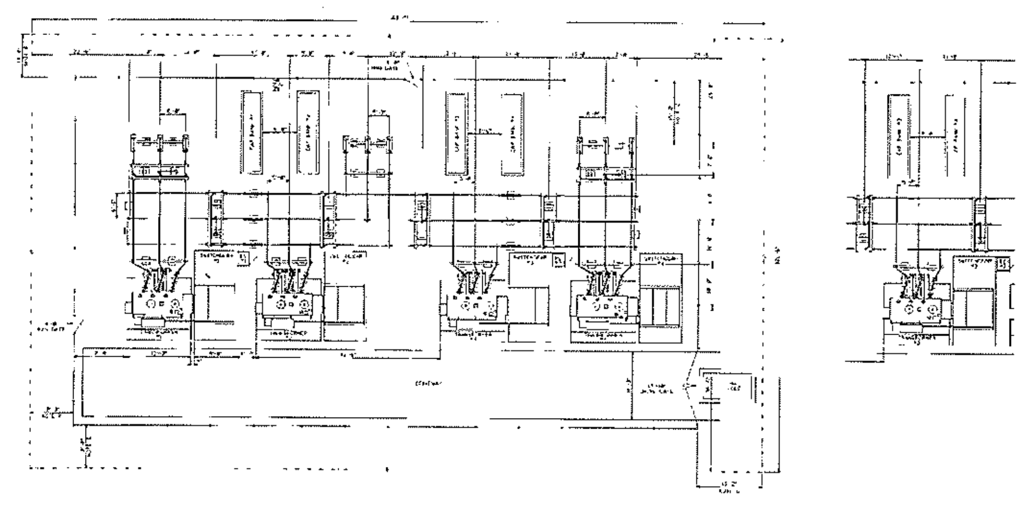
UNIT SUB FOOTPRINT

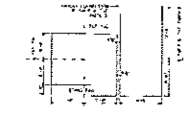
NOTES:

ELECTRICAL - PLAN VIEW
LOW PROFILE SUBSTATION - OPTION 3
MINIMUM DIMENSION - STANDARD

HAWAIIAN ELECTRIC CO., INC.

43-2046 | 0





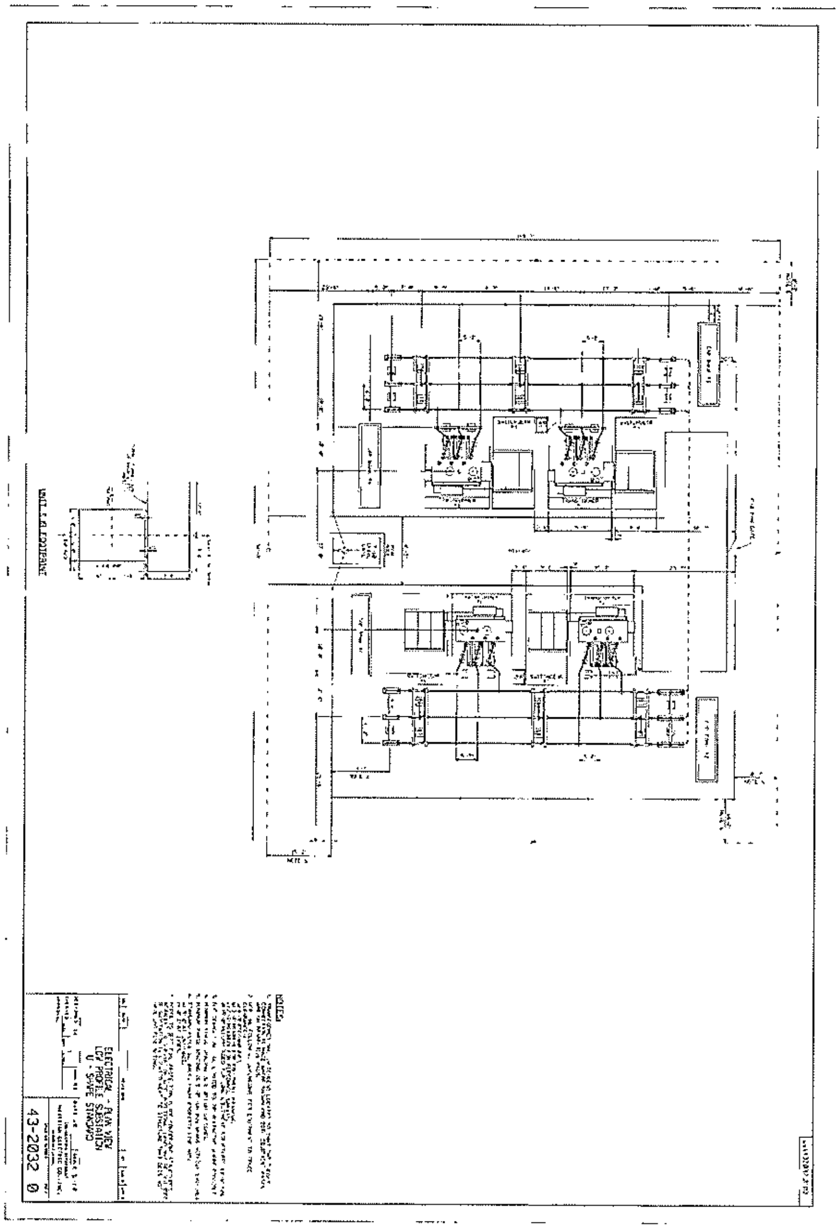
UNIT SUB FOOTPRINT

NOTES:

ELECTRICAL - PLAN VIEW
LOW PROFILE SUBSTATION - OPTION 2
MINIMUM DIMENSION - STANDARD

HAWAIIAN ELECTRIC CO., INC.

43-2044 | 0



Attachment E

HTCOM
Conference Memo

MK Engineers, Ltd.

Consulting Electrical Engineers
286 Kalihi St. $ Honolulu, Hawaii 96819
Telephone # (808) 848-8622 $ Fax # (808) 848-5574
e-mail address: ron@mkhawaii.com

CONFERENCE MEMORANDUM

Project:	Ho'opili Development, East Kapolei – D. R. Horton Schuler Division
Project No.:	06040
Location:	Hawaiian Telcom Airport Baseyard
Date:	4-25-06
Prepared By:	Ron Katahara
Attenders:	Messrs. Les Loo, Gary Sumida, Paul Hanohano, Cliff Onguay, Clay Tang, Kevin Choan of HT and Ron Katahara of MKE

Items of Discussion

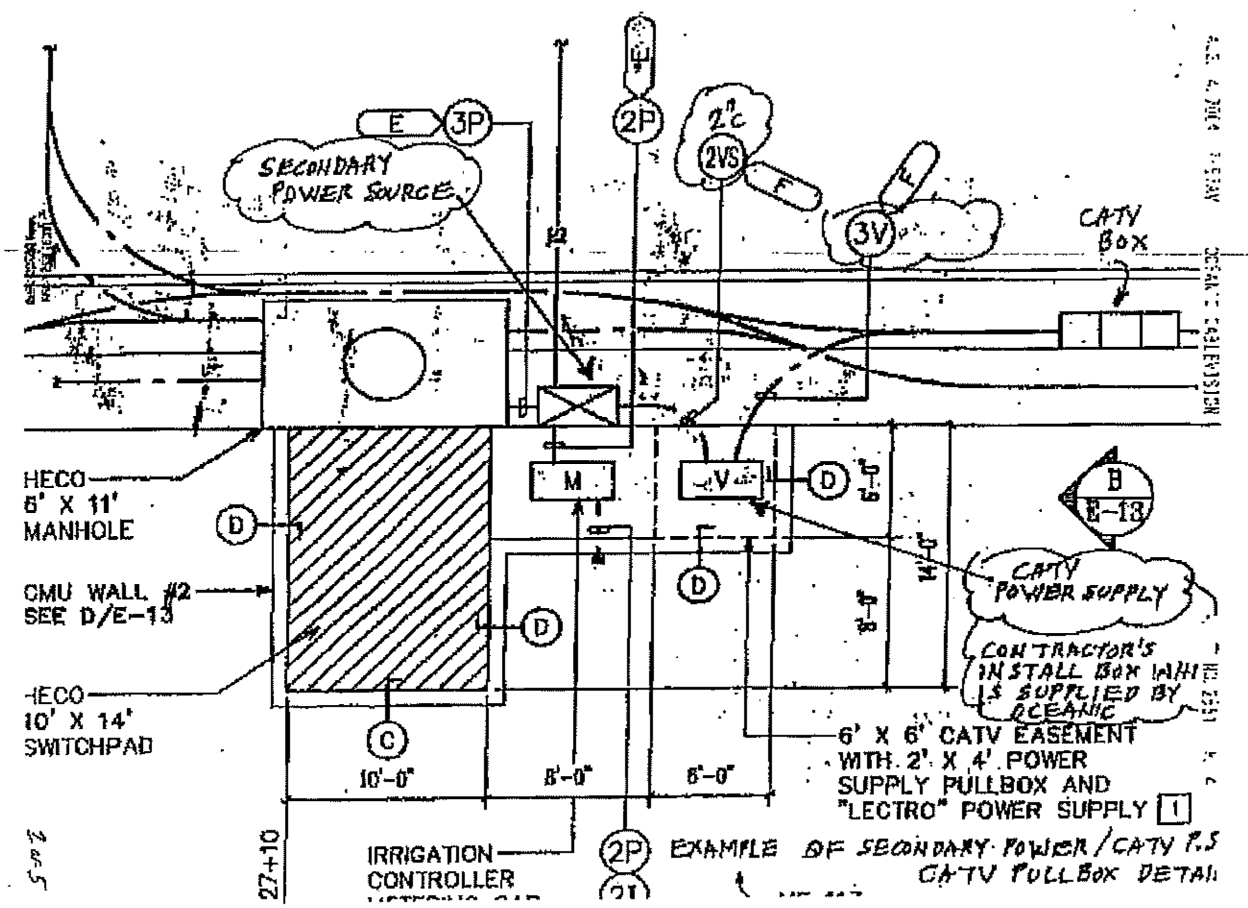
1. Katahara gave a brief overview of the project with reference to the overall colored map sent earlier with the letter to HT:
    a. 16000 single family homes
    b. Retail, commercial, industrial, schools
    c. HECO switching station/substation will stay in same location
    d. First home will be finished in 2012
    e. Development will span about 25 years and include 5 phases, each about 5 years in length
    f. Some data is available on the map – i.e.

2. Katahara requested information on existing easements and facilities in the area, where HT will bring service from and what their infrastructure requirements will be. The telephone systems engineers will study the project and make recommendations. Katahara requested desired location of facilities (hubs) and size of lot be provide while in this preliminary planning stage.
3. HT comments:
    a. Once source of service may be from Kapolei
    b. North South Road design is underway and there are 6 way ducts on the mauka side and 8 way ducts on the makai side. Service to Ho'opili might be from NS road. Ron Ho and Associates is doing the design of NS Road (Gary Funasaki).
    c. HT has not been contacted about the West Oahu Campus. They would like to know what the timing of that project is.
    d. The size of the Ho'opili development suggests that multiple hubs may be required for telephone service. Desire would be to have a lot near the center of area served for the hub.
    e. HT requested the electronic file of the subdivision plan so that they can begin planning and engineering.

END

Attachment F

CATV Power Supply Layout



EXAMPLE OF SECONDARY POWER / CATV P.S CATV PULLBOX DETAI

Appendix Q
Draft Project Master Plan

HO'OPILI

Draft Master Plan

February, 2008

Prepared by

PBR HAWAII & ASSOCIATES, INC.

CITY AND COUNTY OF HONOLULU
DEPARTMENT OF PLANNING AND PERMITTING'S
PROJECT MASTER PLAN
DETAILED REQUIREMENTS

The proposed Ho'opili project is located in the 'Ewa District and will require a zone change. According to the City and County of Honolulu, Department of Planning and Permitting (DPP) criteria, the proposed Ho'opili project would be considered a "significant" zone change. According to DPP, a Project Master Plan must be included as part of the Environmental Assessment (EA) or Environmental Impact Statement (EIS) for significant zone changes which are larger than a specified project size (any significant zone change involving 25 acres or more of land).

According to DPP, "the Project Master Plan is intended solely as a guide to help describe in words and illustrations how a project promotes the vision, policies, principles and guidelines for the Development Plan (DP) or Sustainable Communities Plan (SCP) area...The Project Master Plan should be based on the best information available to the applicant at the time the Environmental Assessment or Environmental Impact Statement is submitted [emphasis added]..."

The following is a Draft Master Plan for the proposed Ho'opili project, which will be finalized when resubmitted with the zone change application.

LIST OF FIGURES

(i) Statement of Consistency with the Development Plan or Sustainable Communities Plan

The Ho'opili Master Plan will be consistent with the vision, policies, and guidelines stated in the *Ewa Development Plan* (Ewa DP), as described in *Section 5.3.2 Ewa Development Plan* of the EIS.

(ii) Site Analysis

The following is a description of prominent site features and their relationship to the proposed development of the property.

Topography. The approximately 1,600.265-acre Project Area consists of 10 distinct parcels of land (See Figure 1: Parcels Map). Parcels A, B, C, D1, D2 and G are situated makai of the H-1 Freeway while Parcels E1, E2, E3, and F are situated mauka of the H-1 Freeway. The topography of each of the 10 parcels is described below.

The topography of Parcel A ranges from approximately 150 feet above mean sea level (MSL) at Farrington Highway to approximately 210 feet MSL at the H-1 Freeway. The slope of Parcel A is 3 percent.

The topography of Parcel B ranges from approximately 170 feet MSL at the southwestern boundary (at Farrington Highway) to approximately 205 feet MSL at its northwestern boundary (at the H-1 Freeway). The topography of Parcel B at the southeastern boundary (at Farrington Highway) is approximately 75 feet MSL and approximately 175 feet MSL at the northeastern boundary (at the H-1 Freeway). The slope of Parcel B is between 1.9 percent and 3.2 percent.

The topography of Parcel C ranges from approximately 65 feet MSL at its southern boundary to approximately 175 feet MSL at Farrington Highway. The slope of Parcel C is 1.4 percent. A ravine and steep, east-facing slope are located on the eastern boundary of the Parcel C, along Old Fort Weaver Road.

The topography of Parcel D1 ranges from approximately 10 feet MSL at its northern boundary to approximately 40 feet MSL at its northern boundary. The central portion of Parcel D1 is 25 feet MSL. The slope of Parcel D1 is 1.2 percent. Parcel D2 ranges from 0 feet at its northern boundary to 35 feet MSL at its southern boundary with a slope of 1.1 percent.

The topography of Parcels E1, E2 and E3 ranges from approximately 410 feet MSL at their southern boundaries to 415, 430 and 415, respectively at their northern

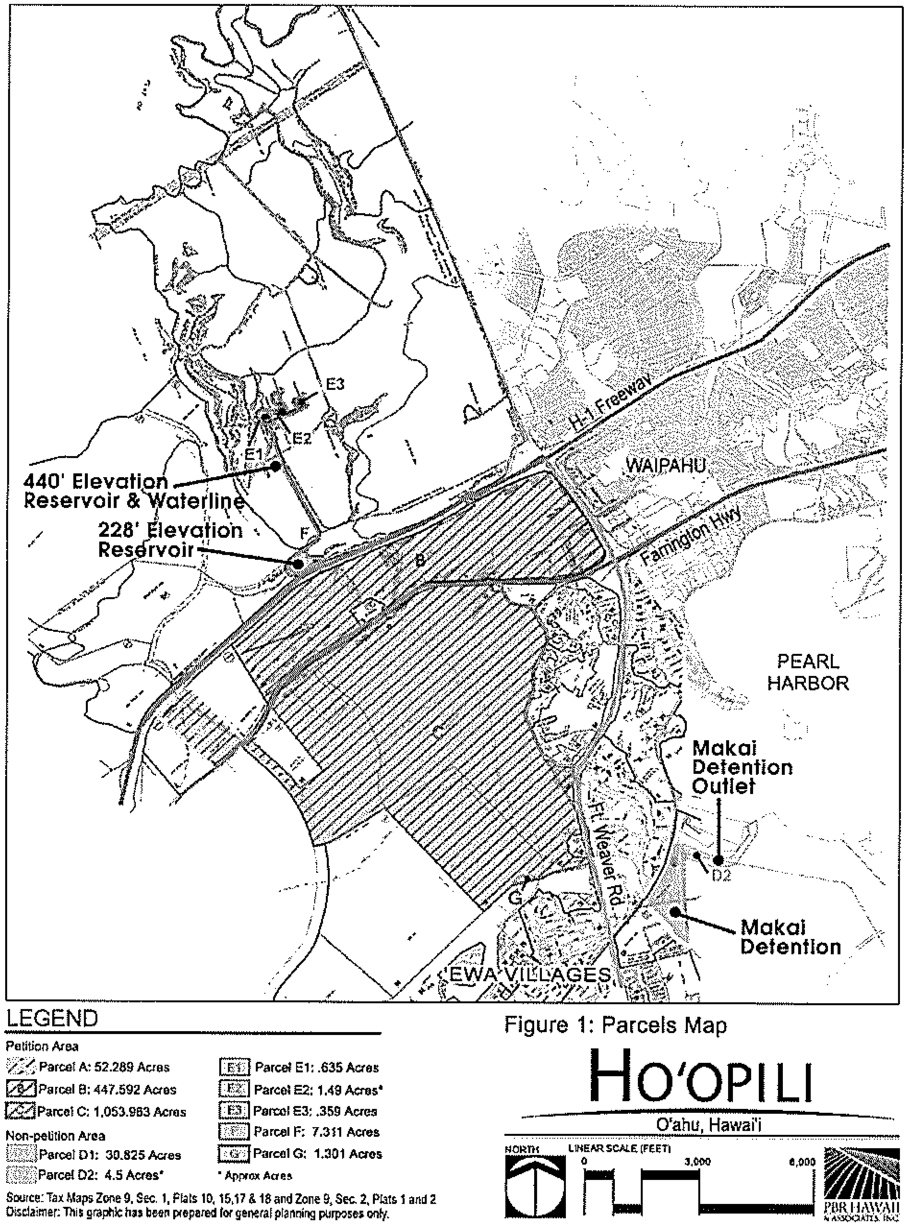


Figure 1: Parcels Map

boundaries. The slope of parcel E1 is 2.8 percent, the slope of E2 is 3.5 percent, and the slope of E3 is 3.9 percent.

The topography of Parcel F runs with an east-west slope with an elevation of 240 feet MSL on the western boundary and an elevation of 205 on the eastern edge. The center of the parcel is at an elevation of 220 feet. Parcel F has a slope of 3.49 percent on the east-west axis.

Parcel G is very small and located along the makai edge of Parcel C, bordering the 'Ewa Villages Golf Course. The slope of Parcel G is approximately 1.4 percent.

The entire Project Area has been historically utilized for sugarcane cultivation and large portions are currently utilized for agricultural production. As such, the Project Area has been extensively modified with dirt roadways, various irrigation systems, and other appurtenant agricultural structures.

The topography of the Project Area is mostly gently sloping (and highly accessible) and provides adequate slope for drainage. The Project Area will be modified with infrastructure improvements and urban structures for residential, commercial, industrial, recreational and educational uses. The Project Area will include drainage detention basins, open space buffers, parks and some undeveloped areas. Most of the developed areas will be extensively landscaped, which will minimize the potential for soil erosion.

Soils. Three soil suitability studies have been prepared for lands in Hawai'i. The principal focus of these studies is to describe the physical attributes and relative productivity of different land types for agricultural production within the State of Hawai'i. The three studies are the U.S. Department of Agriculture (USDA) *Natural Resources Conservation Service Soil Survey*, the University of Hawai'i Land Study Bureau *Detailed Land Classification*, and the State of Hawai'i, Department of Agriculture's *Agricultural Lands of Importance to the State of Hawaii* (ALISH).

Natural Resources Conservation Service Soil Survey. The U.S. Department of Agriculture Natural Resources Conservation Service identified sixteen general soil types within the property (See Figure 2: Natural Resources Conservation Services Soil Survey Map). The soil types include:

- 'Ewa Silty Clay Loam, 3 to 6 percent slopes (EaB);
- Honouliuli Clay, 0 to 2 percent slopes (HxA);
- Honouliuli Clay, 2 to 6 percent slopes (HxB);
- Kaloko Clay, Noncalcareous Variant (Kfa);
- Kawaihāpai Clay Loam, 0 to 2 percent slopes (KlB);

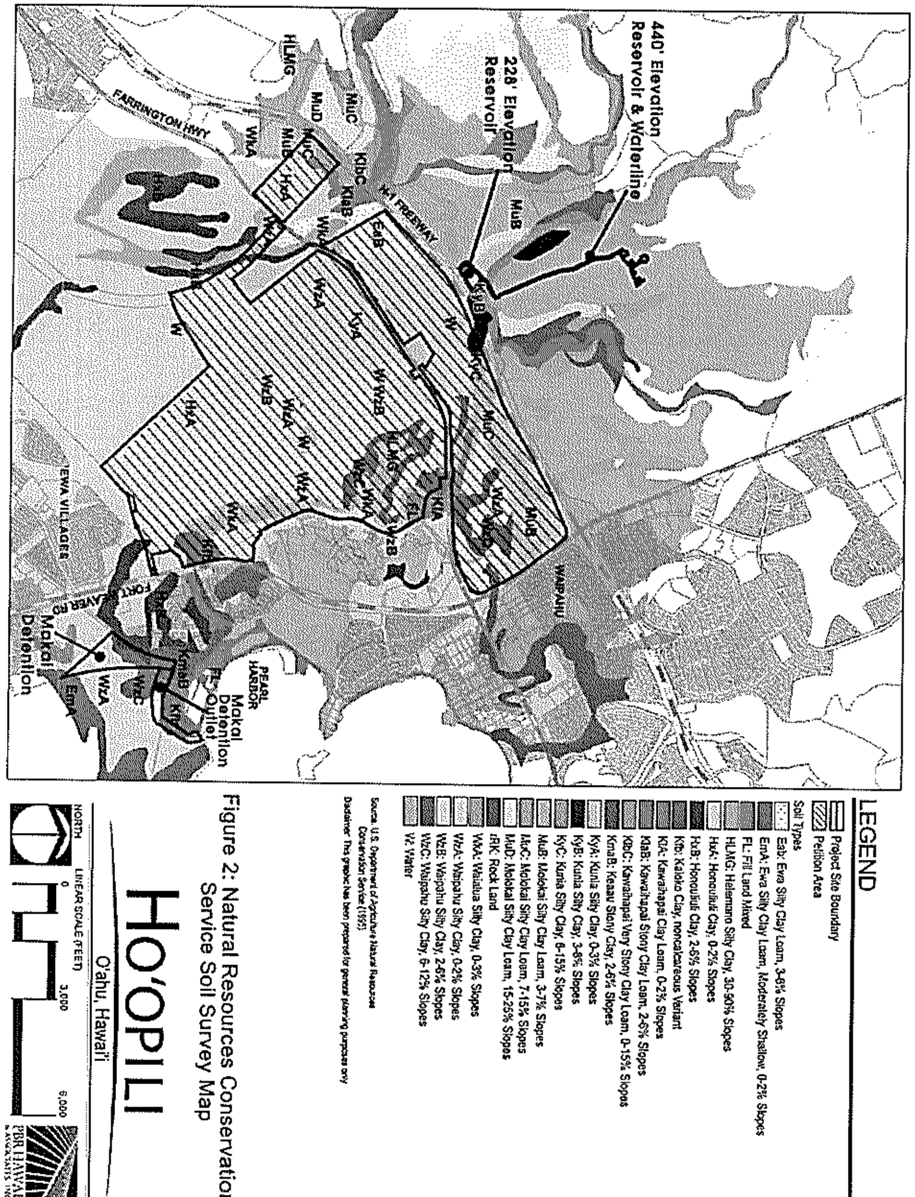


Figure 2: Natural Resources Conservation Service Soil Survey Map

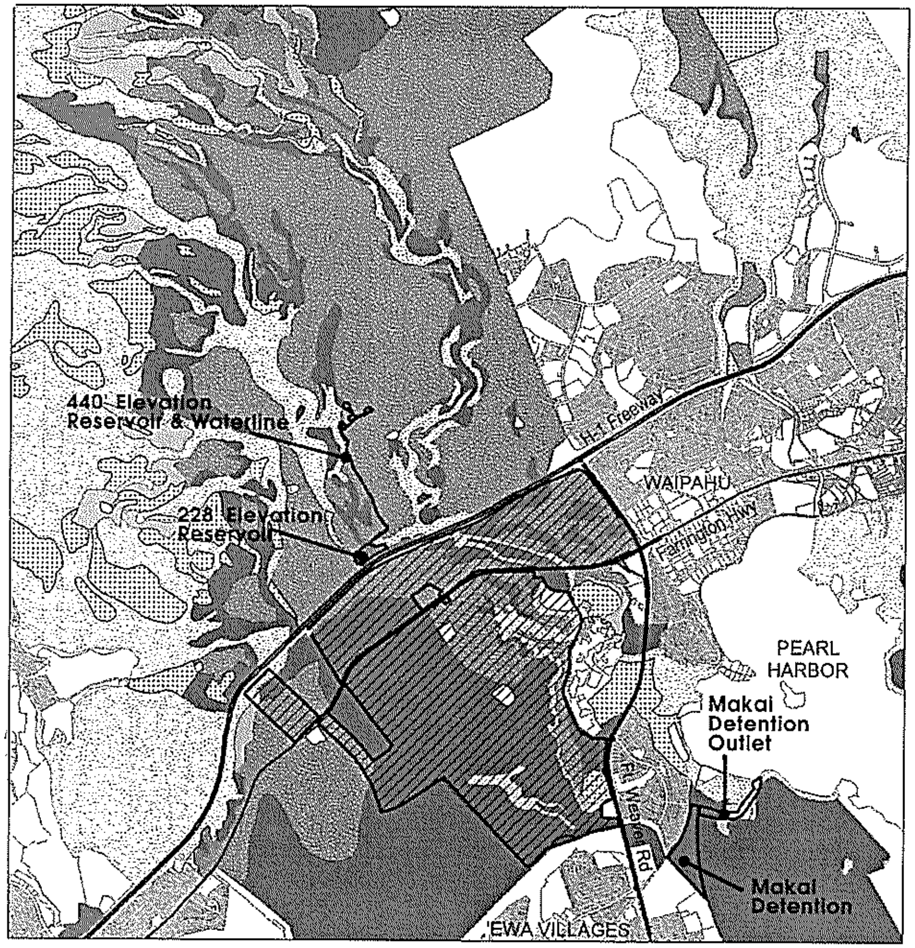
- Kolekole Silty Clay Loam, 6 to 12 percent slopes (KuC);
- Kolekole Silty Clay Loam, 12 to 25 percent slopes (KuD);
- Kunia Silty Clay, 0 to 3 percent slopes (KyA);
- Kunia Silty Clay, 3 to 8 percent slopes (KyB);
- Kunia Silty Clay, 8 to 15 percent slopes (KyC);
- Moloka'i Silty Clay Loam, 3 to 7 percent slopes (MuB);
- Moloka'i Silty Clay Loam, 7 to 15 percent slopes (MuC);
- Waialua Silty Clay, 0 to 3 percent slopes (WkA);
- Waipahu Silty Clay, 0 to 2 percent slopes (WzA);
- Waipahu Silty Clay, 2 to 6 percent slopes (WzB); and
- Wahiawā Silty Clay Loam, 0 to 3 percent slopes (WaA).

Land Study Bureau Detailed Land Classification. The *Detailed Land Classification* (1965 through 1972) series was produced for each island by the Land Study Bureau (LSB) of the University of Hawai'i. The intent of this series of reports was to develop a land inventory and productivity evaluation based on statewide standards of crop yields and levels of management.

A five-class productivity rating is applied using the letters A, B, C, D and E, with A representing the class of highest productivity and E the lowest. Most of the soils within the Project Area are rated B (See Figure 3: Land Study Bureau Land Classification). Other soils are rated A, with fewer soils rated C, D and E. These soil ratings reflect the Project Area's past and present use for agricultural production under irrigated conditions.

Agricultural Lands of Importance to the State of Hawaii. *The Agricultural Lands of Importance to the State of Hawaii* (ALISH) (1977) system classifies lands that are important to agriculture in Hawai'i as Prime, Unique, or Other Agricultural Land, with Prime Agricultural Land representing the class of greatest importance and Other Agricultural Land the least. Most of the Project Area includes soils identified as Prime Agricultural Land, which is defined as "land best suited for the production of food, feed, forage, and fiber crops." The remaining lands are identified as Other Agricultural Land (which is important to agriculture in Hawai'i but exhibits properties that exclude it from the Prime or Unique Agricultural Land classifications) or are not classified by the ALISH system (See Figure 4: Agricultural Lands of Importance to the State of Hawaii).

While the Project Area contains soil with good agricultural productivity, State and County land use policy has directed growth towards 'Ewa, makai of the H-1 Freeway.



LEGEND

- Project Site Boundary
- Petition Area

Soil Classification

- A (Excellent)
- B (Good)
- C (Fair)
- D (Poor)
- E (Very Poor)
- Not Classified

Source: Land Study Bureau (1967)
Disclaimer: This graphic has been prepared for general planning purposes only.

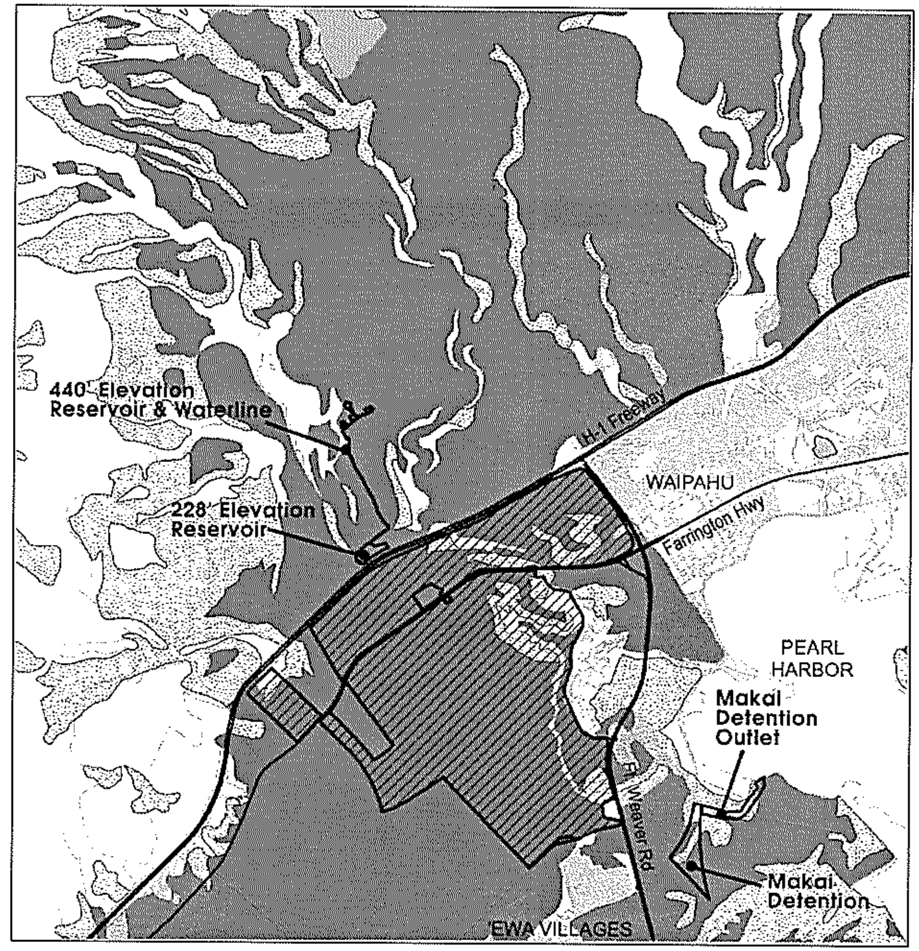
Figure 3: Land Study Bureau Land Classification

HO'OPILI

O'ahu, Hawai'i

NORTH LINEAR SCALE (FEET) 0 3,500 7,000

PBR HAWAII & ASSOCIATES, INC.



LEGEND

- Project Site Boundary
- Petition Area
- Prime Agricultural Lands
- Unique Agricultural Lands
- Other Agricultural Lands
- Unclassified Agricultural Lands

Source: State Dept. of Agriculture (1977).
Disclaimer: This graphic has been prepared for general planning purposes only.

Figure 4: Agricultural Lands of Importance to the State of Hawaii (ALISH)

HO'OPILI

O'ahu, Hawai'i

NORTH LINEAR SCALE (FEET) 0 3,500 7,000

PBR HAWAII & ASSOCIATES, INC.

Drainage. The Project Area is within three distinct drainage basins. These are the Kalo'i drainage basin, the Honouliuli Stream drainage basin and the West Loch drainage basin.

Kalo'i Drainage Basin. The Kalo'i Basin stretches to the top of the eastern slopes of the Wai'anae mountain range and terminates near the ocean in the vicinity of Haseko's Ocean Pointe development. The drainage basin mauka of the H-1 Freeway is 3,000 acres and generates a peak flow of 5,000 cubic feet per second (CFS). The drainage basin size increases to 4,330 acres and carries a peak flow of 8,900 CFS at the entrance to 'Ewa Villages. Approximately 100 acres of the Ho'opili project are within this watershed.

With respect to the portion of the project within the Kalo'i drainage basin, the project will be creating on-site detention basins to collect all storm water runoff and discharge the flow at a rate that will not exceed pre-development conditions. The project will also be providing storage and detention to meet the City and County of Honolulu Drainage Standards with respect to water quality standards. The basin size could be decreased at some time in the future when the terminus of Kalo'i basin is finalized. All developed projects discharging to the Kalo'i basin currently have discharge restrictions and these restrictions will continue until the Kalo'i basin terminus is finalized. The portions of the project within the Kalo'i drainage basin are Parcels A and the western most part of Parcel C adjacent to the North-South Roadway alignment. The D.R. Horton - Schuler Division will continue to coordinate with County and State agencies to discuss issues within the Kalo'i Gulch Watershed.

Honouliuli Stream Drainage Basin. The Honouliuli Stream drainage basin also stretches to the top of the eastern slopes of the Wai'anae mountain range. This basin contains 6,600 acres (11,200 CFS – peak flow) of drainage area mauka of the H-1 Freeway and expands to 7,880 acres (12,300 CFS – peak flow) at its connection with the West Loch of Pearl Harbor. The terminus location is in the vicinity of the West Loch Golf Course. Approximately 635 acres of the Ho'opili project are in the Honouliuli Stream drainage basin. The portions of the project within the Honouliuli Stream drainage basin are Parcels B and the northeastern part of Parcel C adjacent to Old Fort Weaver Road.

With respect to the Honouliuli Stream drainage basin, the project will provide detention basins to collect all storm water runoff and discharge the flow at a rate that will not exceed the 10-year recurrence flow rate. This is the recognized capacity of the Honouliuli Stream channel.

West Loch Drainage Basin. The West Loch drainage basin is the smallest drainage basin affecting the project. The basin upper reaches begin at the makai side of the H-1 Freeway and generally terminates at two locations at the West Loch of Pearl Harbor. One terminus is through West Loch Estates and the other is an overflow from an existing detention basin located east of Fort Weaver Road and just south of the OR&L railroad tracks (See Parcel D1 on Figure 1: Parcels Map). This basin contains approximately 937 acres and generates a peak flow of 2,500 CFS. The total basin is within lands that are part of the Ho'opili project.

With respect to the West Loch drainage basin, the project intends to collect all storm water and route it to the existing detention basin located on the east side of Fort Weaver Road and south of the OR&L railroad tracks. The routing would require the installation of a concrete channel from the southeastern end of Parcel C, under Fort Weaver Road (using the existing cane haul underpass) and connecting to the existing detention basin. The basin would be expanded to ensure that the water quality storage component of the City and County of Honolulu Standards was achieved. An overflow from the detention basin would discharge to the West Loch of Pearl Harbor (See Parcel D2 on Figure 1: Parcels Map). The portion of the project within the West Loch drainage basin is the bulk of Parcel C (See Figure 5: Drainage Basins).

The overflow from the detention basin would have to cross Navy property. Permission of the Navy would be required. Initial inquiries have been made to the Navy to see if the overflow can be negotiated. Issues with the Navy include security and access in a post- "9/11" environment, Navy plans for development in the overflow corridor, and the acquisition of a maintenance commitment by the City and County of Honolulu. The concept of the overflow across Navy property is not new and was approved in concept back in the early- to mid- 1990's. Lack of action and the issues cited above are points that need to be resolved for the overflow option to move forward.

If permitted, the overflow option across Navy property will solve drainage problems occurring on Fort Weaver Road, within West Loch Estates and within portions of 'Ewa Villages by effectively collecting the storm water that currently is misdirected across these properties.

The alternative drainage solution if the overflow across Navy property cannot be resolved is to construct retention basins on site holding back the total volume of a 100 year- 24 hour storm. These basins would be located on the southern portion of Parcel C.

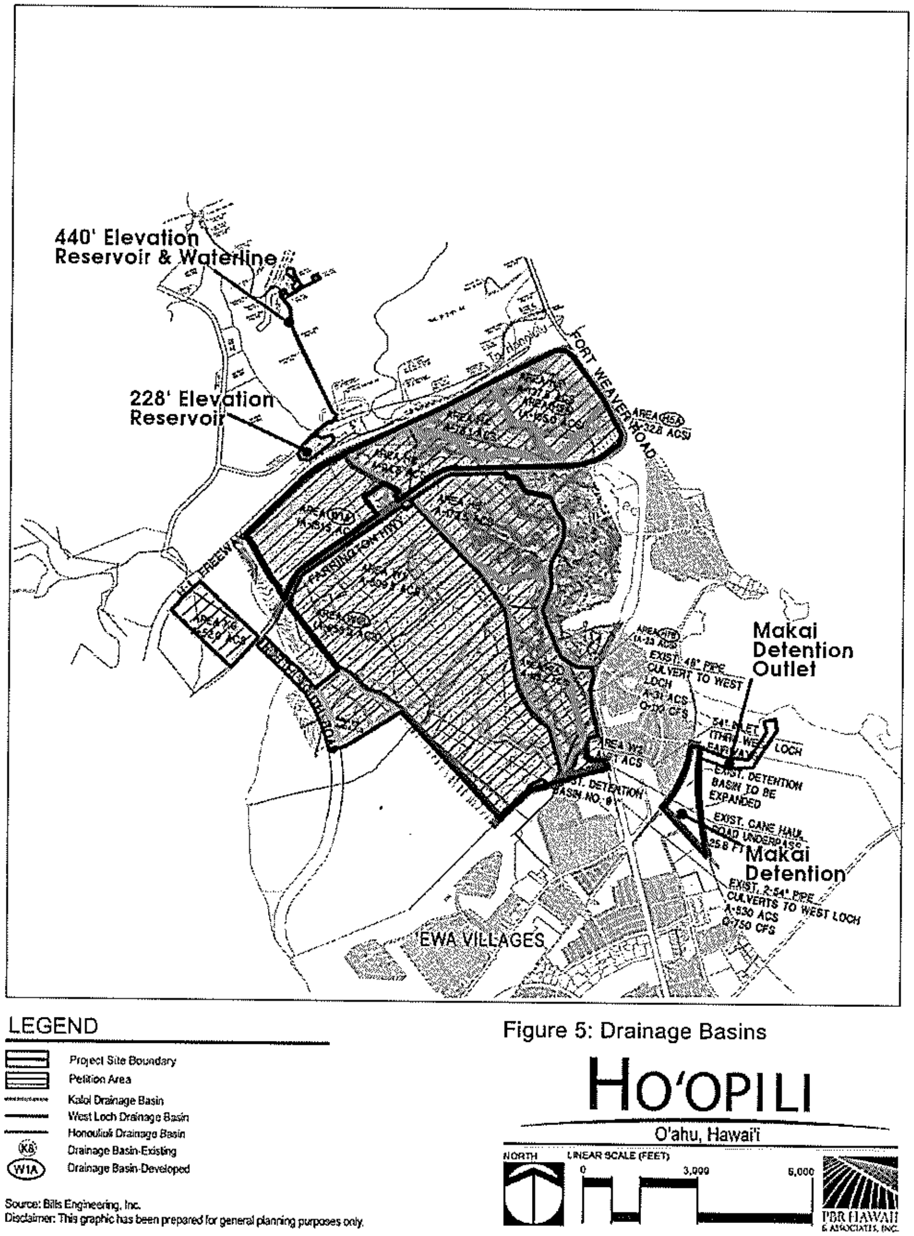


Figure 5: Drainage Basins

Grading. The Project Area will be modified with infrastructure improvements and urban structures for residential, commercial, industrial, recreational and educational uses. The Project Area will include drainage detention basins, open space buffers, parks and some undeveloped areas. Most of the developed areas will be extensively landscaped, which will minimize the potential for soil erosion.

Geotechnical Considerations. No significant geological and/or geotechnical constraints that would preclude the proposed development are expected to be encountered. The primary geotechnical considerations for the development of this property appear to be site drainage, abandoned agricultural infrastructure, (assumed to be) expansive soil conditions, and possible backfilled, undocumented ditches or reservoirs associated with past use of the land. Due to the relatively dry climatic conditions of the 'Ewa Plain, it is important that proper site drainage and landscaping, along with a permanent irrigation system, be developed to help control the (assumed) expansive soils and reduce the potential for significant erosion of soil materials.

Flora. According to the botanical survey reports, conducted by LeGrande Biological Surveys, Inc., in August 2006, most of the Project Area is currently plowed and devoid of trees and brush. Other lands within the Project Area are uncultivated brushland or pastureland. The vegetation is typical of agriculturally cultivated cropland or highly disturbed weedy areas. Little of the original native vegetation remains after over a century of intensive sugarcane agriculture and periodic burning. Native species have been replaced by aggressive non-native plant species. No federally listed endangered or threatened native plants, or candidate endangered species, were encountered on the property. Additionally, no wetlands occur on the property.

None of the plant species which occurred on the Project Area are considered a threatened and endangered species or a species of concern. Although a concerted effort was made in surveying for ko'oloa'ula (*Abutilon menziesii*), no plants were observed on the property. As such, the proposed project is not expected to have a significant negative impact on the botanical resources in this part of O'ahu.

Fauna. According to the biological survey reports prepared by Rana Productions, Ltd., in February 2008, the mammalian and avian species currently found within the Project Area are by and large alien species. All of the mammalian species identified are alien and only three of the avian species present are indigenous. A variety of rats and mice are present in some locations, and are strongly suspected to be present in other areas. Although presence of the endangered Hawaiian Hoary bat (*Lasiurus cinereus semotus*) was suspected, none were observed during the surveys.

The majority of the sites surveyed within the Project Area are lands formerly cultivated in sugarcane or pineapple, having led to high degrees of disturbance or destruction of native habitat. Current habitats are deemed "depauperate" (severely diminished) by the biological consultant. Some of the sites are currently under partial cultivation, but those habitats likewise have been severely degraded.

The notable exceptions to the above are the four endangered waterbird species which currently inhabit the National Wildlife Refuge located north of Parcels D1 and D2 (See Figure 1: Parcels Map). The Pearl Harbor National Wildlife Refuge was established in 1972 as mitigation for construction of the Honolulu International Airport Reef Runway. The refuge is primarily devoted to the recovery of four endemic and endangered waterbirds [Hawaiian Duck x Mallard hybrids (*Anas wyvilliana x platyrhynchos*), Common Moorhen (*Gallinula choropus sandvicensis*), Hawaiian Coot (*Fulica alai*) and Black-necked Stilt (*Himantopus mexicanus knudseni*)]. The refuge is composed of two units, the 37-acre Honouliuli Unit bordering West Loch and the 25-acre Waiawa Unit bordering Middle Loch.

These waterbirds are likely to utilize the detention basin once sufficient water collects to allow ponding. There may be periodic disturbance to the waterbird species if temporary construction occurs within the detention basin (to enlarge it) or if an outlet is allowed. As previously noted, the waterbirds breed in the Honouliuli Unit of the National Wildlife Refuge, less than a sixth of a mile (250 meters) north of Parcels D1 and D2.

Impacts to the other existing mammalian and avian species and their habitats are expected to be minimal. Displacement of alien species is likely to occur as construction and development infill takes place, but these species will re-inhabit any un- or underutilized locations once development is complete. No other mitigation measures are planned for the remaining faunal species.

Historic Sites. An archaeological inventory survey report for the Project Area was conducted in February 2006 by Cultural Surveys Hawai'i Inc. This report is included in Appendix D of the EIS. Five historic properties (SIHP Nos. 50-80-12-4344, 4345, 4346, 4347, and 4348) were documented during Cultural Surveys Hawai'i's (CSH) archaeological inventory survey of the Petition Area. All five historic properties have been assessed as eligible for the State Register of Historic Places under Criteria C and D, except for Site 4344, which is only eligible under criterion D. The State of Hawai'i, Department of Land and Natural Resources, Historic Preservation Division (SHPD) concurs with these significance assessments. All five historic properties are located in the vicinity of Old Fort Weaver Road).

SIHP Nos. 50-80-12-4344. A survey conducted by CSH in 1990 identified three iron pipe features, including a tall metal post and two welded pipe constructions, located in the vicinity of the Drivers/Stable Villages. The age and function of these features elucidate out record of plantation life in 'Ewa. A more recent inventory study conducted by CSH in 2005 could not locate the previously identified features as the area had been bulldozed and the features destroyed. However, four additional plantation infrastructure features adjacent to Honouliuli Gulch were identified. These features were added to the site description, and will not affect the significance and recommendation for this site ("no preservation").

SIHP Nos. 50-80-12-4345 ('Ewa Plantation Railroad Berm). The 'Ewa Plantation Company operated an approximately 30-mile private railroad from 1890 – 1947 for the primary purpose of the transport of sugar cane. While the railroad runs throughout the Petition Area, a particularly good section of railroad can be found in the northeastern portion of the Petition Area in the mouth of a dry stream valley. A railroad berm runs on both sides of the valley access road with well-preserved facings approximately 2 meters in height. The archaeological consultant recommended that the railroad berm be preserved through incorporating the feature into the development of the project where feasible.

SIHP Nos. 50-80-12-4346 (Northern Pumping Station). A survey conducted by CSH in 1990 previously determined the site's significance under Criteria C and D. The site consists of a pumping station with a deep rectangular basalt block, faced wall. The site is believed to pre-date 1928. An adjacent single pump house, which has an exterior or corrugated sheet metal panel construction, is located nearby. The archaeological consultant recommended that the well be preserved and that issues of significance and proper historic documentation be resolved with the SHPD office in advance of any development in the area to avoid adverse impacts. A preservation plan has been drafted and will be submitted to SHPD for review and comments.

SIHP Nos. 50-80-12-4347 (Central Pumping Station). A survey conducted by CSH in 1990 previously determined the site's significance under Criteria C and D. The site consists of a pumping station with a deep rectangular basalt block, faced wall. The site is believed to pre-date 1928. Eight features related to and in the immediate vicinity of the well include a number of small architectural and/or industrial features. The archaeological consultant recommended that the well and portions of the site be preserved. The significance of the site would be evaluated after an assessment of the significance of the architectural features and the assessment of the significance of the 'Ewa Village area. A preservation plan has been drafted and will be submitted to SHPD for review and comments.

SIHP Nos. 50-80-12-4348 (Southern Pumping Station). A survey conducted by CSH in 1990 previously determined the site's significance under Criteria C and D. The site consists of a pumping station with a deep rectangular basalt block, faced wall. The site is believed to be constructed shortly after 1928. An adjacent single pump house, which has an exterior or corrugated sheet metal panel construction, is located nearby. The archaeological consultant recommended that the well be preserved and that issues of significance and proper historic documentation be resolved with SHPD in advance of any development in the area to avoid adverse impacts. A preservation plan has been drafted and will be submitted to SHPD for review and comments.

Research of earlier maps indicates four areas of interest: the Honouliuli taro lands, Kapalani Church, Pipe Line Village and Drivers/Stable Villages. All are located in the vicinity of Old Fort Weaver Road, well below from the main development area.

The Honouliuli taro lands were probably nineteenth century (and earlier) Hawaiian habitation and agricultural area. However, no surface or subsurface remains were found during the 2005 inventory survey. CSH has determined that no additional testing is necessary. However, CSH is recommending on-call/on-site archaeological monitoring during any future development in this area. SHPD concurs with this recommendation.

The Kapalani Church was a nineteenth century Hawaiian Catholic Church, schoolhouse and possible cemetery area. Pipeline Village and the Drivers/Stable Villages were early twentieth century immigrant plantation habitation camps. No surface or subsurface remains were found during the 2005 inventory survey. CSH has determined that no additional inventory survey is necessary. However, CSH is recommending on-call/on-site archaeological monitoring during any future development in this area. SHPD concurs with this recommendation.

SHPD concurs with the consulting archaeologist's (Cultural Surveys Hawai'i) mitigation recommendations, which include: (1) no further archaeological work at Site 4344, (2) preservation of Sites 4345, 4346, 4347, and 4348, and (3) archaeological monitoring in the vicinity of the four areas of historic habitation (Honouliuli taro lands, Kapalani Catholic Church, Pipeline Village, and Drivers/Stable Village).

According to SHPD, the archaeological inventory survey report is now accepted in fulfillment of *Hawaii Administrative Rules* 13-284 and 13-276 (See EIS Appendix E). A preservation plan and archaeological monitoring plan will be prepared and submitted to SHPD for their review and approval. All five sites are located near

Old Fort Weaver Road and well away (and below the bluff) from the main Petition Area. Should any archaeologically significant artifacts, bones, or other indicators of previous on-site activity be uncovered during construction, work will stop immediately and the will be notified in accordance with applicable regulations.

View Analysis. The Petition Area is located in 'Ewa (the area roughly bounded by the H-1 Freeway to the north, Kapolei Golf Course, Kapolei Middle School and the Villages of Kapolei to the west, 'Ewa Villages to the south, and Honouliuli and Fort Weaver Road to the east). Most of 'Ewa is mostly open and is being cultivated. The major man-made features in 'Ewa besides roads (such as Farrington Highway and the North-South Road – under construction) are HECO's transformer station along Farrington Highway and its overhead 138kV powerlines and supporting tower structures crossing the H-1 Freeway, and running along Farrington Highway and North-South Road.

As is the case with the rest of 'Ewa, Parcels A, B and C of the Petition Area are presently undergoing various forms of diversified agriculture. A portion of the Petition Area is being developed during the construction of North-South Road (construction on-going). Views of the Wai'anae Mountains and Diamond Head are offered from certain locations of the project site. However, since most of the Petition Area is being actively cultivated, the public does not have the opportunity to experience these views. The most heavily traveled roadways in the vicinity of the site are the H-1 Freeway and Fort Weaver Road. In fact, as DPP noted in their comments on the EISPN, the *Ewa Development Plan* Open Space Map shows that "panoramic views" of the property are available from these roadways. While nearly all of the Petition Area is lower in elevation than the H-1 Freeway, views makai from H-1 Freeway are infrequent along the stretch of the Freeway between where Kunia Road and Palehua Road cross the Freeway. In some sections of the H-1 Freeway, it appears that the Freeway was cut across slopes and/or the makai shoulder of the Freeway was graded with berms. At posted Freeway speeds of 60 miles per hour, viewing the Petition Area while driving is hazardous.

Most of the Petition Area is higher in elevation than Fort Weaver Road, but lower in elevation than the H-1 Freeway.

The most visible portion of the Petition Area from either the H-1 Freeway and/or Kunia Road/Fort Weaver Road is located near the intersection of the H-1 Freeway and Kunia Road or from Farrington Highway.

The visual appearance of the Petition Area as well as the rest of 'Ewa (including the Kroc Center, UHWO and DHHL East Kapolei Development Parcel 2) will change from vacant scrub and cultivated vegetation to a landscaped mixed-use community with parks and open space. The HHCTC project, a possible transit maintenance and storage facility, transit-oriented development, project landscaping, and the project's architectural design will set the visual character of the Petition Area. .

Analysis of Surrounding Uses. The Project Area consists of 1,553.844 acres of the 1,600.265 acres in the Project Area. The Project Area consists of 10 distinct parcels of land situated within the Agricultural District. For purposes of this EIS, the parcels have been labeled as A, B, C, D1, D2, E1, E2, E3, F and G (See Figure 1: Parcels Map). The Project Area parcels are A, B and C. The remaining Project Area parcels, D1, D2, E1, E2, E3, F and G, do not need to be reclassified to urban.

Parcel A is located west of Parcels B and C, and north of the UHWO. It is bordered by State land to the west, Farrington Highway to the south, the proposed North-South Road (under construction) to the east, and the H-1 Freeway to the north.

Parcel B is located north (mauka) of Parcel C and Farrington Highway. It is the second largest of the 10 parcels. Parcel B is bordered to the west by land proposed for multi-family residential use by the Housing and Community Development Corporation of Hawai'i (HCDCH), to the south by Farrington Highway, to the east by Kunia Road, and to the north by the H-1 Freeway. An out-parcel along Farrington Highway is used by HECO.

Parcel C is located south (makai) of Farrington Highway. It is the largest of the 10 parcels. Parcel C is bordered by the proposed North-South Road to the west; State of Hawai'i, Department of Hawaiian Home Lands (DHHL) landholdings, 'Ewa Villages, and the 'Ewa Villages Golf Course to the south; Old Fort Weaver Road and (new) Fort Weaver Road to the east; and Farrington Highway to the north. There are two out-parcels along Farrington Highway. One out-parcel of land near the planned University of Hawai'i West O'ahu (UHWO) campus and North-South Road is proposed for multi-family residential use by HCDCH. The other out-parcel of land is used by the City and County of Honolulu, Board of Water Supply (BWS).

Parcel D1 is located east of the other four parcels and Fort Weaver Road. Pearl Harbor National Wildlife Refuge is located to the north, West Loch Estates is located to the northwest, 'Ewa by Gentry is located to the south and southwest, and Waipahu and Pearl Harbor are located to the east.

Parcel D2 functions as an outlet, connecting Parcel D1 to Pearl Harbor and its use would require approval from the United States Navy.

Parcels E1, E2 and E3 are located north (mauka) of the H-1 Freeway. The parcels are numbered from west to east, with E1 on the west and E3 on the east. All are surrounded by open space, and are connected to Parcel F via narrow parcel of land which will serve as a waterline.

Parcel F is located north (mauka) near to the H-1 Freeway. It is linked to Parcels E1, E2 and E3 by a narrow band of land. It is bordered by the H-1 Freeway on the southern boundary and by open space on its north, east and western sides.

Parcel G is adjacent to the makai boundary of Parcel C and is located north (mauka) of the 'Ewa Villages Golf Course, and is already located within the State Urban Land Use District boundaries.

(iii)Land Use

The Proposed Action involves the reclassification of approximately 1,553.844 acres from the Agricultural District to the Urban District. Urbanization of the Project Area will enable The D.R. Horton - Schuler Division to develop its proposed Conceptual Land Use Plan (See Figure 6: Conceptual Land Use Plan). The proposed Ho'opili Conceptual Land Use Plan will be a community where residents can live, work, learn, play, and shop.

To achieve the communities' vision for Ho'opili, a Conceptual Land Use Plan has been formulated that illustrates a mixed-use community that would complete and connect 'Ewa with the surrounding communities. Originating from the common vision and values of a community-driven planning effort, the conceptual plan contains a series of neighborhoods with a mix of uses including residential, retail, office and light industrial. Included in this mix are a series of parks, schools, public buildings and community centers which act as a focus and help define the identity of each neighborhood.

Ho'opili will be connected to the surrounding 'Ewa District by a network of streets and bicycle paths which allow a variety of circulation options for residents and visitors. Wider tree-lined boulevards create a distinct axis running north-south and east-west across the site. Ho'opili is being designed to be transit-ready, and the land use plan, while subject to change, has been designed to accommodate a high-capacity transit corridor either along Farrington Highway or diagonally through the project site, with either one or two transit station locations. While the proposed residential unit count will not change, the land use plan will need to be adjusted depending on the final alignment of the high-capacity transit corridor, as the potential for noise impact from an elevated high-capacity transit alignment would likely require taller, higher density residential or industrial uses along the

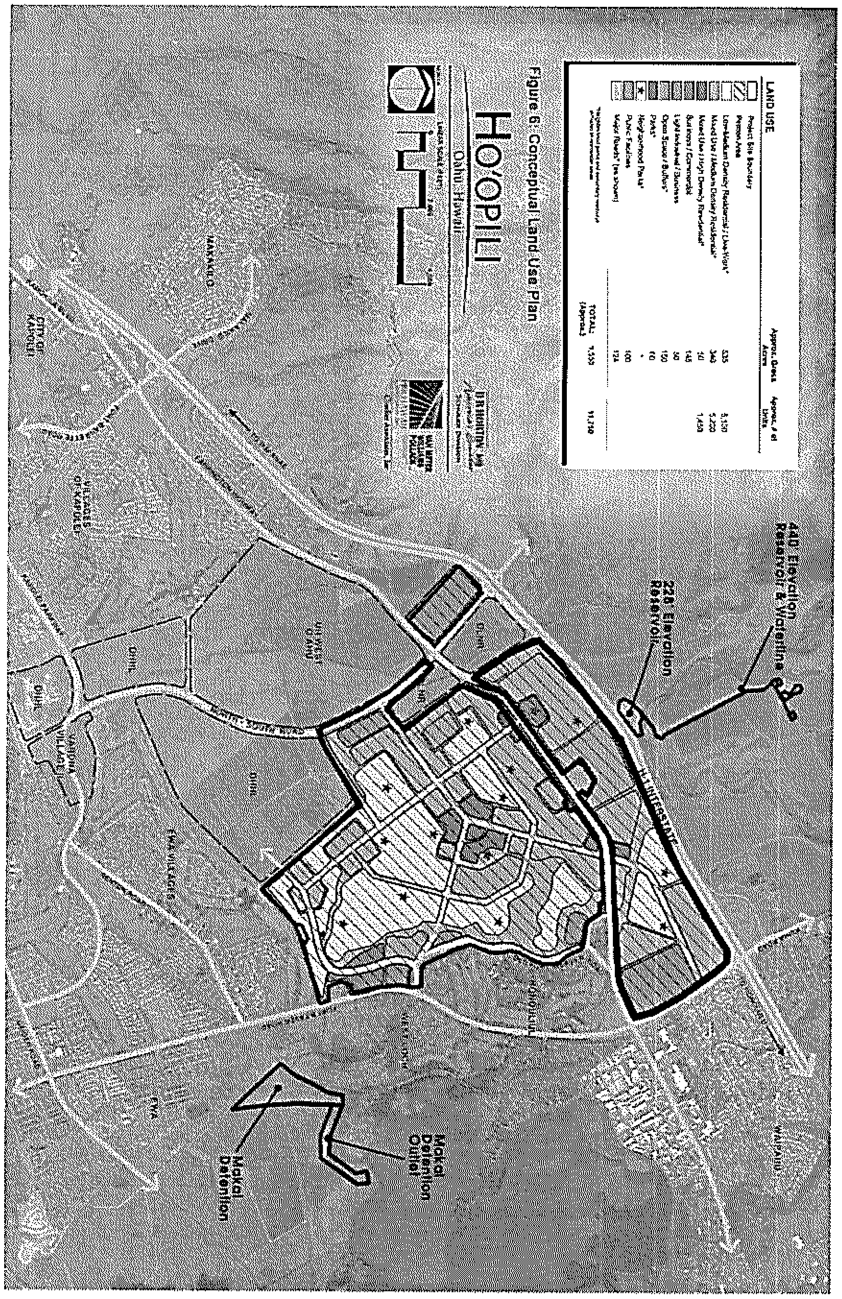


Figure 6: Conceptual Land Use Plan

alignment. The final siting of the transit station location(s) will also provide transit-oriented development potentials, which will also cause the plan to be refined, as higher intensity development (and density) will probably be concentrated around the transit station(s). Also possible is a site for a transit maintenance and storage facility.

In the geographical center of the site there is a public square or Civic Plaza that is surrounded by higher density housing development and mixed-use buildings. Housing intensity transitions to lower-density small-lot single family homes along the eastern and southern peripheries of the site. A significant open space and pedestrian/bicycle trail network provides a wide variety of recreational opportunities for residents and other members of the 'Ewa community. Ho'opili will incorporate traditional Hawaiian building styles with a modern, contemporary aesthetic and will reflect the landscape and climate.

The general land use allocation illustrated on the Conceptual Land Use Plan is summarized in Table 3 of the EIS and described below:

Low-Medium Density Residential/Live-Work
Ranging from traditional single family detached homes on varying lot sizes to multifamily dwellings with a variety of live-work opportunities, there are approximately 535 gross acres (which includes secondary roads and mini-"neighborhood" parks) planned to accommodate approximately 5,100 residential units at densities of 5 to 14 units per acre. These areas would include mini-parks located as focal points and activity centers of the community.

Mixed-Use/Medium Density Residential
Planned to be oriented along future high-capacity transit and major roadway alignments, these medium density mixed use districts would include live-work residential units or residential uses over ground floor commercial and office uses. Within these districts that comprise approximately 340 acres (all of which will not be developed for housing because the acreage includes secondary roads, off-street parking and mini-"neighborhood" parks), there are approximately 5,200 dwelling units planned at densities of 15 to 29 units per acre along with retail and office use.

Mixed-Use/High Density Residential
Planned to be located near major transportation junctions, these higher density mixed use districts would include commercial, office space, and higher density live-work residential units or residential uses above ground floor businesses. Within these districts that comprise approximately 50 gross acres (which includes secondary roads, off-street parking and mini-"neighborhood" parks) would be approximately 40 net developable acres that would accommodate approximately 1,450 dwelling units planned at densities of 30 to 50 units per acre along with retail and office use.

Business / Commercial
To serve the neighborhoods and surrounding communities and to provide a variety of employment opportunities within Ho'opili, the business/commercial uses are located to be conveniently accessed from the major transportation corridors of the region. The approximately 145 gross acres illustrated (which includes secondary roads and off-street parking) are estimated to yield a net development area of approximately 130 acres that are projected to accommodate retail and office use. These areas would be significant employment generators for Ho'opili and the region.

Light Industrial / Business Mixed-Use
To meet regional demands and to provide for an additional employment center for Ho'opili, approximately 50 gross acres (which includes secondary roads and off-street parking) are planned to provide an area for larger light industrial type users and businesses. It is estimated that there would be a net development area of approximately 40 acres industrial mixed-use.

Open Spaces / Buffers
Integral to the connectivity of Ho'opili to the surrounding neighborhoods, a variety of open space buffers and drainage detention areas are planned. Some of the key open space buffers include along the H-1 Freeway, Honouliuli Gulch and along Old Fort Weaver Road.

Parks
Some of the key parks being planned include a district park along Fort Weaver Road and a downtown civic square to serve as the community gathering area.

Mini-Parks
Integral to the establishment and identity of neighborhoods, a variety of smaller parks of approximately one to two acres in size are planned. Properly planned and located, most residents will be within walking distance of one of these mini-parks.

Public Facilities
The proposed project could include as many as five public school sites. The Conceptual Land Use Plan shows the possible locations for five State of Hawai'i, Department of Education (DOE) school sites planned to be as accessible to the neighborhoods of Ho'opili as the community is developed; one high school, one middle school and three elementary schools. The plan can also accommodate private schools as the need is determined. In addition, area is set aside along the western end of Farrington Highway fronting the Project Area for either a fire station or a police substation. In total, approximately 100 acres are allocated to meet public facility needs.

Major Roads and the Honolulu High-Capacity Transit Corridor (HHCTC) Project
To provide for improved regional circulation and to define and serve the various neighborhoods of Ho'opili, the major boulevards planned within the community are illustrated. In addition, there will be a well planned network of local streets to provide connectivity and alternate routes throughout the community in a safe and pedestrian friendly manner. This land use category includes the portion of the property that will be utilized for 1) the widening of Farrington Highway fronting the Project Area, 2) a portion of North-South Road between Farrington Highway and Kapolei Parkway, 3) portions of the intersections of North-South Road with Farrington Highway and the H-1 Freeway, and 4) the segment of the East-West Connector through the Project Area. As previously mentioned, a significant portion of the project site will be taken for a segment of the HHCTC project, including a possible transit maintenance and storage facility.

Proposed land uses are shown in the Conceptual Land Use Plan (See Figure 6: Conceptual Land Use Plan) and generally described below. The approximate land use areas may be adjusted as the proposed Ho'opili Conceptual Land Use Plan is refined through the land use review and approval process, as well as when the HHCTC alignment is finalized within Ho'opili. During the EISPN public review period, the City and County of Honolulu, Department of Design and Construction recommended that "the developer meet with City officials from the Department of Planning and Permitting, Department of Design and Construction, and Department of Parks and Recreation (DPR) at an early stage in the development's planning process to develop a conceptual plan for overall development which is acceptable and appropriate." As such, D.R. Horton - Schuler Division will continue to coordinate with City and County of Honolulu agencies to develop a conceptual plan for overall development which is acceptable and appropriate.

Conceptual Land Use Plan – Land Use Summary for Project Area

LAND USE	APPROX. GROSS ACREAGE	APPROX. DEVELOPABLE NET ACRES	APPROX. NUMBER OF UNITS	GENERAL LAND USE DENSITY RANGE (DWELLINGS/UNITS PER ACRE)	PROPOSED ZONING DISTRICT****
PROJECT AREA					
Low-Medium Density Residential/Live-Work*	535	400-475	5,100	5-14	R-5/AMX-2
Mixed Use/Medium Density Residential*	340	250-300	5,200	15-29	AMX-3
Mixed Use/High Density Residential*	50	40	1,450	30-50	BMX-3
Business/Commercial	145	130	-	-	B1
Light Industrial/Business Mixed Use	50	40	-	-	IMX-1
Open Space/Buffers*,**	150	N/A	-	-	P-2
Parks*	60	N/A	-	-	P-2
Mini-"Neighborhood" Parks*	*	N/A	-	-	P-2
Public Facilities	100	N/A	-	-	AMX-3
Major Roads (as shown)**	124	N/A	-	-	Varies
TOTAL (approx.)	1,554***	-	11,750	-	-

* - Mini-"Neighborhood" parks and secondary roadways included in residential areas
** - May increase as developable areas decrease in residential and commercial categories
*** - Total acreage to be rezoned is approximately 1,555.145 acres
**** - Zoning designation may vary depending whether a Transit-Oriented Development overlay district is adopted

(iv)Open Space

Assuming an average of three residents per each of the proposed 11,750 households (estimated 35,250 future residents), and the Ewa DP's minimum requirement of two acres of park space per 1,000 residents, the proposed project, would require 70.5 acres of park space. The Ho'opili project is consistent with the Ewa DP's objectives and policies to protect and preserve open space. As many as 210 acres of parks and open space will be provided within the Project Area. An additional 30 acres will be maintained as open space and will be used for off-site drainage. Open space buffers are proposed to be located along the H-1 Freeway and Old Fort Weaver Road. In addition, linear parks and open space will encircle the Ho'opili project with walking/biking paths to create a separate but welcoming identity for the Ho'opili community.

(v) Circulation

Prior to rezoning, a Circulation Plan delineating the hierarchy of streets within the Ho'opili project and its relationship to the surrounding transportation network will be developed. Ho'opili is being designed to maximize connectivity within and to/from surrounding properties. To provide multiple routes for traveling through Ho'opili, a fine grid of closely-spaced blocks is envisioned over most of the site and where topography allows. Major planned and proposed regional connectors have been considered in the planning of the proposed project. These include: setting aside additional right-of-way for the City and County of Honolulu's widening of Farrington Highway; multiple connections to Farrington Highway; setting aside land for the proposed East-West Road; connection to the proposed North-South Road (under construction); and construction of a mauka-makai "North-South Bypass" road.

As shown on Figure 7: Proposed Circulation Plan, the Circulation Plan will also indicate:

- The currently proposed HHCTC alignment; existing and proposed bus routes; and specific measures, such as a "circulator shuttle" (local bus route connecting Ho'opili and UHWO) to accommodate efficient transit service for as many households as possible.
- Any principal pedestrian and bicycle paths that are physically separated from roadways. Within the proposed fine network of gridded streets, it is envisioned that most streets will include on-street parking and sidewalks and/or grade-separated multi-modal bike/pedestrian paths. This will allow experienced bicyclists to travel on most roadways and inexperienced bicyclists to stay off roads, except at intersections.

Not shown on Figure 7: Proposed Circulation Plan, but will be addressed in the Circulation Plan are:

- That street intersections along principal pedestrian and bicycle paths should have a narrow curb radius and include special signage and paving to encourage safe and convenient pedestrian and bicycle crossings; and
- A five-minute walking radius from proposed bus and transit routes (unless localized topographic conditions make such a requirement impractical).

(vi)Design Theme and Character

Ho'opili will be highly consistent with the goals and objectives of two primary recognized long-range development plans for the area, the City and County of Honolulu's directed growth policy for the area, the *Ewa Development Plan* and the *Kapolei Area Long Range Master Plan*, which was adopted by the City and County

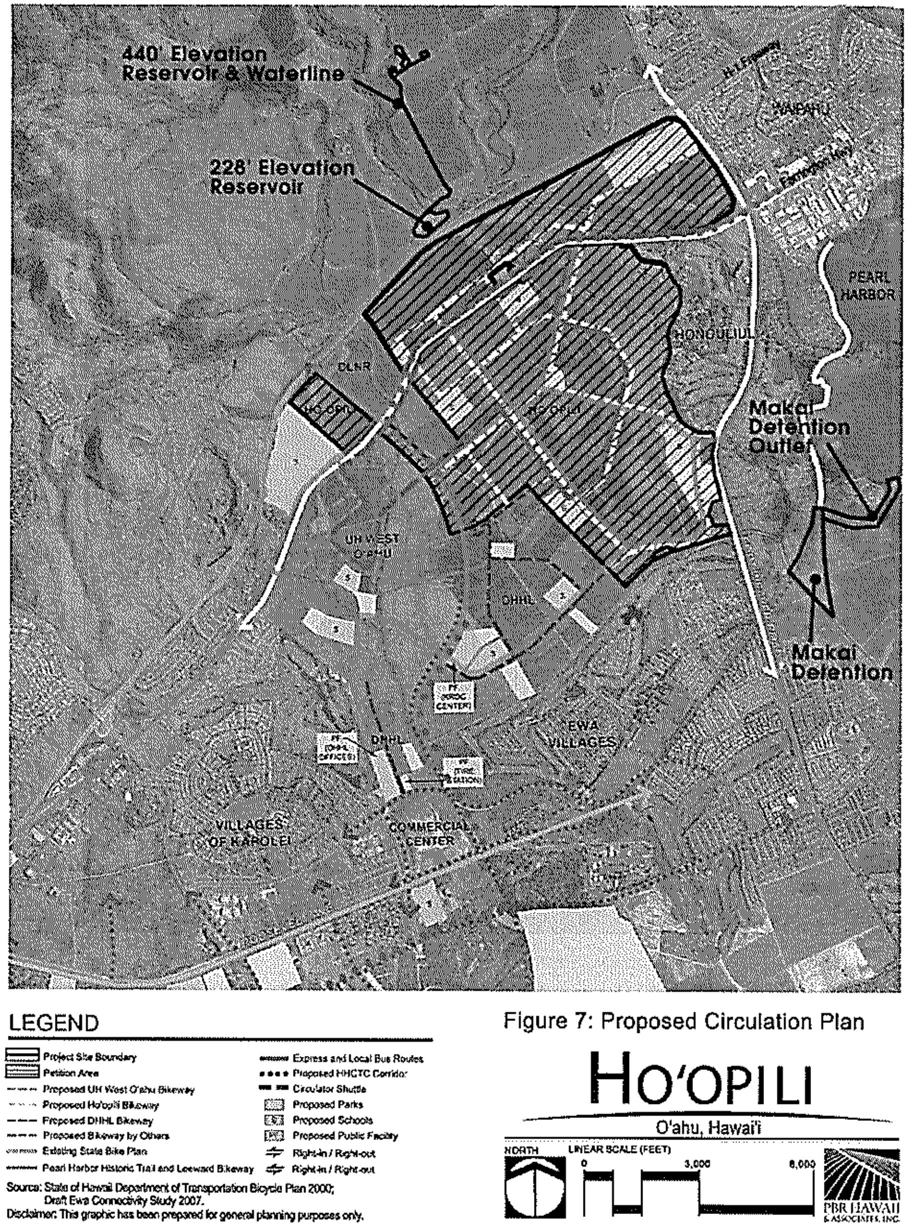


Figure 7: Proposed Circulation Plan

of Honolulu as part of Resolution 91-34. The Ewa DP states that growth in the area will include community building, not just project development, with communities designed to enhance lives, reduce automobile dependency, and be connected via a network of greenways ('Ewa will be built around a regional system of open space and greenways so that it has the feel of a network of communities "within a garden").

Ho'opili will adhere to the best intentions of the area's long-range master plans and the possibilities for a better 'Ewa with its proposed:

- concentrated mixed-use development pattern;
- embrace of "Traditional Neighborhood Design" and "Transit-Oriented Development" principles so that the entire project is walkable, connected and transit-ready; and
- earmarking of large areas for community gathering places, schools, parks and open space and a comprehensive bicycle/pedestrian network.

Ho'opili can play a key role in actualizing the community's vision for 'Ewa and enhancing the desirability of living on the 'Ewa Plain. Ho'opili, or "coming together," is part of the bridge where Honolulu's existing central corridor that reaches to Waipahu meets the urban core of the 'Ewa Plain, the City of Kapolei. It is where neighboring towns from Waipahu to Ko 'Olina and from Makakilo to 'Ewa Beach will be welcome and can gather.

Ho'opili will be connected to the surrounding 'Ewa District by a network of streets and bicycle paths which allow a variety of circulation options for residents and visitors. Wider tree-lined boulevards create a distinct axis running north-south and east-west across the site. Ho'opili is being designed to be transit-ready, and the land use plan, while subject to change, has been designed to accommodate a high-capacity transit corridor either along Farrington Highway or diagonally through the project site, with either one or two transit station locations. While the proposed residential unit count will not change, the land use plan will need to be adjusted depending on the final alignment of the high-capacity transit corridor, as the potential for noise impact from an elevated high-capacity transit alignment would likely require taller, higher density residential or industrial uses along the alignment. The final siting of the transit station location(s) will also provide transit-oriented development potentials, which will also cause the plan to be refined, as higher intensity development (and density) will probably be concentrated around the transit station(s). Also possible is a site for a transit maintenance and storage facility.

Residents should celebrate the benefits of this connected community for generations to come. Ho'opili will be a community that will:

- Be innovative, incorporating principles of "transit-oriented development" and "Traditional Neighborhood Design";

- Be highly liveable with a range of housing options – including affordable, workforce, and senior housing – plus parks, community facilities, schools, and a diversity of jobs and retail options;

- Be based on a healthy, walkable, live-work environment;

- Enhance living in 'Ewa: fewer vehicle trips to for commuting to work or school outside of the District, more time spent with families, less auto emissions, and greater community gathering opportunities; and

- Be sustainable, "green" requiring fewer car trips with its bicycle and pedestrian paths, and using renewable resources for energy consumption and recycling other resources, such as wastewater and solid waste.

Sustainability options are being considered for the Ho'opili project. Where feasible, project buildings, activities, and site grounds are intended to be designed with energy-saving considerations. Given the natural climate, the project may be suited for the use of renewable energy technologies including photovoltaics.

(vii) Telecommunications

Hawaiian Telcom, which provides telephone service to the area, owns and maintains a pole line along Farrington Highway, Old Fort Weaver Road and Kunia Road. This pole line is substandard; however, Oceanic Time Warner Cable and Pacific Lightnet have an agreement with Hawaiian Telcom for use of its poles and have attached cables to extend their facilities to Kapolei. AT&T has a fiber cable buried within the southern shoulder of the existing Farrington Highway right-of-way. In addition, the Federal government owns a buried joint tactical support cable within the Farrington Highway right-of-way.

Due to the substandard location of the existing telephone pole line along Farrington Highway; Hawaiian Telcom, Oceanic Time Warner Cable, and Pacific Lightnet will have to relocate their lines to new poles along Farrington Highway in the future. These telephone and communication lines will require easements within and the use of State and County road right-of-ways.

Appendix R

Arthropod Survey and Assessment

ARTHROPOD SURVEY AND ASSESSMENT

HO'OPILI PROJECT

'EWA DISTRICT, O'AHU, HAWAI'I

May 2008

Prepared for

PBR HAWAI'I &
D.R. HORTON - SCHULER DIVISION
Honolulu, Hawai'i

Pacific Analytics, L.L.C.
P.O. Box 1064
Corvallis, Oregon 97339
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INTRODUCTION

A survey of arthropods on the Ho'opili Project Site was conducted on May 09, 2008 by Dr. Gregory Brenner of Pacific Analytics, LLC. The primary objectives of the survey were to provide a general description of the arthropod fauna of the Ho'opili Project Site, evaluate the habitats, and search and assess the potential for threatened and endangered arthropod species as well as species of concern (DLNR 1997, Federal Register 1999, 2005).

GENERAL SITE DESCRIPTION

The approximately 1,550 acre (627 hectares) Ho'opili Project Site in the 'Ewa District on the Island of O'ahu includes three main parcels, Parcels A, B, and C, and seven smaller parcels, Parcels D1, D2, E1, E2, E3, F, and G (see Figure 1.5, DEIS page 4). The Ho'opili Project Site ranges in elevation from near sea level to about 430 ft (131 m). The Ho'opili Project Site was cultivated in sugarcane from the late 1800s to 1995, and currently contains cultivated fields for diversified agriculture, pasturage, and agricultural research, and some small gulches and cliffs. The edges of the fields and the small gulches and cliffs on the site are weedy areas dominated by alien plant species (LeGrande 2006).

There are neither unique floral habitats nor unique avian and mammalian faunal habitats on the Ho'opili Project Site and a survey for botanical, avian, and mammalian resources found no threatened endangered, or species endemic to Hawai'i at the site (LeGrande 2006, David 2008).

SURVEY METHODS

Prior to the site visit a search of literature pertaining to arthropods found in the 'Ewa District was conducted. Maps and aerial photographs of the Ho'opili Project Site were examined to familiarize the principal investigator with the general area and locate potential arthropod habitats. After examining the maps and aerial photographs it was determined that special attention should be given to the gulch and the cliff areas where the botanical survey identified scrub vegetation with native plant elements (LeGrande 2006). These areas were determined to have the best potential as native arthropod habitats.

The areas selected as requiring special attention include Honouliuli Gulch running through Parcel B, two flumes that run east-west through Parcel C, and the cliffs along the eastern boundary of Parcel C.

The arthropod survey was conducted on May 9, 2008. Roads were driven on the Ho'opili Project Site to locate potential arthropod habitats previously identified from maps and aerial photographs. A Staged Random-Walk survey method was used in these areas. Vegetation was sampled on foot along roads and between cultivated fields where arthropods would likely be found using the following methods.

Aerial Netting - Flying insects were captured in aerial nets and placed into vials for immediate identification in the field. Species present were recorded in a field notebook with annotations about relative abundance and other ecological information. Specimens were released after identification.

Sweep Netting - Grasses, small shrubs and other low-lying vegetation was sampled with a sweep net. An insect net was brushed along the top of the vegetation or grass to capture insects. Specimens were released after identification.

Foliage Beating -Foliage was sampled using a beating sheet. An insect net was placed under a branch and the stem was struck with a short stick. Arthropods on the foliage were dislodged and fell onto the sheet where they were collected with an aspirator into vials for identification. Specimens were released after identification.

Visual Inspection – Plants were visually inspected for arthropods that were not collected by other methods. Time was also spent observing larger flying insects that could be identified on the wing. The Honouliuli Gulch was also visually inspected for aquatic insects after water began flowing, apparently released from the state flood control detention pond upstream of the site.

Sampling Transects – The length of sampling transects varied with location. Staged Random-Walk sampling transects were used to survey each area. Sampling transects were selected at random to represent at least twenty percent of the vegetation on each Parcel. Sampling intensity was increased to at least fifty percent in those areas identified from maps and aerial photographs as requiring special attention.

DESCRIPTION OF THE ARTHROPOD FAUNA

Twenty-seven species of insects representing eight orders and at eighteen families were observed at the site. In additional three species of spiders were also recognized.

The entire site is disturbed by agriculture and related activities, and the vegetation is composed of non-indigenous, weedy species. This is reflective of the overall arthropod community which is almost entirely non-indigenous. Only one indigenous species, *Pantala flavescens*, a common dragonfly, was observed. No endemic native Hawaiian arthropods were detected.

Plants that were in bloom attracted pollen and nectar feeders, especially bees and butterflies. Other insects were found feeding on plant juices, under leaves and on stems. Ants were the most abundant insect on the ground.

There have been no previous arthropod surveys at the Ho'opili Project Site and a search of literature revealed only one reference of an arthropod study in the Barbers Point vicinity. The nearest and most complete comparative survey was one conducted in 2006 by the principal investigator for the proposed development of the Kapolei Harborside Center (Pacific Analytics 2006). In that study one hundred and ninety-five species of insects representing sixteen orders and at least seventy-five families were collected with an additional nineteen species of spiders, three species of other arthropods, and five species of fossilized snail.

More than ninety percent of the species collected in the Kapolei Harborside Center Project Site survey were non-indigenous. Many are cosmopolitan, weedy species found throughout the Pacific and the World. The few indigenous and endemic species observed at the Project Site are common and no rare, endangered, threatened, or species of concern were detected. The large proportion of non-indigenous species was an indication of the amount of habitat degradation that resulted from the various agricultural and mining operations that have occurred at the site.

Similar degradation has occurred at the Ho'opili Project Site as a result of the more than one hundred years of agricultural use. The vegetation at the Ho'opili Project Site is similar to but less diverse than that at Kapolei Harborside Center Project Site. In my judgment, the arthropod fauna at the Ho'opili Project Site is not substantially different from that found at the Kapolei Harborside Center Project Site and it is unlikely that an intensive inventory of the site would yield significantly different findings from the 2006 study.

Despite particular attention to gulches, flumes, and water detention areas, no native Hawaiian damselflies of other endemic aquatic arthropod species were detected. Given the intermittent nature of the water flow in these some of these areas it is unlikely that aquatic species would persist there. Only one species of native Hawaiian damselfly is historically known from this area, *Megalagrion xanthomeles*, and that species is nearly extirpated from Oahu, known recently from only one locality above Honolulu (BPBM 2008).

SUMMARY OF THE ARTHROPOD FAUNA

The arthropods species that were collected during this study would be considered typical of what would be found in lowland sites with little or no native vegetation and disturbed by agricultural operations. No species were found that are locally unique to the site. Nor were any species found whose habitat would be threatened by the proposed development at the site.

The results of this arthropod survey at the Ho'opili Project Site indicate there are no special concerns or legal constraints related to invertebrate resources in the project area. Although several species of Hawaiian endemic arthropods may occur on the 'Ewa plain, these species are not likely to be abundant in the highly disturbed agriculture lands that comprise the Ho'opili site. No invertebrate species listed as endangered, threatened, or that are currently proposed for listing under either federal or State of Hawai'i endangered species statutes are known to exist at the Project Site (DLNR 1997, Federal Register 1999, 2005).

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