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Office of the Director

March 8, 1994

Dr. Bruce Anderson, Acting Director
Office of Environmental Quality Control
220 South King Street, 4th Floor
Honolulu, HI 96813

Dear Dr. Anderson:

Subject: Negative Declaration for Advanced Electro-Optical System (AEOS) Telescope and Related Improvements at the Maui Space Surveillance Site (MSSS), Haleakala, Maui, Hawaii

The public review period for the Draft Environmental Assessment/Negative Declaration for the above-referenced project ended on February 7, 1994. The Institute for Astronomy has reviewed and responded to all the comments that were received. Upon completion of our review, we have determined that this project will not have a significant environmental effect and have issued a negative declaration. A copy of the determination is attached (Attachment 1).

We have enclosed a completed OEQC Bulletin Publication Form for the Negative Declaration and four (4) copies of the Final Environmental Assessment. The Final Environmental Assessment contains copies of the comment letters and our responses to them.

It is our understanding that the announcement of the determination will be published in the April 8, 1994 edition of the OEQC *Bulletin*. Please contact Mr. Wayne Lu at 1-878-1215 if you have any questions.

Sincerely,

L. Cowie for D. N. B. Hall

Donald N. B. Hall
Director

attachments:
(1) Negative Declaration
(2) OEQC Bulletin Publication Form
(3) Final Environmental assessment (4 copies)

cc: Charles Fein, Rockwell Power Systems
Perry White, Belt Collins Hawaii Ltd.
Wayne Lu, Institute for Astronomy-Maui

1994-03-23-MA-FEA-Haleakala Advanced Electro-Optical System Telescope

MAR 23 1994

FINAL

ENVIRONMENTAL ASSESSMENT/ NEGATIVE DECLARATION

ADVANCED ELECTRO-OPTICAL SYSTEM (AEOS) TELESCOPE AND RELATED IMPROVEMENTS AT THE MAUI SPACE SURVEILLANCE SITE (MSSS) HALEAKALA, MAUI, HAWAII

Proposed by:
University of Hawaii
Institute for Astronomy

Prepared on behalf of:
U. S. Air Force Space Systems Command

Prepared by:
Belt Collins Hawaii
Honolulu, Hawaii

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FINAL
ENVIRONMENTAL ASSESSMENT/
NEGATIVE DECLARATION

PROJECT:	ADVANCED ELECTRO-OPTICAL SYSTEM (AEOS) TELESCOPE AND RELATED IMPROVEMENTS AT THE MAUI SPACE SURVEILLANCE SITE (MSSS) HALEAKALA, MAUI, HAWAII
LOCATION:	Maui Space Surveillance Site (MSSS), Haleakala Island of Maui State of Hawaii
PROPOSING AGENCY:	University of Hawaii Institute for Astronomy
DETERMINATION:	The University of Hawaii has determined that the project would have no significant adverse effects on the environment and that no environmental impact statement is required.
CONTACTS:	Dr. Donald N. B. Hall University of Hawaii Institute for Astronomy 2680 Woodlawn Drive Honolulu, Hawaii 96822 Telephone: 808-948-8566 SMC/CEV 2420 Vela Way, Suite 1467 Los Angeles AFB, CA 90245-4659 310-363-1524

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CHAPTER 1

SUMMARY

1.1 PURPOSE OF THIS DOCUMENT

The U.S. Air Force has asked the University of Hawaii Institute for Astronomy (IfA) for permission to expand the area it leases in the IfA's Haleakala Observatories on the summit of Haleakala Volcano, Maui, Hawaii. The Air Force plans to expand its existing Maui Space Surveillance Site (MSSS) to accommodate the proposed Advanced Electro-Optical System (AEOS) telescope and related facilities. Because the Haleakala Observatories is located within the State Conservation District, the University of Hawaii Institute for Astronomy will file a Conservation District Use Application (CDUA) on behalf of the U.S. Air Force and its agent, the U.S. Army Corps of Engineers with the Board of Land and Natural Resources. *This Environmental Assessment was prepared to fulfill the* requirements of Chapter 343 Hawaii Revised Statutes, the State EIS Rules (Chapter 200, Title 11, 11-200-5), the National Environmental Policy Act (NEPA), and 15 CFR Part 15.

1.2 PROPOSED ACTION

The proposed action includes expansion of the area the Air Force leases from IfA and construction of AEOS. The proposed increase in leased land area is 1.74 acres. AEOS is designed to accommodate a telescope with a primary mirror about 8 meters (27 feet) in diameter, but a smaller, 3.67-meter (12-foot) telescope will be installed initially. The telescope will be capable of exceptional resolution. The facility will include laser and optics laboratories, offices, and other support spaces and will be fully integrated with the existing MSSS facilities. An innovative system will make ice during periods that the telescopes are not in use. The ice will be used to chill the facilities during viewing hours, eliminating the heat releases associated with traditional cooling systems and improving the viewing conditions for all the telescopes at the MSSS. A mirror coating facility will enable on-site resurfacing of all mirrors used at MSSS. Renovations and upgrades to the existing facilities are planned as well.

1.3 BENEFITS OF THE PROPOSED ACTION

The following are among the important benefits of the proposed project:

- The larger telescope would have much greater light-gathering ability than any existing MSSS telescope, significantly enhancing the MSSS's capabilities for space surveillance and scientific research. AEOS would improve resolution and infrared sensitivity greatly. These improvements would permit more extensive work on exoatmospheric (i.e., outside the atmosphere), and atmospheric objects and characteristics.

- AEOS would use active image-compensating technology developed over the past decade; this new imaging technology would further improve resolution and would permit measurements not currently possible.

- The configuration of AEOS would greatly increase the size, number, and sophistication of the experimental instruments that can be used; it would also simplify maintenance and provide much higher utilization rates.

- The ice making capability of the mechanical plant, smaller paved area, and other thermal control features, would reduce thermal pollution and atmospheric turbulence, and thus improve the quality of astronomical observations at MSSS.

- The active image-compensating technology incorporated in AEOS is not readily *available elsewhere for astronomical research and cannot be used on Mauna Kea,* where lasers might interfere with astronomical measurements. Its availability on Haleakala would benefit the University of Hawaii Institute for Astronomy and other users who could take advantage of the new technology for astronomical purposes.

- AEOS would increase opportunities for shared use by making it easier to switch between different users, thereby reducing experimental setup time and allowing more viewing time for more users.

1.4 POTENTIAL IMPACTS

The proposed project would include grading, excavation, and other construction activity on the summit of Haleakala. Once AEOS is operational, the activities at MSSS would be similar to those that presently occur. The potential effects of the proposed project are summarized below.

- Vehicular traffic on Haleakala Crater Road would increase by about five percent during the construction period, but the level of service would remain at "A" (the highest possible level). The movement of large trucks would be scheduled at off-peak hours, and truck drivers would be informed of the need to provide other motorists with passing opportunities to avoid undue delays to others. Because there would be no increase in personnel at the summit, no operational traffic impacts are expected.

- Construction activity would temporarily increase the amount of dust in the atmosphere at the summit and in the vicinity of the concrete batch plant. Mitigation measures, such as limiting the area being worked, will minimize the amount of particulate generated.

- Once the mechanical plant becomes operational and upgrades to the existing facilities are completed, thermal releases from MSSS during viewing hours would be lower than they are at present. This would improve the quality of "seeing" from MSSS as well as from surrounding areas that the University of Hawaii may wish to use for observational purposes in the future.

- Noise levels would increase during construction. Visitors at the Pu'u Ula'ula (Red Hill) Overlook in Haleakala National Park are likely to be able to hear construction activities at the summit, as well as large vehicles moving to and from the site. Noise levels at the Overlook would remain in the "clearly acceptable" or "normally acceptable" ranges as defined by the U.S. Environmental Protection Agency. Noise levels in all areas would return to their present levels once the facility becomes operational.

- The proposed facilities have been sited to avoid known archaeological resources. The sites closest to the construction activities will be fenced off and flagged prior to construction.

- *Previous analyses indicate that the proposed project would* not have a significant adverse effect on the endangered Hawaiian dark-rumped petrel which has burrows near, but off, the site. Measurements conducted during January 1993 confirm this. Nevertheless, burrows will be monitored by National Park Service personnel during construction.

- The two ahinahina plants currently located at the MSSS will be transplanted prior to construction. Because these plants have already been transplanted successfully, another transplanting should not adversely affect them.

- Construction would require the movement of construction equipment and materials from lowland areas to the summit of Haleakala. This represents an opportunity for alien species of plants and animals to be introduced into the native ecosystem. As part of a major program designed to prevent this, the Air Force would limit the importation of fill from areas outside the summit and would require inspection and thorough cleaning of all construction equipment before its entry into the National Park.

- The proposed facility, approximately 120 feet above grade, would be the largest structure on the upper portions of Haleakala. However, it would be generally consistent with the existing structures, and it would not greatly alter the general appearance of the complex as seen from a distance. The proposed facilities would be clearly visible from the Pakaoao Visitor Center and Red Hill Overlook, where the height and mass of the proposed telescope dome enclosure would make it a strong visual element under certain conditions. The visual impact of the telescope dome would be mitigated by its reflective surface. This type of surface tends to take on the color of the sky, and does not stand out strongly. In addition, its proximity to the existing observatory structures that are readily recognizable as telescope housings would indicate the scientific purpose of the entire complex.

- Operation of the project would not adversely affect water quality, or generate significant amounts of solid waste. Solid waste generated during construction would be frequently removed from the site and disposed at an approved landfill.

- The additional power used by the proposed facilities would amount to less than approximately 0.002% of the total power usage on Maui; adequate electrical generation and transmission facilities are available to provide this.

- Under certain conditions (e.g., when the lasers are operated at full power), some of the types of lasers that would be used at AEOS are capable of causing eye damage if the source is viewed directly. Consequently, numerous procedural, electro-mechanical, and software controls will be incorporated in the AEOS control system design to prevent this possibility. The absence of significant adverse biological effects as a result of past laser operations at the existing MSSS facilities indicates that the proposed project would not have a significant adverse effect on the area's biota.

1.5 CHAPTER 343 DETERMINATION

Title 11, Chapter 200, Section 11-200-11 (the Department of Health's Environmental Impact Statement Rules) requires the responsible agency to use the environmental assessment to determine if the potential impacts of a proposed action are significant enough to require preparation of an environmental impact statement. Section 11-200-12 establishes 11 criteria to be used in determining whether an action will have a significant impact on the environment. The Institute for Astronomy evaluated the potential primary, secondary, and cumulative impacts of the proposed AEOS project in light of these significance criteria. It also provided a preliminary version of the Draft Environmental Assessment to the following individuals for review:

- Mr. Keith Ahue — Department of Land and Natural Resources
- Mr. Abe Aiona — Office of Hawaiian Affairs
- Mr. Keoni Fairbanks — Upcountry CAC
- Mr. Goro Hokama — Maui County Council
- Mr. Brian Miskae — Maui County Planning Director
- Mr. Alan Tokunaga — Department of Land and Natural Resources - Maui
- Mr. Mark White — The Nature Conservancy

Their comments and suggestions were incorporated into the Draft Environmental Assessment/Proposed Negative Declaration that was published in December 1993.

An announcement of the availability of the Draft Environmental Assessment/Proposed Negative Declaration was published in the January 8, 1994 edition of the *OEQC Bulletin*. Atlhough the deadline for comments on the proposed negative declaration was February 7, 1994, the IfA accepted and responded to all comments received through the end of February. The comments letters, and the IfA's responses to them, are reproduced in Chapter 8 of this report. Minor revisions were made to the text of the environmental assessment to reflect the additional information and/or corrections that commentors had requested.

After reviewing the additional material, the IfA once again evaluated the proposed action using the significance criteria contained in the Environmental Impact Statement Rules. Based upon that review, it has determined that the proposed action would not have any significant adverse effects and has filed a Negative Declaration for the project.

The significance criteria, and AEOS' relationship to them are presented below. These form the basis for the negative declaration.

(1) *Involves an irrevocable commitment to loss or destruction of any natural or cultural resource.*

AEOS would be constructed adjacent to existing structures in an already developed portion of Haleakala Observatories on the summit of Haleakala. Consequently, its construction and operation would have minimal impact on natural areas. AEOS would, however, be visible from locations within Haleakala National Park, including from two lookouts. The AEOS dome enclosure would be coated with reflective material to mitigate any potentially adverse visual impacts. Archaeological resources and native fauna that are present on and near the project site will be avoided. The observatory location provides good viewing conditions without compromising the usefulness of other portions of the summit for astronomical or other purposes. In addition, installation of the mechanical plant and reduced heat generation during viewing hours would improve atmospheric stability, thereby enhancing this aspect of the natural environment.

(2) *Curtails the range of beneficial uses of the environment.*

The construction and operation of AEOS would not have a significant adverse effect on other beneficial uses of the environment. It is within an area that has been designated for research use, has been integrated with the Institute for Astronomy's overall master planning effort for the summit, and would not interfere with existing activities in the area. Further, its location within the Haleakala Observatories science reserve would minimize any impact that it might have on the public's enjoyment of Haleakala National Park [see (1) above].

(3) *Conflicts with the state's long-term environmental policies or goals and guidelines as expressed in Chapter 344, Hawaii Revised Statutes, and any revisions thereof and amendments thereto, court decisions, or executive orders.*

The information presented in the Environmental Assessment indicates that the proposed action is consistent with the State's long-term environmental policies and goals. AEOS would emit virtually no air or water pollutants and would be an economically and socially valuable, non-consumptive use of the land.

(4) *Substantially affects the economic or social welfare of the community or state.*

Construction and operation of the proposed AEOS project would help insure the continuation of the employment and economic activity associated with astronomical activities on Haleakala. It would provide continued technical and professional employment at MSSS that would support a stable community.

(5) *Substantially affects public health.*

The proposed action would not have a measurable effect on public health. All measures needed to insure compliance with existing health standards have been incorporated in the project.

(6) *Has substantial secondary effects.*

The proposed action would not generate substantial secondary effects, such as population growth or the need to construct additional public facilities or infrastructure. AEOS would provide continuing employment of individuals already involved in the research sector of the economy.

(7) *Substantially degrades environmental quality.*

AEOS complies with all existing environmental standards. It does not involve substantial emissions or other activities with the potential to degrade environmental quality. Where minor potential risks do exist, as in the on-site storage of fuel needed for the emergency generator, design features minimize the potential for adverse effect.

(8) *Is individually limited but cumulatively has considerable effect upon the environment or involves a commitment for larger actions.*

The lease of additional land to the Air Force for the proposed AEOS project does not commit the IfA to other, larger actions. Nor does AEOS represent an Air Force commitment to additional projects. Thus, the proposed action would not contribute substantially to effects which are cumulatively significant.

(9) *Substantially affects a rare, threatened, or endangered species, or its habitat.*

Potential effects on the two endangered species present in the vicinity of the proposed project (the Hawaiian dark-rumped petrel ('ua'u) and the silversword (ahinahina) have been thoroughly investigated. Measures, such as relocating the ahinahina and scheduling certain construction activities (e.g., use of vibratory rollers) for periods when 'ua'u are not nesting, have been incorporated in the plans to avoid adverse effects on these natural resources.

(10) *Detrimentally affects air or water quality or ambient noise levels.*

The AEOS project would not have substantial adverse effects on air or water quality. Neither would its operation increase noise levels in surrounding areas. The noisiest construction activities would be audible from nearby portions of Haleakala National Park, but would be temporary and not interfere substantially with the public's enjoyment of these areas.

(11) *Affects an environmentally sensitive area such as a flood plain, tsunami zone, erosion-prone area, geologically hazardous land, estuary, fresh water, or coastal waters.*

The AEOS project would not affect any of these environmentally sensitive areas.

CHAPTER 2

BACKGROUND, PURPOSE, AND NEED FOR AEOS

2.1 INTRODUCTION

This chapter describes the purpose and mission of the Maui Space Surveillance Site (MSSS), the facilities presently located at it, and the operations that are currently conducted there. It also explains why the Advanced Electro-Optical System (AEOS) telescope is needed if MSSS is to continue to accomplish the Air Force's mission and to support the Institute for Astronomy's (IfA's) research activities.

2.1.1 LOCATION

The U.S. Air Force proposes to construct and operate the AEOS telescope and related facilities at the Maui Space Surveillance Site. MSSS is located within the University of Hawaii Institute for Astronomy's (IfA) "Haleakala Observatories" complex[1] on the summit of Haleakala Volcano, Maui, Hawaii (TMK No. 2-2-07:08 por.). The MSSS site will be increased by approximately 1.74 acres to a total of 4.4 acres to accommodate the additional facilities. The new AEOS telescope would be fully integrated with the existing facilities at the MSSS.

MSSS is 60 kilometers (39 miles) by road southeast of Kahului Airport and is accessible over a primary two-lane all-weather road (see Figure 2.1). Figures 2.2 and 2.3 show existing facilities on and around the Haleakala Observatories science reserve. Figure 2.4 depicts the additional land that will need to be leased from the University of Hawaii to accommodate the new facilities.

2.1.2 HISTORICAL DEVELOPMENT OF THE MSSS

The existing facilities at MSSS have been developed over a 30-year period. The University of Michigan's Willow Run Laboratory was one of the first institutions to recognize the potential importance of satellites to national defense. In the early 1960s it proposed the establishment of a high-altitude facility that could be used to test infrared devices and to observe satellites. Haleakala's proximity to the trajectory followed by missiles fired from Vandenberg Air Force Base in California towards the impact area near Kwajalein Atoll, as well as the presence of the University of Hawaii's pre-existing infrastructure on its summit, made Haleakala an ideal location for such a high-altitude research facility. The University of Michigan, under contract to the Advanced Research Projects Agency, obtained a lease agreement for a portion of the University of Hawaii Haleakala Observatories site for the observatory (U.S. Air Force 1991). The U.S. Army Corps of Engineers began work on the MSSS in 1963, and the

[1] Executive Order 1987 assigned responsibility for the management of Haleakala Observatories site to the University of Hawaii Institute for Astronomy (IfA). The "Haleakala Observatories" complex was formerly known as "Science City," and previous environmental reports refer to it by that name.

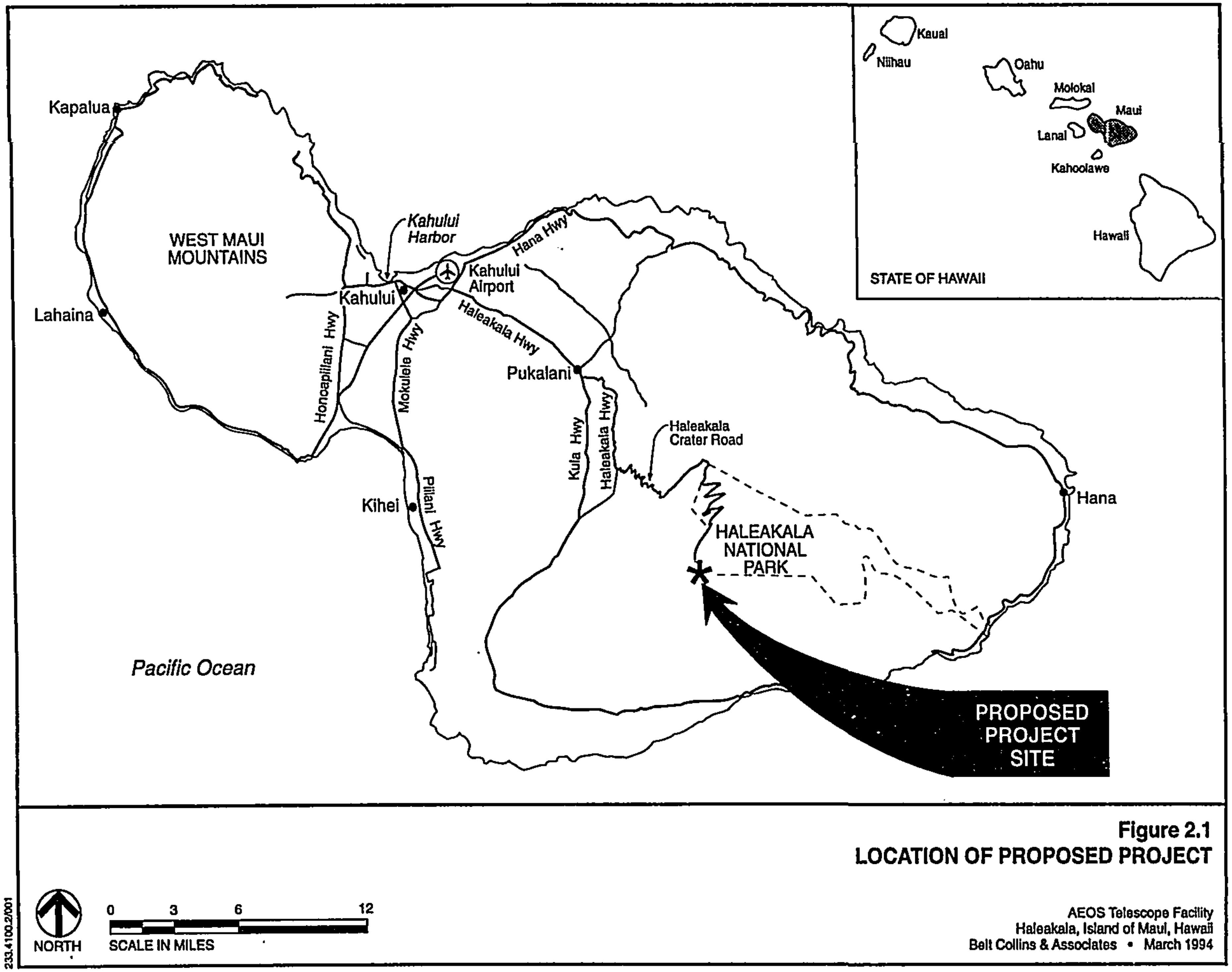
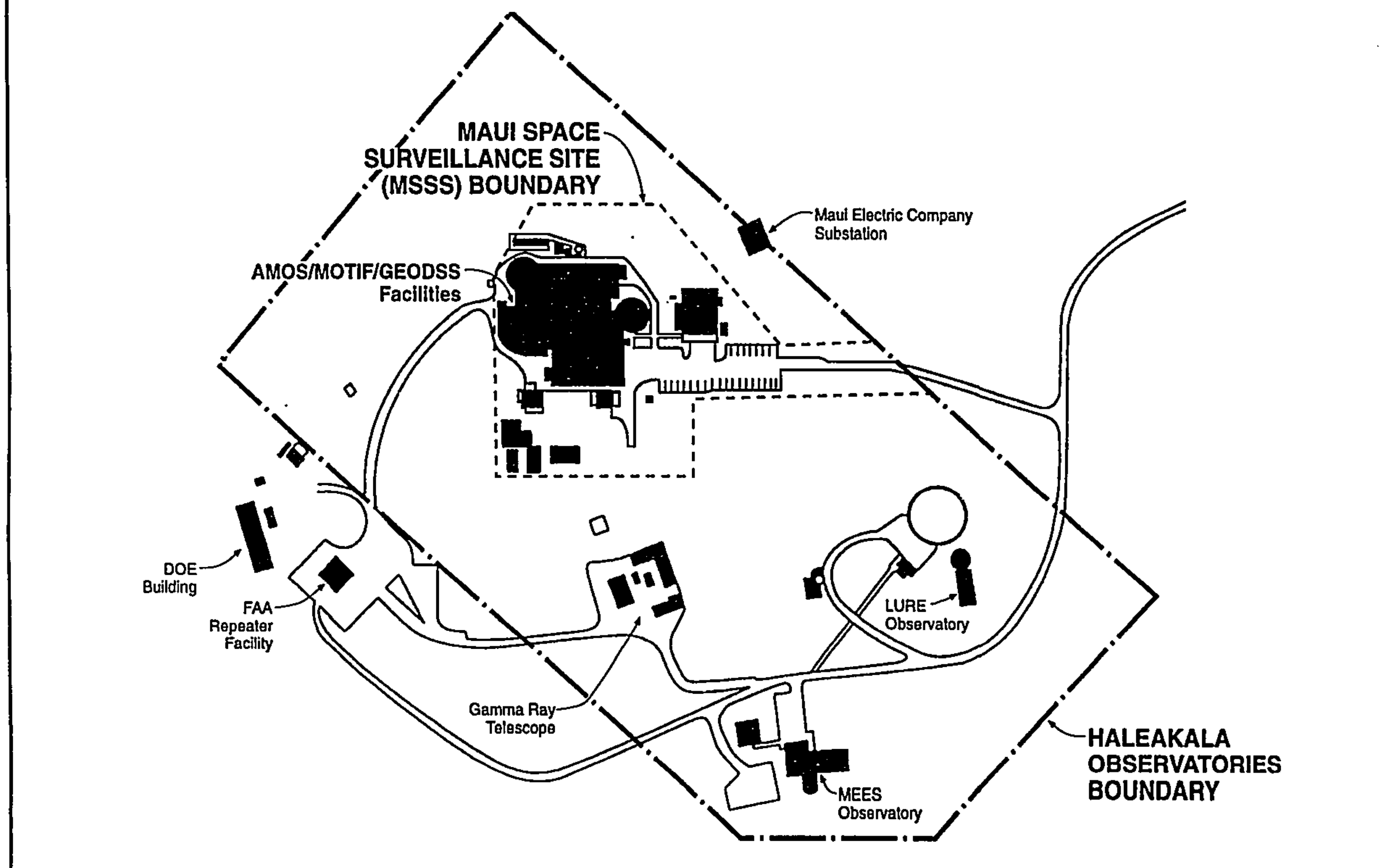


Figure 2.1
LOCATION OF PROPOSED PROJECT

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
Belt Collins & Associates • March 1994

233.4100.2/001

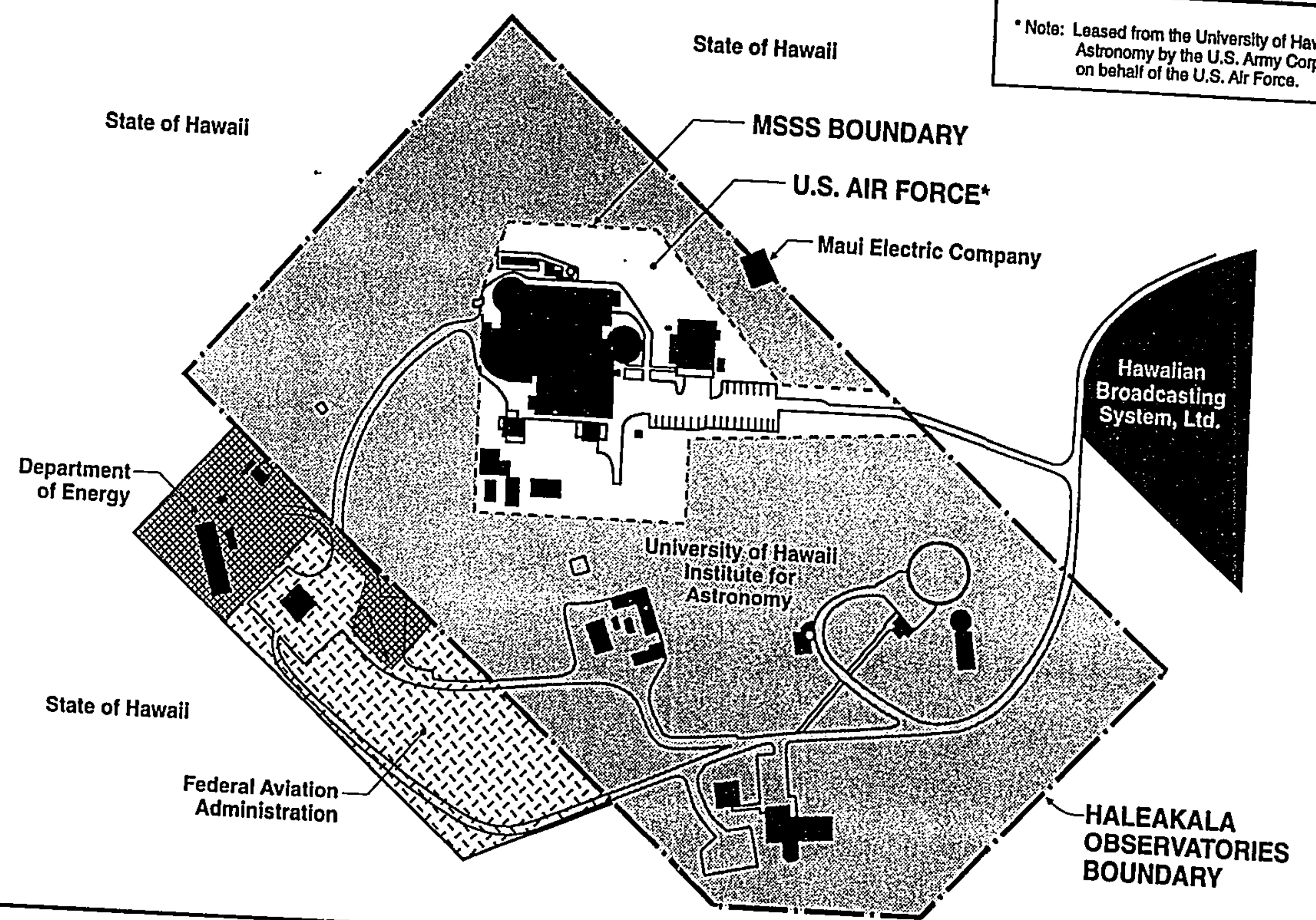


Source: ***Environmental Impact Analysis Process,*** Programmatic Environmental Assessment Maui Space Surveillance Site, U.S. Air Force, May 1991

Figure 2.2
EXISTING MAUI SPACE SURVEILLANCE SITE (MSSS) AND HALEAKALA OBSERVATORIES FACILITIES

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
Belt Collins & Associates • March 1994

233.4100.2/002



* Note: Leased from the University of Hawaii Institute for Astronomy by the U.S. Army Corps of Engineers on behalf of the U.S. Air Force.

Source: *Environmental Impact Analysis Process*, Programmatic Environmental Assessment Maui Space Surveillance Site U.S. Air Force, May 1991

233.4100.2/003

Figure 2.3
HALEAKALA OBSERVATORIES BOUNDARY AND LAND MANAGEMENT

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
Belt Collins & Associates • March 1994

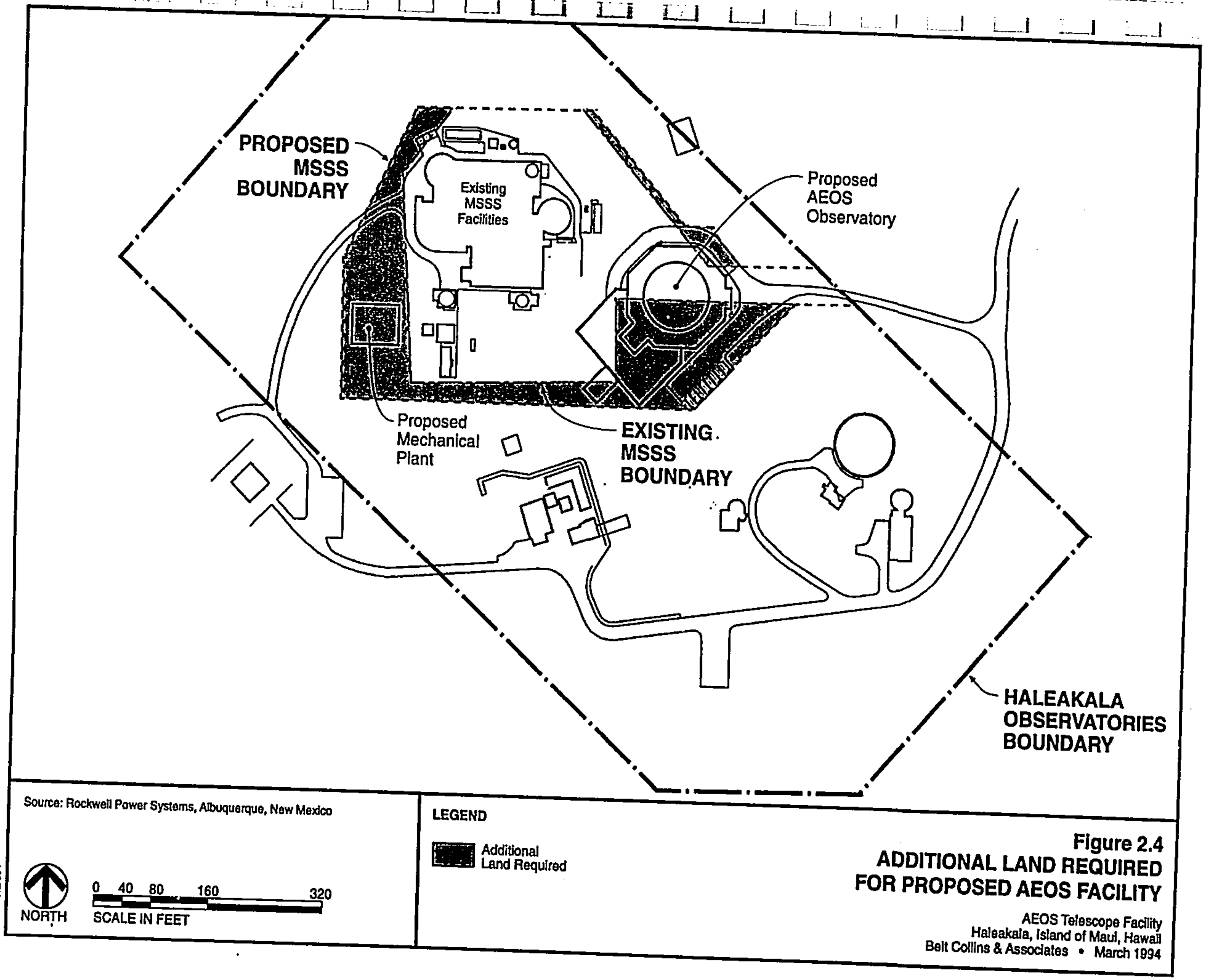


Figure 2.4
ADDITIONAL LAND REQUIRED FOR PROPOSED AEOS FACILITY

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
Belt Collins & Associates • March 1994

first facilities became operational in 1967. The MSSS has been in continuous operation since that date. Significant additions were made in 1972, 1980, and 1986-1987.

2.1.3 MSSS PURPOSE AND MISSION

MSSS's primary mission is to conduct space surveillance activities for the U.S. Department of Defense (DoD); limited amounts of non-DoD research are carried out as well. Currently, the facility contains 1.2- and 1.6-meter tracking telescopes, visible and infrared sensors, and lasers and laser-projectors. These are used to collect data from sub-orbital, near-earth, and deep-space objects. These objects include satellites and missiles launched from Vandenberg Air Force Base and the Pacific Missile Range Facility on Kauai. While the MSSS facilities have only been used infrequently for civilian research in the past, they have the capability to support astronomical, atmospheric, and other non-DoD research.

2.1.4 MSSS MANAGEMENT STRUCTURE

The IfA is responsible for the development of astronomical facilities on both Haleakala and Mauna Kea, Hawaii's two premier astronomical research sites. The Institute for Astronomy also participates in research and teaching activities at the University of Hawaii Manoa campus and at the observatories.

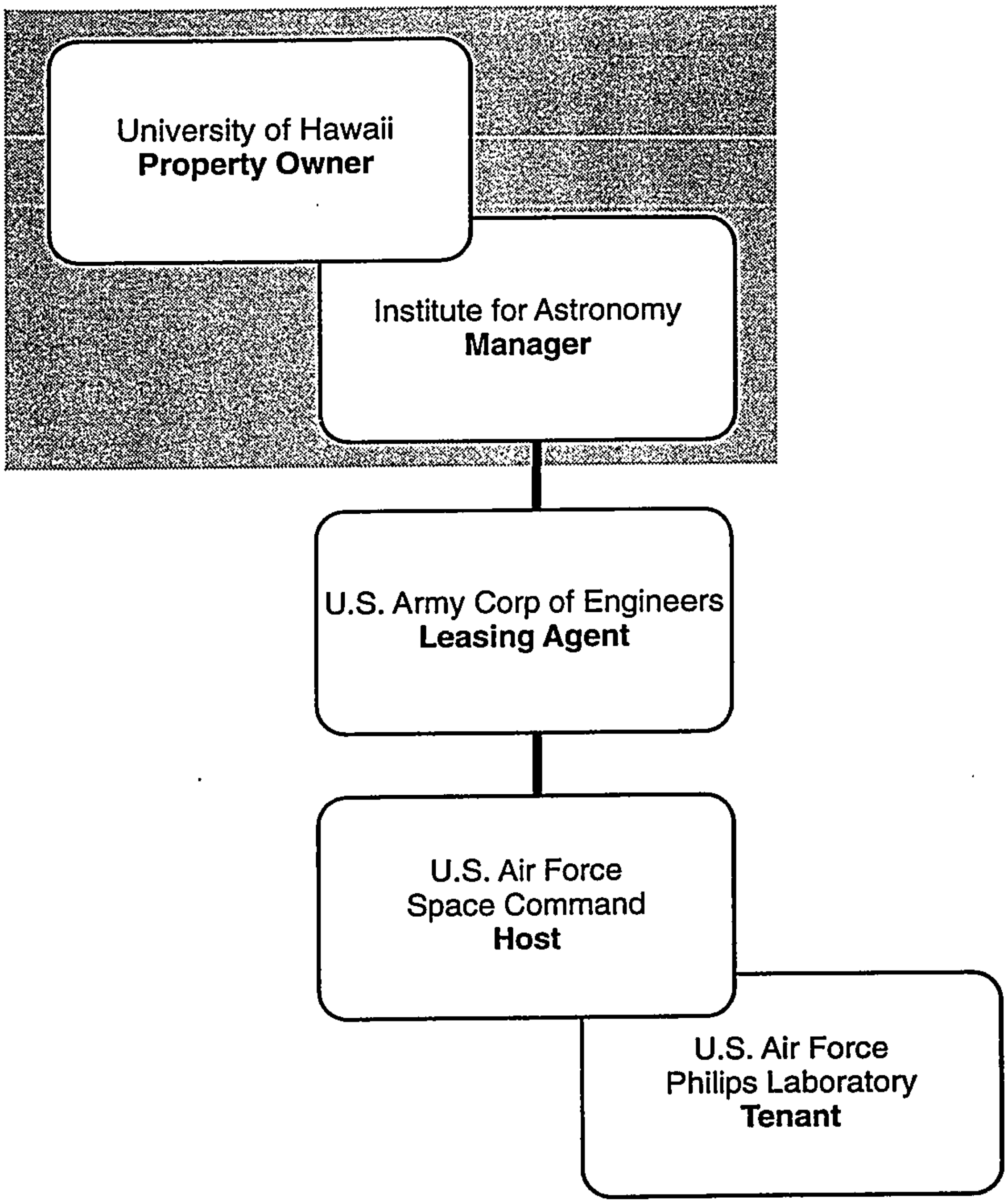
The U.S. Army Corps of Engineers leases the parcel on which the MSSS located from the IfA, on behalf of the Air Force Space Command and Phillips Laboratory. Air Force Space Command, located at Peterson Air Force Base in Colorado Springs, is the host command. Phillips Laboratory, the tenant, is an Air Force research laboratory based at Kirtland Air Force Base in New Mexico. The proposed AEOS telescope facility will be constructed and owned by the U.S. Air Force Phillips Laboratory. It is anticipated that it will be operated initially by Rockwell Power Systems Co., under contract to Phillips Laboratory. Figures 2.5 and 2.6 show the ownership and management structures for MSSS and its component facilities.

2.2 <u>OVERVIEW OF EXISTING MSSS FACILITIES</u>

2.2.1 EXISTING FACILITIES

The main building at MSSS houses three separate operations (Figure 2.7). These are described below

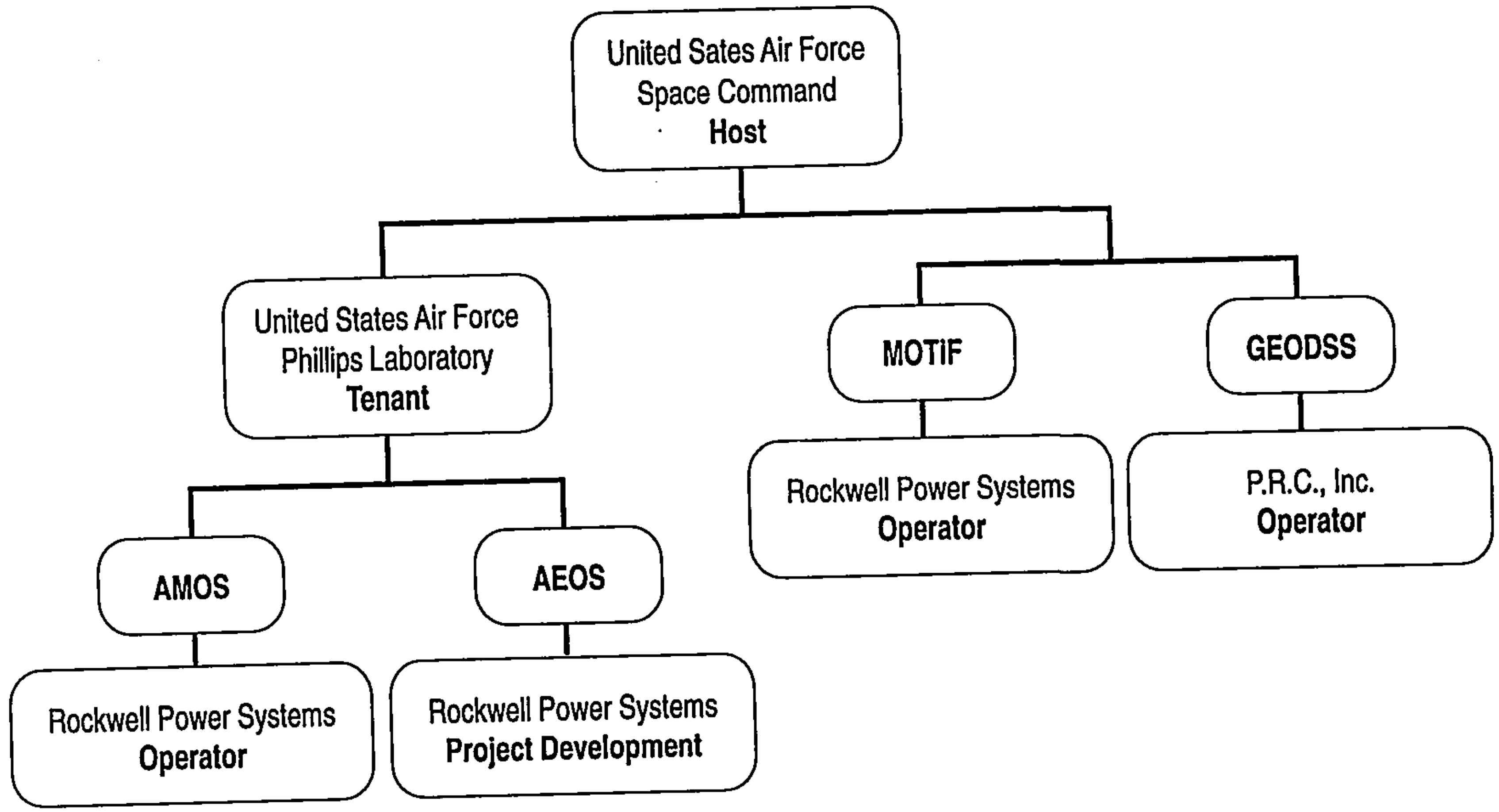
- <u>Ground-Based Electro-Optical Deep Space Surveillance System</u> (GEODSS) uses passive techniques to search for, track, and collect data from space objects out to, and beyond, geosynchronous orbital distance (35,000 kilometers, or 22,000 miles). It is a U.S. Air Force Space Command resource that is currently operated by PRC, Inc.



Source: ***4 Meter Telescope Facility***
"Conceptual Design" Phase Design Program, March 20, 1992
Holmes Sabatini Associates / GYA

Figure 2.5
OWNERSHIP AND MANAGEMENT OF MSSS

AEOS Telescope Facility.
Haleakala, Island of Maui, Hawaii
Belt Collins & Associates • March 1994

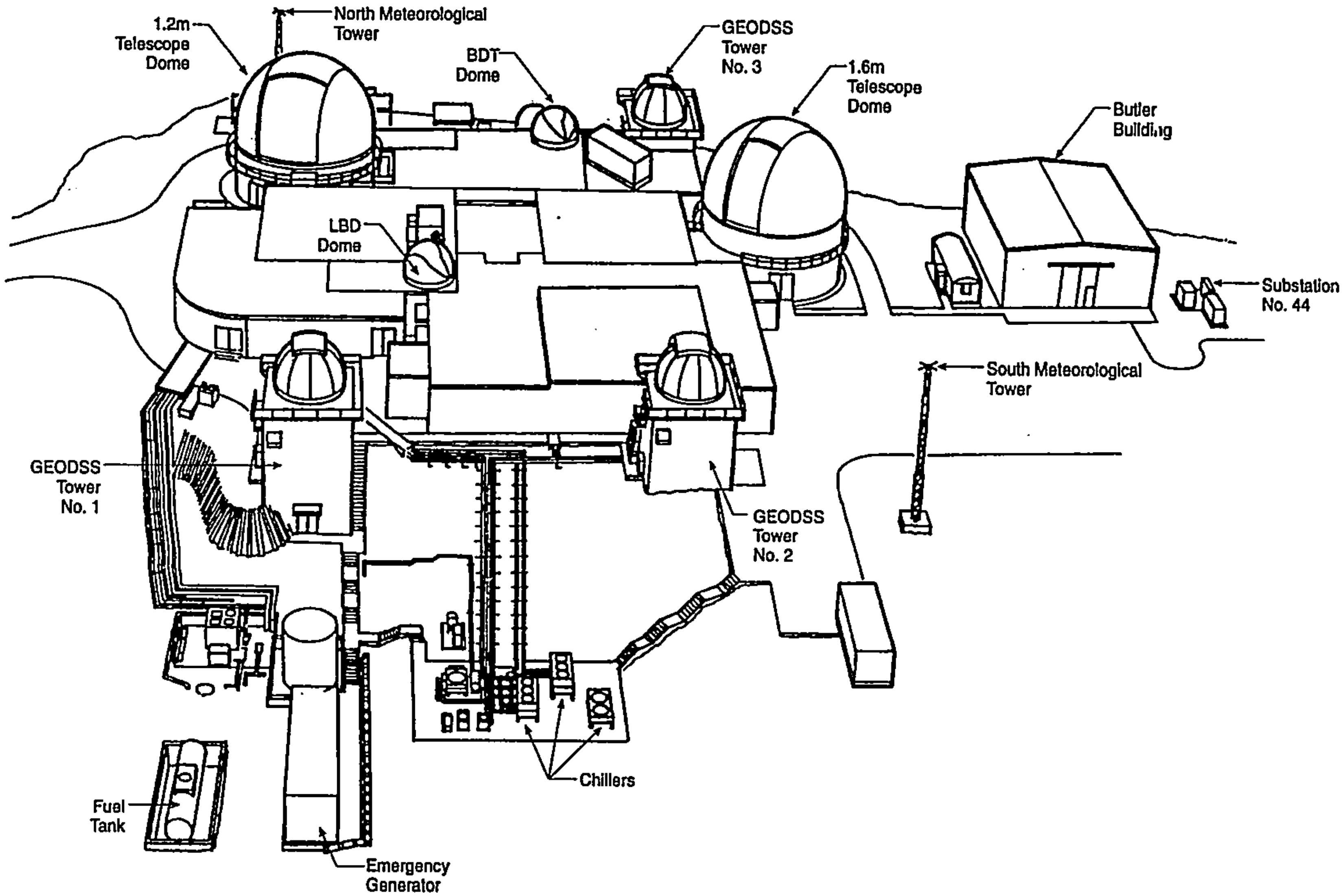


Source: *4 Meter Telescope Facility*
"Conceptual Design" Phase Design Program, March 20, 1992
Holmes Sabatini Associates / GYA

Figure 2.6
MANAGEMENT OF THE MSSS FACILITIES

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
Belt Collins & Associates • March 1994

233.4100.2/006



Source: *AMOS Users Manual*
Notes: LBD: Laser Beam Director
BDT: Beam Director/Tracker

Figure 2.7
MAJOR EXISTING STRUCTURES AND FACILTIES AT MSSS

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
Belt Collins & Associates • March 1994

233.4100.2/007

- **Air Force Maui Optical Station** (AMOS) provides state-of-the-art measurement support to research and development programs conducted by various government agencies and the scientific community. It also serves as a test site for newly developed and/or evolving electro-optical sensors. The facility is managed by U.S. Air Force Phillips Laboratory and is currently operated by Rockwell Power Systems. AMOS facilities include telescopes and Laser Beam Directors. One dome houses a 1.6-meter (62-inch) diameter Cassegrain telescope. A smaller dome houses the optics for a 0.6-meter laser beam director; this director is used to project beams from a variety of laser systems. A third dome houses a 0.8-meter Beam Director/Tracker; this instrument can be used to either send or receive a laser beam. AMOS lasers are used to range on and illuminate objects in low earth orbit.

- **Maui Optical Tracking and Identification Facilities** (MOTIF) is a primary sensor of the Air Force SPACETRACK network; it is currently operated by Rockwell Power Systems. Its objectives are to: (a) detect, track, and identify man-made objects in space; (b) maintain a catalog of these objects; (c) collect, process, and analyze data on man-made space objects needed to evaluate possible threats to national security; (d) provide information on man-made space objects to authorized agencies; and (e) support scientific space research and development operations. MOTIF facilities include the west dome, which contains two 1.2-meter (48-inch) diameter Cassegrain telescopes on a common mount. The telescope mount and dome for these are designed for high tracking rates. MOTIF also includes an operations control and computer facility, a secure communications facility, and optical and electronics laboratories.

In addition to the facilities housed in the main structure, the Butler building contains additional office space, a mirror coating facility, an electronics calibration laboratory, and a fully equipped machine shop. Additional support equipment located at the site includes a clean room, a liquid nitrogen cryogenerator, a 1.6-meter (62-inch) diameter optical flat, a water storage system, a cooling system, and electronic test equipment (U.S. Air Force 1991).

2.2.2 PRESENT OPERATIONS OF MSSS

Both "passive" and "active" operations are currently conducted at the MSSS. Passive observations involve the collection of photons (light) from naturally illuminated (solar-illuminated) objects. Passive operations require object location, telescope tracking and control capabilities, data acquisition, and data analysis. Active operations use lasers to range on and/or illuminate objects that are not solar-illuminated, to determine distance and location, to provide a "snapshot" image of a non-solar-illuminated object, and to conduct experiments relating to sensor improvements in various regions of the electromagnetic spectrum.

The existing lasers are all in the low to moderate range of output energy. The wave lengths used are determined by the natural limits set by atmospheric components and by the technical ability to generate a coherent, directed beam of electromagnetic radiation of a given wavelength. Gas, solid-state, dye, and chemical lasers have been used at the site. Numerous experiments are conducted each year; each experiment lasts from a few days to several weeks or months.

Numerous environmental studies, analyses, and assessments have been prepared for past and current activities at the MSSS. In addition, environmental management plans and monitoring programs, including a Spill Prevention and Response Plan and a Hazardous Waste Management Plan, have been developed for the facility. Management Plans include detailed information regarding inspections, reporting procedures, disposal, and other regulatory and compliance issues. An Environmental Compliance Assessment and Management Program (ECAMP) is on-going at the facility (Argonne National Laboratory 1988, 1991). ECAMP is a comprehensive assessment program designed to ensure compliance with federal, state, local, Department of Defense, and Air Force environmental laws and regulations. No significant adverse effects on the health and safety of workers, general population, or the environment have been identified in these reports or in the ongoing environmental monitoring that is performed at the facility. A complete listing of these environmental documents is included in Table 2.1.

2.3 NEED FOR AEOS

When first constructed, the existing MSSS facilities housed the most technologically advanced electro-optical systems in the world. With highly advanced sensor systems and the excellent viewing conditions atop Haleakala, the site established a reputation for excellence in supporting the space surveillance and research and development needs of the U.S. Air Force.

The most recent major upgrade to the facilities was in 1987, when additional laser facilities were constructed. Upgrades to the sensor systems, e.g., the addition of the compensated imaging system, have thus far enabled MSSS to maintain its usefulness. However, the relatively small size of the largest existing telescope and aging technology of the present facilities cannot meet the Air Force's requirements into the 21st century. An upgrade to a larger telescope is needed to retain MSSS's usefulness. Technological limitations prevent immediate installation of the 8-meter instrument that is contemplated; consequently, a 4-meter class telescope will be installed initially.

The limitations of the existing facilities and the advantages afforded by AEOS are described below.

- While the optics in the existing telescopes are extremely good, their small size limits the amount of light they can gather. As a result, they are unsuitable for many types of space surveillance and astronomical measurements. The proposed facility would significantly improve the resolution of space objects and enhance infrared sensitivity. Infrared measurements are central to both DoD and astronomical research and development. Improved infrared sensitivity would permit more detailed examination of deep space temperatures and phenomena such as gas clouds and plumes.

Table 2-1
Environmental Studies and Reports at MSSS

ENVIRONMENTAL STUDIES AND REPORTS	STATUS
Environmental Impact Assessment for Ground Electro-Optical Deep Space (GEODSS) Project Mount Haleakala, Maui (11 March 1980) U.S. Army Corps of Engineers.	Completed
EMC Survey of the Mt. Haleakala Defense Advanced Research Projects Agency's (sic) (20-24 June 1983) EMC and Measurements Branch/EIEM Engineering Division 1843RD Engineering Installation Group.	Completed
Biological Assessment for the U.S. Air Force Relay Mirror Experiment (1987) U.S. Air Force Systems Command.	Completed
Electromagnetic Interference Survey of Mt. Haleakala, Maui; Hawaii (September 1987) Naval Research Laboratory.	Completed
U.S. Air Force Relay Mirror Experiment Environmental Assessment (October 2, 1987) U.S. Air Force Systems Command and Air Force Weapons Laboratory.	Completed
Biological Assessment for the BOLT Experiment on Maui, Hawaii (March 1988) URS Consultants.	Completed
Environmental Assessment U.S. Air Force BOLT Experiment on Maui, Hawaii (March 1988) U.S. Air Force.	Completed
Environmental Compliance Assessment and Management Program (ECAMP), Report of Preliminary Findings (September 1988, December 1991) Argonne National Laboratory.	Ongoing

ENVIRONMENTAL STUDIES AND REPORTS	STATUS
U.S. Air Force Installation Restoration Program, Final Preliminary Assessment for Maui Satellite Tracking Site, Hawaii (August 18, 1989) HAZWRAP Support Contractors Office (Dames & Moore).	Completed
U.S. Air Force Installation Restoration Program, Final Decision document for MSSS, Maui, Hawaii (March 9, 1990) HAZWRAP Support Contractors Office.	Completed
Biological Assessment for Maui Space Surveillance Site Expansion (1991) Department of the Air Force.	Completed
Calculations of a Fuel Oil Spill (1991) Department of the Air Force.	Completed
Cultural Resources Inventory and Evaluation for Science City, Conducted for Expansion of the Maui Space Surveillance Site, Haleakala, Maui, Hawaii (July 1991) J. C. Chatters.	Completed
Geologic Site Assessment in Science City Area, Haleakala Summit Region, East Maui (1991) S. Bhattacharji.	Completed
Hazardous Waste Management and PRC Contingency Plan (18 January 1991) PRC, Inc.	Completed
Spill Prevention and Response Plan Maui Space Surveillance Site Haleakala Summit, Maui, Hawaii (10 April 1991, Revision 1, 17 March 1992) Rockwell Power Systems.	Ongoing
Asbestos Management Plan and Asbestos Operations Plan for Maui Space Surveillance Site Maui, Hawaii (30 May 1991; Revision 1, 16 March 1992) Rockwell Power Systems.	Ongoing
Potable Water System; Remediation Presurvey Report & Pilot Study (May 1991, December 1991) Environmental Science & Engineering, Inc.	Completed

ENVIRONMENTAL STUDIES AND REPORTS	STATUS
Programmatic Environmental Assessment U.S. Air Force Maui Space Surveillance Site Haleakala, Maui (May 1991) U. S. Air Force Systems Command, Headquarters Space Division.	Completed
Petroleum Products Recovery Plan for the Maui Space Surveillance Site Maui, Hawaii (3 June 1991; Revision 1, 17 March 1992) Rockwell Power Systems.	Ongoing
Hazardous Waste Mangement Plan for Maui Space Surveillance Site Muai, Hawaii (6 June 1991; Revision 1, 17 March 1992) Rockwell Power Systems.	Ongoing
Environmental Pollution Monitoring Plan for the Maui Space Surveillance Site Muai, Hawaii (21 August 1991; Revision 1, 16 March 1992) Rockwell Power Systems.	Ongoing
Natural Resources Plan for the Maui Space Surveillance Site Maui Hawaii (31 August 1991; Revision 1, March 16, 1992) Rockwell Power Systems.	Ongoing
Seismic Risk of the Summit Area of Haleakala Volcano (October 31, 1991) Hawaii Institute of Geophysics.	Completed
A Review of the Arthropod Fauna at the Proposed Air Force Facility Construction Site at the Summit Area of Haleakala Volcano, Maui, Hawaii (1992) A.C. Medeiros and L.L. Loope.	Completed
Pest Management Plan (15 April 1992) Rockwell Power Systems.	Ongoing
Preliminary Drainage and Erosion Control Report for 4.0 Meter Telescope Facility at Haleakala, Maui, Hawaii (October 1992) Richard M. Sato & Associates.	Completed

- The existing telescopes are configured such that experimental instrumentation packages must be "hung" on the telescope mounts. This limits the configuration and size of the instrumentation, and number of the experiments that can be conducted at any one time. The existing arrangement also makes it difficult to change the instrument packages used for experiments because the telescopes must be re-balanced every time the instrumentation is replaced, making for a relatively high setup-to-viewing time ratio. Maintenance and repairs are also time-consuming and difficult. The AEOS design allows a number of different experimental packages to be set up at the same time in separate lab spaces, providing greater flexibility and increased capabilities.

- The existing 1.6-meter telescope uses a passive adaptive optical image-compensating technology to improve image resolution through the turbulent atmosphere. Improved image-compensating devices using active, laser-based technology have been developed over the past decade, but are used to best advantage on larger telescopes. If the facilities at Haleakala are not upgraded to accommodate this new technology, the MSSS will be unable to provide a state-of-the-art large optical platform. It is then likely that the advanced image-compensating technology would be implemented at other sites, and the MSSS would become non-competitive for space surveillance.

- Over the years, development on the mountain has degraded optical conditions by increasing atmospheric turbulence from inadequately controlled heat sources. This has become a problem for the existing facilities. AEOS incorporates an efficient mechanical plant that would be used to cool all MSSS facilities and would not be operated during viewing hours. This, and other thermal control features, would help restore the site to the thermally pristine conditions that are needed for both astronomical research and space surveillance observations.

U.S. Air Force Phillips Laboratory is committed to developing AEOS as a "shared-use" facility that will be available to non-DoD users for astronomical and atmospheric science research and equipment development. Towards this end, the Air Force initiated discussions with the civilian space and atmospheric sciences communities in early 1992. The resulting AEOS Scientific Advisory Board, which includes members from both the DoD and civilian communities, provided input on the telescope design and recommended instrumentation needed for scientific research at AEOS.

The University of Hawaii Institute for Astronomy is playing an important role in developing the research plan for the proposed facilities and will be allocated instrument time and space within the complex for its work. The clear, dry atmosphere and dark sky at the Haleakala site will make possible observation of some of the faintest, most distant objects in the Universe. The IfA anticipates that the advantages of the site, in conjunction with the superb optical performance anticipated of the AEOS telescope and image-compensating system, will allow AEOS to generate some of the best-resolved imagery of astronomical objects of any research facility on the globe.

Astronomical research programs at AEOS will provide new and potentially unique data to astronomers and will provide an unparalleled opportunity for training of students in such diverse fields as astronomy, optics, atmospheric sciences, and electronics. In addition, AEOS's planned use as an equipment development facility represents a superb, and perhaps unequaled, opportunity for the instrumentation development community. Several research issues of national and international importance have already been identified for investigation from AEOS, including global climatic change and ozone depletion (Gardner and Carlson 1993). Other key issues whose understanding would be furthered by research which AEOS would make possible are determination of the current state of the atmosphere, examination of the chemistry of atmospheric constituents such as ozone and water vapor (to better define their role in global climate change), and the compilation of a high-quality, long-term database needed to identify and assess atmospheric variations that may be related to global climate change.

The active adaptive optical technology of the proposed AEOS telescope provides superb spatial and temporal resolution and atmospheric measurement capabilities that are not possible with existing passive sensing techniques. The technology is not available at existing observatories, and, because of its high cost, it is unlikely to be funded at other facilities. Moreover, because the design of the facility allows several experiments to be undertaken simultaneously and simplifies the setup of experimental instrumentation, AEOS is extremely flexible and efficient from an operational viewpoint. This will maximize viewing time and minimize experimental costs, stretching research dollars and improving scientists' productivity. The high elevation of the Haleakala Observatories site in combination with the quality of the AEOS instruments will make Haleakala Observatories one of the best sites in the world for a variety of ground-based research programs. The project will further enhance Hawaii's already excellent reputation among the astronomical research community.

CHAPTER 3

PROPOSED ACTION AND ALTERNATIVES

3.1 INTRODUCTION

In order to meet the objectives described in Chapter 2, the U.S. Air Force proposes to construct an Advanced Electro-Optical System telescope at the MSSS. The facility will be available to the Department of Defense (DoD) and its contractors for operations, research, and development activities; the University of Hawaii Institute for Astronomy will have its own laboratories and research facilities. The Air Force will make operational time on the AEOS telescope available to the University and other non-DoD users on a scheduled basis.

The proposed AEOS design is described in Section 3.2. Section 3.3 describes the alternatives that were considered by the Air Force and the University of Hawaii and discusses reasons why the alternatives were rejected in favor of the current proposal.

3.2 PROPOSED ACTION — ENHANCE CAPABILITIES TO MEET INCREASING USE REQUIREMENTS

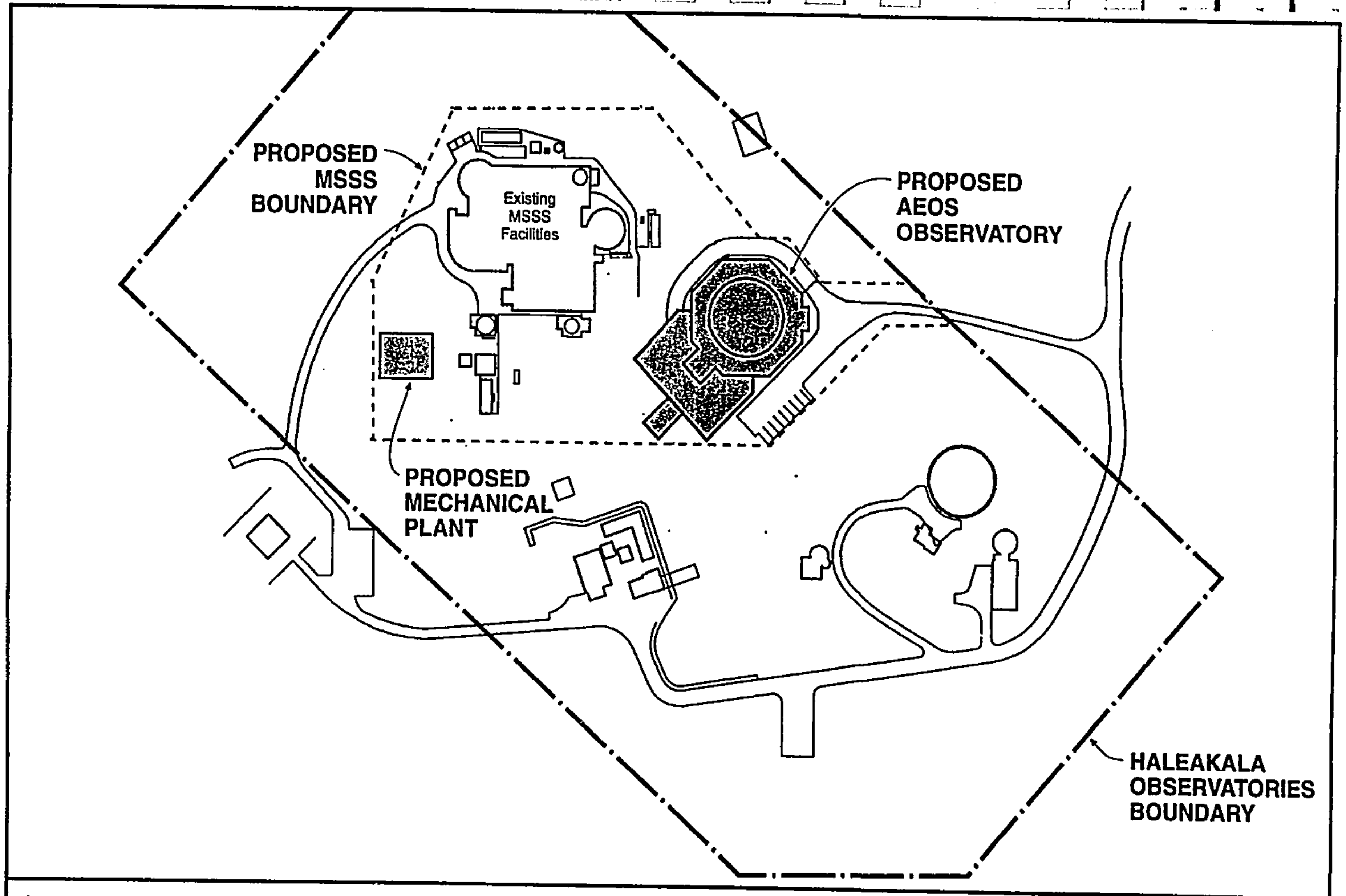
The proposed action includes several components:

- Expansion of the Air Force's leased area by 1.74 acres;
- Construction of the AEOS Observatory;
- Construction of the Mechanical Plant;
- Operation of a temporary concrete batch plant;
- Upgrades to existing facilities; and
- Operation of the proposed facilities, including increased remote operations.

The technology required for rotating the telescope at rates fast enough to track satellites does not yet exist for an 8-meter telescope. Consequently, a 3.67-meter telescope will be installed in AEOS initially, to be replaced by the proposed 8-meter instrument when the necessary equipment becomes available. The dimensions, operations, and impacts of the two telescopes are similar, although the dome enclosure of the 8-meter instrument will be slightly larger than that for the 3.67-meter telescope. The 8-meter facility is considered the preferred alternative and is discussed in detail in the following sections.

3.2.1 OVERALL SITE LAYOUT

Figure 3.1 shows the proposed site plan for MSSS after construction of AEOS. It shows the approximate sizes of the structures and their relationship to the existing MSSS. A building section of the full-scale AEOS Observatory is reproduced in Figure 3.2. Figure 3.3 shows elevation drawings of the proposed mechanical plant. Figure 3.4 is an artist's rendering showing the appearance of MSSS after AEOS is completed.



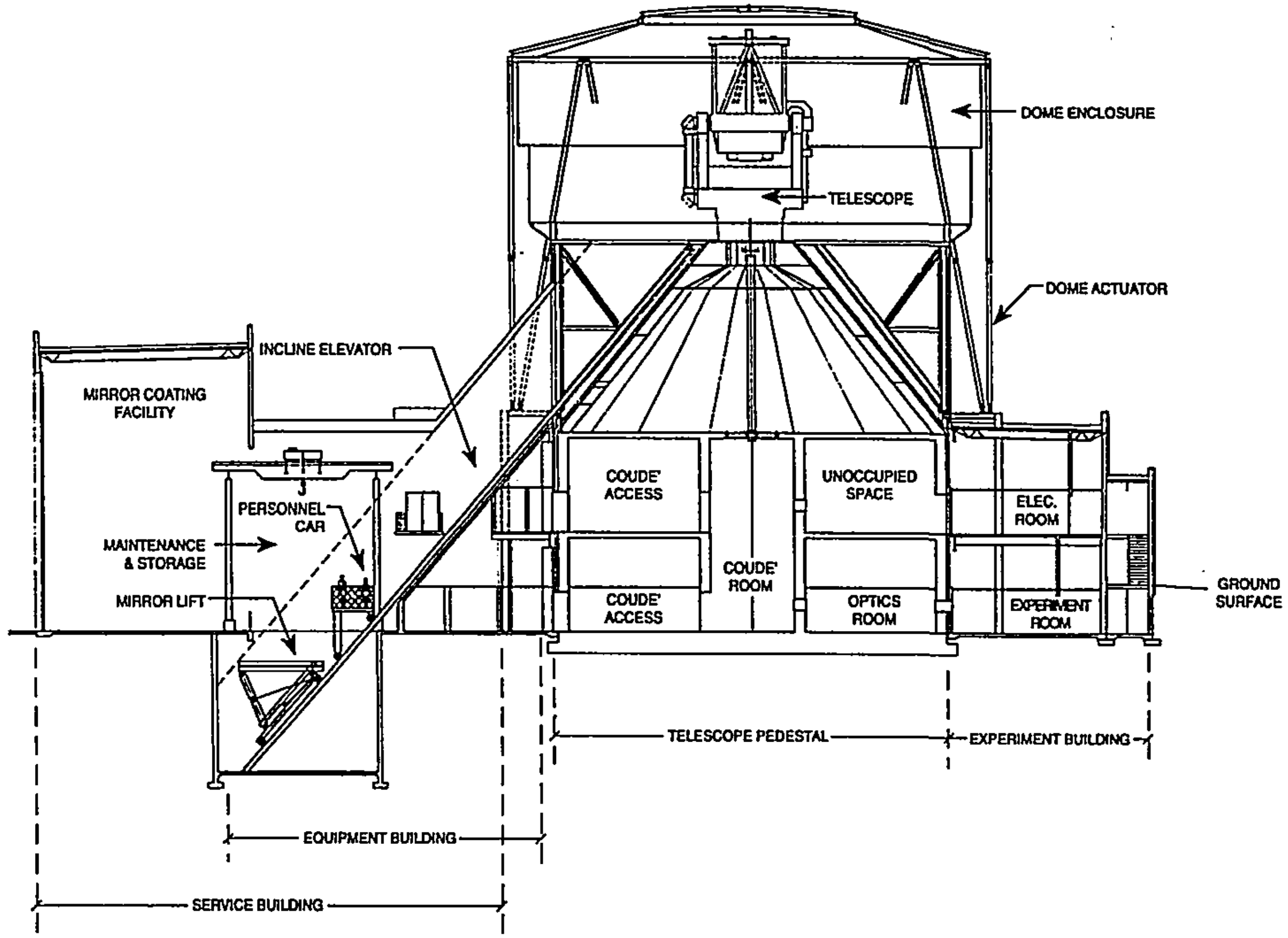
Source: *AEOS Telescope Facility - Reduced Scope Facility Study*
Holmes Sabatini Associates / GYA, March 1993

Figure 3.1
PROPOSED MSSS SITE PLAN

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
Belt Collins & Associates • March 1994

233.4100.2/048

Note: Dome enclosure shown is for a 4-meter class telescope; dome of 8-meter instrument will be outside of dome actuators.



Source: *AEOS Telescope Facility - Reduced Scope Facility Study*
Holmes Sabatini Associates / GYA, March 1993

0 8 16 32 64
SCALE IN FEET

233.4100.2/045

Figure 3.2
APPROXIMATE BUILDING SECTION
AEOS OBSERVATORY

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
Belt Collins & Associates • March 1994

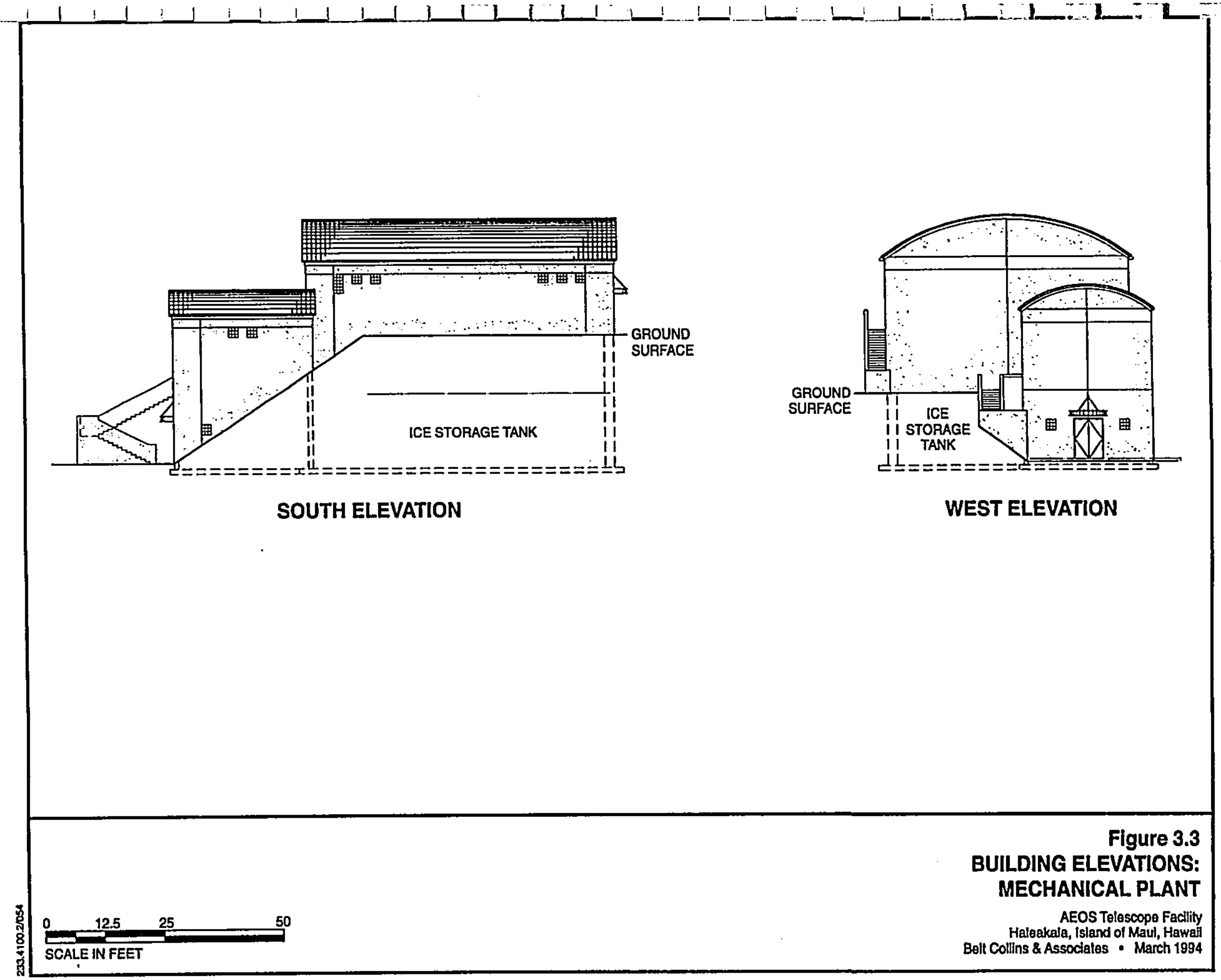
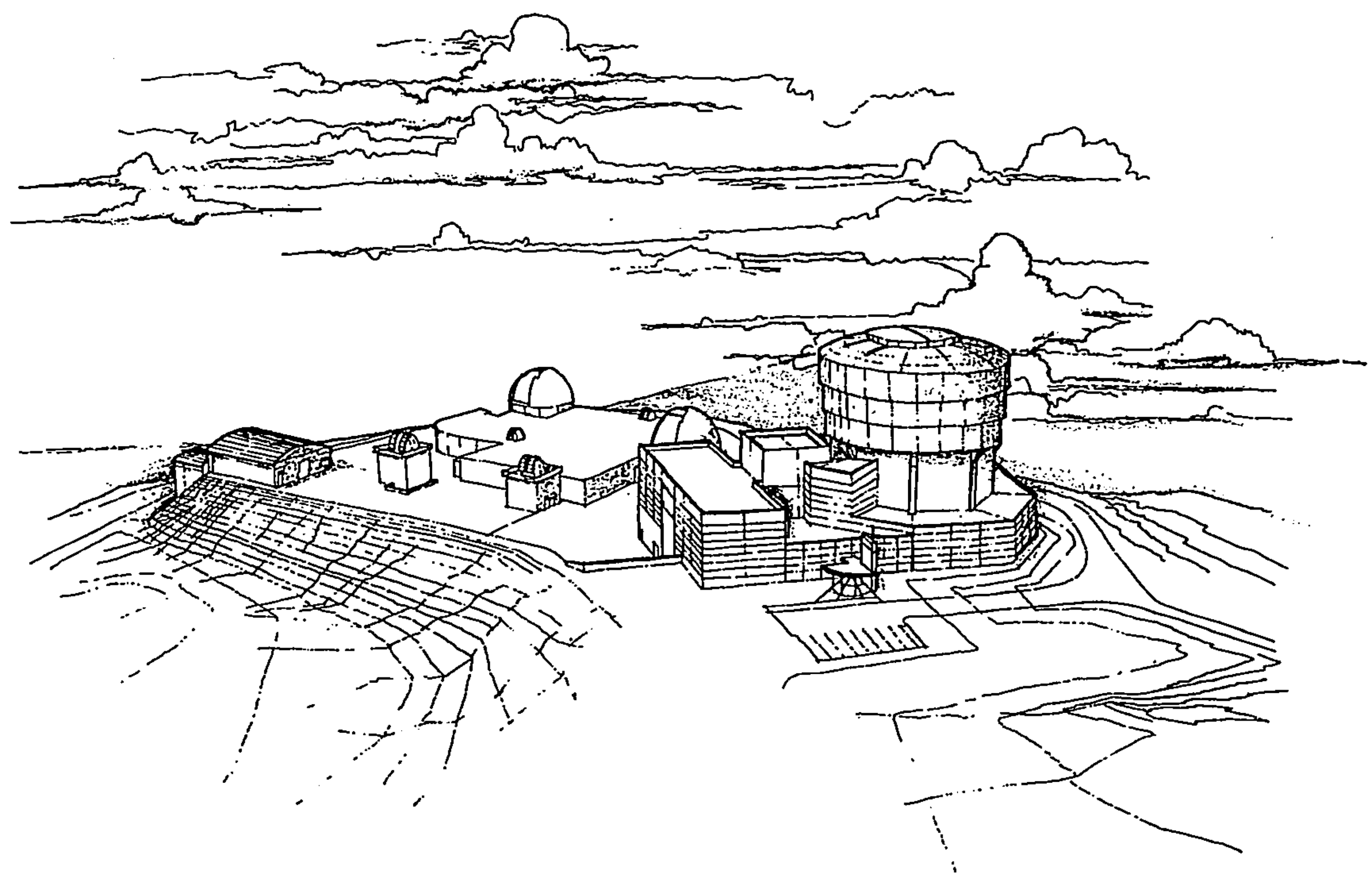


Figure 3.3
BUILDING ELEVATIONS: MECHANICAL PLANT

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
Belt Collins & Associates • March 1994



Source: ***4 Meter Telescope Facility***, Revised 30% Design Submittal
Holmes Sabatini Associates / GYA

Figure 3.4
RENDERED VIEW OF THE PROPOSED FACILITY

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
Belt Collins & Associates • March 1994

233.4100.2/037

3.2.1.1 Circulation and Security

AEOS is expected to use and collect data that will be classified up to "Top Secret" level. Department of Defense and Air Force procedures will be followed when receiving, storing, using, transmitting, and destroying classified data. Both cleared and non-cleared users, possibly including foreign nationals, will have access to AEOS; the facility design incorporates several features and procedures intended to maintain security in this shared-use environment.

Facility users will be given color-coded identification badges and will be briefed on security procedures. The badges will be used in a card-reader system that will regulate room access and track room occupancy for security and safety reasons. Access and privileges to the telescope control system will be limited to authorized staff and researchers.

The central coudé room will be secured as needed by the Air Force and site operating contractor. Light ports and doors between the laboratories into the central coudé room will be double-locked; opening them will require coordination and cooperation between the user and the facility manager. All other spaces will be considered "site general access." Access to the site general areas can be restricted on a temporary basis for specific operations or experiments. Users will designate the classification level of the operations and activities in their laboratory modules. Classified operations will be conducted in controlled areas in which access restrictions will be imposed. Laboratory modules will have intercoms and locks at the exterior hall door to facilitate access control. Users will be responsible for complying with appropriate Department of Defense and Air Force procedures and regulations and site security procedures; Restrictions and penalties may be imposed for failure to comply with site security procedures.

3.2.1.2 Maintenance of Atmospheric Stability

A stable atmosphere is important for good telescope viewing. Several features of the proposed facilities are intended to provide this. First, the telescope will be mounted relatively high above the ground to avoid most of the air turbulence closer to the earth. It is sited upwind (relative to the prevailing tradewinds) of existing structures and topographic features, minimizing turbulence caused by their interaction with the wind. Second, roadways and parking areas will be constructed of the material most likely to provide the optimum thermal properties with a minimum of particulate generation. Third, the proposed design minimizes the heat released to the atmosphere during prime viewing periods from mechanical and electrical equipment. Wherever possible, the facility has been designed to operate without such equipment. Where essential to the facility's operation, the equipment will be thermally insulated and its emissions controlled; exhausts are sited downwind of the proposed and existing MSSS facilities.

Finally, the telescope will be insulated from heat generating sources within the AEOS Observatory by its location at the core of the structure, physical isolation from the surrounding areas, and additional thermal insulation (see Figure 3.2).

3.2.2 AEOS OBSERVATORY

The proposed Observatory consists of four distinct elements, the telescope pier (which supports the telescope), the metal dome enclosure, the equipment building, containing laboratories and offices, and the service building, which contains maintenance and storage facilities. These are described below.

3.2.2.1 Telescope Pier

Telescope Pier. AEOS's most important element is a coudé path[1] telescope. The telescope pier will support the telescope mount. It is designed to be extremely stable, preventing vibration from reaching the telescope optics and degrading viewing conditions. The natural structural frequency will minimize the transmission of low frequency vibrations to the telescope from mechanical equipment and/or seismic forces. The pier will be isolated from the other AEOS facility structural systems and heat sources *to further enhance viewing conditions.*

Coudé Room. The coudé room, located at the base of the pier and bottom of the coudé path, contains the telescope "switching mirror". This switching mirror allows the optical beam to be directed into or out of the various optics laboratories, thus permitting simultaneous experiments in more than one laboratory. The resulting flexibility is a major advantage of the proposed facility.

Optics Laboratories. Seven optics laboratories will be located adjacent to the coudé room. They will contain equipment for processing the optical signals to and from the telescope. Measurements, experiments, and/or data gathering efforts will be conducted in these laboratories.

3.2.2.2 Dome Enclosure

The AEOS design incorporates a collapsible cylindrical dome that will be lowered out of the line of sight during viewing. This provides excellent seeing conditions and a 360 degree range of visibility.

The dome will be mounted on the dome enclosure platform that forms the top of the equipment building (see section 3.2.2.3). It will be about 32 meters (106 feet) in diameter, and it top will be approximately 36.6 meters (120 feet) above grade. It will be constructed of aluminum and covered with aluminum foil tape. The surface will be highly reflective, providing better thermal properties than those of white domes.

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[1]The coudé path is the path that the optical beam follows to or from the telescope. The AEOS telescope will have a vertical coudé path, with the beam of light passing down from the telescope through the core of the telescope pier to the sensors and laboratories.

3.2.2.3 Equipment Building

The equipment building contains the majority of areas that need to be isolated from the telescope pier. These areas, with the exception of the laser laboratories, are relatively insensitive to thermal or vibration disturbances. In fact, some of them are actually the source of heat or vibration that is detrimental to telescope performance, and so will be segregated and/or isolated from the telescope pier.

Laser Laboratories. These laboratories will contain the lasers used in some of the planned experiments. Like the optics laboratories, they will be thoroughly isolated from vibration and other disturbances.

Electronics Rooms. The electronics rooms will house computers to monitor and/or control experiments being conducted in the optical and laser laboratories. They will be located close to the optical and laser labs in order to minimize transmission losses, but will be thermally isolated from them to prevent heat-generating equipment from adversely affecting the laboratory experiments.

Experiment Control Rooms. Each laboratory module will contain an experiment control room from which scientists and technicians can monitor and control experiments. The control rooms' locations adjacent to the electronics rooms will provide easy access to the computers.

Dome Enclosure Platform. The dome enclosure platform will be located near the telescope base. It will surround the top of the telescope pier and serve several functions, including telescope maintenance/alteration, dome maintenance, mirror handling, storage, and beam-tube access.

3.2.2.4 Service Building

The service building will be located adjacent to the equipment building and will contain the mirror coating facility and maintenance and storage areas. These facilities will be available to all MSSS users.

Mirror Coating Facility. Telescope mirrors require periodic re-coating to maintain the necessary high reflectivity. Therefore, the AEOS design provides for a specialized processing area that will serve the existing telescopes at the MSSS as well as AEOS. The proposed mirror coating process is similar to that currently being used at MSSS and will be operated by Air Force Phillips Laboratory. The proposed design includes an incline elevator to move the AEOS mirror from the upper level of the telescope pier to the lower level of the service building for processing.

The existing MSSS mirror coating facility will be dismantled when the Butler building is removed. If necessary, the AEOS mirror and existing mirrors will be re-coated off-site during the period prior to completion of the proposed coating facility.

Maintenance. The proposed maintenance area will have space for a variety of tasks and equipment. Equipment will be fabricated or repaired in the machine shop, which will contain a metal lathe, milling machine, drill press, and chain hoist. The mechanical shop will function as an electro-mechanical repair shop. The welding shop will be used for component fabrication and/or alteration; it will contain welding machines, welding cubicles, and a chain hoist. Other possible facilities and activities being considered for this area include a radio frequency-shielded laboratory, equipment calibration, offices, and worker lounge and locker room.

Storage. The proposed warehouse area in the service building will replace the existing storage in the Butler building and will provide additional space for uses that are not accommodated currently. Separate storage spaces for the various MSSS users are included in the design.

3.2.3 MECHANICAL PLANT

The heating, cooling, and ventilation (HVAC) systems that would be housed in the mechanical plant are designed to maintain space and process temperatures at desired levels in both AEOS and the existing MSSS facilities. The proposed design includes siting the mechanical plant downwind of both the proposed and existing telescopes and minimizing potential heat releases to the atmosphere. Therefore, the proposed facility will reduce thermal pollution and enhance viewing conditions at the summit. The existing cooling units will be removed when the new plant is operational.

The heating boilers within the proposed mechanical plant will be high-efficiency, liquid propane-fired units. Their exhaust will be cooled prior to discharge, minimizing the heat released to the atmosphere.

In order to minimize the release of heat from the temperature control system during telescope viewing hours, an ice storage system will be used. Ice will be produced and "harvested" into a below grade storage tank (see Figure 3.3). During viewing hours, the chillers and condensers will be turned off and variable-speed pumps will circulate chilled water through the HVAC system. This will reduce heat releases and enhance viewing conditions during the critical observing hours.

The proposed closed-loop ice-making and cooling systems will be filled initially with water supplied by the Maui Board of Water Supply. No additional "makeup" water will be required once the system is operational, unless it develops a leak. Evaporation will be minimal in the cold underground storage tank and should be offset by condensation during periods of high humidity. A similar system in use on the mainland has not needed makeup water in over one-and-a-half years. Current plans call for installation of a single ice harvester and provisions for two additional units in the future.

3.2.4 POWER/COMMUNICATIONS

The existing overhead line that crosses the AEOS project site will be relocated below ground. New Maui Electric Company (MECO) transformers will be installed in an electrical vault near the AEOS facility. These will supply power both to AEOS and to the existing MSSS facilities. The existing MECO substation (No. 45) will not be altered.

A change in the need for operational capacity during a MECO power outage (only GEODDS would continue to operate; all other facilities, including AEOS, would be on standby) decreases the need for emergency generating capacity. Therefore, one of the two existing 250 kVA diesel emergency power generators will be installed in the new electrical vault; the other generator will be removed. The existing 4,000-gallon diesel oil storage tank will remain.

The existing overhead telephone line will be relocated to an underground duct that will be installed across the MSSS site. A new underground communication duct system between MSSS and Kihei to enable remote control of operations at the summit is also under study. This upgrade is still in the preliminary stage and is not discussed in this environmental assessment. Future environmental documents will address the potential impacts of the upgrade when it is developed.

3.2.5 CONCRETE BATCH PLANT SITE AND LAYDOWN AREA

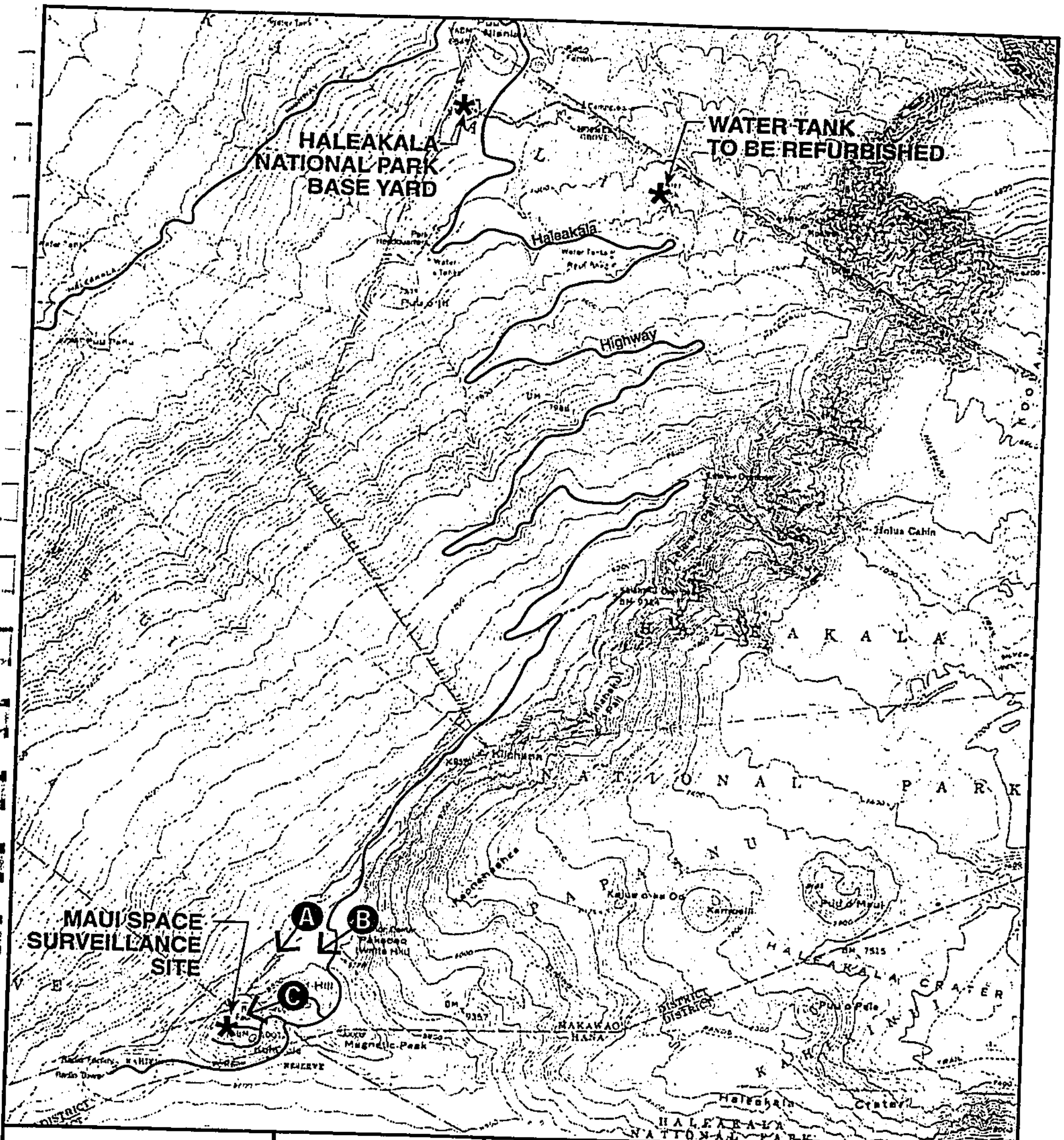
Contingent upon satisfactory completion of the environmental impact analysis process, the National Park Service has agreed to make space available for a concrete batch plant in its maintenance base yard near Haleakala Park headquarters (Figure 3.5). A site plan of this area shows topography, existing structures, and other features (Figure 3.6). The solid constituents of the concrete (cement, lime, gravel, and sand) will be hauled to the batch plant and temporarily stored there. The batch plant will be obtained off-island and will consist of a 30-foot-tall cement silo and a fifteen foot tall metering structure with hoppers.

Water will be supplied from an existing, but unused, catchment system and 100,000-gallon storage tank located near Hosmer Grove. The storage tank and catchment will be refurbished at Air Force expense. The upgraded system will be returned to the National Park Service when construction of AEOS is complete. Similarly, following completion of the cast-in-place pours, the batch plant will be dismantled and the site returned to its pre-construction condition.

The laydown area for other construction materials will be adjacent to the construction site (Figure 3.7). This location was chosen because it is the only large, relatively flat area available in the vicinity of MSSS. It is presently vacant.

3.2.6 CONSTRUCTION ACTIVITIES

Construction of the initial phase of the proposed facilities is expected to take approximately 18 months. The construction activities that will occur are described below.



NORTH

0 1500 3000

SCALE IN FEET

LEGEND

Location of Views Toward Haleakala Observatories

A: Figure 4.2
B: Figure 4.3
C: Figure 4.4

Figure 3.5
UPPER HALEAKALA

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
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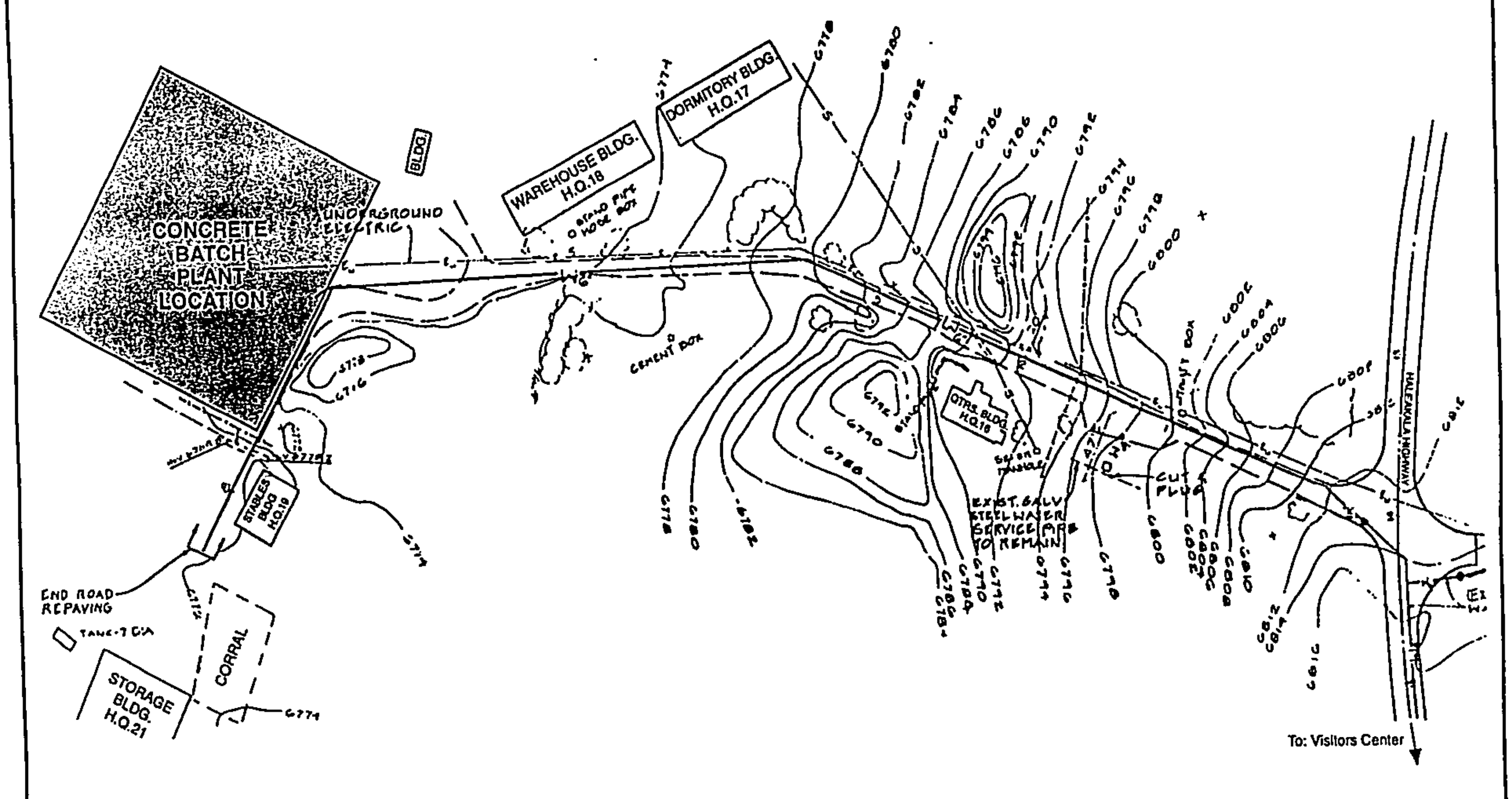

Source: National Park Service

Figure 3.6
HALEAKALA NATIONAL PARK BASE YARD

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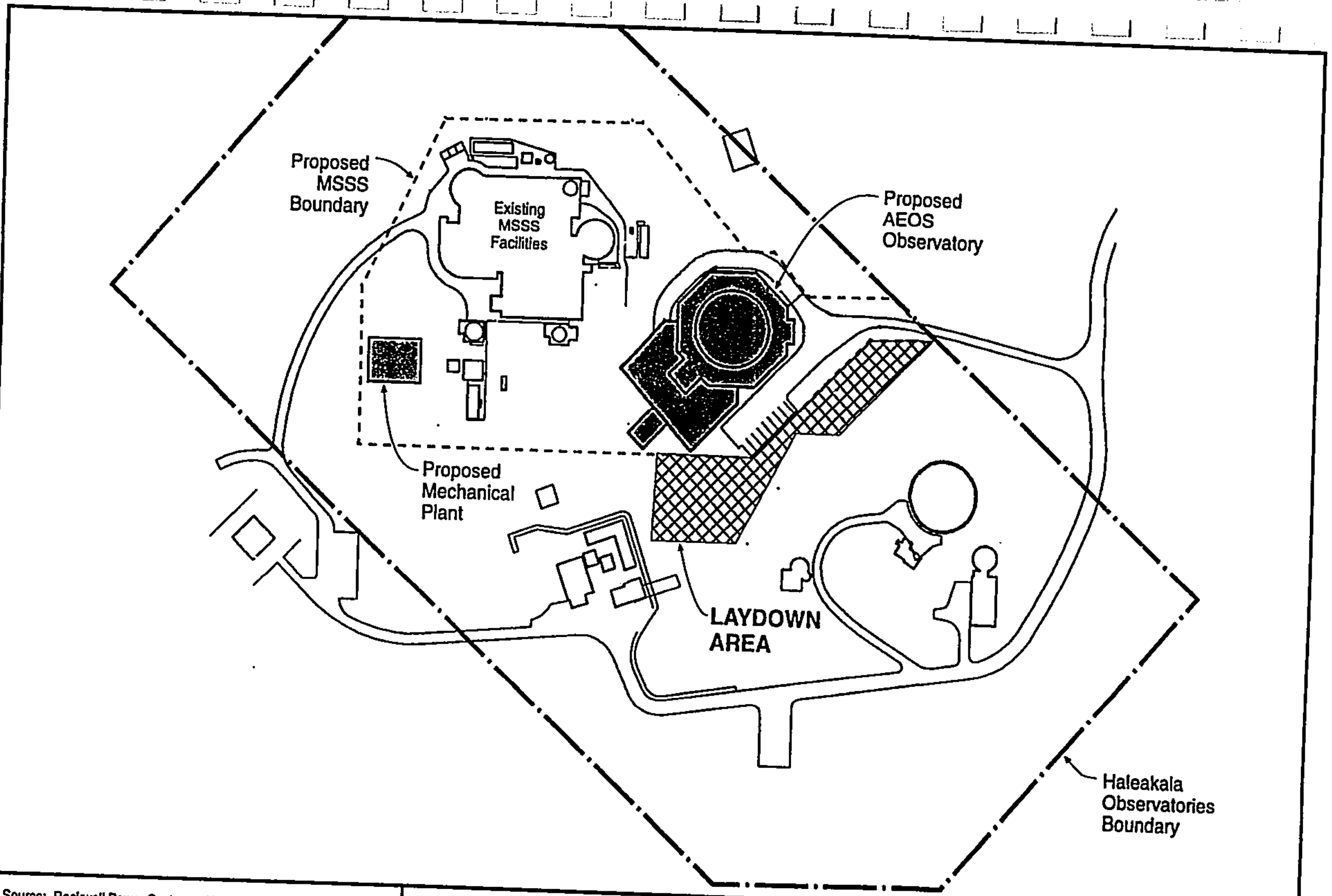

Source: Rockwell Power Systems, Albuquerque, New Mexico

NORTH

0 40 80 160 320
SCALE IN FEET

233.4100.2/053

LEGEND

Laydown Area

Figure 3.7
LOCATION OF LAYDOWN AREA

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
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- The site of the proposed AEOS Observatory, mechanical plant, electrical vault, and access road will be prepared using bulldozers, graders, and compactors. A rough balance between cut and fill is anticipated; therefore, little off-site truck traffic would be needed. Backhoes and other equipment will be used to cut the trenches needed for the underground utilities. The National Park Service has indicated that it will use any excess material that is produced by the site preparation activities for park maintenance.

- The access road to the AEOS facility will be constructed using the naturally occurring cinders and a binding agent. Equipment used during this phase will include rollers, spreaders, and graders. Dust suppression in graded areas will use up to 5,000 gallons of water per day.

- Concrete will be mixed in the temporary batch plant in the National Park Service's base yard near Haleakala Park headquarters. Trucks will carry cement, lime, and aggregate from Kahului to the batch plant using Haleakala and Hana Highways. Once at the batch plant, these materials will be mixed and trucked to the AEOS construction site, where water will be added. Typically, fewer than ten workers will be present at the batch plant site at any one time.

- The building foundations will be cast in place. Mixers, pumpers, trenchers, and small compactors will be used during this phase of construction. Water will be trucked from the restored catchment system near Hosmer Grove or from a valley water source to the summit. Most of the wall components will be fabricated off-site and stored on a graded laydown area south of the existing MSSS facilities prior to their installation. They will be transported to the summit in large trucks.

- Work following completion of the foundation will involve erecting the concrete walls and roof structures, installing and assembling the aluminum telescope enclosure dome and the telescope itself, installing mechanical equipment, installing plumbing and electrical equipment, and completing interior spaces. This work is expected to involve between 75 and 125 tradespersons; not all will be on site at any one time. The construction vehicles and equipment used during this phase will include flatbed tractor-trailers (to deliver equipment and building materials), heavy-capacity tracked cranes, light-capacity tire-mounted cranes, and an assortment of medium- and light-weight trucks. Special arrangements will be made to escort these vehicles to the summit during periods when their movement on the roads will not conflict with normal use of the National Park.

- To ensure that MSSS operations are not interrupted, a temporary cooling unit will be installed, if necessary, until the proposed mechanical plant is brought on line.

- The equipment will then be tested, the finish-grading completed, and the interior spaces furnished. Then the 3.67-meter telescope mirror will be transported to the site and installed. Up to 50 people and an assortment of light and medium trucks will be involved in these efforts. A large truck will be needed to transport the mirror to the summit.

- At some later date, the 8-meter telescope and dome enclosure platform and dome enclosure will be installed to replace the 3.67-meter telescope.

3.3 ALTERNATIVES TO THE PROPOSED ACTION

The Air Force and University of Hawaii have considered several alternatives to the proposed action. These include: (1) telescope sites other than the summit of Haleakala, (2) alternative sites on the summit, (3) alternative technologies, (4) alternative AEOS designs, (5) integration of AEOS into the existing MSSS facilities, and (6) no action.

3.3.1 LOCATIONS OTHER THAN HALEAKALA

MSSS has been selected as the site for AEOS for a number of reasons:

- **Coverage.** At 21° north latitude, Haleakala is an excellent location for observing the majority of low-earth-orbit objects, as well as a good number of deep-space objects. Latitudinal coverage at Haleakala is 85 percent.
- **Astronomical "Seeing" and Viewing Conditions.** With Mauna Kea, Haleakala summit has some of the best "seeing" available in the United States. Conditions are predictable and consistent, providing good seeing a majority of the time. Also, the wind pattern is established, the air is clean and dry, and an inversion layer at between 5,000 and 7,000 elevation feet keeps water vapor, aerosols, and other particles that might interfere with seeing below the summit. Unlike other telescope sites that have been degraded by light pollution, the Haleakala summit is dark at night.
- **Location.** Haleakala is near the mid-point of the Western Test Range, which is comprised of Vandenberg Air Force Base in California and Kwajalein Atoll in the Marshall Islands. It offers an ideal site for tracking missiles deployed from Vandenberg to Kwajalein, and is also in a perfect position to view suborbital launches from the Pacific Missile Range Facility (PMRF) at Barking Sands, Kauai. Launch tracking is an important component of the research and development of the missiles and associated equipment. The current schedule indicates about 10 launches per year. This number has been fairly constant for about a decade and is expected to remain so in the future. Without the Haleakala observatory, less effective aircraft sensors would have to be used to track the missiles.
- **Accessibility.** Haleakala is easily accessible via an all-weather highway, which facilitates the transport of people, supplies, and equipment. In addition, a deep-draft harbor and airport are located in nearby Kahului.
- **Infrastructure.** In addition to its transportation infrastructure, Maui also has the other types of facilities, utilities, communications systems, etc., and services needed to support an observatory and its staff.

Although Mauna Kea on the island of Hawaii provides similar coverage and conditions as those at Haleakala, constraints imposed by the existing functions preclude its consideration as the AEOS site. The policy regarding activities at Mauna Kea has been developed by the University of Hawaii Board of Regents. At present, this policy does not permit lasers or classified research on Mauna Kea, both of which are integral to the proposed project. Other mountain sites exist in the U.S.—for example, in the Rockies—but these areas lack Haleakala's advantages of good coverage (latitude) and consistently good seeing. There are mountain sites at similar latitudes in the Andes of Chile and Peru, but these are in foreign countries.

3.3.2 OTHER SITES ON HALEAKALA

Other areas of the summit were considered as the site for the proposed project, including areas within Haleakala Observatories and areas on state-owned land outside the existing Haleakala Observatories boundary. The site-selection was guided by a number of criteria, including the following:

- The telescope site cannot be downwind of other structures or landforms such as hills, cinder cones, or large boulders due to air turbulence caused by these obstructions. Likewise, it cannot be upwind of the existing observatories.
- The underlying soils and geological conditions must provide an adequate foundation for the structure.
- A site adjacent to the existing MSSS is preferred to enable shared use of facilities and joint operations (for example, communications linkages and shared utilities). A physical connection would permit integration of the existing and proposed facilities.

Alternative telescope sites are limited on the summit. Most of the suitable upwind sites are on National Park land. Several sites on state-owned land are unsuitable because of air turbulence, including land further to the west. The old radio telescope site adjacent to the LURE Observatory could provide good seeing, but geological conditions and space limitations would result in significantly higher costs. Moreover, access to that site could interfere with other University of Hawaii facilities and it is physically separated from the existing MSSS facilities.

3.3.3 ALTERNATIVE TECHNOLOGIES

Space-borne telescopes are an alternative to some aspects of the proposed project, but they are much more expensive, cannot achieve the necessary tracking rates, and do not have proven reliability. Consequently, emphasis has now returned to earth-based electro-optical platforms such as AEOS. There are passive image compensating technologies (as contrasted to the active compensating system incorporated in AEOS), but the proposed system has a number of technical advantages. These include real-time image compensation and improved spatial and temporal resolution. No other technology currently available provides as many benefits as those associated with AEOS.

3.3.4 ALTERNATIVE AEOS DESIGNS

Several reduced-scale alternatives were investigated as alternatives to the proposed project. These have been rejected, however, because they do not provide the required benefits of the full-scale option, e.g., mirror coating facility, new emergency generating capacity, etc. The alternatives considered ranged from a "bare bones" design (Option 1) to the preferred alternative. All alternatives include an electrical vault and a mechanical plant containing one ice harvesting unit, with provisions for up to two more units.

The Option 1 AEOS Observatory consists of the telescope pier (Section 3.2.2.1) and the dome enclosure (Section 3.2.2.3). All laboratory spaces are within the pier and no experiment control rooms, offices, or maintenance facilities are provided. In addition to limiting experimental options, this design is undesirable from thermal and vibrational standpoints.

Option 2 expands the Option 1 design by adding the equipment building (Section 3.2.2.2) which contains experimental control rooms, warehouse, mechanical and electrical rooms, and offices. It does not, however, include any provisions for mirror coating, additional emergency generating power, or maintenance facilities.

Option 3a adds the maintenance facilities described in Section 3.2.2.4 to the Option 2 design. Option 3b, the full-scale facility described above, expands upon Option 3a by including the mirror coating facility (Section 3.2.2.4), the new emergency generators, and a personnel tunnel between AEOS and MSSS.

3.3.5 INTEGRATION OF AEOS INTO EXISTING MSSS FACILITIES

Another alternative that was explored involved installing AEOS in the 1.6 meter AMOS dome. This was determined to be not feasible, however, because of the structural and stability requirements of the AEOS pedestal and mount. In addition, installation of AEOS in the existing facilities would preclude an upgrade to an 8-meter class telescope. Therefore, this alternative was rejected.

3.3.6 NO ACTION

This alternative retains the existing MSSS facilities without significant expansion or renovation. No new facilities would be constructed and no new research equipment would be installed.

The types of data collection and research activities that must be carried out at MSSS if it is to fulfill its mission require state-of-the-art equipment. While the existing facilities provided this when they were new, subsequent technological advances mean that this is no longer the case. The existing structures cannot accommodate the equipment needed to keep MSSS a viable facility and do not provide the necessary space required to conduct essential research experiments.

If MSSS is not upgraded to accommodate these evolving needs, it is likely that funds will be reallocated to other institutions and locations. Over time, this would reduce MSSS's usefulness to both the scientific community and the DoD; this could eventually lead the Air Force to severely curtail or cease activities at the site. Although the facilities could be transferred to the University of Hawaii if the Air Force were to abandon them, they are unsuited for the kinds of cutting-edge scientific research that is being funded currently. Consequently, it is likely that they would fall into disuse.

This alternative does not provide any of the benefits afforded by the proposed project. In addition, it would likely result in the eventual abandonment of MSSS. Therefore, it is not considered further.

CHAPTER 4

AFFECTED ENVIRONMENT

This chapter presents an overview of existing environmental conditions in the vicinity of the proposed project. This information provides the environmental context for the impact assessment presented in Chapter 5; additional detail needed to understand specific potential impacts is provided in that chapter.

4.1 LAND USE

As indicated in Chapter 2, the MSSS is located in the University of Hawaii's "Haleakala Observatories" complex at the summit of Haleakala. Other facilities within Haleakala Observatories include the University of Hawaii LURE Observatory, a satellite laser-ranging facility that is under contract to NASA, the University of Hawaii Mees Solar Observatory, and a gamma-ray telescope operated jointly by the University of Hawaii, Purdue University, University of Wisconsin, and the University of Georgia.

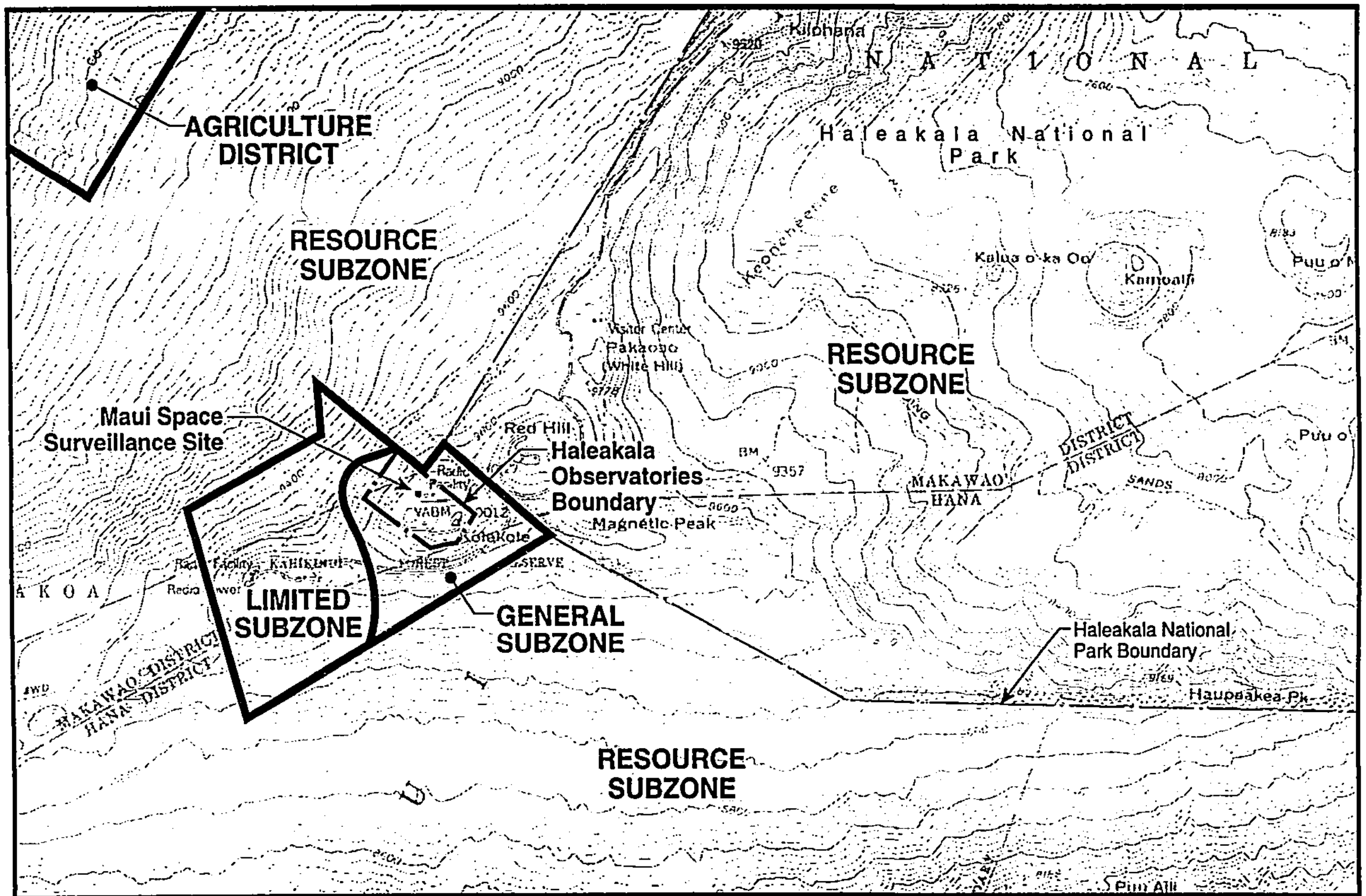
Immediately east of Haleakala Observatories are television transmitting and receiving stations on land which is managed by Hawaiian Broadcasting System, Ltd. A repeater station that is part of the Federal Aviation Administration's (FAA) air traffic control system and a U.S. Department of Energy (DOE) research facility are situated immediately to the west. The other land bordering Haleakala Observatories is owned by the State of Hawaii and controlled by the State Department of Land and Natural Resources.

The entire "Haleakala Observatories" complex is situated in the "general" sub-zone of the State Conservation District (see Figure 4.1). Other nearby conservation areas include the National Park Service's Haleakala National Park and four state forest reserves (Kula, Makawao, Koolau, and Kahikinui). The forest reserves function as watersheds and biological preserves; they are also used for recreational purposes such as hunting, hiking, and camping. Ranch lands used for cattle grazing border these conservation lands. Physical development (e.g., roads, buildings, and water catchment projects) is minimal throughout the conservation and agriculture areas.

4.2 VISUAL SETTING

4.2.1 HALEAKALA OBSERVATORIES AND MSSS

The absence of trees and dark lava ground surface give the summit of Haleakala a barren appearance, particularly since it contrasts so sharply with the lush tropical environment that one passes through on the drive up from the lower part of the mountain.



Note: All subzones are with the State Conservation District.

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SCALE IN FEET

NORTH

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Figure 4.1
STATE LAND USE DISTRICTS

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
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When there is no cloud cover at mid- or upper-elevations on the mountain, the largest of the existing structures in Haleakala Observatories can be seen faintly from as far away as Kahului and Wailuku in Maui's central valley. However, they are hidden from view from most public points on the mountain itself by the natural terrain. The MSSS complex facilities are readily visible along the skyline from the upper portion of the summit access road (Figure 4.2). The nearest public viewpoints are the Pakaoao (White Hill) Visitor Center and the Haleakala National Park's Pu'u Ula'ula (Red Hill) Overlook. The Visitor Center is just over 1,100 meters (3,650 feet) northeast of, and approximately 90 meters (300 feet) below, the MSSS. There is a direct line of sight between the Visitor Center and the MSSS, and MSSS is visible from much of the roadway connecting Park headquarters with the summit. The Pu'u Ula'ula Overlook is located on the east side of Red Hill, just below its summit. It is approximately 550 meters (1,800 feet) to the east-northeast of the MSSS. The intervening terrain blocks direct views between the Overlook and the summit. The views from the Visitor Center and Overlook towards the existing Haleakala Observatories area are shown in Figures 4.3 and 4.4.

The domes of some of the of the existing facilities in Haleakala Observatories, including those in the MSSS, are painted white, while others are aluminized. The colors of the buildings are in contrast to the dark hues of the cinders and lava flows that make up the natural landscape.

4.2.2 CONCRETE BATCH PLANT SITE

The site that the National Park Service has agreed to make available for the temporary concrete batch plant is located in an open area of the National Park Service's maintenance base yard near Haleakala National Park headquarters (Figure 3.8). The area had been used by the National Park Service to store cut trees, brush, and other debris; the Park Service recently removed this material and cleared the site for storage of road construction materials during refurbishment of Haleakala Crater Road. The general appearance of the base yard area, including storage and warehouse structures, is shown in Figure 4.5. Trees block most views of this area from the road; however, it is possible to look down on it from the summit on clear days.

4.3 TOPOGRAPHY, GEOLOGY, AND SOILS

4.3.1 EXISTING TOPOGRAPHY

Haleakala is a large shield volcano that forms the eastern half of the island of Maui. It is capped by an erosional crater, and has a rocky summit and rugged eastern and southwestern slopes. The mountain is dissected by ridges radiating from the summit along the volcano's north, east, and southwest rift zones (Macdonald *et al.* 1983). MSSS is located near the upper terminus of the southwest rift zone. The region south of MSSS, which is bounded by the sea and the extensions of the east and southwest rift zones, is the steepest part of the mountain, forming a cupped, south-facing facet. The ground falls away steeply on either side of the summit. To the west, for example, it drops about 2,000 meters (6,600 feet) over six kilometers (3.7 miles), an average slope of about 30 percent.

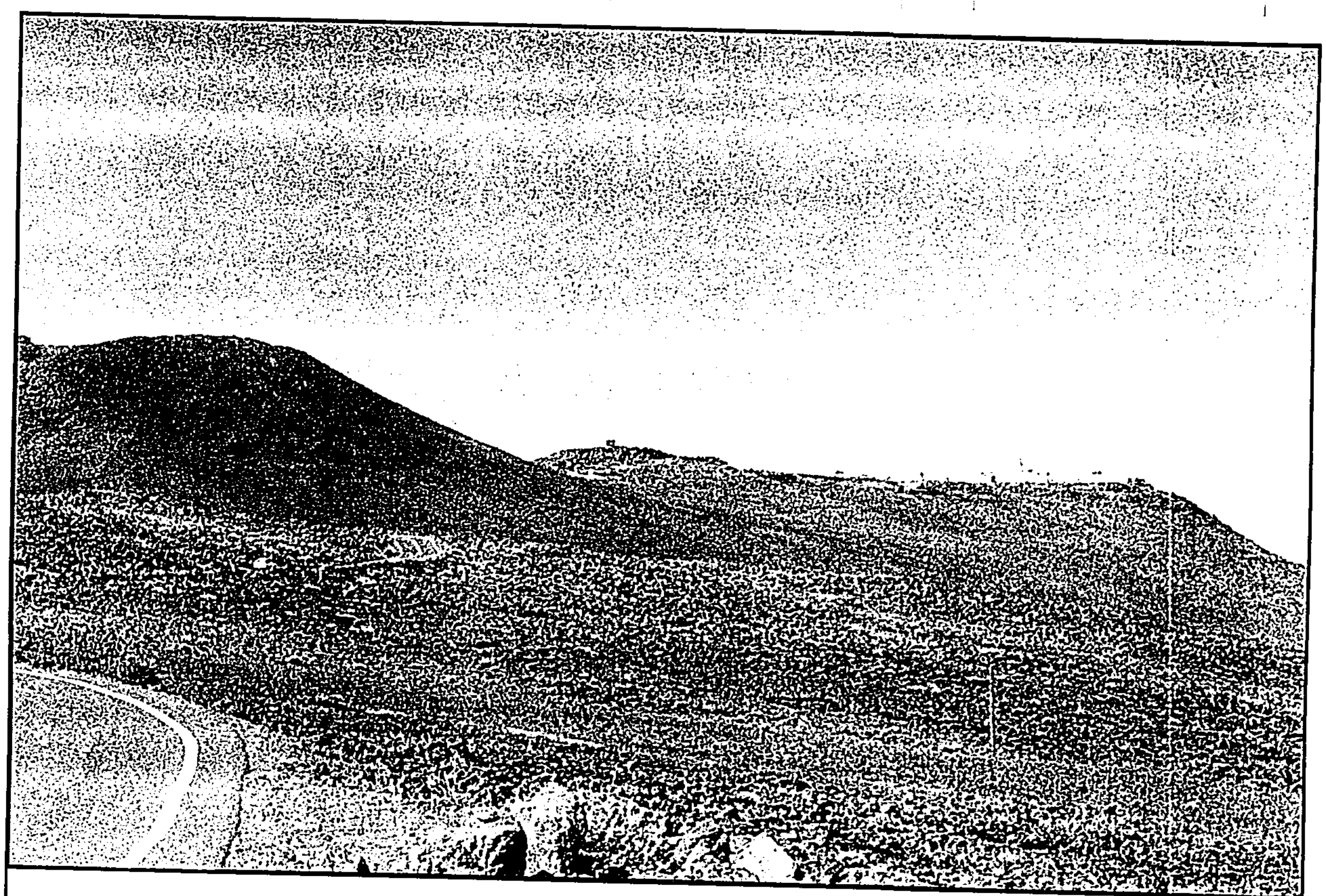

Figure 4.2
VIEW A: TOWARDS HALEAKALA OBSERVATORIES
FROM ROAD APPROXIMATELY ONE MILE FROM SUMMIT

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
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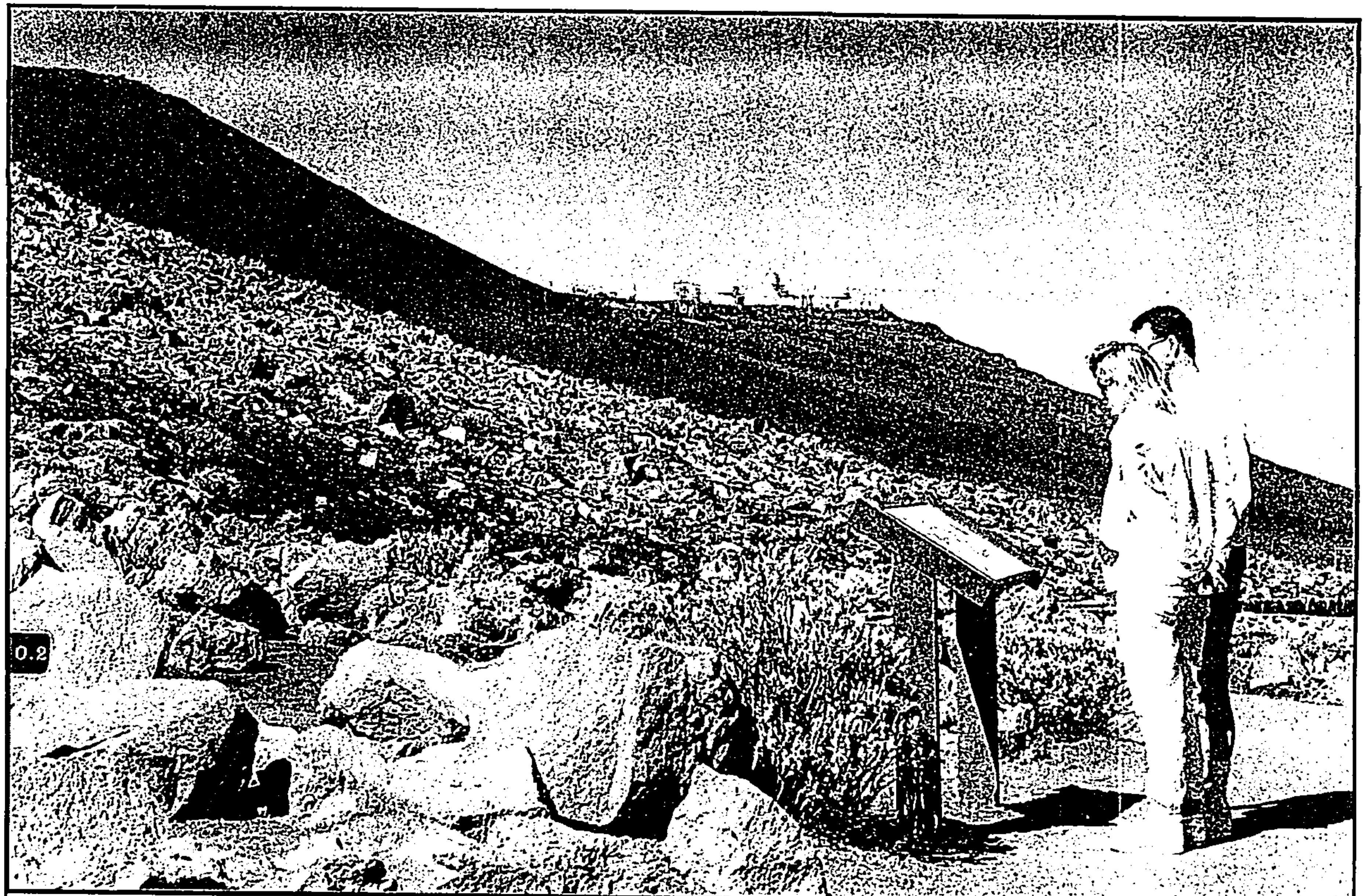

Figure 4.3
VIEW B: TOWARDS HALEAKALA OBSERVATORIES FROM PAKAOAO (WHITE HILL) VISITOR CENTER

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
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233 4100 2/021

Figure 4.4
VIEW C: TOWARDS HALEAKALA OBSERVATORIES FROM RED HILL OVERLOOK

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Haleakala, Island of Maui, Hawaii
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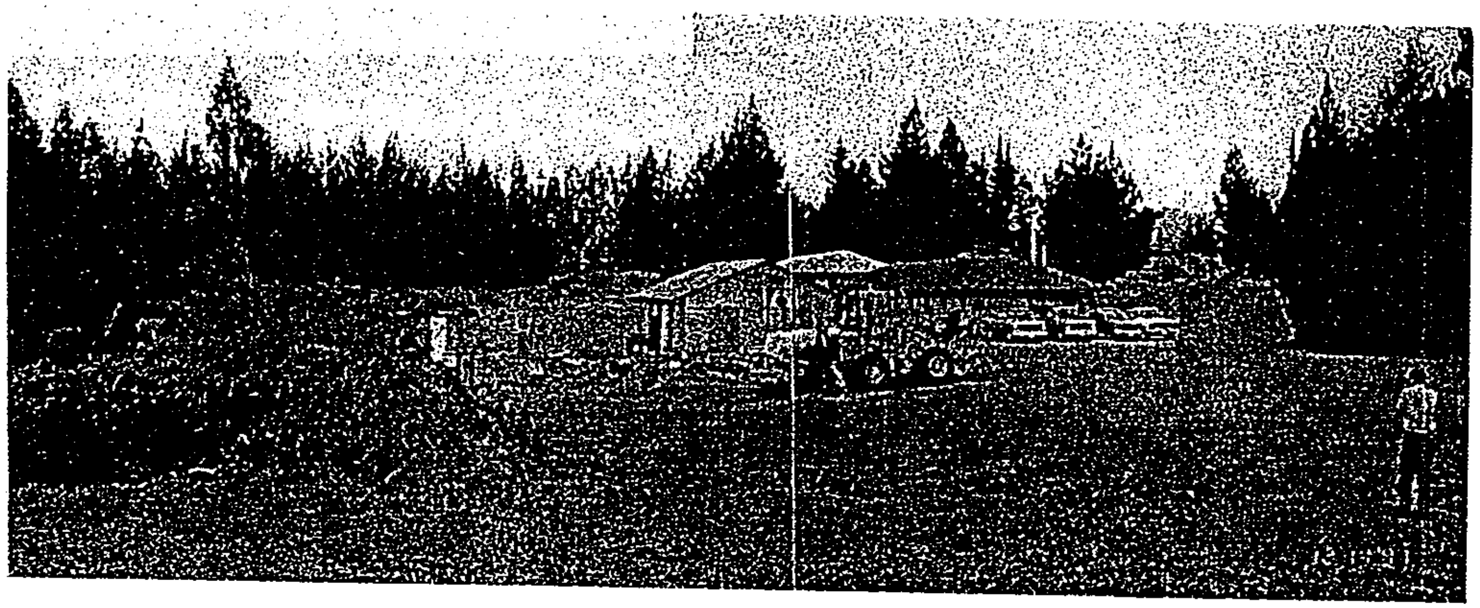

Figure 4.5
VIEW OF EXISTING STRUCTURES IN THE HALEAKALA NATIONAL PARK BASE YARD

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
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233.4100.2/023

The main structures at the MSSS are located approximately 150 meters (500 feet) to the northwest and 15 meters (50 feet) below the highest point on the mountain. The main MSSS building is located at an elevation of 3,030 meters (9,950 feet). The ground slopes upward from there towards the southeast, reaching its highest point within Haleakala Observatories near the site of the old radio telescope. Slopes are fairly steep, exceeding 30 percent in some areas.

Most of the existing MSSS site has been graded to make room for the existing structures and is relatively flat. However, the land slopes steeply away from the property boundaries on all but the southern side.

The site of the proposed concrete batch plant is located at an elevation of 2,065 meters (6,770 feet). It is relatively level, sloping gently upward toward the roadway to the east.

4.3.2 GEOLOGY

4.3.2.1 Eruptive Activity

Haleakala volcano is dormant, with the only eruption during historic times occurring about 1790. That activity was limited to two vents located near the base of the mountain. The lava from this eruption flowed into the ocean and formed Cape Kinau and Cape Hanamanioa (La Perrouse Bay).

The Haleakala Observatories area lies adjacent to a collapsed cinder cone (Bhattacharji 1991). Most of the ground surface in the vicinity of the project site is covered with ejecta from this vent. The lava flows on the eastern flank of the peak between the MSSS and the summit are believed to be a remnant of the eastern flank of the cone. Bhattacharji (1991) characterizes the upper layers of lava in this area as a spatter, vesicular, and tubular zone, with the flow material becoming more massive below this.

4.3.2.2 Seismic Conditions

Likely Sources of Seismic Events. Earthquakes likely to affect the summit of Haleakala are expected to originate in two general areas: (1) the Molokai Fracture Zone (which includes the Island of Maui itself) and (2) the Island of Hawaii. The Molokai Fracture Zone consists of a system of fractures in the sea floor that stretches from the Hawaiian Islands to Baja, California. Although the fracture zone is seismically inactive along much of its length, significant earthquakes are associated with the portion near Hawaii.

Earthquakes that affect the Hawaiian Islands are generated by both volcanic and tectonic activity. Most of the volcanically related earthquakes are associated with underground movement of magma and are relatively small. However, magma sometimes builds up to such a high pressure that the surrounding rock fractures. This can produce large earthquakes, such as the Great Ka'u earthquake of 1868 and the 1975 Big Island earthquake. Because the volcanoes which formed the other islands in the Hawaiian chain are now extinct or relatively inactive, earthquakes from this source tend to be rare.

Tectonic earthquakes can result from the cracking of the earth's crust under the great weight of the islands, as well as from erosion and slumping of the older islands. The Kona earthquake of 1951 (magnitude 6.9 Richter scale) has been attributed to such an outward and downward movement of part of the flank of Mauna Loa.

Magnitude of Past Seismic Events Affecting Maui. The magnitude of an earthquake is a measure of its energy content and, therefore, of its ability to do damage. Based on a review of the data from earthquakes recorded on Maui during historical times, Furumoto (1991) concluded that two large earthquakes generated in the Molokai Fracture Zone, one on February 18, 1871 and the other on January 23, 1938, and the Great Ka'u Earthquake of 1868, probably produced magnitude 7 earthquakes in east Maui as measured on the Richter scale.

Analyzing these events on a statistical basis, Furumoto concluded that an earthquake of magnitude 7 or greater could occur on East Maui on the average of once every 37 years. He further estimated that there is a 90 percent probability that an earthquake with a magnitude of 7 or greater will be felt on Haleakala sometime within the next 75 years. Based on this conclusion, and on the possibility that the summit of Haleakala will oscillate more than the lower elevations where the previous data had been collected, he recommended that buildings planned for the summit be designed to resist a ground acceleration of at least 0.3 g.

4.4 HYDROLOGY

4.4.1 GROUNDWATER

Stearns and MacDonald (1942) identify two basic types of groundwater aquifers in East Maui: basal aquifers that are in contact with seawater, and high-level aquifers that are not in contact with seawater. More recent investigations of Maui groundwater resources produced an Aquifer Code derived from the basic classification system of Stearns and MacDonald (Mink and Lau 1990).

Basal groundwater in Haleakala's rift zones is confined in segmented dikes. The north and east rifts probably contain the largest supplies of dike-confined water because of high rainfall in those areas. However, dike water is also found in the southwest rift zone in which the MSSS is located. This water is thousands of feet beneath the summit, far too deep to be tapped economically by wells.

Perched aquifers contain rainwater that has been retarded in its downward percolation by impermeable or low-permeablility structures such as intrusive rocks, ash beds, and soil. These aquifers are relatively small compared to the basal or dike-confined aquifers. Most of the springs located on the middle and upper slopes of Haleakala are fed by perched water, but few exist in the crater area.

There are no groundwater wells used for drinking water within a 6.4-kilometer (4-mile) radius of the summit (Dames and Moore 1989). The existing facilities at MSSS rely on water from the Maui Board of Water Supply.

4.4.2 SURFACE WATER

Most streams on Haleakala are intermittent, even on the rainy northeast slope, because of the steep, permeable lava terrain. Perennial streams that do exist occur at low elevations and originate from groundwater springs. No perennial streams or other surface water bodies are located within a 6.4-kilometer radius of MSSS (Dames and Moore 1989; Takasaki 1972). Runoff from impermeable surfaces at MSSS drains onto the surrounding areas and infiltrates quickly into the highly permeable cinder surface.

4.5 CLIMATOLOGY AND AIR QUALITY

The climate on East Maui is influenced strongly by elevation and by the dominant northeast trade winds. The summit of Haleakala experiences greater seasonal variations than lower elevations. The windward northeast side of East Maui has a relatively wet, tropical climate; leeward areas to the southwest have a relatively hot, dry, desert-like climate. Temperatures at the Haleakala Ranger Station (2,140-meter [7,000-foot] elevation) average 11 °C (52 °F), but have reached as high as 26 °C (80 °F) and as low as -3 °C (40 °F).

Temperatures tend to be lower at the summit. Temperature data collected between 1985 and 1991 are summarized by month in Figure 4.6. These data show that December, January and February have the lowest average temperature (about 5.5°C, or 42°F) and August has the highest average temperature (10°C, or 50°F).

At higher elevations, sub-freezing temperatures and frost are common in the winter months. Between 1985 and 1991, for example, December temperatures were below zero (Fahrenheit) an average of nearly 20 hours, while sub-zero temperatures occur during February an average of 90 hours. Snow, hail, and sleet fall occasionally from December to February, with thunderstorms sometimes preceding the snowfalls.

Winds are a significant feature of the climatology at the summit. The wind environment is dominated by the northeast trade winds, which are most persistent from March to November. Kona, or southwesterly, winds, which persist for a few days at a time, occur in the winter months. The less frequent Kona winds commonly bring clear weather to the summit, as they prevent formation of low-level clouds associated with the trade winds. Sustained winds of 22 meters per second (50 miles per hour) or more and gusts in excess of 27 meters per second (60 miles per hour) occur virtually every month of the year. The maximum wind recorded at the summit is over 125 miles per hour. The strongest winds generally occur during the winter and are associated with North Pacific storm systems passing through the island chain. Wind data from recording devices at the AMOS facility are summarized in Figures 4.7 and Figure 4.8.

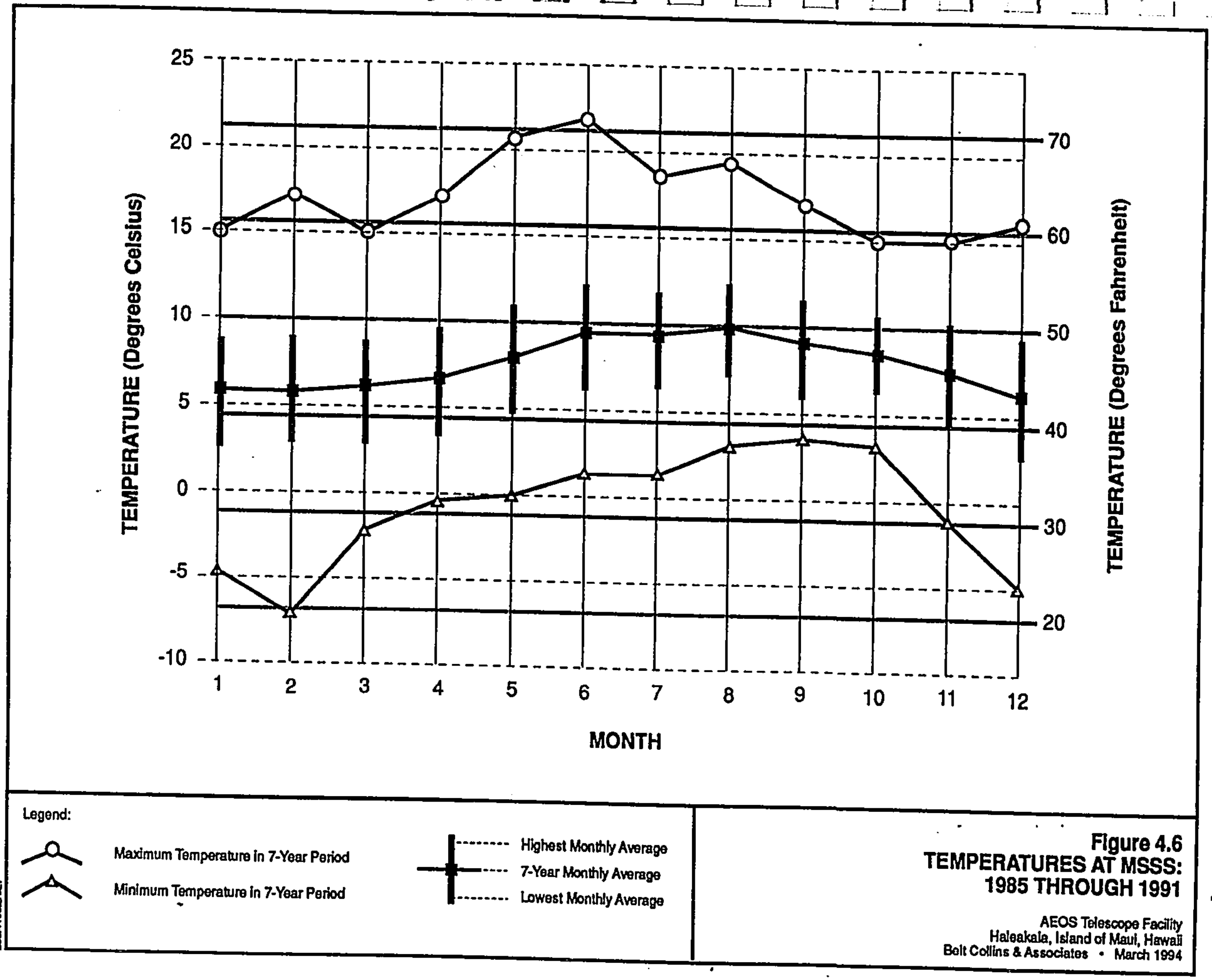
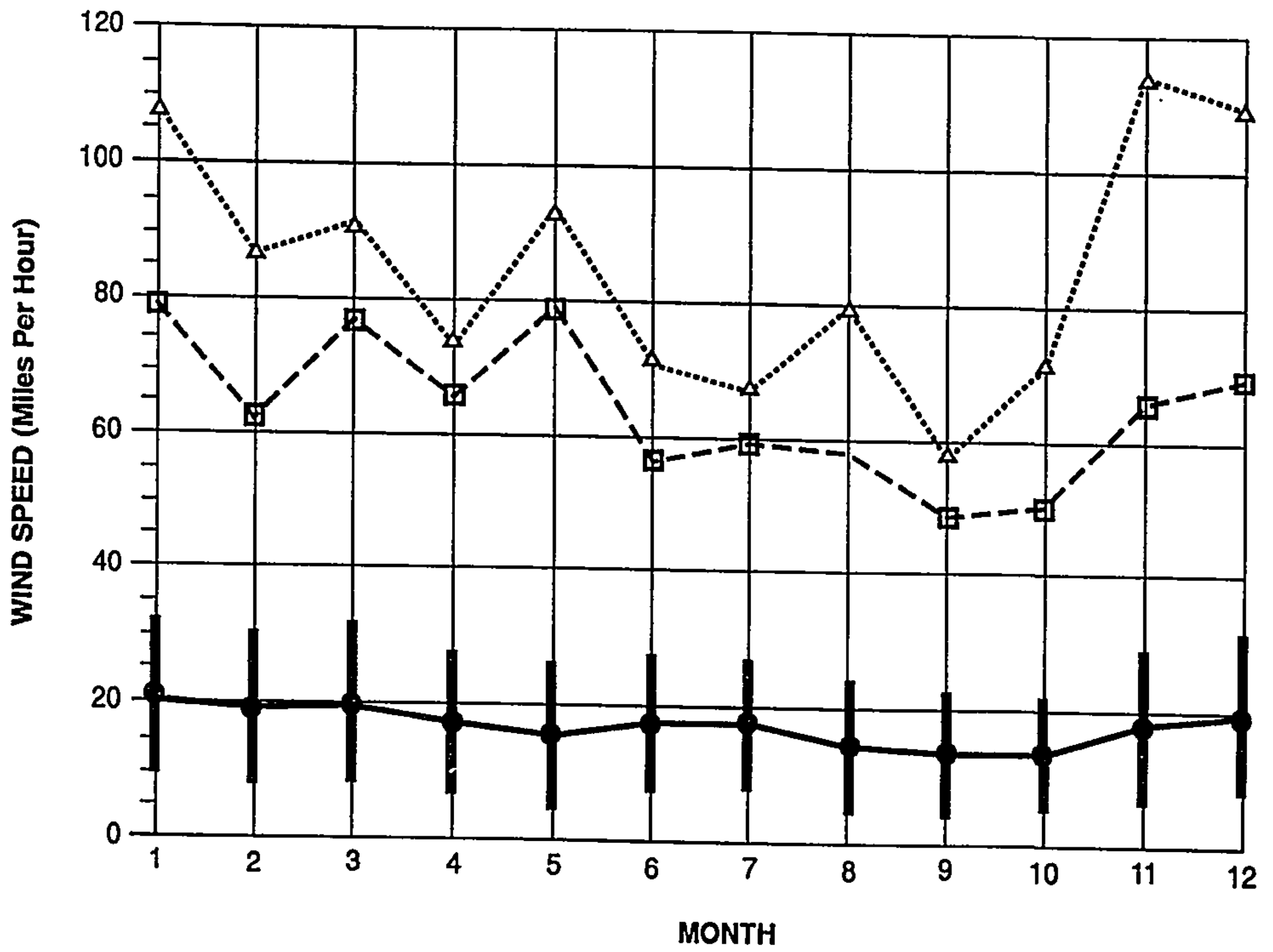


Figure 4.6
TEMPERATURES AT MSSS: 1985 THROUGH 1991

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
Belt Collins & Associates • March 1994

233.4100.2/027



Source: AMOS North Tower Hourly Average Data., 9960 Ft. Elevation

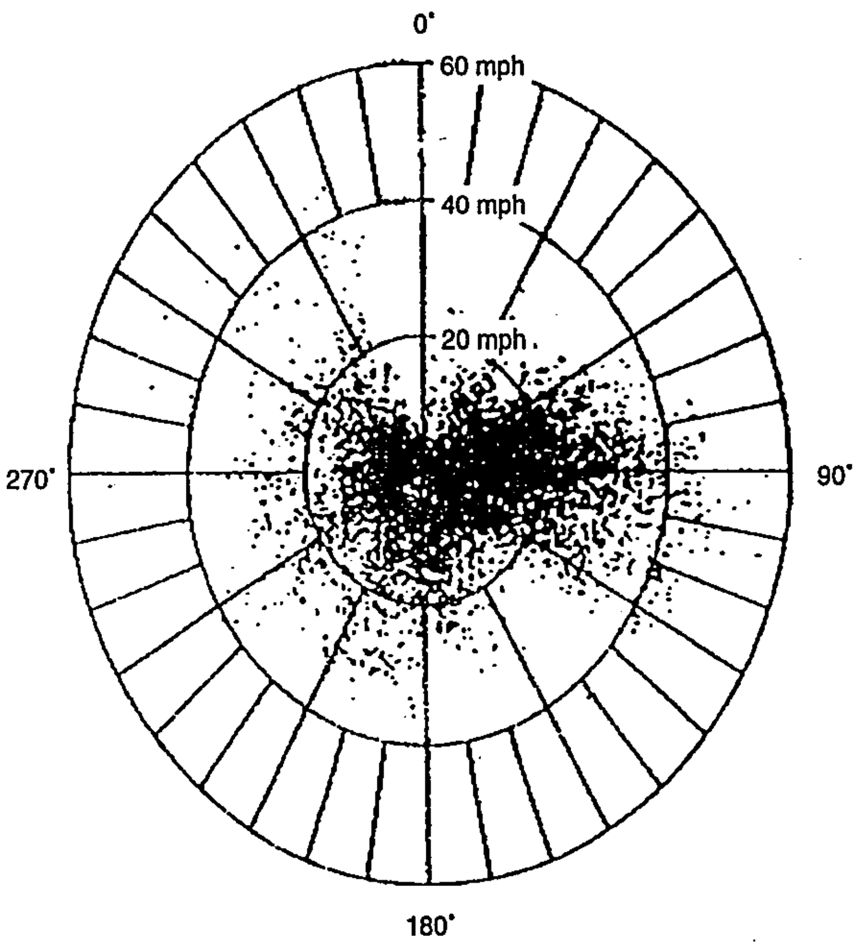
Legend:
Maximum Peak Wind Speed
Maximum Hourly Average
Highest Monthly Average
7-Year Monthly Average
Lowest Monthly Average

Figure 4.7
WIND SPEED AT MSSS:
1985 THROUGH 1991

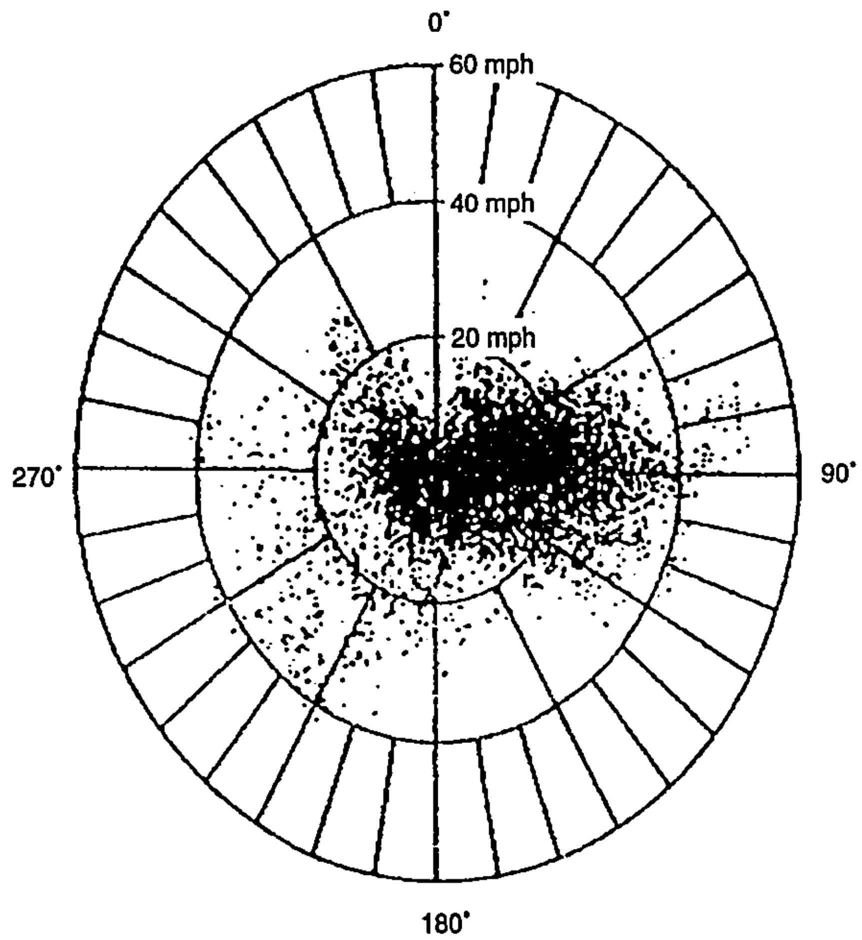
AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
Belt Collins & Associates • March 1994

23.4100.2/028

1989 HOURLY AVERAGE
WIND SPEED AND DIRECTION



1990 HOURLY AVERAGE
WIND SPEED AND DIRECTION



Source: AMOS North Tower

Figure 4.8
WIND SPEED AND DIRECTION AT MSSS: 1989 AND 1990

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
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233.4100.2/029

The heaviest rainfall on Haleakala occurs at elevations between 900 and 1,500 meters (3,000 to 5,000 feet) where the moisture-laden trade winds are cooled as they rise against the mountain front. The air at higher elevations is much drier, and rainfall is substantially lower. At the MSSS, precipitation averages about 64 centimeters (25 inches) per year, with most of this occurring from November through May. Average monthly rainfall in the vicinity of Haleakala Observatories for the period 1963 through 1973 is charted in Figure 4.9.

Air quality at MSSS, and on Haleakala as a whole, is excellent. This is due to the high altitude and the persistent tradewinds, which prevent the buildup of air pollutants. The lack of nearby pollution sources also helps maintain good air quality. The MSSS area is in an attainment area for U.S. Environmental Protection Agency (EPA) "criteria" pollutants. In addition, Haleakala is one of the few places in the state designated as a "Class 1" area with respect to the EPA's "Prevention of Significant Deterioration" regulations. These regulations are designed to maintain air quality in areas that currently are in attainment. Class 1 areas are the most restrictive quality regions.

4.6 BIOLOGICAL ENVIRONMENT

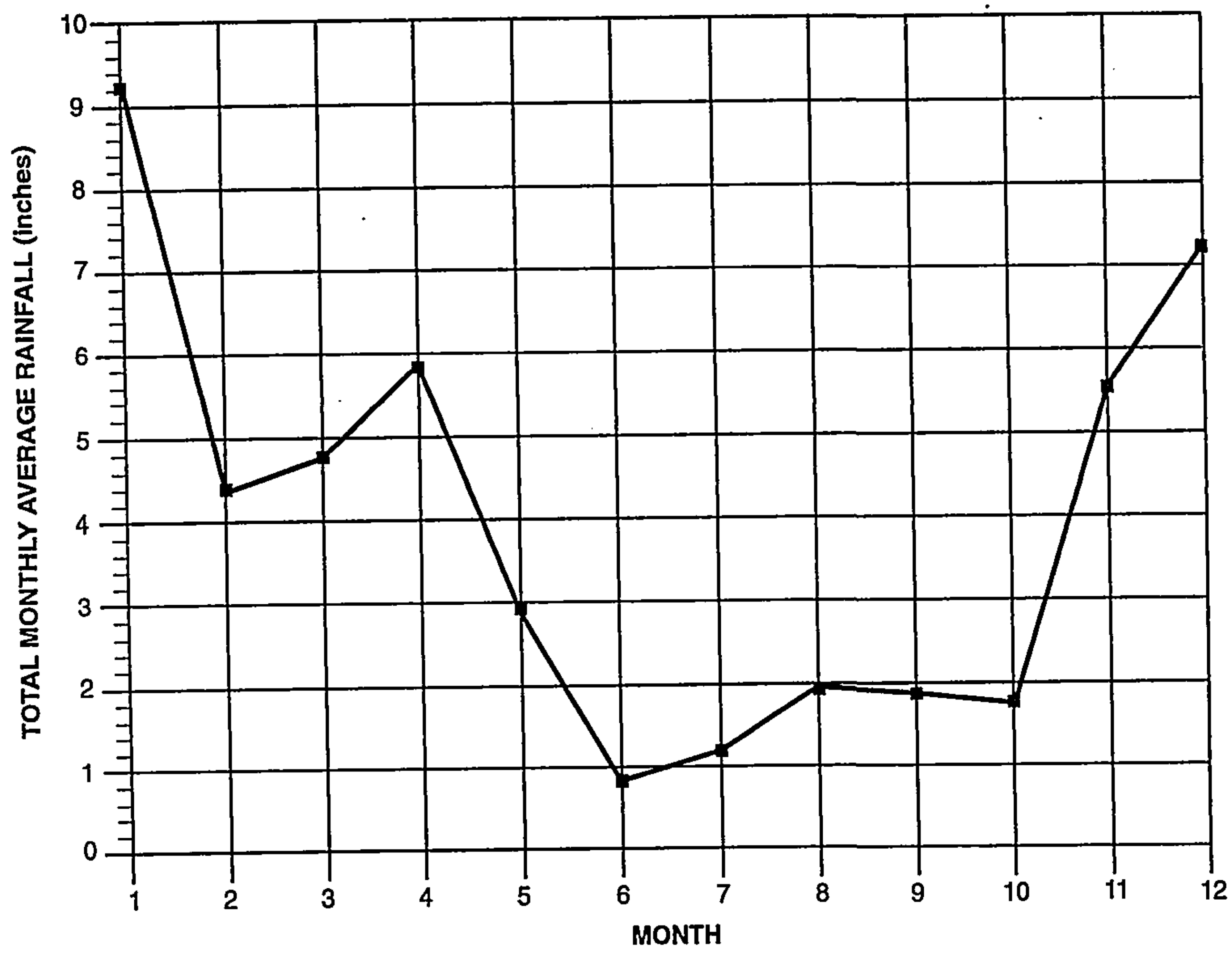
4.6.1 FLORA

4.6.1.1 Haleakala Observatories and MSSS

The summit of Haleakala is classified as an alpine dry shrubland (Wagner *et al.* 1990). A combination of environmental factors, including low temperature and rainfall, minimal moisture-holding capacity of the soils, and strong winds, make the summit a harsh environment for plants. As a consequence, the MSSS area is nearly devoid of plant life (less than one percent plant cover).

A survey of the plants in the vicinity of the existing MSSS facilities and proposed expansion was conducted in October 1990 (see Appendix C; U.S. Air Force 1991). Endemic plants found within the study area (which included most of Haleakala Observatories and extended well beyond the MSSS) included the ahinahina (*Argyroxiphium sandwicense macrocephalum*), kupaoa (*Dubautia menziesii*), kawa'u (*Styphelia tameiameiae*), *Tetramolopium humile*, ohelo (*Vaccinium reticulatum*), hinahina (*Geranium cuneatum*), he'upueo (*Agrostis avenacea*), *Deschampsia nubigena*, and mountain pili (*Trisetum glomeratum*). The threatened ahinahina is discussed further in Section 4.6.3.

A number of non-native species occur at the summit in locations that have been disturbed (e.g., near buildings). These exotic species include dandelion (*Taraxacum officinale*), gosmore (*Hypochoeris radicata*), and common groundsel (*Senecio vulgaris*). All are recently introduced weedy species. Many of these plants occupy, or have spread from an experimental plot of grasses located approximately 20 meters (65 feet) southeast of the MSSS complex that was planted in 1972.



Source: Lyons, *Summer Weather on Haleakala Maui*, UHMET 79.09

Figure 4.9
AVERAGE MONTHLY RAINFALL AT HALEAKALA OBSERVATORIES: 1963 THROUGH 1973

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
Belt Collins & Associates • March 1994

233.4100.2/030

4.6.1.2 Concrete Batch Plant Site

The proposed site of the temporary concrete batch plant was recently cleared and a pile of cut trees and other debris removed by the National Park Service. The site is largely devoid of vegetation.

4.6.2 FAUNA

4.6.2.1 Haleakala Observatories and MSSS

Fauna at MSSS consist primarily of non-native species. The MSSS is not part of the normal ranges of any native amphibians or reptiles (National Park Service 1978; U.S. Air Force 1991). Few insect species occur in the vicinity of MSSS because of the sparse vegetation (see Appendix A).

Introduced fauna occurring within the nearby National Park include chukar partridge (*Alectoris chukar*), mongoose (*Herpestes auropunctatus auropunctatus*), roof rat (*Rattus rattus rattus*), and Polynesian rat (*Rattus exulans hawaiiensis*) (Shallenberger 1986; Tomich 1986). Feral goats (*Capra hircus*), cats (*Felis domesticus*), and dogs (*Canis familiaris*) occur sporadically in the more vegetated areas (National Park Service 1978).

The Hawaiian dark-rumped petrel or 'ua'u (*Pterodroma phaeopygia sandwichensis*), a native bird that is on the endangered species list, is also present in the summit area. The Hawaiian Hoary bat (*Lasiurus cinereus semotus*), also on the endangered species list, has been reported near the summit of Haleakala (National Park Service 1989b). These endangered species are discussed further in Section 4.6.3.

Due to the harsh environment, fewer insects are present at upper elevations on Haleakala than are found in the warm, moist lowlands. However, a unique assemblage of insects and spiders are present on the mountain's upper slopes. A survey of the MSSS and surrounding areas conducted for this environmental assessment (Medeiros and Loope 1992) is reproduced in Appendix A. The study concluded that the proposed site is a typical, but somewhat depauperate example of Haleakala's aeolian zone. The reduced diversity of key invertebrate groups, such as carabid beetles and moctuid larvae, was thought to be due to previous construction on the site. No locally unique taxa were encountered.

4.6.2.2 Concrete Batch Plant Site

As noted above, the concrete batch plant site has been cleared by the National Park Service. Hence, minimal fauna are likely to be present when the area is used for the proposed project.

4.6.3 THREATENED OR ENDANGERED SPECIES

Two species listed by the U.S. Fish and Wildlife Service as threatened or endangered are known to occur within the vicinity of the proposed project area. These are the silversword, or ahinahina (*Argyroxiphium sandwicense macrocephalum*) and the Hawaiian dark-rumped petrel, or 'ua'u (*Pterodroma phaeopygia sandwichensis*).

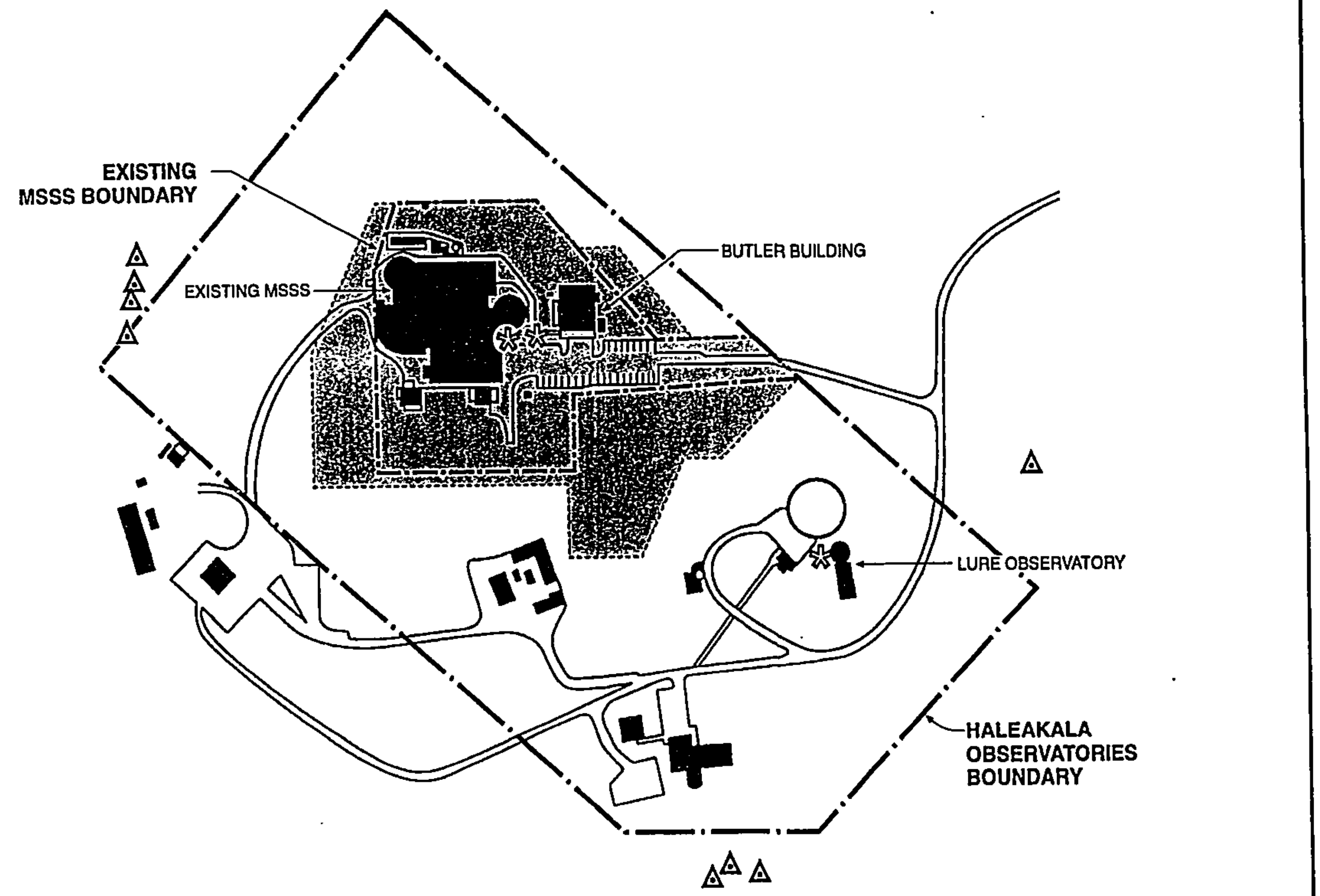
Ahinahina. The ahinahina, or silversword, is found only on Haleakala and on Mauna Kea on the Island of Hawaii, growing at elevations between 2,125 and 3,750 meters (7,000 and 12,300 feet). The variety found on Haleakala is designated threatened by the U.S. Fish & Wildlife Service.

Three ahinahina have been successfully transplanted to locations within the MSSS complex, and a fourth ahinahina is growing near the LURE facility. The oldest ahinahina within the existing MSSS complex flourished until it bloomed, then died, a natural part of its lifecycle. The remaining plants continue to do well. Figure 4.10 shows the locations of existing ahinahina plants.

Hawaiian Dark-Rumped Petrel. The Hawaiian dark-rumped petrel or 'ua'u is listed as an endangered species. It occurs regularly on the islands of Maui, Lanai, and Hawaii, but the only known breeding colony occurs on the summit of Haleakala (Simons 1985). Critical habitat has not been defined for this species. 'Ua'u may be found in deep burrows inside and outside Haleakala Crater from late February to early November; they spend the remainder of the year at sea. All known burrows are at elevations ranging from about 2,100 meters (7,000 feet) to 2,900 meters (9,500 feet). About 77 percent are located in three sub-colonies along the inner wall of the west crater rim, approximately 970 meters (3,200 feet) northeast of MSSS. Two other sub-colonies in the vicinity of MSSS have been mapped—one outside the west rim, and one south of Haleakala Observatories (Simons 1985). Active burrows nearest MSSS have been found 120 meters (390 feet) to the west, 250 meters (820 feet) to the southeast, and 330 meters (1,080 feet) to the southeast. The locations of these burrows are shown in Figure 4.10.

Most 'ua'u arrive at the summit during March and April; egg-laying generally occurs in May. The eggs are incubated from then until July, when hatching occurs. Adults that did not breed or whose eggs failed to hatch usually depart during August. 'Ua'u chicks are fed at approximately two- to three-day intervals for their first three months (July to September), then less frequently through October (Simons 1985). Fledging occurs between mid-October and mid-November.

The 'ua'u fly to and from their nests after dark (Simons 1985). They are assumed to approach the crater from the west and leave through the Koolau Gap to the north where rim elevations are less than 2,900 meters (9,500 feet). Primary threats to the 'ua'u are thought to be predation by rats, dogs, and mongooses; collapsing of burrows by feral goats; collisions with artificial light sources; and disease (U.S. Fish and Wildlife Service 1983).



Source: ***Environmental Impact Analysis Process***, Programmatic Environmental Assessment Maui Space Surveillance Site, Department of the Air Force, May 1991

LEGEND

- Ahinahina Plants
- 'Ua'u Burrows
- Approximate Limit of Disturbed Area

Figure 4.10
LOCATION OF AHINAHINA AND 'UA'U BURROWS IN THE VICINITY OF HALEAKALA OBSERVATORIES

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
Belt Collins & Associates • March 1994

233.4100.2/031

Other Species. Another federally listed endangered species, the nene or Hawaiian Goose (*Nesochen sandwicensis*), occurs only on the islands of Maui (on Haleakala) and Hawaii (on Mauna Loa and Hualalai) above elevations of 1,200 meters (4,000 feet). The nene sanctuary on Haleakala is located on the northeast slope between approximately 1,500 meters (5,000 feet) and 2,100 meters (6,900-feet elevation). Suitable habitat does not occur in the vicinity of MSSS, and the nene is not known to occur at the MSSS elevation (U. S. Air Force 1991).

The Hawaiian Hoary bat (*Lasiurus cinereus semotus*) is a federally listed endangered species. Although a resident of lowland forests (Tomich 1986), it has occasionally been observed at elevations up to 4,000 meters (13,000 feet) (U. S. Air Force 1988b). This nocturnal species forages primarily on flying insects, which it tracks using reflection of high-pitched sounds which it emits. The population size is estimated at several thousand, with the largest number occurring on the island of Hawaii (Tomich 1986). National Park Service records indicate that one bat was found in the south park boundary fence and another near Kalahaku Overlook at an elevation of 2,800 meters (9,200 feet). Other individuals have been found dead at about the same elevation, and observations of the bat flying in the summit area have been reported. It is considered extremely unlikely that this species is a resident at the summit, however, because it is unsuited to the cold temperatures there (Tomich 1986; U. S. Air Force 1988a). At an elevation of approximately 2,065 meters, the location of the proposed concrete batch plant is within the theoretical range of the bat.

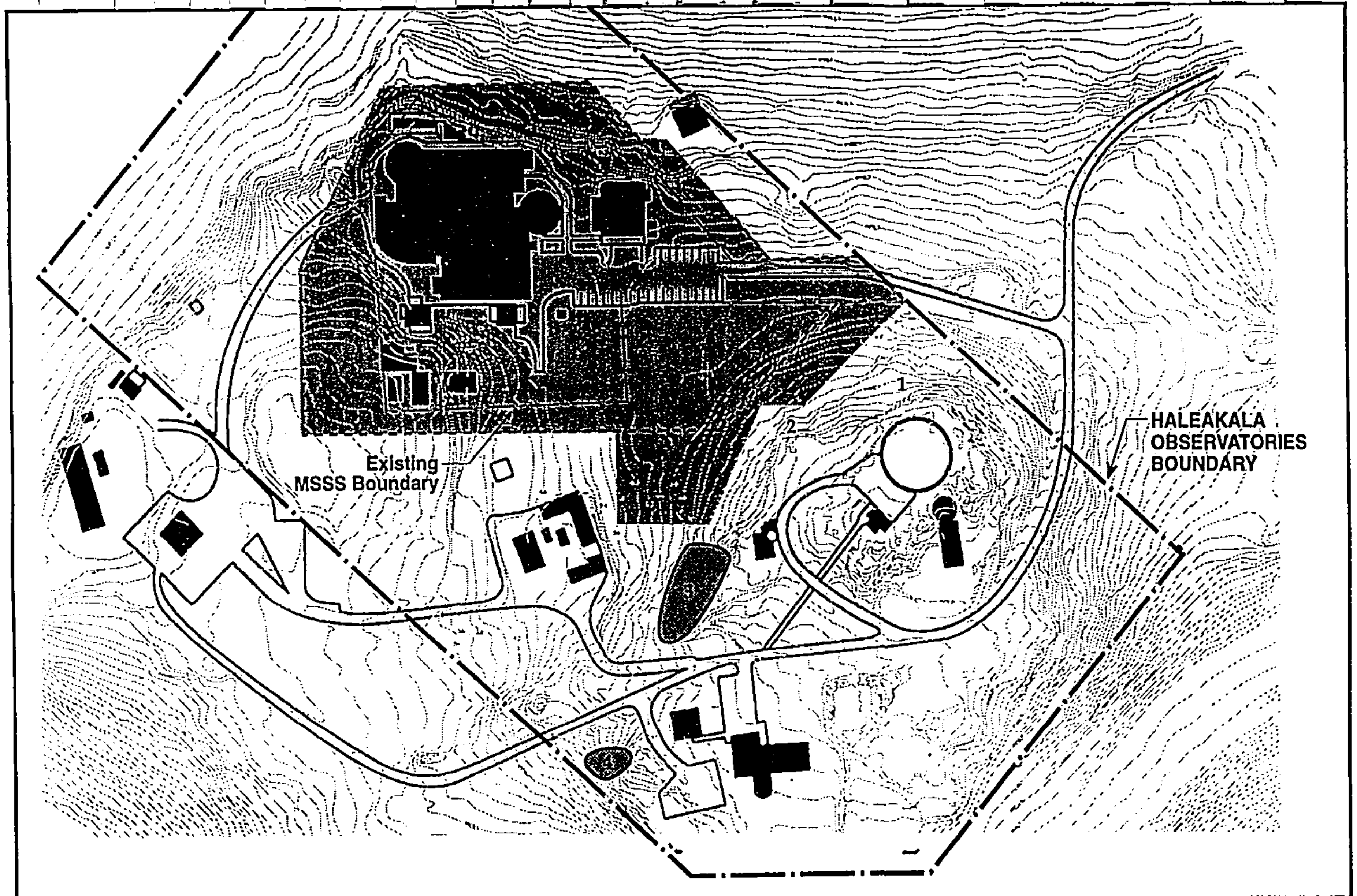
4.7 HISTORICAL, ARCHAEOLOGICAL, AND CULTURAL RESOURCES

4.7.1 HALEAKALA OBSERVATORIES AND MSSS

In pre-historic times, Haleakala Crater was used as a trans-Maui thoroughfare and as a source of basalt for adze blade manufacture. Numerous archaeological sites have been recorded on the crest and in the crater, including, in order of frequency, temporary shelters, cairns, platforms with presumed religious purposes, adze quarries and workshops, caves, and trails (Rosenhdahl 1978).

A literature review and archaeological survey of the Haleakala Observatories property conducted for the U.S. Air Force's Programmatic Environmental Assessment of the MSSS (U.S. Air Force 1991) revealed four archaeological sites outside the boundaries of MSSS. All sites contain one or more temporary, single-person shelters consisting of low rock walls built to enclose leveled sleeping platforms constructed against natural wind breaks. Two sites, numbered 50-11-2805 and 50-11-2806, are located along the north face of the rocky promontory called Kolekole (Figure 4.11), north of the LURE Observatory. Each site contains a single shelter. The other two sites, Sites 50-11-2807 and 50-11-2808, are located in the south-central part of Haleakala Observatories; they contain 14 shelters and three shelters, respectively. All are outside the project area.

A literature review revealed no historic mention of this area. Real estate records of the State of Hawaii reveal that the site has been owned by the State since the institution of the modern system of land ownership.



Source: *Cultural Resources Inventory & Evaluation for Science City, Conducted for Expansion of the Maui Space Surveillance Site, Haleakala, Maui, Hawaii*, J.C. Chatters, July 1991.

0 40 80 160 320
SCALE IN FEET

NORTH

LEGEND

Archaeological Sites:

1: Site 50-11-2805
2: Site 50-11-2806
3: Site 50-11-2807
4: Site 50-11-2808

Approximate Limit of Disturbed Area

Figure 4.11
LOCATION OF ARCHAEOLOGICAL SITES IN HALEAKALA OBSERVATORIES

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
Belt Collins & Associates • March 1994

233.4100.2/032b

4.7.2 CONCRETE BATCH PLANT SITE

No surficial archaeological or historic sites are present on or in the vicinity of the temporary concrete batch plant site. Moreover, the National Park Service's past use of the area is likely to have destroyed any shallow sub-surface resources that may have been present.

4.8 INFRASTRUCTURE

4.8.1 ROADS/TRAFFIC

All vehicular traffic to and from Haleakala Observatories is via Haleakala Crater Road, a two-lane roadway through the National Park. This road is owned and maintained by the National Park Service from its intersection with Haleakala Highway through the National Park, to the park boundary adjacent to Haleakala Observatories. Maintenance of the segment within Haleakala Observatories is the responsibility of the University of Hawaii. Several routes are available below the Haleakala Highway/Haleakala Crater Road intersection, but the majority of vehicles use Haleakala Highway.

Most vehicles using Haleakala Crater Road are occupied by visitors to the National Park. In April 1991, traffic averaged approximately 1,900 vehicles per day. Of this, fewer than five percent were believed to be associated with facilities located in Haleakala Observatories. The highest traffic volumes occur from early morning, when visitors drive up the mountain to view the sunrise, until about 10:00 am. On a typical day in April 1991, the peak hourly count was approximately 185 vehicles. The high elevations, relatively steep grades, and numerous switchback curves on the road limit vehicle speeds, particularly those of trucks and buses.

4.8.2 WATER

As previously indicated, the groundwater aquifer beneath the site is so deep that it is prohibitively expensive to bring water to the surface. No groundwater supply wells are located within 6.4 kilometers (four miles) of MSSS (Dames and Moore 1989). Instead, MSSS relies on Maui County Board of Water Supply for water that is trucked to the summit and stored in a 73,000-gallon capacity underground storage tank. Water usage varies significantly, depending on the type of projects being undertaken at the facility and ranges from approximately 5,000 to 20,000 gallons a week. The water system is operated under a State of Hawaii permit as a public drinking water system.

Water for fire-fighting at the existing MSSS facilities is supplied from a 10,000-gallon capacity non-potable water tank. Dry chemical and carbon dioxide fire extinguishers are available as well.

Water used at the Haleakala National Park base yard is collected from intermittent springs and surface runoff, and stored in tanks near the facilities (National Park Service 1978). The National Park Service's system does not have sufficient capacity to meet the needs of the proposed concrete batch plant, however. An unused rainwater catchment system and 100,000 gallon storage tank are located near Hosmer Grove, a short distance from the proposed batch plant site. The system is currently in disrepair, but the Air Force, in conjunction with the Park Service, will rehabilitate it prior to the start of construction. The catchment system will supply non-potable water for various construction needs of the AEOS project.

4.8.3 POWER/COMMUNICATIONS

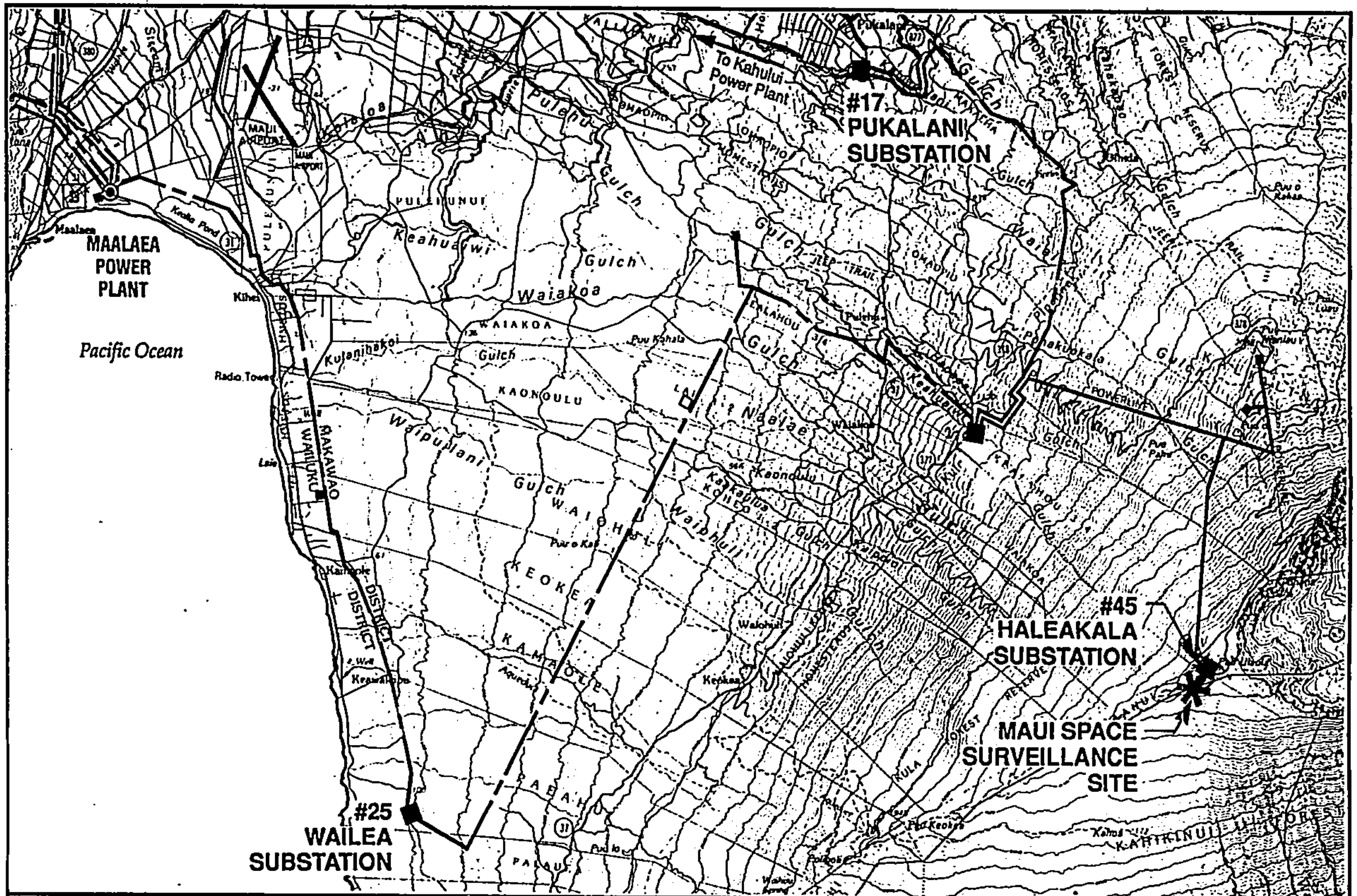
The existing MSSS facilities obtain electrical power from the Maui Electric Company's (MECO) Ma'alaea and Kahului power plants. Power is transmitted up the mountain by overhead 69 kV lines from Wailea Substation (No. 25) and Pukalani Substation (No. 17) to Kula Substation (No. 13). The Kula Substation transforms the voltage from 69 KV to 23 KV via two transformers. The first transformer is a 7,500 KVA, 69 KV to 12 KV transformer and the second a 1,500 KVA, 12 KV to 23 KV transformer. Haleakala Substation (No. 45) reduces the voltage to 4.16 kV. The location of Haleakala Substation relative to the MSSS is shown in Figure 2.3. A 4.16 kV overhead line extending across the site provides power to the FAA, DOE, and University facilities at the summit. MSSS is served by Substation No. 44, which is connected to Haleakala Substation by an underground line. The maximum demand load recorded on Substation No. 44 was 685 kVA, in May 1991 (locations of transmission lines and substations are shown on Figure 4.12).

A 500 kW capacity emergency diesel-powered generator unit was installed at the MSSS in 1985 to insure continuation of power in the event of a failure in the MECO system. Fuel lines connect the generator with a 15,000 liter (4,000 gallon) fuel tank located on the south side of the MSSS. The tank is within a 53,000 liter (14,000 gallon) concrete basin that provides more than adequate secondary containment.

GTE Hawaiian Telephone (HTCO) supplies telephone service to the facility. The telephone lines are located within an underground conduit that surfaces south of the MSSS within Haleakala Observatories. The lines then run on above ground utility poles to the existing MSSS facility.

4.8.4 WASTE DISPOSAL

Currently, wastewater from the existing MSSS facilities is disposed of through two septic systems; one serves AMOS/MOTIF, the other serves GEODSS. Each consists of a septic tank and leach field. The GEODSS septic system is located south of the main building and receives approximately 650 gallons of non-industrial waste per day (Dames & Moore 1989). The AMOS/MOTIF septic system, located north of the main building, receives about 1,200 gallons of wastewater per day. Nearly all is domestic wastewater and grey-water from the sinks in the building.



Source: Maui Electric Company

NORTH

0 10000 20000 40000
SCALE IN FEET

LEGEND

———	23 KV
— — —	69 KV
■	Substation

Figure 4.12
MAUI ELECTRIC COMPANY
TRANSMISSION SYSTEM: CENTRAL MAUI

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Haleakala, Island of Maui, Hawaii
Belt Collins & Associates • March 1994

233.4100.2/051m

MSSS generates very little solid waste. Trash is collected two times a week by the site contractor and disposed of off-site in a licensed landfill. Computer paper and aluminum are recycled. Hazardous wastes and petroleum product wastes are segregated at the generation point and handled separately. Sampling and analyses of hazardous wastes are performed by the waste disposal contractor prior to removal off-site for disposal. In addition, MSSS has a Hazardous Waste Management Plan to ensure that management procedures are in place to comply with the Resource Conservation and Recovery Act (RCRA), as amended, and implementing regulations (Rockwell Power Systems 1992b). A Petroleum Products Recovery Plan includes procedures to ensure that petroleum products and wastes are handled in an environmentally acceptable manner (Rockwell Power Systems 1992d). The MSSS is in compliance with the Federal Facilities Compliance Act of 1992.

4.9 NOISE

Existing noise levels in the vicinity of the MSSS are low, with wind noise accounting for the majority of background noise. Vehicles driving to and from the MSSS and other facilities in Haleakala Observatories are the loudest regular noise sources, and air conditioning compressors and exhaust fans can be heard in certain areas. Spot measurements made in the vicinity of the Butler building on a day with moderate wind speeds indicated instantaneous noise levels on the order of 45 to 50 dBA; noise levels very close to exhaust fans were somewhat louder, but none were obtrusive. It is expected that background noise levels during periods of low wind speed would be lower.

As indicated above, the existing facilities are equipped with a diesel-powered emergency generator. The unit, which is located on the southwest corner of MSSS, operates only when there is a failure in the power supplied by the MECO system or during periodic testing of the equipment. Because of its intermittent operation, no measurements were made of noise from the diesel generator during the course of this study. Generic data compiled by the U.S. Environmental Protection Agency indicate that similar equipment typically produces noise levels between 75 and 80 dBA at a distance of 50 feet. The existing emergency electrical generator is probably somewhat quieter because of the enclosure in which it is located.

4.10 VIBRATION

Dames and Moore, Rockwell Power Systems, and the National Park Service conducted a ground vibration study in January 1993 (Dames and Moore 1993). During the study, vibration recordings were made of operation of one of MSSS's existing domes, and of visitor-related activities in the National Park. Results of the study indicate that ground vibrations at MSSS, at Red Hill Overlook, and at various roadside sites are well below the level perceptible to humans. The highest vibrations were produced by rotation of one existing telescope dome at MSSS, and by bus traffic and opening and closing doors at the Red Hill Overlook. Even the highest vibrations measured were approximately an order-of-magnitude less than the level of perception. These vibrations are not known to have caused any disturbances to petrels or other biota in the area.

CHAPTER 5

ENVIRONMENTAL CONSEQUENCES

This chapter discusses the environmental effects that are likely to result from the construction and operation of the proposed 8-meter AEOS telescope and support facilities. As discussed in Chapter 3, a 3.67 meter telescope and appropriately-sized dome enclosure will be installed initially and replaced with an 8-meter instrument as the technology and funds need to accomplish this become available. Where this phasing has a significant influence on the potential environmental consequences of the proposed action, the effects of the different phases are discussed.

5.1 CONSTRUCTION PERIOD IMPACTS

5.1.1 TRANSPORTATION IMPACTS

Construction of the initial phase of the proposed project is expected to take approximately 18 months. Construction would not affect the number of trips made by employees of the existing facilities, but it would generate trips by construction workers and vehicles bringing construction equipment and materials to the site. Forecasts of the traffic type and volume of vehicle-trips that would be generated by the construction activities were compared with estimates of roadway capacity to determine if these movements are likely to have a significant adverse effect on the level of service provided by the roadway system.

5.1.1.1 Trip Generation

From a volume standpoint, the greatest trip generation is likely to occur late in the construction period when numerous tradespeople would drive to the summit each day to complete the finishing work on the new buildings. Based on the construction scenario outlined in Chapter 3, it is possible that as many as 125 persons might be on-site on a given day, although the number would normally be in the range of 50 to 75 persons. Contractors would provide group transportation for at least some of these workers, and the distance and time that it takes to reach the summit from most workers' homes means that there is also likely to be a substantial amount of voluntary car-pooling. Because of this, it is estimated that the average number of persons per vehicle would be substantially higher than is typical of most construction jobs. A figure of 1.5 persons per vehicle was used for this analysis, but it is likely that the number may be two or more persons per vehicle.

Assuming a 7:00 am starting time for construction, which is typical for work on Maui, most of the vehicles would pass through the intersection of Haleakala Highway and Haleakala Crater Road (the summit access road) between 6:00 and 6:30 am. Most of the vehicles would have reached that intersection via Haleakala Highway and would, therefore, make left turns from Haleakala Highway onto Haleakala Crater Road. For the most part, these vehicles would consist of automobiles and light trucks, but some contractors might use medium-duty trucks and/or vans at least part of the time. During mid-day, relatively few automobiles would travel to and from the site, probably averaging just a few per hour.

The heaviest truck traffic would occur between the concrete batch plant site and the AEOS site when concrete pours for the dome foundation are underway. During that time, as many as 12 mixer trucks per hour may make the trip between the batch plant and the construction site, and travel at this intensity would continue until the pour is completed, as long as 24 to 48 hours. While it is desirable from a construction standpoint for the pours to be made during the daytime, night work is possible.

A number of elements that would be used for the AEOS project would be fabricated off-site and transported to the site. The telescope base, with an estimated weight of about 45 tons, would be the heaviest of these. In addition, some of the structural members and wall sections would be quite heavy and/or oversize. Transporting these items to the summit (or in some cases to the concrete batch plant site) would require large, slow-moving vehicles. The exact number is uncertain, but it is reasonable to assume that at least a dozen such loads would be transported up the mountain. Current plans are to do this during mid-day or nighttime, when other traffic is at a minimum.

5.1.1.2 Traffic Impacts

Because of the popularity of the view of the sunrise from atop Haleakala, peak up-hill traffic on Haleakala Crater Road just above its intersection with Haleakala Highway occurs about one and a half hours before sunrise (in April 1991, for example, the highest 30-minute period was between 4:15 am and 4:45 am, when 58 up-bound vehicles were counted). Traffic slacks off to about a third of that number during the period when vehicles bound for AEOS would be up-bound on Haleakala Crater Road. Virtually all of the uphill traffic would consist of automobiles and light trucks. This and the very light opposing traffic on Haleakala Highway (which becomes Kekaulike Avenue south of the intersection) during this period means that the intersection and Haleakala Crater Road would continue to operate at service level "A"[1] throughout construction.

Downhill construction worker traffic would peak during the late afternoon, adding about 50 vehicles to the approximately 80 peak-hour downhill vehicles that are currently recorded. The total (130 vehicle-trips per hour) is far below the capacity of the road and the intersection. Service levels would remain at "A" during this period as well. As previously noted, project-related automobile traffic would be light during the middle of the day. Hence, no capacity problems are anticipated during this time period.

A more serious concern is the effect of the large, heavy trucks that would occasionally travel up the mountain carrying equipment and construction materials to the summit. These movements would inevitably cause some slow-downs and queuing. However, the number of large, oversize loads that would be needed is small, and they would be mobilized during off-peak hours when other traffic is light. Hence, disruption

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[1]Service level "A" is the highest level of service; on open roads it is characterized by free flowing traffic in which there is little or no restriction on speed or maneuverability. At intersections, service level "A" represents a situation where average delays are minimal.

to the operations of the National Park and inconvenience to visitors is expected to be slight.

5.1.1.3 Harbor and Airport Facilities

The construction materials and equipment that would be used for the AEOS project are sizeable relative to existing facilities atop the mountain. They are, however, relatively small compared to what moves through Kahului Harbor on a regular basis. Hence, the land-based facilities needed to handle them are already in place. Similarly, Kahului Airport provides ready access to other airports in the state and is currently served by direct flights to and from the mainland United States. No airport additions or alterations would be required to accommodate AEOS.

5.1.1.4 Mitigation Measures

The loads that would be trucked to the summit would meet existing load standards of the State Department of Transportation. Hence, no exceptional road maintenance requirement is expected on Haleakala Highway or other state roads. The Air Force is coordinating all of its construction plans with the National Park Service and has prepared a written agreement to fund repairs to Haleakala Park Road prior to the start of construction. Weakened roadbed areas have been identified by the Federal Highways Administration and repairs are expected to result in a roadway surface that will accommodate all Park traffic, including construction traffic associated with AEOS, for the remainder of the decade.

To ensure the safety of park users, a signal person will be stationed at the intersection adjacent to the Park maintenance base yard whenever significant numbers of heavy trucks are expected to be travelling between the concrete batch plant and the summit (e.g., during concrete pours).

5.1.2 ATMOSPHERIC IMPACTS

5.1.2.1 Gaseous Emissions

The temporary batch plant would probably be run by diesel-powered motors. These, and other diesel-powered construction equipment would generate air emissions. These emissions would be temporary, however, and are not expected to be significant.

Vehicles bringing workers and material to and from the summit would also contribute emissions. The proposed project would not increase peak-hour traffic above current levels. Therefore, it would not substantially affect peak emission rates of gaseous pollutants. Total vehicular emissions are too small to alter ambient concentrations for averaging periods longer than approximately one hour, the averaging period of concern.

5.1.2.2 Particulate Matter

Summit Area. AEOS's greatest potential for affecting air quality at the summit is associated with fugitive dust emissions during site grading. Measurements from the preliminary site plan for the proposed AEOS facility indicate that up to 1.5 acres would be disturbed during site preparation. Most of this area consists of cinders with only a small amount of fine-grained soil. Some of the material excavated during construction of the foundations would be used to re-contour the site. Any excess material would be trucked down the mountain to the National Park's base yard and stored there for use in park maintenance activities. Additional particulate matter may be generated by the movement of heavy construction equipment across the exposed cinders.

Maintenance of good air quality is critical to the Air Force's ability to continue to make full use of its existing facilities at the MSSS. Thus, the Air Force has a vested interest in limiting fugitive dust emissions. Consequently, foundations would be completed as soon as possible after the land is graded to limit the period of time that the land is exposed. Dust suppression measures, particularly wetting exposed areas, will be undertaken. The construction lay-down area would be limited in areal extent (Figure 3.7), and areas subject to repetitive vehicle movements would be sealed using the binding agent used to construct the roadway to reduce their contribution to particulate levels.

Concrete Batch Plant Site. Sand and gravel storage piles normally contain clean material and so are minor sources of particulate matter. The greatest potential for emissions at the batch plant is the release of particulates when dry cement is being loaded into mixer trucks. Modern plants contain emission control devices designed to capture fugitive dust. As long as these devices are in good operating order, truck operating areas are maintained, and spills of dry cement cleaned up immediately, minimal releases would occur. It is anticipated that the batch plant would be needed only for the initial phase of the project.

5.1.2.3 Mitigation Measures

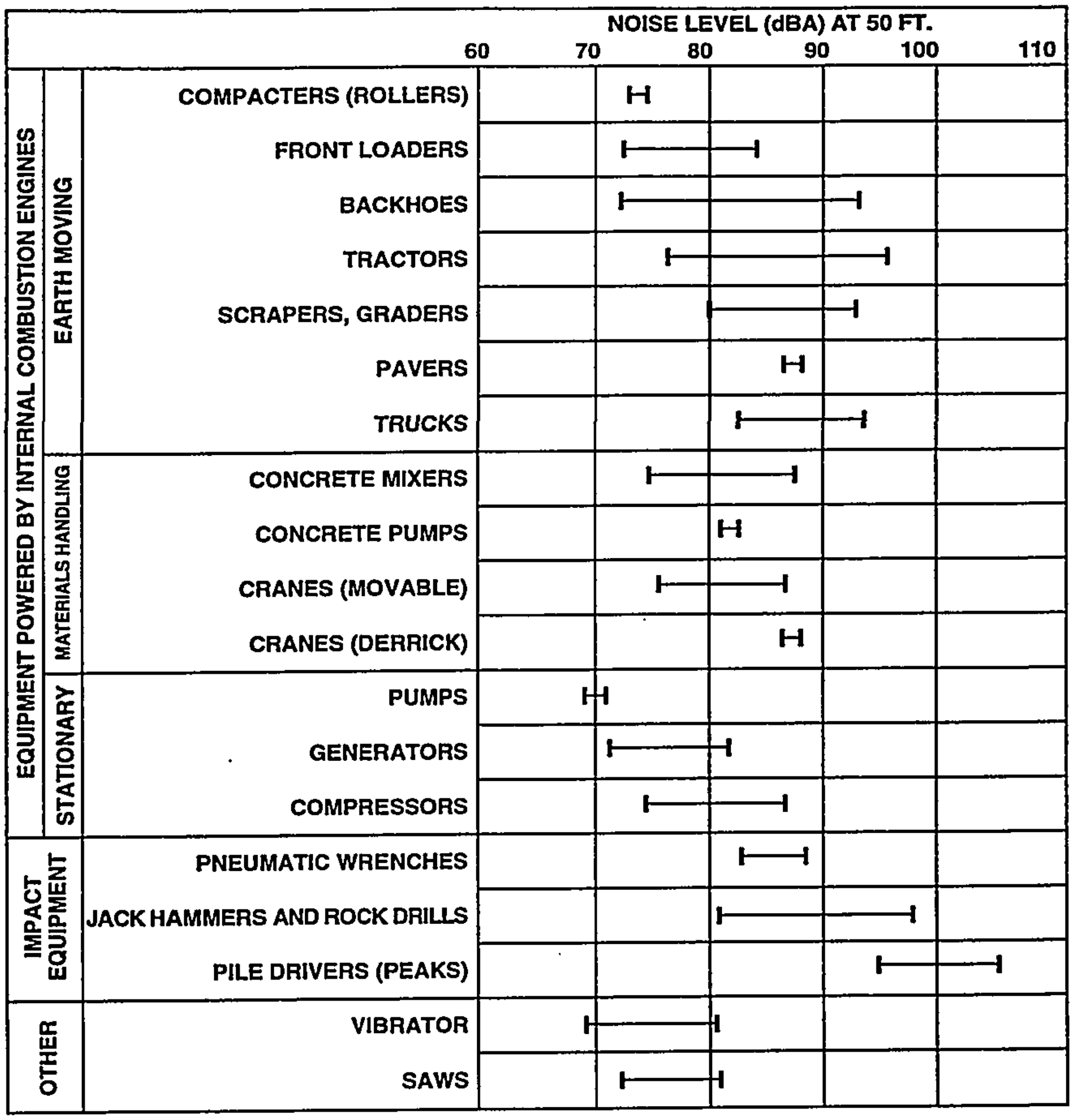
The Air Force would develop an air quality maintenance plan in cooperation with the University of Hawaii, other users of Haleakala Observatories, and the National Park Service. The plan would specify the measures that are to be taken to limit unnecessary emissions, and adherence to its provisions would be required by the construction contract.

5.1.3 NOISE IMPACTS

Construction of AEOS would involve the use of various types of noise-procuding heavy construction equipment, including heavy trucks, cement mixers, cement pumpers, trenchers, small compactors, flatbed tractor trailers, heavy- and light-capacity cranes, and an assortment of medium- and light-duty trucks.

5.1.3.1 Noise Emissions

Most of the construction equipment expected at the summit generates noise levels of 90 dB(A) or less at a distance of 50 feet (Figure 5.1). The loudest potential noise sources include derrick cranes (88 dBA), concrete mixers (88 dBA), scrapers (93 dBA), pavers (88 dBA), pneumatic tools (88 dBA), and trucks (93 dBA) (Bolt, Beranek and Newman 1971). Rock drills are the noisiest pieces of equipment that might be used at



Note: Based on Limited Available Data Samples

Source: Bolt, Beranek and Newman, (December 31, 1971)
Noise From Construction Equipment and Operations, Building Equipment, and Home Appliances, Prepared For: U.S. Environmental Protection Agency, Office of Noise Abatement and Control, Washington, D.C. 20460

Figure 5.1
CONSTRUCTION EQUIPMENT NOISE RANGES

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
Belt Collins & Associates • March 1994

the site (98 dBA), but their use (if they are used at all) would be limited to a few weeks during the construction of the foundations for the proposed facility. Average noise levels during construction are expected to be at or below the following (Bolt, Beranek and Newman 1971):

Ground Clearing	84 to 87 dBA
Excavation	74 to 89 dBA
Foundation Work	78 dBA
Building Erection	74 to 85 dBA
Finishing	75 to 89 dBA

Operations at the concrete batch plant would be quieter than those at the summit, generally producing levels less than about 85 dBA at 50 feet.

5.1.3.2 Forecast Noise Levels At Key Receptors

None of the activities that take place within Haleakala Observatories or the immediate environs are considered noise-sensitive uses. The individuals who would be working in other facilities at MSSS and elsewhere in Haleakala Observatories during construction hours would be in enclosed structures that would greatly attenuate the noise.

The nearest-noise sensitive locations are the Pu'u Ula'ula Overlook and the Haleakala Park Visitor Center on White Hill. These are located approximately 550 meters (1,800 feet) and 1,100 meters (3,650 feet) from the AEOS site, respectively. Natural sound attenuation (a reduction of approximately six dBA for each doubling of the distance beyond 15 meters [50 feet]) would reduce average construction noise levels audible at those two locations during the noisiest phase of construction to the upper 50 dBA range and upper 40 dBA range, respectively. Peak construction-noise levels would be slightly higher, but short-lived.

Comparing the forecast noise levels with the existing ambient noise levels reported in Chapter 4, it is apparent that construction noise would be only slightly above existing ambient noise levels at the visitor center. Construction activities may be audible occasionally when winds are gentle or from the south, but most of the time visitors there would be unable to hear the construction equipment operating at the AEOS site. Noise levels at the Pu'u Ula'ula Overlook would be somewhat higher, and visitors there are likely to be aware of the presence of the construction activity during site preparation, foundation work, and early stages of building erection. Noise levels at both noise-sensitive locations would be in either the "clearly acceptable" or "normally acceptable" ranges throughout the construction period as defined by the U.S. Environmental Protection Agency (Bolt Beranek and Newman 1971). Construction period noise levels are expected to be below those known to cause adverse effects on animals and birds. This, together with the relatively short duration of the loudest construction activities, indicates that AEOS construction activities would not adversely affect fauna in the area.

The concrete batch plant site is relatively close to Haleakala National Park headquarters. When the plant is in operation, some activities would be audible to visitors in the headquarters parking area, but not inside the headquarters buildings. Trucks carrying raw materials to the batch plant would also be heard in the parking area. Noise from trucks travelling between the batch plant and the AEOS construction site at the summit would be louder in the parking area. The sound attenuation provided by the building walls would reduce this noise to the point where it would not interfere with activities inside the headquarters building.

Most of the activities currently occurring in the Park Service's base yard are compatible with the noise levels that would be generated by operation of the temporary concrete batch plant. Some conflicts could occur if nighttime operations are needed while the dormitories are in use, and individuals in the offices could experience relatively high noise levels for brief periods of time. However, elevated noise levels in the vicinity of the concrete batch plant would be temporary and relatively short-lived.

5.1.4 IMPACTS ON HISTORICAL, ARCHAEOLOGICAL, AND CULTURAL RESOURCES

None of the archaeological sites that have been identified at Haleakala Observatories are within the area that would be disturbed by construction of the AEOS project (see Figure 4.11). A Section 106 Historic Preservation review has been completed by the State Historic Preservation Officer (SHPO). The SHPO has determined that the proposed project would have "no effect" on any of the four identified archaeological sites (a copy of the Section 106 Historic Preservation review documents are included in Appendix B). To ensure that the sites are completely protected during the construction phase of the project, the two sites closest to the construction area (Sites 50-11-2805 and 50-11-2806) would be identified on construction drawings, fenced off, and flagged prior to the start of work to insure that they are not inadvertently damaged by construction activities. None of the sites are of the sort likely to be damaged by ground vibration or indirect effects of the proposed construction activities.

5.1.5 BIOLOGICAL IMPACTS

Construction activities have the potential to affect biota both directly and indirectly. Direct effects are limited primarily to crushing or displacement by the construction equipment. Indirect effects can result from increased noise levels, degradation of air quality, introduction of new species that compete with or destroy native biota, and increased human presence. In the case of the AEOS project, concerns focus on the following areas:

- potential effects on the endangered 'ua'u (Hawaiian dark-rumped petrel, *Pterodroma phaeopygia sandwichensis*) that have burrows in the vicinity of the summit;
- potential effects on the Hawaiian hoary bat (*Lasiurus cinereus semotus*) that may be present near the concrete batch plant site;

- potential effects on the threatened ahinahina plants (silversword, *Argyroxiphium sandwicense macrocephalum*) that grow within the boundaries of the MSSS; and

- the potential to introduce alien species to the summit area that could threaten the existing native biological communities.

Other effects (e.g., the possibility that project-related garbage or other refuse could attract, feed, or house rodents that would, in turn, feed upon native species) are unlikely. This is due partly to natural factors, such as the harsh environment at the summit, and partly to the controls that the Air Force would impose on the construction activities, particularly transport of materials to the summit and storage and disposal of construction debris (see Section 5.1.5.4). Consultation with the U.S. Fish and Wildlife Service has resulted in an opinion that proposed mitigation measures are sufficient to minimize any potential adverse impacts (see Appendix C).

5.1.5.1 Impacts On 'Ua'u

A field survey conducted in March 1991 (Appendix C; U.S. Air Force 1991) did not identify any 'ua'u within the proposed new MSSS boundaries. No 'ua'u burrows, or habitats suitable for such burrows, were found within the project area, although active burrows exist less than 250 feet to the west of the existing facilities.

Direct Effects. Construction of the proposed project would not directly affect the birds or their habitat. The proposed construction activities would be distant from the existing 'ua'u burrows. Materials and equipment would be kept within specified areas within the site boundaries or trucked to an off-site storage area to prevent rocks or other debris from rolling out of the area and damaging birds or their burrows.

Effects of Vibration. Because of speculation that chicks and nesting adults of some bird species may be sensitive to ground vibration, data on vibrations produced by heavy equipment similar to that which will be used on the proposed project were collected and compared to the vibrations that presently occur, including those due to dome rotation, vehicular traffic, and activities at the Red Hill Overlook (Dames and Moore 1993). The comparison indicates that the vibration levels that would be generated by the proposed construction are similar to, or lower than, those that currently occur in the area. Since 'ua'u continue to nest in areas subject to vibration levels as great or greater than those generated by construction of AEOS, the construction activities should have no significant effect on the birds or their burrows. To further protect the birds, construction activities near the burrows would be scheduled for a time period when the birds are not nesting insofar as this is feasible. Where construction activities must be conducted while the birds are present, steps would be taken to minimize the level of vibration. National Park Service personnel would monitor nests during the site clearing and foundation work for the project to ensure that neither the birds nor the burrows are disturbed. Corrective actions would be taken immediately if any adverse effects are observed.

Effects of Lighting. Porcellariiform birds in the Hawaiian Islands, including the 'ua'u, fly at night and are sometimes attracted to, and/or disoriented by, bright lights. This has occasionally caused them to crash into buildings, wires, tall vegetation, and vehicles (Telfer *et al.* 1987). Reed *et al.* (1985) note that 'ua'u have been found dead along the roadway to the Haleakala Park Visitor Center on White Hill, presumably after having been hit by the vehicles whose headlights attracted them. With the possible exception of a few concrete pours, AEOS construction activities would be limited to daylight hours. Because of this, they would not significantly increase the potential for 'ua'u mortality as a result of such collisions. The types of roadway lighting that would be used (low-intensity lights shielded so that they shine on the ground, not into the sky) is similar to the type that has been used at the MSSS since 1965. Since no 'ua'u groundings have been reported during the nearly thirty years that the lights have been in use, it is considered unlikely that the lights installed or relocated as part of the proposed project would have a significant adverse effect on the birds.

'Ua'u flying at night have been known to collide with difficult-to-see objects such as power lines and utility poles. Because the utility lines that would serve the AEOS project would be located underground, they would not pose any threat to the birds. The structures that would be constructed above-ground are large enough that the birds would have little difficulty seeing and avoiding them.

5.1.5.2 Potential Effects on the Hawaiian Hoary Bat

The endangered Hawaiian Hoary Bat is believed to be absent from the summit area. However, the concrete batch plant site is within its theoretical range. The size and height of the batch plant, the fact that other structures are already located there, bats' ability to easily detect structures using their sound-ranging capabilities, and the very short period of time during which the batch plant would be present make it unlikely that it would affect any bats.

5.1.5.3 Impacts On Silversword

The two ahinahina (silversword) plants located between MSSS and the Butler building would be relocated as part of the proposed project. These plants were transplanted to their present location as part of a previous action. The proposed relocation would be done in consultation with the National Park Service to insure that an appropriate location is selected. Because ahinahina have been transplanted successfully on numerous previous occasions, no adverse effect is anticipated.

5.1.5.4 Potential Introduction of Non-Native Species

The heavy visitor traffic between lowland areas and Haleakala National Park imposes the risk that non-native species that could compete with (and eventually displace) native plants, will be introduced to the area (Medeiros and Loope 1992; see Appendix A). Among the species that are known to have been introduced to upper elevations on Maui are the predatory *Vespula pennsylvanica*, a wasp that feeds on indigenous species, and *Irido myrmex humilis*, an Argentine ant that is displacing certain native high elevation beetles.

By increasing the volume of traffic to the summit and, more importantly, by bringing large pieces of equipment and other materials into the National Park, the proposed project increases the potential for the introduction of non-native species. The Air Force would require the following measures to prevent AEOS construction activities from introducing new species that could disrupt the native ecosystem:

- The construction contractor would be required to arrange for a qualified biologist or agricultural inspector to check shipments of equipment, supplies, and construction materials which are of concern before departure from the mainland and prior to unloading at Kahului Harbor or Airport. Specimens of non-native species that are found by these inspections would be collected and offered to the Bishop Museum for curation; those not wanted by the Museum would be destroyed. Containers that are too heavily infested to permit complete cleaning would be returned undelivered.

- The construction contractor would be prohibited from importing fill material into the National Park. Instead, fill would be limited to material obtained from excavation within the Haleakala Observatories area. In addition, the contractor would be prohibited from returning excavated material to the site once it has been taken to lower elevations. The contractor would also be required to make surplus material available to the University of Hawaii for use elsewhere within Haleakala Observatories or to the National Park Service for utilization within Haleakala National Park.

- The contractor would be required to wash all equipment before entering the National Park to insure removal of organic matter and insects. Personnel would inspect the equipment while it is still at lower elevations to assure that the cleaning is thorough. National Park Service personnel would make spot checks of the equipment at the Park entrance to confirm the adequacy of the cleaning. Equipment failing the inspections would not be allowed to enter the Park.

- The contractor would be required to cooperate with the National Park Service in developing and implementing a construction worker education program designed to inform workers of the damage that can be done if non-native species are introduced into the Park. Successful completion of a test approved by the National Park Service would show fulfillment of this requirement. All workers bringing vehicles into Haleakala Observatories would be required to pass the test before beginning work, as would all drivers of AEOS-related construction vehicles entering the National Park.

- Parking of heavy equipment and storage of construction materials would be prohibited on areas adjacent to the construction site that would not otherwise be disturbed by the proposed construction, thus limiting the disturbance to the ground surface and minimizing the potential for contamination.

- Construction trash, particularly materials that could serve as a food source for small non-native mammals (such as mice) that prey on native insects and arthropods would be removed frequently.

5.1.6 VISUAL IMPACTS

Construction activities at the summit would be readily visible from Red Hill Overlook. In addition, large construction equipment could be seen from the Pakaoao Visitor Center and from the road leading to the summit. The equipment would be smaller than the existing structures, however, and the impacts would be temporary.

Because of the nature of the natural environment at the summit, scars, concrete spills, and debris associated with construction cannot be hidden by landscaping. Thus, the construction contractor would be required to minimize the area disturbed, to maintain the disturbed area, to store construction materials properly, and to remove waste from the summit frequently.

The temporary concrete batch plant would be located at the far end of the National Park Service's baseyard near the Haleakala Park headquarters. Cut trees, brush, and other debris have been stored there in the past, but have now been removed. The batch plant, and its accompanying piles of sand and aggregate, would not be visible from Haleakala Crater Road, the closest public vantage point. However, the area could be seen by persons looking down from the parking lot outside Park headquarters. While it would be seen by the occasional visitor, the fact that it would be in place for only a few months, would replace an existing trash pile, and would have a line of trees as a visual backdrop tend to minimize its visual intrusiveness. National Park Service personnel who use the buildings located in the base yard are accustomed to the industrial character and purpose of the area and are likely to accept its temporary use as the site of a concrete batch plant. Cleanup of the concrete batch plant site would also be made a requirement of the contract.

5.1.7 HYDROLOGIC/WATER QUALITY IMPACTS

Construction of the proposed facilities would not significantly alter the surface drainage pattern in Haleakala Observatories or surrounding areas. It would slightly increase the extent of impermeable surface and, therefore, the surface runoff from it during storms. However, the increase would be slight, and the additional water would infiltrate into the ground once reaching the permeable surface that surrounds the man-made facilities. Because of this, no measurable effect on flooding or on recharge is anticipated.

There is always some potential for accidental spillage of construction-related fuels and chemicals during construction of a project of this magnitude. The probability of substantial amounts of spillage is low, however, and means already exist at MSSS for remediation, if they should occur. The construction contract would require the contractor to perform refueling activities in an area with an impermeable surface that is equipped with an oil-water separator system. This would eliminate significant potential for soil or water contamination.

5.1.8 INFRASTRUCTURE IMPACTS

Construction activities associated with the proposed project would not have a measurable effect on electrical power use. They would, however, increase water use (for dust suppression, concrete mixing, and in support of other construction activities). The increase in potable water use for domestic purposes and to replenish water used by construction equipment would be modest (less than three tanker truck-trips per week during the period when the greatest number of construction workers are on site). The largest volumes of water would be used for dust suppression during excavation and grading activities (up to 5,000 gallons per day) and for concrete mixing (25,000 gallons, total). Some of this water would be obtained from the National Park Service's existing rain catchment system and storage tank near Hosmer Grove which will be repaired and returned to service. This system is unlikely to be able to supply all construction needs however, and additional water will be transported by truck up to the summit. Construction would not increase domestic wastewater disposal because portable chemical toilets would be used.

The planned construction activities would generate a substantial amount of solid waste. Some of this would be in the form of packing materials; other waste would consist of material removed during refurbishment of the existing MSSS facilities. Removal of the existing cooling unit, the Butler building, and other temporary structures would generate the greatest volume of waste and the largest pieces. Frequent removal of this waste from the summit would be a requirement of the construction contract. Although small quantities of hazardous chemicals are added to the concrete mixture to improve its physical properties, their concentrations in the concrete is expected to be of the order of parts per million or less, well below the levels at which they are of concern.

5.2 OPERATIONAL PERIOD IMPACTS

5.2.1 INTRODUCTION

Although additional staff would be needed to operate AEOS, this would be offset by reductions in the number of personnel at the existing facilities. Thus, operation of AEOS is not expected to affect the number of persons on-site at MSSS significantly (see Table 5-1). Maintaining the summit staffing at or below its present level is considered an important factor in improving the overall efficiency of the MSSS, and it would help to minimize potential adverse effects associated with the operation of AEOS and other Air Force facilities at the MSSS.

TABLE 5.1
Estimated Proposed Staffing

	GEODSS		AMOS/MOTIF		AEOS		
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	**TOTAL**
MSSS PERMANENT	11	8	27	7	8	8	69
KIHEI SUPPORT	0	0	6	2	6	2	16
VISITING EXPERIMENTERS	0	0	2	8	2	8	20
TOTAL	11	8	35	17	16	18	105

The proposed AEOS facility is intended for data collection and research purposes. It is designed to accommodate a wide range of experimental equipment which is expected to change as new concepts are tested and new technology becomes available. While it is impossible to precisely characterize all of the of activities that might take place at the facility over its useful life, sufficient information is available to adequately assess the potential environmental effects of AEOS's operation. The evaluation presented below takes into consideration the astronomical and atmospheric sciences research that would be carried out, in addition to DoD research similar to that presently occurring.

5.2.2 TRANSPORTATION IMPACTS

Following completion of construction of the proposed facilities, traffic to and from MSSS would be limited to vehicles carrying staff, supplies, and experimental equipment to and from the new facilities. Both day and night viewing would take place, although fewer people would be on-site at MSSS during the night. This is similar to the current situation, so travel patterns are also expected to be similar. The equipment that would be used in the facility is expected to be relatively small and could be transported to the summit in light and medium-size trucks that would not interfere with regular traffic flow on Haleakala Crater Road. The existence of mirror resurfacing equipment and other maintenance capabilities in the new facility eliminates the need to regularly transport oversize equipment to and from the MSSS. No adverse effects on the service levels of Haleakala Crater Road or Haleakala Highway are anticipated. There would not be a significant increase in the volume of cargo or passengers using Kahului Airport or Harbor as a result of the facility's operation.

5.2.3 ATMOSPHERIC IMPACTS

Because vehicular traffic to and from the MSSS would not be increased by the proposed project, there would be no effect on air quality from this source. Therefore, areas of potential atmospheric concerns are limited to possible effects on airflow patterns across the summit and to emissions from the emergency generator.

5.2.3.1 Air Turbulence

Turbulent airflow degrades telescope viewing conditions. Because of this, the proposed facility has been sited so that the AEOS telescope would be above as much of the turbulence associated with the near-ground boundary layer as possible and would not be in the lee of topographic highs, building masses, or heat sources (all of which cause turbulent airflow). Care has also been taken to situate it so that turbulence produced by the proposed structures would have as little effect as possible on other areas within Haleakala Observatories which the University might wish to use for *observational activities in the future.*

5.2.3.2 Emergency Generator

A review of Maui Electric Company's records (Table 5.2) indicates the following outages during the three-year period between 1989 and 1991.

TABLE 5.2
MAUI ELECTRIC COMPANY OUTAGES 1989 - 1991

TIME	DATE	DURATION (hrs & min.)
15:11	March 31, 1989	00:16
12:30	July 20, 1989	01:00
06:05	August 20, 1989	00:19
07:56	February 21, 1990	07:31
14:35	February 21, 1990	02:42
10:10	May 30, 1990	00:02
15:10	July 4, 1990	00:30
10:00	December 20, 1990	01:00
06:58	January 27, 1991	00:40
09:21	January 27, 1991	01:45
22:30	August 7, 1991	00:58

The data indicate that the electrical supply to the summit is generally reliable. This, in turn, suggests that the emergency generator would be operated infrequently and only for short periods of time. A reduction in the number of generators is planned (only one of the two existing 250 kVA generators will remain). Even at maximum output, the single generator will produce fewer emissions than are produced by the existing generators. All emissions will meet applicable air quality standards.

5.2.4 NOISE IMPACTS

Operation of the proposed facilities would not increase the volume or type of vehicular traffic to or from the MSSS. Because of this, roadside noise levels would not change. None of the proposed telescope or laboratory facilities would generate significant levels of noise.

The mechanical plant would contain equipment, such as compressors, that are potential noise sources. Assuming noise emissions from the proposed plant would be similar to those from a similar plant on the mainland, noise levels at a distance of 50 feet from the building would be comparable to the noise produced by the existing air conditioning equipment. Thus, no measurable increase in ambient noise levels at the summit is anticipated. The mechanical plant would not be audible from the Red Hill Overlook, which is the closest public gathering place. The fact that the emergency generator would operate infrequently and for short periods of time means that even those areas close to MSSS at which the generators would be audible would not be significnatly affected.

5.2.5 IMPACTS ON HISTORICAL, ARCHAEOLOGICAL, AND CULTURAL RESOURCES

The activities associated with operation of the proposed facility would not affect the archaeological resources that exist in the area. Neither would they alter the type or overall intensity of human activity at the summit of Haleakala. In view of the nature of the archaeological sites and the fact that astronomical facilities are already present on the summit, construction of the proposed structures is not expected to have any significant adverse effects on the archaeological or historical context of the area (see Appendix B).

5.2.6 BIOLOGICAL IMPACTS

The level of outdoor activity within the MSSS that would occur during the operational phase of AEOS would be the same as at present. Hence, no additional impact on biological resources is anticipated from this source. Changes in the gaseous emissions from the MSSS associated with AEOS and their effect on ambient air quality are discussed in Section 5.2.3. As discussed in Appendix C, forecast pollutant concentrations are an order-of-magnitude or more below ambient air quality standards and are even further below the levels that have been shown to cause significant adverse effects on plants or animals. Operation of the proposed facility would also involve increased telescope observations and the use of additional lasers. Potential impacts from lasers and nighttime lighting are discussed below.

5.2.6.1 Health and Safety Issues

Inherent with the use of lasers is the potential, particularly at higher powers, for harmful effects related to absorption and conversion of light energy into heat. Some of the lasers that could be used at AEOS have the ability to cause eye damage if viewers look directly down the axis of the beam. However, extensive procedural, software, and electro-mechanical safeguards that are already a part of MSSS operations would also be instituted at the proposed facility, reducing the potential of visual hazards associated with AEOS. For instance, these safeguards ensure that lasers are not inadvertently aimed at objects on the ground and that the airspace above the facility is free of aircraft when potentially hazardous laser operations are underway. Flight control over the site is managed by the Honolulu Center for Radar Approach (CERAP). The CERAP would be notified of the dates and times that lasers are scheduled to be operated, and by telephone approximately 30 minutes before each laser operation. Notices to Airmen (NOTAM) to avoid the area would be posted as well. If CERAP is unable to ensure that the airspace will be clear, the operations would be canceled or postponed until assurances can be given. Further protection would be provided by stationing observers outside the facilities during the tests; they would be authorized to terminate the laser tests if it appears that an aircraft might cross the laser's path.

5.2.6.2 Potential for Affecting the Biological Environment

Fledgling seabirds from the same family as the 'ua'u are known to be attracted to unshielded lights. The lights apparently cause them to become confused, which can lead them to fly into obstructions on the ground or land where they may be run over (if the light source is from moving automobiles), or preyed upon. Many of the lasers likely to be used at MSSS, including all of those used most frequently, are believed to be outside the visible range of birds (Terres 1980), and so have no potential to attract and/or disorient them. As previously mentioned, the laser beams are quite narrow, and this, combined with their relatively low intensity, means that even lasers which are in the visible part of the spectrum do not constitute a significant light source that is likely to attract or disorient birds.

It is possible, although highly unlikely, for birds, bats, and insects to fly though one of the laser beams. The retinas of these animals could be damaged if they looked directly into the laser source. However, because the beams are very narrow, animals flying through the beam would be exposed for only a fraction of a second. This, coupled with the fact that lasers are operated for only a few minutes at a time, indicates that the probability that birds or other creatures would be injured is extremely remote. This conclusion is consistent with the fact that no birds with eye or other laser-related damage have been found in the vicinity of the existing MSSS or IfA facilities.

Because of the low visibility of the laser beams, insects are not generally attracted to them. Hence, the lasers used at MSSS are unlikely to create concentrations of insects to which bats would be attracted. Moreover, the Hawaiian Hoary Bat (which is extremely rare, or absent, at the summit) typically forages within five meters of the ground, whereas the lowest laser source would be located above this level. Consequently, there is little likelihood that bats would be attracted to, or harmed by the beams.

Operations of the MSSS facilities (both those already in place and the AEOS project) involve other light sources. These include lights used to illuminate building entries, roadways, and paths. Because of the need to minimize extraneous light that might interfere with nighttime telescope use at the summit, all of the outside lighting sources on the site would use low-intensity lamps and would be shielded so that light is projected downward, rather than into the sky. Regulations require vehicles approaching the MSSS facilities at night to turn down their lights when they are within 150 meters (500 feet) of the parking lot. Moreover, the proposed facilities would include the installation of additional low-intensity marker lights along the entrance road that would reduce the need for headlight use. No significant risk to the 'ua'u or other animals as a result of AEOS-related light source is expected.

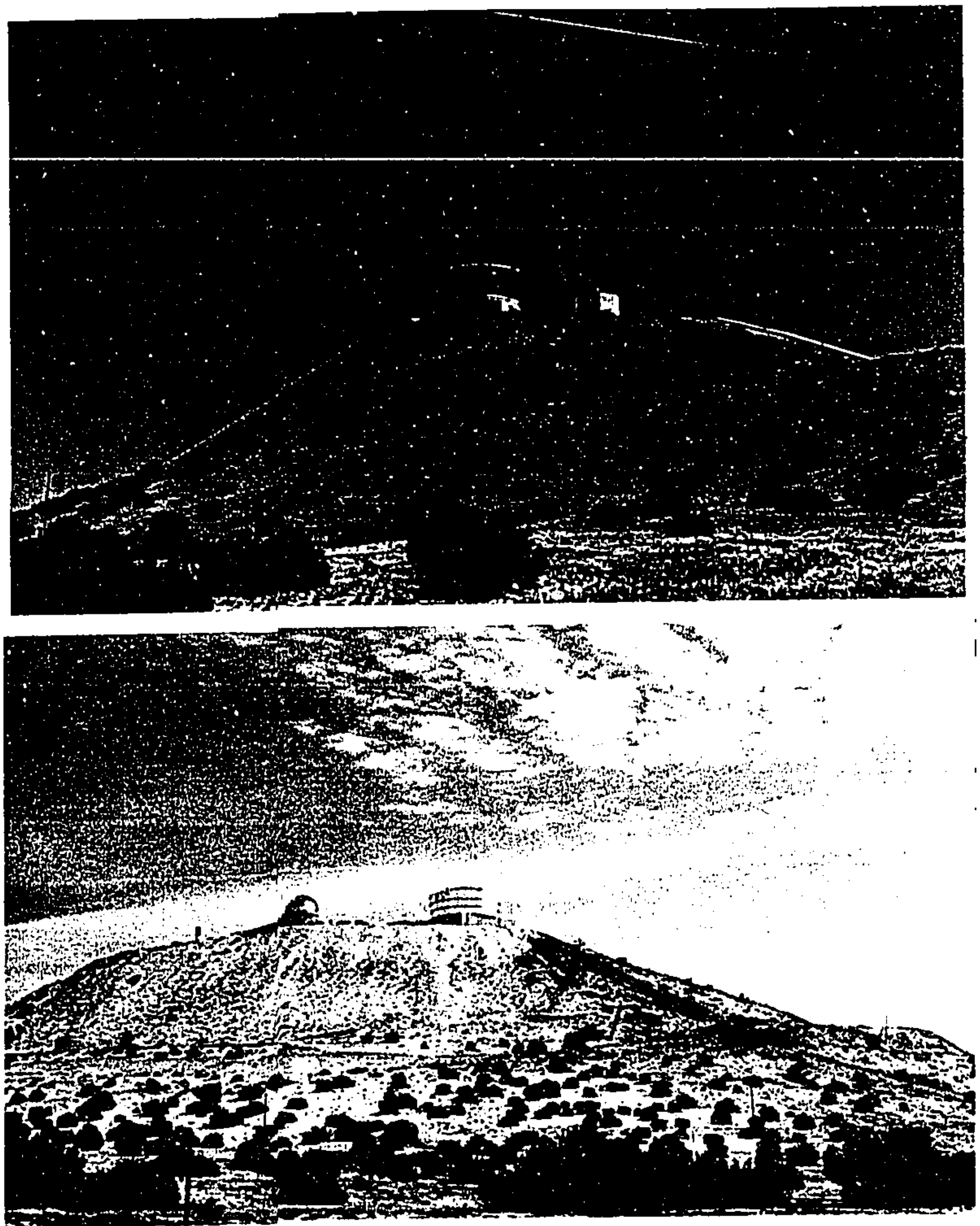
5.2.7 VISUAL IMPACTS

The proposed AEOS facility would add two buildings, the AEOS Observatory, and the mechanical plant, to the structures that already exist at the summit. The proposed telescope dome enclosure would rise approximately *70 feet* above the two-story equipment building, reaching a total height of 120 feet above the surrounding terrain. This height is needed to locate the telescope above as much of the turbulence in the "boundary layer" (i.e., the layer closest to the ground surface) as possible, in order to provide the best seeing conditions for the instrument.

As noted in Chapter 4, the existing facilities can be seen faintly from Maui's central valley when clouds are absent and the air is clear. While the proposed AEOS telescope enclosure would be more than twice as high as any of the existing domes at the summit, the distance would make AEOS appear very small in relationship to the overwhelming mass of the mountain. In addition, since AEOS represents an expansion of an existing use, the existing relationships between the natural and man-made environments would be maintained. The visual impact of the structure will be mitigated further by the highly reflective aluminum surface that is proposed for the enclosure. This type of surface has been shown to significantly reduce the visibility of a similar telescope enclosure located on the mainland. Two photographs of this facility, the "Starfire Optical Range" (SOR), under both clear and cloudy conditions, are reproduced in Figure 5.2. As shown by the photographs, the reflective surface tends to take on the color of the surrounding sky, so that the dome enclosure does not stand out.

The terrain blocks views of the structures in Haleakala Observatories from most of the roadway up the mountain. They first become noticeable approximately two miles below the summit, but appear relatively inconspicuous until about a mile from the summit. The project's greatest visual effect would be on views of the area from the Pu'u Ula'ula (Red Hill) Overlook and Pakaoao (White Hill) Visitor Center.

The view of the proposed AEOS facility as it would look from Haleakala Crater Road approximately one mile below the summit is shown in Figure 5.3. The proposed 120-foot high telescope enclosure would be, by far, the tallest man-made structure visible, but it would be generally consistent with the scale of the natural terrain. From this location, Red Hill blocks views of the other structures in the Haleakala Observatories complex, limiting the prominence of the man-made environment.



Photographs of Starfire Optical Range (SOR) Facility. Kirtland Air Force Base, New Mexico during clear and cloudy conditions.

Figure 5.2
PHOTOGRAPHS OF SOR FACILITY

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
Belt Collins & Associates • March 1994

233.4100.2/052m

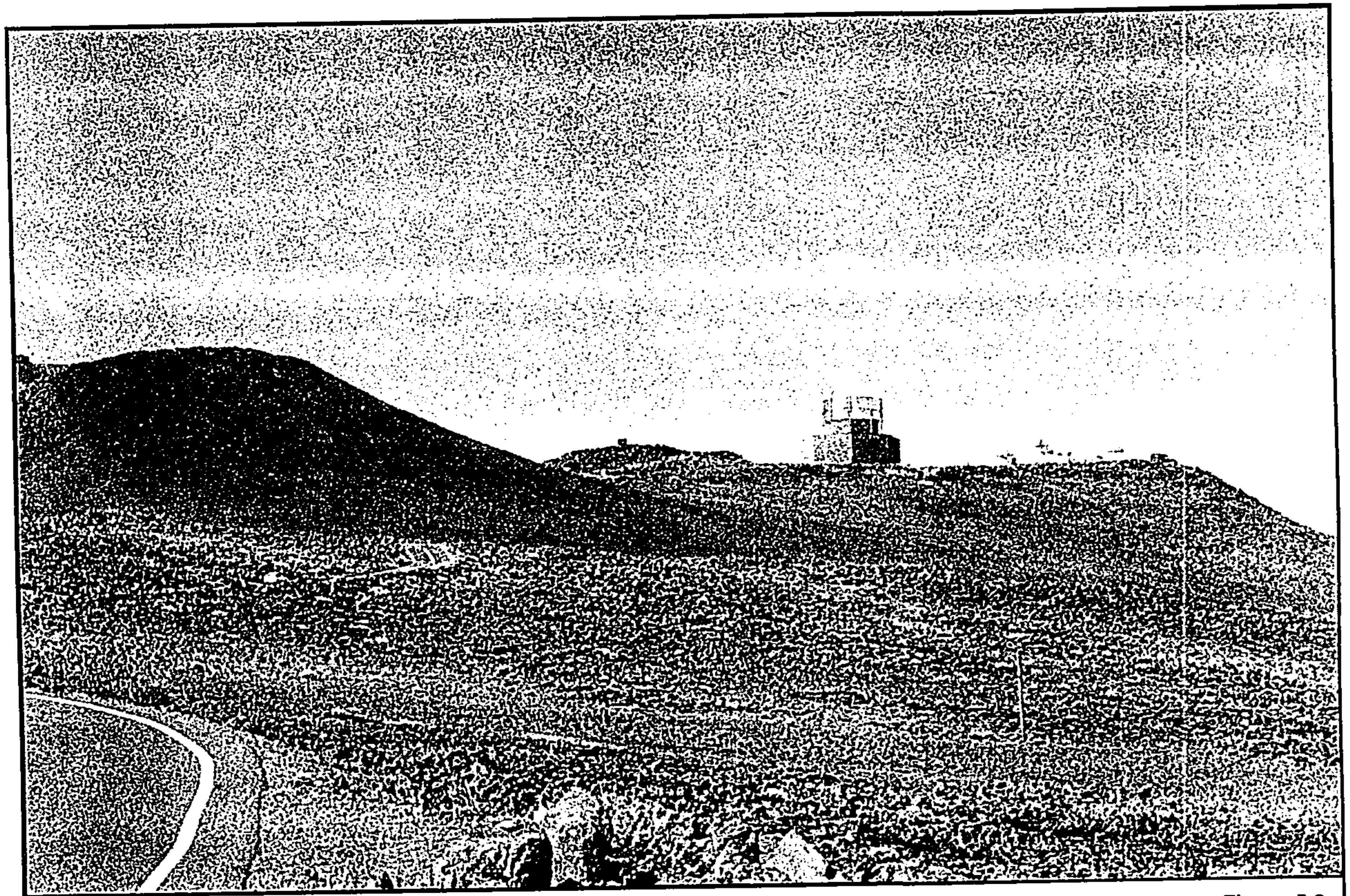


Figure 5.3
VIEW OF PROPOSED AEOS FACILITY FROM ROAD APPROXIMATELY ONE MILE FROM SUMMIT

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
Belt Collins & Associates • March 1994

233.4100.2/034m

The view of the AEOS facilities as they would appear from the Pakaoao Visitor Center is shown in Figure 5.4. Again, Red Hill obscures views of other Haleakala Observatories structures from this location, leaving only the MSSS visible. From this vantage point, the proposed observatory would be clearly visible and its size apparent. However, the presence of Red Hill, which rises well above the top of the proposed observatory, would lessen its visual impact.

The view of the existing and proposed facilities in Haleakala Observatories, as seen from the Red Hill Overlook, is shown in Figure 5.5. The proposed low-rise structures that are part of AEOS (i.e., the mechanical plant and the equipment and service buildings) are similar in scale to those in the existing MSSS complex and would have little impact on the visual character of the summit. Because of its size, the proposed telescope enclosure would constitute a strong visual element when viewed from this vantage point. The reflective surface would reduce this impact.

5.2.8 HYDROLOGIC IMPACTS

5.2.8.1 Stormwater Runoff/Groundwater Recharge Volumes

The proposed project would increase the amount of impermeable surface within the MSSS. However, because the increase would be comprised of additional roof area (rather than paved surface) that would be used as catchment for the water system, there would be no increase in runoff under most conditions. Additional runoff would occur only during intense rains at times when water storage is already at capacity. Given the high permeability of the surrounding ground surface and the very limited additional volume that would be generated by the increase in impermeable surfaces, the change would have no significant effect on surface runoff, flooding, or groundwater recharge.

5.2.8.2 Water Quality

Wastewater. Because the number of persons on-site is not expected to increase, operation of the proposed facilities would not increase water use or wastewater generation. Wastewater from the proposed facilities would be disposed of through a third septic tank and leaching field system that would be located north of the AEOS Observatory. The existing septic systems would continue to serve GEODSS, MOTIF, and AMOS facilities.

The wastewater generated by the proposed and existing facilities would continue to consist principally of human waste. Human coliform bacteria are present in the discharge from the septic tanks and leach fields, but die off during passage through the ground. Some proportion of the wastewater would be composed of wastes from the laboratory facilities. These would receive pre-treatment, however, and thus would be safe to dispose in the septic system. The closest spring or potable water source is more than four miles from the site. Consequently, wastewater disposal would not significantly alter groundwater quality.

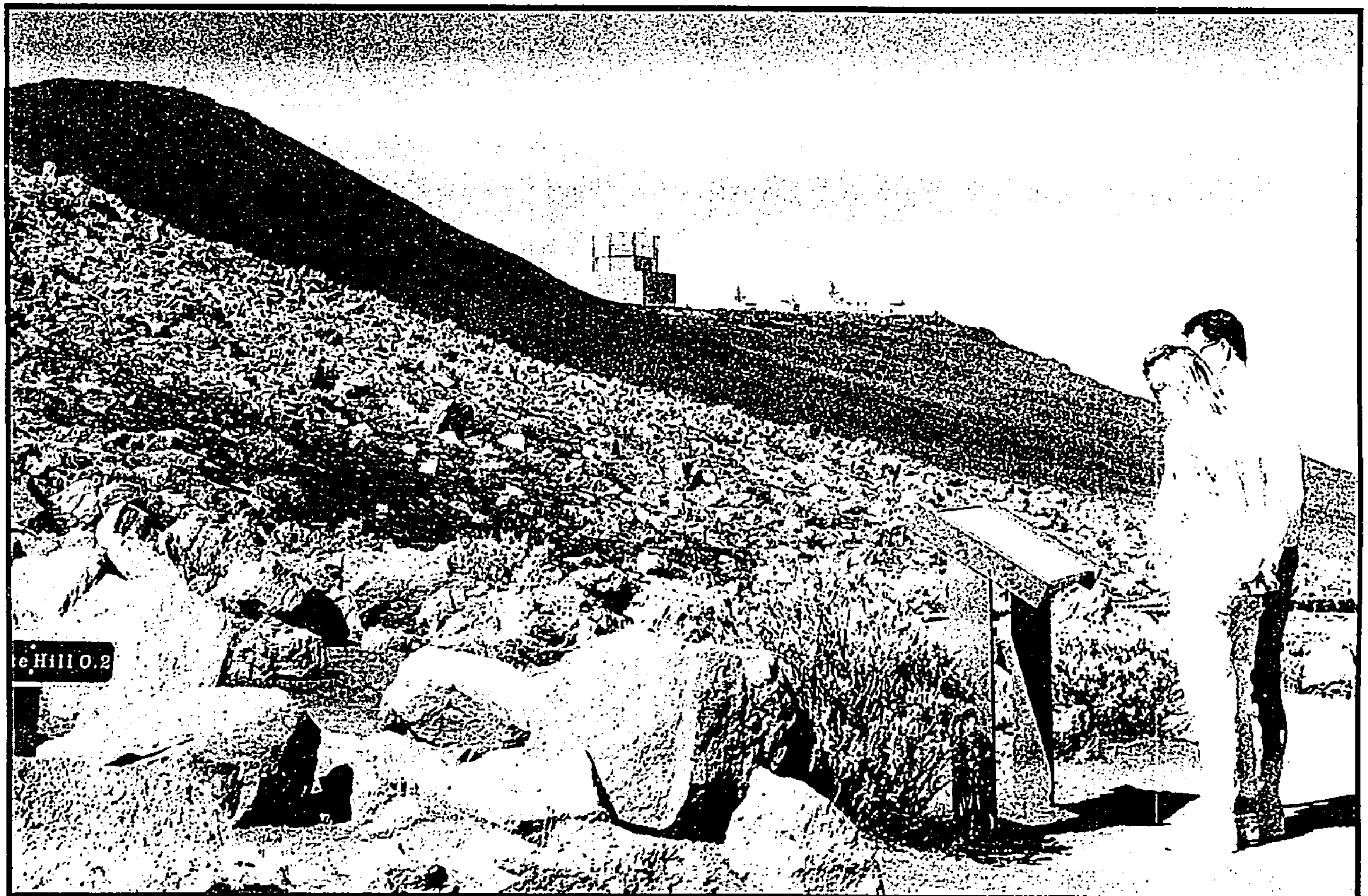


Figure 5.4
VIEW OF PROPOSED AEOS FACILITIES FROM PAKAOAO (WHITE HILL) VISITOR CENTER

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
Belt Collins & Associates • March 1994

233.4100 2/035m

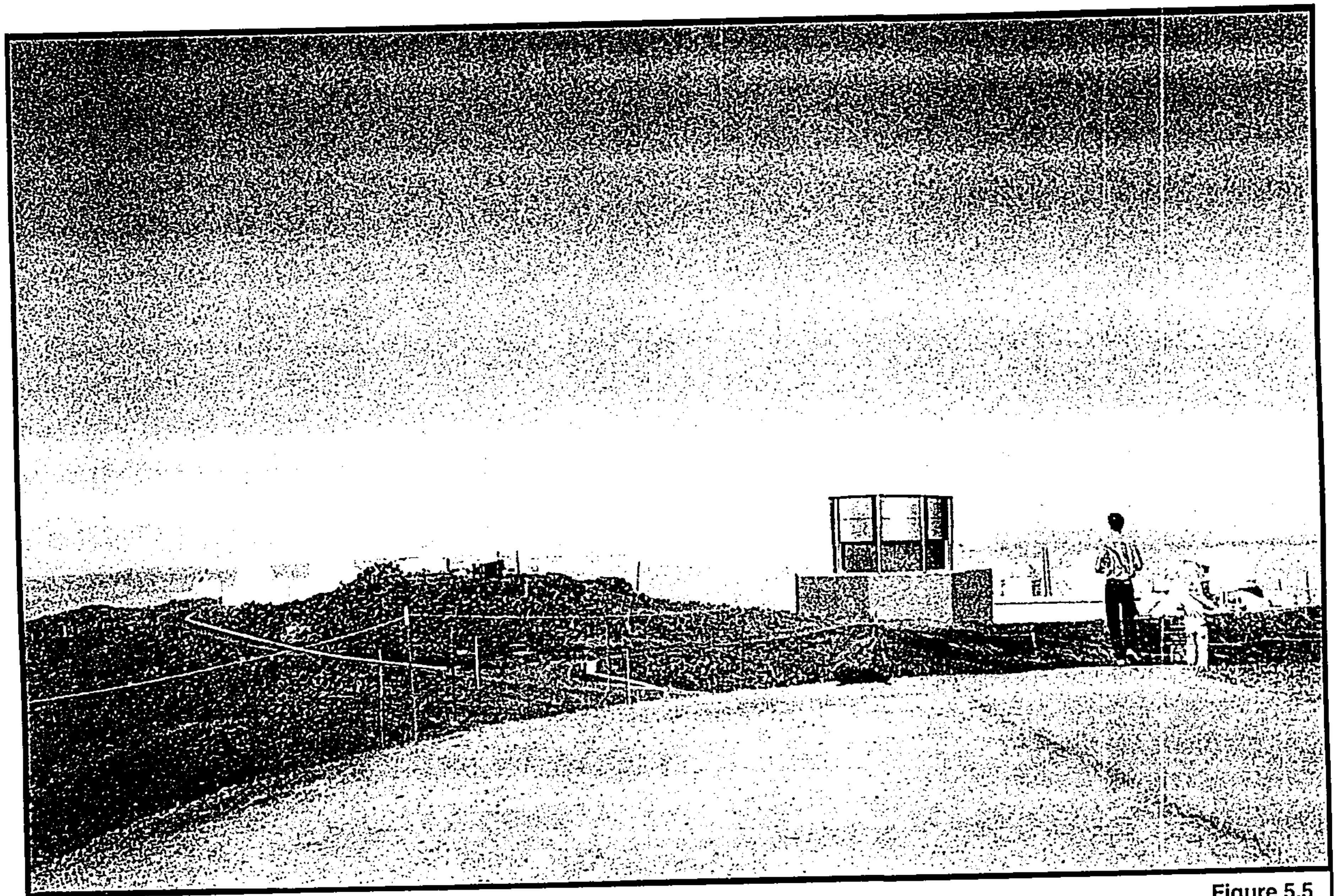


Figure 5.5
VIEW OF PROPOSED AEOS FACILITY FROM RED HILL OVERLOOK

AEOS Telescope Facility
Haleakala, Island of Maui, Hawaii
Belt Collins & Associates • March 1994

233.4100.2/036m

Chemical/Petroleum Spills. Only small volumes of hazardous chemicals would be used at the proposed facility (see Section 5.2.9.6). These would be handled in areas designed to contain any accidental spills, avoiding the potential for significant releases to the surrounding environment. No new petroleum storage facilities would be constructed as part of the proposed project. The existing 15,000 liter (4,000 gallon) on-site fuel tank (used to store diesel fuel for the emergency generator) would remain in use. The tank is entirely enclosed within a 53,000 liter (14,000 gallon) concrete basin that provides more than adequate secondary containment. It is inspected daily and the inspections documented. In addition, the MSSS has a comprehensive Spill Prevention and Response Plan (SPRP) that identifies potential spill sites, defines responsibilities, and discusses personnel training (Rockwell Power Systems 1992c).

The containment, inspections, maintenance, and other procedures set forth in the SPRP minimize the chance of a significant release of fuel or chemicals to the surrounding environment. Nevertheless, an analysis of the potential environmental effects of a large release of fuel (11,000 gallons) was undertaken. The resulting report, which is reproduced in Appendix D, concluded that hydrocarbon concentrations on the top of the water table resulting from such a spill would be less than 0.03 micrograms per liter. This concentration is eight orders of magnitude below the U.S. Environmental Protection Agency's water quality criteria for aquatic life (U.S. Environmental Protection Agency 1986).

5.2.9 UTILITIES AND PUBLIC SERVICES ADEQUACY AND IMPACTS

5.2.9.1 Water Supply

As previously indicated, the proposed project would not increase the number of persons working at the summit. Hence, it would not alter domestic water use. Neither would the AEOS project significantly increase the amount of water used for other purposes (e.g., laboratory experiments, equipment cooling, etc.). Because the proposed facilities would incorporate roofing material certified for potable use, a rain catchment system would be re-established at MSSS. This is expected to reduce the amount of water that would be required from outside sources and would thus reduce the demand on the Maui Board of Water Supply.

5.2.9.2 Electrical Power

The proposed upgrades to the MSSS electrical power system would increase reliability, would provide a simple path for upgrading service to other facilities within Haleakala Observatories in the future, and would reduce maintenance costs. Investigation of the capacity of MECO's existing transformer at the Kula substation indicates that it has sufficient excess capacity to accommodate the anticipated increase in peak load.

The installation of the proposed telescope and associated equipment would result in an increase in total energy consumption at MSSS when the new facilities become operational. The increase is difficult to predict because it is dependent upon utilization rates, the types of experiments that are conducted, and other factors. Assuming that use would at most double, average daily power use at MSSS would be approximately 14,000 kilowatt hours per day. To place this in perspective, that usage amounts to roughly 0.005 percent of the electrical energy used on Maui in 1990. The increase is far too small to have a significant effect on the need for generating capacity.

5.2.9.3 Wastewater Collection and Disposal

As indicated in the discussion of water quality impacts presented in Section 5.2.8, an additional septic tank and leaching field system would be installed to treat wastewater generated by the proposed facilities. The existing MSSS facilities would continue to use the current system.

5.2.9.4 Telecommunications

It is anticipated that the proposed project would increase the data and voice transmission requirements at MSSS. These requirements would be met by the existing system initially. However, plans for installation of a fiber-optic communication link between Kihei and the summit are being considered. The existing telephone cable conduit appears to be unsuitable for installation of the proposed fiber optic cable. Therefore, Rockwell Power Systems is investigating development of a new telecommunications duct to connect the site to Kihei for remote control of MSSS. Implementation of this plan is currently being discussed with representatives of GTE Hawaiian Telephone. The potential impacts of this project will be discussed in future environmental documents.

5.2.9.5 Solid Waste Storage and Disposal

Because personnel staffing at MSSS would not change significantly, the quantity of solid waste that is generated would not increase. Any significant volumes of solid waste (such as packing materials, crates, etc.) generated as a result of the installation of new equipment would be removed as part of the regular maintenance activities at the summit.

5.2.9.6 Hazardous Materials and Waste Storage and Disposal

Although the majority of the lasers used at MSSS produce no hazardous wastes, some lasers that do generate small quantities of such waste may be used in the future in conjunction with existing or proposed facilities. Small quantities of other potentially hazardous materials would be used in the facility. A detailed plan of operations for the proposed AEOS facility has not been developed as yet. However, because most of the operations that would take place at AEOS are similar to those already occurring at the MSSS, information about existing operations assembled as part of the U.S. Air Force's Hazardous Waste Remedial Program (Dames and Moore 1989) and various environmental management plans (Rockwell Power Systems 1992a, 1992b, 1992c) provide useful means of characterizing the kinds and volumes of hazardous materials likely to be found at AEOS:

- The mirror support systems of two of the existing telescopes use neoprene "boots" that contain mercury to float the telescopes. Each boot contains between 15 and 25 pounds of mercury; sumps below the telescope pedestal provide catchment for any leakage. The AEOS mirror would be hydraulically floated and would not, therefore, increase the amount of mercury at MSSS.

- Toluene, methanol, or ethanol is used regularly on the telescope mirrors to remove dust. The cleaner is sprayed on and wiped off with cloths. These are disposed of off-site by a contractor licensed to handle hazardous waste.

- Various chemicals are used during the mirror recoating process. These include 10 percent sodium- or potassium-hydroxide solution or a concentrated solution of hydrochloric, nitric, or sulfuric acid; these are applied to the mirrors, then rinsed with water. The wastewater from this operation is stored in tanks on the site until it can be removed by a licensed contractor for off-site disposal.

- Small quantities of lubricating oil are used in the machine shop. Unused oil is stored within secondary containment. Weekly inspections and monthly maintenance are performed. Waste oil and oily rags are disposed of off-site by a licensed contractor.

- The mechanical/carpentry shop at MSSS uses solvent for cleaning various types of small mechanical parts. The used and unused solvents are stored in separate drums within secondary containment that are subject to weekly inspection and monthly maintenance. Waste solvents are removed by a licensed contractor for off-site disposal.

- The electronics repair shop uses small quantities (less than one gallon per year) of solvents such as trichloroethane to clean electrical components; rags used to apply these are stored on site in a separate container and periodically collected and disposed of by a licensed contractor.

The proposed AEOS project would increase the amount of electronic and mechanical equipment at MSSS and increase the total surface area of the mirrors that require periodic recoating. Use of the same solvents and cleaners listed above is likely to increase accordingly, possibly doubling once the new facility is fully operational. The Air Force has implemented an Ozone Substance Reduction Plan that will eliminate the use of ozone depleting substances at the site by the end of 1995.

In addition, the proposed mechanical plant would house equipment (e.g., the ice harvesters) that do not exist on the site currently. The chillers that are part of this system would employ Freon 22, a hydrofluorocarbon. It does not pose the potential threat to the earth's ozone layer that other refrigerants, such as Freon 12 do, and is not otherwise considered dangerous.

In summary, operation of the existing and proposed facilities would involve the use of only small quantities of hazardous substances, and strict measures would be taken to ensure that these are properly stored, used, and disposed. Consequently, the proposed action would not significantly increase risks from hazardous substances.

5.2.10 SOCIO-ECONOMIC IMPACTS

The total cost of the AEOS project is approximately $79 million. Of this, slightly less than $30 million would be spent on the site improvements, structures, and mechanical equipment. The remainder would be spent on the telescope and related support equipment (which would be fabricated off-site and shipped to Hawaii partially assembled), and on initial operation and shakedown. Some of the functions currently carried out by personnel working at MSSS would be automated, while others would be shifted off-site. No change in total personnel associated with MSSS is expected.

In addition to the national defense needs that would be served by operation of the proposed facility, AEOS would provide important research facilities for the University of Hawaii's Institute for Astronomy and other scientific institutes. The Institute has established a world class reputation that has attracted leading researchers and numerous research grants to the state. These astronomical research activities are supported by funding from national and international sources and represent an important component of the primary sector in the Hawaiian economy, both in terms of the jobs and the industries that support it. Consequently, the proposed project would help diversify the employment and educational opportunities available to the people of Maui and the State of Hawaii.

5.3 RELATIONSHIP OF THE PROPOSED PROJECT TO EXISTING LAND USE PLANS

The proposed project is located within the general subzone of the State Conservation District. The objective of this subzone is to designate open space where specific conservation uses may not be defined, but where urban use would be premature. The conservation uses appropriate for Haleakala Observatories site are defined in the Executive Order conveying the property to the University of Hawaii and in previously granted Conservation District Use Permits for scientific facilities on Haleakala. AEOS is compatible with other scientific uses of the area and would add to the research capabilities of Haleakala Observatories by providing innovative, state-of-the-art equipment and facilities.

5.4 CUMULATIVE IMPACTS OF THE PROPOSED ACTION

The University of Hawaii Institute for Astronomy is preparing a Research Development Plan (RDP) for future use of Haleakala Observatories; a draft has been completed and is currently undergoing review. The Haleakala Observatories RDP will be part of the University's overall plans for astronomy development in the state. It will be consistent with UH policy to reserve the limited number of available sites on Haleakala for facilities that can make the highest and best scientific use of the summit's excellent attributes. Thus, the RDP will establish goals, objectives, and guidelines for future development at Haleakala Observatories. The primary objectives of the RDP are:

- to provide a plan that recognizes the multiple-use objectives of Haleakala and addresses environmental, recreational, and conservation concerns responsibly and
- to develop equitable arrangements so that Haleakala continues to be an economically viable location for telescope projects, while maximizing scientific, educational, and socio-economic objectives.

Upon adoption of the RDP by the UH Board of Regents, the University of Hawaii Institute for Astronomy will prepare a Complex Development Plan (CDP) which will incorporate the policies and criteria set forth in the RDP and provide the physical planning framework necessary for implementation. The CDP will specify design and environmental criteria to be followed when implementing the development program and will present plans and implementation strategies for managing and monitoring the various resources and uses of UH-controlled land. The CDP will include recommendations regarding the optimum number of telescope sites, potential telescope sites outside the existing Haleakala Observatories boundaries, buffer zones, and other elements at optimum development. The IfA will work closely with the State Department of Land and Natural Resources, Office of Hawaiian Affairs, the National Park Service, Maui County, and the general public in developing the CDP.

The University of Hawaii Institute for Astronomy is taking an active role in the planning and permitting of the AEOS project and is incorporating the expanded MSSS site into the RDP for Haleakala Observatories. The AEOS project is consistent with the goals and objectives of the draft RDP. Because of Air Force funding and scheduling requirements, the University of Hawaii Institute for Astronomy has agreed to allow the AEOS project to proceed in parallel with development of the RDP, and ahead of the CDP for Haleakala Observatories.

5.5 ENVIRONMENTAL IMPACTS OF ALTERNATIVES TO THE PROPOSED PROJECT

As discussed in Section 3.3, a variety of alternatives were evaluated before the Air Force settled on the proposed action as the best means of achieving its objectives. These alternative included the use of alternate sites and technologies. None of the alternatives appeared likely to provide the same combination of performance and economy as the AEOS project.

Various site layouts and building designs were considered during the design development process for AEOS. The proposed action represents the results of review by the Air Force and its contractors, comments and recommendations from the University of Hawaii, and input from the international telescope observatory community. The proposed design incorporates measures (such as the use of the ice harvesters to minimize thermal pollution, the use of the least visually obtrusive surface coatings consistent with the need to optimize seeing from the telescope, and the selection of an access route that is consistent with the University of Hawaii's long-range plans for additional use of the mountain) designed to prevent or minimize adverse effects.

None of the changes that are proposed appear likely to cause significant adverse effects to the man-made or natural environment. Hence, there is no environmentally superior alternative means of achieving the same objectives.

The alternative of taking no action would involve less earthwork on the mountain and would not increase building mass on the summit over the short term. In view of the fact that the University of Hawaii's goal is to develop Haleakala Observatories into a major astronomical research center, however, it appears likely that similar facilities would eventually be built on the summit even if AEOS were not. Thus, the no-action alternative would not necessarily prevent the kinds of changes that AEOS would produce from ultimately occurring.

CHAPTER 6

ENVIRONMENTAL PERMIT AND REGULATORY REQUIREMENTS

6.1 COASTAL ZONE MANAGEMENT PROGRAM

The proposed project involves the use of state land and the expenditure of federal funds. Because of this, it must be consistent with the policies and objectives of the State of Hawaii's Coastal Zone Management Program. A Coastal Zone Management Program Consistency Certification will be filed; it will be accompanied by this environmental assessment.

6.2 AIR QUALITY PERMITS

Responsibility for implementation of the provisions of the Clean Air Act, as amended, has been delegated to the State of Hawaii Department of Health. Normal operation of the optical systems and laboratories at the proposed AEOS facility will not generate emissions of any regulated pollutants and will not require air quality permits. The emergency generator that will be installed will be used only as a standby unit to provide electricity during power outages. §11-60-40(c)(11) of Hawaii Administrative Rules specifically exempts such units from air quality permit requirements.

6.3 WATER PERMITS

AEOS and other MSSS facilities will use water for drinking, sanitary, and laboratory purposes. Waste from the drinking and sanitary systems would be discharged into existing and planned on-site septic tank systems. Discharges from the laboratory areas will be treated prior to discharge into the septic system. The area affected by storm runoff from construction of the proposed project is too small to trigger a requirement for a National Pollutant Discharge Elimination System (NPDES) stormwater permit for construction activities. In addition, neither the proposed nor existing facilities are included in the list of industries and activities subject to EPA's stormwater requirements. Therefore, the project will not need an NPDES permit for operation. The project would not involve underground injection of liquids.

6.4 CONSERVATION DISTRICT USE PERMIT

Because the proposed site is in the State Conservation District and involves land not currently controlled by the federal government, the AEOS project requires a Conservation District Use Permit from the State of Hawaii. The University of Hawaii Institute for Astronomy has responsibility for the land on which the proposed facility would be located. Therefore, it will file the Conservation District Use application and would be the permit holder of record. The Conservation District Use Permit would grant certain rights and would impose certain conditions and restrictions that would be extended to the U.S. Army Corps of Engineers/U.S. Air Force through an amendment to the lease for the land on which the existing MSSS facilities are located.

6.5 COUNTY PERMITS AND APPROVALS

The Air Force will submit plans for the proposed facility to the Maui County Building Department and will conform to all county requirements.

CHAPTER 7

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CHAPTER 8

COMMENTS AND RESPONSES

LIST OF AGENCY COMMENTS AND RESPONSES

United States Department of Agriculture, Soil Conservation Service

United States Department of the Interior, National Park Service

State of Hawaii, Department of Land and Natural Resources

Office of Hawaiian Affairs

State of Hawaii Department of Health

State of Hawaii, Department of Land and Natural Resources

Chair, Maui County Council

Environmental Center, University of Hawaii at Manoa

Maui Electric Company, Ltd.

United States
Department of
Agriculture

Soil
Conservation
Service

P. O. Box 50004
Honolulu, HI
96850-0001

January 18, 1994

JAN 20 1994

Dr. Donald N.B. Hall, Director
Institute for Astronomy
University of Hawaii
2680 Woodlawn Drive
Honolulu, Hawaii 96822

Dear Mr. Hall:

Subject: Draft Environmental Assessment–Expansion of the U.S. Air Force Maui Space Surveillance Site (MSSS) to Provide Space Needed of Construction and Operation of an Advanced Electro-Optical System Telescope and Related Facilities at Haleakala Observatories, Maui

We have completed our review of the Draft EIS and have no major resource concerns at this time. Thank you for the opportunity to provide comment concerning the project. Should you have any questions please contact Mr. Michael C. Tulang at (808) 541-2606.

Sincerely,

NATHANIEL R. CONNER
State Conservationist

cc: Neal Fujiwara, District Conservationist, Wailuku Field Office

University of Hawaii at Manoa

Institute for Astronomy
2680 Woodlawn Drive • Honolulu, Hawaii 96822
Telex: 723-8459 • UHAST HR

Office of the Director

March 2, 1994

Mr. Abraham Aiona, Vice-Chairman
Office of Hawaiian Affairs
711 Kapiolani Boulevard, Suite 500
Honolulu, Hawaii 96813-5249

Subject: Comments On *Draft Environmental Assessment/Negative Declaration Advanced Electro-Optical System (AEOS) Telescope and Related Improvements At The Maui Space Surveillance Site (MSSS), Haleakala, Maui, Hawaii*

Dear Mr. Aiona:

Thank you for your January 12, 1994, letter concerning the Draft Environmental Assessment for the AEOS project. We appreciate your acknowledging receipt of the report and informing us that you have forwarded it to OHA's Land and Natural Resources Division for review, evaluation, and comments.

We have not yet received comments from that Division and have had to finalize the Environmental Assessment without them. However, my staff and I will be happy to answer any questions that may arise out of the Division's review.

In the meantime, if you would like additional information about the project or to be kept apprised of its progress, please call Wayne Lu at 1-878-1215.

Sincerely,

Donald N. B. Hall
Director

DNBH:nll

United States Department of the Interior

TAKE PRIDE IN AMERICA

NATIONAL PARK SERVICE
Haleakala National Park
P.O. Box 369
Makawao, Maui, Hawaii 96768

IN REPLY REFER TO:

L76

February 4, 1994

FEB 11 1994

Dr. Donald N. B. Hall, Director
Institute for Astronomy
University of Hawaii
2680 Woodlawn Drive
Honolulu, Hawaii 96822

Dear Dr. Hall:

We have reviewed DRAFT ENVIRONMENTAL ASSESSMENT/NEGATIVE DECLARATION, Advanced Electro-Optical System (AEOS) Telescope And Related Improvements At The Maui Space Surveillance Site (MSSS) Haleakalā, Maui Hawaii.

We believe the document adequately addresses Haleakalā National Park's environmental concerns. It also accurately describes the proposed batch plant operation at Puu Nianiau and the proposal to repair the park's 100,000 gallon water tank as a source for the project's water supply.

We did note significant errorss in the Climatology section (4.5), on p. 4-10, paragraph #2. The paragraph misinterprets the graph on the facing page. If you need clarification please contact Dr. Lloyd Loope at 572-1983.

Thank you for the opportunity to review the document.

Sincerely,

Donald W. Reeser
Superintendent

University of Hawaii at Manoa

Institute for Astronomy
2680 Woodlawn Drive • Honolulu, Hawaii 96822
Telex: 723-8459 • UHAST HR

Office of the Director

March 2, 1994

Mr. Donald W. Reeser
Superintendent, Haleakala National Park
National Park Service
U.S. Department of the Interior
P.O. Box 369
Makawao, Maui, Hawaii 96768

Subject: *Draft Environmental Assessment/Negative Declaration*
Advanced Electro-Optical System (AEOS) Telescope and Related Improvements
At The Maui Space Surveillance Site (MSSS), Haleakala, Maui, Hawaii

Dear Don:

Thank you for your February 11, 1994, letter concerning the Draft Environmental Assessment for the AEOS project. We are pleased that you believe the document adequately addresses Haleakala National Park's environmental concerns.

We agree that the text on page 4-10 does not accurately characterize the existing temperature data summarized in Figure 4.6. The inconsistency has been corrected in the Final Environmental Assessment.

We will keep you apprised of our progress with the project. In the meantime, if you have any questions related to Haleakala Observatories, please call Wayne Lu at 878-1215.

Sincerely,

Donald N. B. Hall
Direector

DNBH:nll

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

KEITH W. AHUE, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

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AQUACULTURE DEVELOPMENT PROGRAM
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CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

RECEIVED FEB 10 1994

REF:OCEA:KCK

FEB 9 1994

File No.: 94-437
DOC. NO.: 4131

Mr. Donald N.B. Hall, Director
Institute for Astronomy
University of Hawaii
2680 Woodlawn Drive
Honolulu, Hawaii 96822

Dear Mr. Hall:

Subject: Draft Environmental Assessment (DEA): Expansion of the U.S. Air Force Maui Space Surveillance Site (MSSS), Haleakala, Maui, TMK: 2-2-07: 8

We have reviewed the DEA information for the subject expansion project transmitted by your letter dated January 5, 1994, and have the following comments:

Office of Conservation and Environmental Affairs

The Office of Conservation and Environmental Affairs (OCEA) comments that the existing facility was the subject of a number of Conservation District Use Permits (CDUP) approved by the Board of Land and Natural Resources.

As such, OCEA suggests that the U.H. Institute for Astronomy review these CDUP files in preparing the CDUP application for the proposed expansion project.

We will forward our Historic Preservation Division comments as they become available.

We have no other comments to offer at this time. Thank you for the opportunity to comment on this matter.

Please feel free to call Steve Tagawa at our Office of Conservation and Environmental Affairs, at 587-0377, should you have any questions.

Very truly yours,

KEITH W. AHUE

cc: Wayne Lu, U.H. Institute for Astronomy

FEB [illegible] 10:31

JOHN WAIHEE
GOVERNOR OF HAWAII

RECEIVED

FEB 22 1994

KEITH AHUE, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

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JOHN P. KEPPELER II
DONA L. HANAIKE

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CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION DIVISION
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 6TH FLOOR
HONOLULU, HAWAII 96813

February 16, 1994

MEMORANDUM

LOG NO: 10616
DOC NO: 9402KD02

TO: Roger C. Evans, Administrator
Office of Conservation and Environmental Affairs

FROM: Don Hibbard, Administrator
State Historic Preservation Division

SUBJECT: Historic Preservation Review of the Draft Environmental Assessment--Expansion of the U.S. Air Force Space Surveillance Site, Haleakala Observatories, Papaanui, Makawao District, Maui
File No.: 94-437
TMK: 2-2-07: 8

The University of Hawaii, Institute for Astronomy is proposing to enter into a lease agreement that will increase the area of the existing U.S. Air Force Space Surveillance Site by approximately 1.74 acres. A telescope and related facilities will be constructed within the expansion area, which is contained within the boundaries of Haleakala Observatories (Science City).

This project has been previously reviewed by the Historic Preservation Division, and we have concurred with the determination of "no effect" on known historic sites. The applicant has agreed to flag and fence two sites that are in close proximity to the project area, in order to insure their protection and preservation during construction.

We request that the following condition be attached to the Conservation District Use Permit:

> Prior to the commencement of any earthmoving activities, the applicant shall:
>
> a) Submit a preservation plan to the Historic Preservation Division for approval. The plan should minimally include updated maps showing the location of

proposed construction, the location of Historic Sites 50-50-11-2805 and 50-50-11-2806, proposed short-term (construction) buffer zones, and a discussion of site fencing procedures and materials to be used. Long-term site preservation should also be discussed.

b) Upon approval of the plan, all short-term preservation measures shall be implemented and inspected by a Historic Preservation Division staff archaeologist.

Please contact Ms. Theresa K. Donham at 243-5169 if you have any questions regarding these comments.

KD:jcn

c: Dr. Donald N.B. Ball, Director

CORRECTION

THE PRECEDING DOCUMENT(S) HAS BEEN REPHOTOGRAPHED TO ASSURE LEGIBILITY
SEE FRAME(S)
IMMEDIATELY FOLLOWING

proposed construction, the location of Historic Sites 50-50-11-2805 and 50-50-11-2806, proposed short-term (construction) buffer zones, and a discussion of site fencing procedures and materials to be used. Long-term site preservation should also be discussed.

b) Upon approval of the plan, all short-term preservation measures shall be implemented and inspected by a Historic Preservation Division staff archaeologist.

Please contact Ms. Theresa K. Donham at 243-5169 if you have any questions regarding these comments.

KD:jen

c: Dr. Donald N.B. Ball, Director

JOHN WAIHEE
GOVERNOR OF HAWAII

KEITH W. AHUE, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES
JOHN P. KEPPELER, II
DONA L. HANAIKE

MAR 1 1994

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

P. O. BOX 621
HONOLULU, HAWAII 96809

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

REF:OCEA:KCK

FEB 28 1994

File No.: 94-437
DOC. NO.: 4158

Mr. Donald N.B. Hall, Director
Institute for Astronomy
University of Hawaii
2680 Woodlawn Drive
Honolulu, Hawaii 96822

Dear Mr. Hall:

Subject: Draft Environmental Assessment (DEA): Expansion of the U.S. Air Force Maui Space Surveillance Site (MSSS), Haleakala, Maui, TMK: 2-2-07: 8

The following are our additional comments on the subject project which supplement those forwarded by our previous letter dated February 9, 1994:

Division of Forestry and Wildlife

The Division of Forestry and Wildlife (DOFAW) comments that although the report indicated that active Uau or dark-rumped petrel nesting burrows were found to exist less than 250 feet from the project site, DOFAW should be notified should burrows be located on site during construction.

Lighting is still a concern because it disorients fledgling seabirds in the lowland areas. Shielded low-intensity lights directed toward the ground should be used.

Should Nene begin to frequent the project area, DOFAW should be contacted.

Historic Preservation Division

The Historic Preservation Division (HPD) comments that the project has been previously reviewed by HPD, and they concur with the determination of "no effect" on known historic sites. The applicant has agreed to flag and fence two sites that are in close proximity to the project area, in order to insure their protection and preservation during construction.

HPD requests that the following condition be attached to the Conservation District Use Permit:

Prior to the commencement of any earthmoving activities, the applicant shall:

1) Submit a preservation plan to HPD for approval. The plan should minimally include updated maps showing the location of proposed construction, the location of Historic Sites 50-50-11-2805 and 50-50-11-2806, proposed short-term (construction) buffer zones, and a discussion of site fencing procedures and materials to be used. Long-term site preservation should also be discussed.

2) Upon approval of the plan, all short-term preservation measures shall be implemented and inspected by an HPD staff archaeologist.

We have no other comments to offer at this time. Thank you for the opportunity to comment on this matter.

Please feel free to call Steve Tagawa at our Office of Conservation and Environmental Affairs, at 587-0377, should you have any questions.

Very truly yours,

KEITH W. AHUE

cc: Wayne Lu, U.H. Institute for Astronomy

University of Hawaii at Manoa

Institute for Astronomy
2680 Woodlawn Drive • Honolulu, Hawaii 96822
Telex: 723-8459 • UHAST HR

Office of the Director

March 2, 1994

Mr. Keith W. Ahue
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Subject: Comments On *Draft Environmental Assessment/Negative Declaration Advanced Electro-Optical System (AEOS) Telescope and Related Improvements At The Maui Space Surveillance Site (MSSS), Haleakala, Maui, Hawaii*

Dear Mr. Ahue: Keith

Thank you for your February 9, 1994 letter concerning the Draft Environmental Assessment for the AEOS project. We appreciate the time you and your staff spent reviewing the document. Responses to your comments follow below.

- We are aware that a number of Conservation District Use Permits (CDUP) have been granted for the existing facilities at the Air Force's Maui Space Surveillance Site (MSSS). We have reviewed the CDUP files for these and are incorporating the information in them into our CDUP application.

- We have received the Historic Preservation Division comments noted in your letter. The Division has concurred with the Draft EA's conclusion that the proposed project would not have a significant adverse effect on archaeological or historical resources. We will comply with the two proposed CDUP conditions stated in your letter.

- Both government supervisory personnel and the construction contractor will be required to notify the Division of Forestry and Wildlife should any dark-rumped petrel burrows be encountered on the project site. Information about the petrel will be included in the orientation material that will be provided to all individuals working on the site to insure that they are aware of this requirement and have the knowledge necessary to comply with it.

- As indicated on page 5-17 of the Draft Environmental Assessment, the Air Force's plans call for the use of the kind of low-intensity lighting you requested.

- The Division of Forestry and Wildlife will be notified if Nene begin to frequent the project area.

We look forward to working with you and your staff during the review and processing of our CDUA. In the meantime, if you have any questions please call Wayne Lu at 1-878-1215.

Sincerely,

Donald N. B. Hall
Director

DNBH:nll

OFFICE OF HAWAIIAN AFFAIRS
Ke'ena Kuleana Hawai'i

711 Kapi'olani Blvd., Suite 500
Honolulu, Hawai'i 96813-5249
Ph: (808) 586-3777
Fax: (808) 586-3799

January 12, 1994

Dr. Donald N. B. Hall, Director
Institute for Astronomy
University of Hawaii
2680 Woodlawn Drive
Honolulu, HI 96822

Dear Dr. Hall:

This is to acknowledge receipt of the Draft Environmental Assessment for the Expansion of the U. S. Air Force Maui Space Surveillance Site at Haleakala.

I am referring the report to the OHA Land and Natural Resources Division for review, evaluation and comments.

Sincerely yours,

Abraham Aiona, Vice Chairman
Chairman, Committee on Budget, Finance & Policy

cc: Mr. Wayne Lu

University of Hawaii at Manoa

Institute for Astronomy
2680 Woodlawn Drive • Honolulu, Hawaii 96822
Telex: 723-8459 • UHAST HR

Office of the Director

March 2, 1994

Mr. Abraham Aiona, Vice-Chairman
Office of Hawaiian Affairs
711 Kapiolani Boulevard, Suite 500
Honolulu, Hawaii 96813-5249

Subject: Comments On *Draft Environmental Assessment/Negative Declaration Advanced Electro-Optical System (AEOS) Telescope and Related Improvements At The Maui Space Surveillance Site (MSSS), Haleakala, Maui, Hawaii*

Dear Mr. Aiona:

Thank you for your January 12, 1994, letter concerning the Draft Environmental Assessment for the AEOS project. We appreciate your acknowledging receipt of the report and informing us that you have forwarded it to OHA's Land and Natural Resources Division for review, evaluation, and comments.

We have not yet received comments from that Division and have had to finalize the Environmental Assessment without them. However, my staff and I will be happy to answer any questions that may arise out of the Division's review.

In the meantime, if you would like additional information about the project or to be kept apprised of its progress, please call Wayne Lu at 1-878-1215.

Sincerely,

Donald N. B. Hall
Director

DNBH:nll

@

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF HEALTH

P. O. BOX 3378
HONOLULU, HAWAII 96801

JOHN C. LEWIN, M.D.
DIRECTOR OF HEALTH

In reply, please refer to:

February 11, 1994,

94-003/epo

RECEIVED
FEB 23 1994
DIRECTOR
INSTITUTE FOR ASTRONOMY

Mr. Donald N. B. Hall, Director
Institute for Astronomy
2680 Woodlawn Drive
Honolulu, Hawaii 96822

Dear Mr. Hall:

Subject: Draft Environmental Assessment
Expansion of the U.S. Air Force Maui Space
Surveillance Site (MSSS)
Haleakala Observatories, Maui
TMK: 2-2-07: 08

Thank you for allowing us to review and comment on the subject project. We have the following comments to offer:

Wastewater

As the subject project is located in a critical wastewater disposal area as determined by the Maui Wastewater Advisory Committee, no new cesspools will be allowed in the subject area. We concur with the proposed method of wastewater treatment and disposal, which is the continued use of treatment individual wastewater systems (septic tanks and leaching fields). Irrigation, utilizing the treated effluent, is encouraged.

All wastewater plans must conform to applicable provisions of the Department of Health's Administrative Rules, Chapter 11-62, "Wastewater Systems."

If you should have any questions on this matter, please contact Ms. Lori Kajiwara of the Wastewater Branch at 586-4290.

Very truly yours,

[signature] for
John C. Lewin, M.D.
Director of Health

c: Wastewater Branch
Maui, District Health Office

University of Hawaii at Manoa

Institute for Astronomy
2680 Woodlawn Drive • Honolulu, Hawaii 96822
Telex: 723-8459 • UHAST HR

Office of the Director

March 2, 1994

Dr. John C. Lewin, M.D., Director
Department of Health
State of Hawaii
P.O. Box 3378
Honolulu, Hawaii 96801

Subject: Comments On *Draft Environmental Assessment/Negative Declaration Advanced Electro-Optical System (AEOS) Telescope and Related Improvements At The Maui Space Surveillance Site (MSSS), Haleakala, Maui, Hawaii* (Your Reference No. 94-003/epo

Dear Dr. Lewin: John

Thank you for your February 23, 1994 letter concerning the Draft Environmental Assessment for the AEOS project. We appreciate the time you and your staff spent reviewing the document and are pleased that you concur with the proposed method of wastewater treatment and disposal.

The facility is being designed to comply with the applicable provisions of the Department of Health's Administrative Rules, Chapter 11-62, "Wastewater Systems." Construction plans for the system will be submitted to the Department of Health for review and approval when they are available. In the meantime, if you have any questions, please contact Wayne Lu at 1-878-1215.

Sincerely,

Donald N. B. Hall
Director

DNBH:nll

JOHN WAIHEE
GOVERNOR OF HAWAII

RECEIVED
JAN 28 1994

filed 1/28

KEITH W. AHUE
~~WILLIAM W. PATY~~, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

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JOHN P. KEPPELER, II
DONA L. HANAIKE

AQUACULTURE DEVELOPMENT PROGRAM
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WATER AND LAND DEVELOPMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF LAND MANAGEMENT
54 SOUTH HIGH STREET, ~~1ST FLOOR~~ Rm. 101
WAILUKU, HAWAII 96793

January 27, 1994

Dr. Donald N.B. Hall, Director
Institute for Astronomy
University of Hawaii
2680 Woodlawn Drive
Honolulu, Hawaii 96822

Dear Dr. Hall:

Subject: Draft Environmental Assessment - Expansion of the U.S. Air Force Maui Space Surveillance Site (MSSS) to Provide Space Needed for Construction and Operation of an Advanced Electro-Optical System Telescope and Related Facilities at Haleakala Observatories, Tax Map Key: 2-2-07: 08, Haleakala, Makawao, Maui.

The Maui District Land Office has reviewed and has no comments on the Draft Environmental Assessment regarding the proposed expansion of the U.S. Air Force Maui Space Surveillance Site (MSSS) to provide space needed for construction and operation of an advanced electro-optical system telescope and related facilities at Haleakala Observatories on State property identified by Tax Map Key: 2-2-07: 08, Haleakala, Makawao, Maui.

If you may have any questions, please contact this office at the above address or by telephone at 243-5352.

Very truly yours,

Alan Tokunaga

ALAN TOKUNAGA
Maui District Land Agent

cc: Mr. W. Mason Young
Mr. W. Kennison
Mr. Wayne Lu

University of Hawaii at Manoa

Institute for Astronomy
2680 Woodlawn Drive • Honolulu, Hawaii 96822
Telex: 723-8459 • UHAST HR

Office of the Director

March 2, 1994

Mr. Alan Tokunaga
Maui District Land Agent
Department of Land and Natural Resources
State of Hawaii
54 South High Street, Room 61
Wailuku, Hawaii 96793

Subject: Comments On *Draft Environmental Assessment/Negative Declaration Advanced Electro-Optical System (AEOS) Telescope and Related Improvements At The Maui Space Surveillance Site (MSSS), Haleakala, Maui, Hawaii*

Dear Mr. Tokunaga:

Thank you for your February 9, 1994, letter concerning the Draft Environmental Assessment for the AEOS project. We appreciate the time you and your staff spent reviewing the document and understand that you have no comments at this time.

Sincerely,

Donald N. B. Hall
Director

DNBH:nll

Council Chair
Goro Hokama

Council Vice-Chair
Dennis Y. Nakamura

Council Members
Kimo Apana
Lynn Britton
Patrick S. Kawano
Alice L. Lee
Rick Medina
Manuel "Junior" Moniz
Thomas P. Morrow

COUNTY COUNCIL
COUNTY OF MAUI
200 S. HIGH STREET
WAILUKU, MAUI, HAWAII 96793

Ken R. Fukuoka
Director of Council Services

RECEIVED
JAN 24 1994

✓ 1/24

January 20, 1994

Dr. Donald N. B. Hall, Director
Institute for Astronomy
University of Hawaii
2680 Woodlawn Drive
Honolulu, HI 96822

Dear Dr. Hall:

SUBJECT: PROPOSED TELESCOPE AND RELATED FACILITIES AT HALEAKALA OBSERVATORIES (PAF 94-11)

Thank you for your January 5, 1994 letter and attached draft Environmental Assessment/Negative Declaration regarding the proposed Advanced Electro-Optical System (AEOS) telescope and related facilities at Haleakala observatories.

The sophisticated capabilities of the AEOS telescope, with its exceptional resolution, and ability to enhance space surveillance and scientific research, seems extraordinary, and I would like to offer my support for the proposal to expand the U.S. Air Force Maui Space Surveillance Site (MSSS) for this purpose. I do hope, however, that construction will not in any way interfere with the fragile ecosystem at Haleakala.

If I can be of further assistance, please do not hesitate to contact me.

Sincerely,

Goro Hokama

GORO HOKAMA, Chair
Maui County Council

PAF:94-011a:sjp

cc: Mr. Wayne Lu

University of Hawaii at Manoa

Institute for Astronomy
2680 Woodlawn Drive • Honolulu, Hawaii 96822
Telex: 723-8459 • UHAST HR

Office of the Director

March 2, 1994

Honorable Goro Hokama, Chairman
Maui County Council
County of Maui
200 High Street
Wailuku, Maui, Hawaii 96793

Subject: Comments On *Draft Environmental Assessment/Negative Declaration Advanced Electro-Optical System (AEOS) Telescope and Related Improvements At The Maui Space Surveillance Site (MSSS), Haleakala, Maui, Hawaii*

Dear Chairman Hokama:

Thank you for your January 20, 1994, letter concerning the Draft Environmental Assessment for the AEOS project. We greatly appreciate your support of the proposed expansion of the Maui Space Surveillance Site.

The Institute for Astronomy firmly believes that the proposed project will greatly enhance Hawaii's ability to remain on the cutting edge of astronomical research. As indicated in the Draft Environmental Assessment, the facilities can, indeed, be constructed without interfering with Haleakala's fragile ecosystem.

We will keep you apprised of the project's status. In the meantime, if you have any questions or would like additional information, please contact Wayne Lu at 878-1215.

Sincerely,

Donald N. B. Hall
Director

DNBH:nll

University of Hawaii at Manoa

Environmental Center
A Unit of Water Resources Research Center
Crawford 317 • 2550 Campus Road • Honolulu, Hawaii 96822
Telephone: (808) 956-7361

February 7, 1994
EA:00042

Dr. Donald Hall
University of Hawaii
Institute for Astronomy
2680 Woodlawn Drive
Honolulu, Hawaii 96822

Dear Dr. Hall:

Draft Environmental Assessment
Maui Space Surveillance Site
Advanced Electro-Optical System Telescope and Related Improvements
Haleakala, Maui

The U.S. Air Force has asked the University of Hawaii Institute for Astronomy (IfA) for permission to expand the area it leases in the IfA's Haleakala Observatories on the summit of Haleakala Volcano on Maui. The Air Force plans to expand its existing Maui Space Surveillance Site (MSSS) by 1.74 acres to accommodate the proposed Advanced Electro-Optical System (AEOS) telescope and related facilities. This project proposes to construct the AEOS telescope with a primary mirror of 8 meters in diameter, but a smaller 3.67-meter telescope will be installed initially. Laser and optics laboratories, offices, and other support spaces are included in the proposal. An innovative system will make ice during periods that the telescopes are not in use. The ice will be used to chill the facilities during viewing hours, eliminating the heat releases associated with traditional cooling systems and improving the viewing conditions for all the telescopes at the MSSS. A mirror coating facility will enable on-site resurfacing of all mirrors used at MSSS. Renovations and upgrades to the existing facilities are planned as well.

The Environmental Center has reviewed the Draft Environmental Assessment (EA) with the assistance of Sheila Conant, General Science; Howard McAllister and Michael Jones, Physics/Astronomy; Richard Mayer, Geography-Maui Community College; and Heather Keevill of the Environmental Center.

Coordination of Planning Efforts

There are a number of land use issues that appear to require more detailed examination before AEOS proceeds. Section 5.4 addresses the cumulative impacts of the proposed action. The section notes that the IfA is preparing a Research Development Plan (RDP) for future use of Haleakala Observatories to be followed by a Complex Development Plan (CDP) "to specify design and environmental criteria to be followed when implementing the development program." While it is acknowledged that these plans are being developed, the UH IfA "has agreed to allow the AEOS project to proceed in parallel with development of the RDP, and ahead of the CDP for Haleakala Observatories."

In addition to the two UH plans, there is also the Makawao-Pukalani-Kula Community Plan that specifically notes support for a Science City master plan and allocates responsibility for that plan to the State. With all of these plans on the horizon, one thing seems clear: there is a general consensus that a plan is indeed needed for the future development of research facilities on Haleakala. Proceeding with AEOS prior to the completion of the RDP and the CDP could create conflicts and may preclude projects from being considered in the RDP. The rationale for proceeding with the AEOS project prior to the completion of a master plan should be presented in the Final EA. Alternative projects should be investigated in more detail before AEOS is approved. For instance, are there other projects that would contribute more scientifically as well as economically? What are the cumulative impacts of all the research facilities on Haleakala? These options need to be addressed prior to the project's approval, and that is the purpose of the planning process that is already underway. There are limits to the number of facilities that can be located on Haleakala without creating undesirable visual and environmental impacts. AEOS should be evaluated not only in terms of the impact of the individual facility, but also in the context of future plans and cumulative impacts.

Health and Safety

No detailed information regarding the type, power or wavelength of the lasers is included in the Draft EA, which makes it difficult to evaluate the human health risk or the safety measures that may be needed. Section 5.2.6.1 states that eye damage would result to viewers who look directly down the axis of the beam. While the procedures to avoid damage to humans appear adequate, as presently described, it would be difficult for state agencies to determine whether the proposed procedures were implemented during AEOS operation or whether environmental regulations are being followed. Will a safety officer be on site to oversee the operations? While the health risk may be low, the consequences to affected individuals are great.

Protection of Wildlife

Page 4-16 lists the chukar partridge, mongoose, roof rat, polynesian rat, cat, dog, and feral goat as fauna occurring in the vicinity of MSSS. Page 5-8 on the other hand indicates that the presence of these animals is unlikely because of the harsh environment. These subtle contradictions should be eliminated in the Final EA.

The statement on page 5-8 regarding the possibility that feral animals could be attracted to wastes produced on site is an appropriate concern. We urge that waste be stored in rat proof containers and removed daily so as to discourage the presence of mongoose, cats, dogs and rats that are all known predators of the endangered *'ua'u* or dark-rumped petrel. The statement on page 5-11 does not specify storage facilities or frequency of removal.

Facility Access and Ownership

AEOS is to be developed by the U.S. Air Force on lands leased from the IfA, owned by the University of Hawaii. Plans were developed in coordination with the IfA both to conduct military surveillance activities and to support research. While the document states the U.S. Air Force is "committed to developing AEOS as a shared use facility," no specifications are outlined for the degree of access researchers would have to the facility. An access agreement should be clearly defined in the Final EA given the commitment of resources required by the Air Force on land owned by the University.

It appears that inconsistencies in UH policies exist for research on Haleakala and Mauna Kea. On page 3-16 the Draft EA states that the policy on research activities does not permit lasers or classified research on Mauna Kea. Page 3-6 clearly states that "AEOS is expected to use and collect data that will be classified up to Top Secret level." The UH policy prohibiting classified research and the use of lasers at Mauna Kea but not at Haleakala should be clarified in the Final EA. In the past we understand that the conduct of classified research was permitted at Haleakala since no UH faculty or students were involved. It appears from the Draft EA that this is not to be the case for this project where UH personnel, including students, are specifically cited users (p. 2-15) It is important to have clear and concise understandings between the Air Force and UH since UH has the right to terminate the lease after 15 years from the commencement date if the educational demands of the lessor should so dictate.

Dr. Donald Hall
February 16, 1994
Page 4

Thank you for the opportunity to review this document and we hope our comments are helpful.

Sincerely,

Jacquelin N. Miller

Jacquelin N. Miller
Assistant Environmental Coordinator

cc: OEQC
Haleakala Observatories
Roger Fujioka
Sheila Conant
Howard McAllister
Richard Mayer
Michael Jones
Heather Keevill

University of Hawaii at Manoa

Institute for Astronomy
2680 Woodlawn Drive • Honolulu, Hawaii 96822
Telex: 723-8459 • UHAST HR

March 2, 1994

Office of the Director

Ms. Jacquelin N. Miller
Crawford Hall 317
2550 Campus Road
Honolulu, Hawaii 96822

Subject: Comments On *Draft Environmental Assessment/Negative Declaration: Advanced Electro-Optical System (AEOS) Telescope*

Dear Ms. Miller:

Thank you for the Environmental Center's comments on the *Draft Environmental Assessment/Negative Declaration: Advanced Electro-Optical System (AEOS) Telescope.* Complete responses to your comments are provided below.

Comment Concerning Coordination of Planning Efforts

> **Comment.** *Proceeding with AEOS prior to the completion of the Research Development Plan (RDP) and the Complex Development Plan (CDP) [for Haleakala Observatories] could create conflicts and may preclude projects from being considered in the RDP. The rationale for proceeding with the AEOS project prior to the completion of a master plan could be presented in the Final EA. Alternative projects should be investigated in more detail before AEOS is approved. For instance, are there other projects that would contribute more scientifically as well as economically? What are the cumulative impacts of all the research facilities on Haleakala? These options need to be addressed prior to the project's approval, and that is the purpose of the planning process that is already underway. There are limits to the number of facilities that can be located on Haleakala without creating any undesirable visual and environmental impacts. AEOS should be evaluated, not only in terms of the impact of the individual facility, but also in the context of future plans and cumulative impacts.*

Response. The University of Hawaii Institute for Astronomy has completed an internal draft of the *Haleakala Observatories Research Development Plan*, and the document is being reviewed at the present time. The AEOS project is an integral and important part of that plan. Thus, while the Research Development Plan for Haleakala Observatories has not yet been formally adopted by the University of Hawaii Board of Regents, the issues mentioned in your comment have been thoroughly considered and addressed as part of the IfA's planning process. More specifically, the draft Research Development Plan:

- Provides for the IfA to continue to act as the lessor of the MSSS site and to play a more substantial role in the formulation and conduct of the research conducted there.

- Recognizes that Haleakala Observatories offers unique opportunities for optical and infrared observations of objects in space that are important for national defense and the U.S. space program and continues to provide space for those activities.

- Makes it the policy of the IfA to encourage uses of Haleakala Observatories that will expand the research opportunities available to Hawaii scientists.

While the IfA would prefer that final action had been taken on the RDP before having to act on the AEOS project, the need to proceed immediately with AEOS in order to take advantage of research opportunities and available funding makes this impossible. As discussed below, we believe that there is overwhelming evidence that AEOS is consistent with the State's goals and represents a wise choice for Haleakala Observatories.

First, analyses conducted during preparation of the draft Haleakala Observatories Research Development Plan show that making land available for the AEOS project would not preclude other projects that might provide greater scientific or economic benefits. The additional acreage that has been requested for AEOS is modest in comparison to the total land that is available. Moreover, it is located on the periphery of Haleakala Observatories, and an analysis of the plans using generalized telescope siting criteria shows that the proposed 1.74-acre expansion of AEOS would not interfere with the use of other potential observatory sites at the summit.

Second, operation of lasers at AEOS will not interfere with existing uses of the Haleakala Observatories or with other uses that might benefit from being there in the foreseeable future. Mauna Kea Observatories is capable of satisfying the need for laser-free astronomical sites in the State, and the continuation of laser-based research at Haleakala Observatories is consistent with the State's desire to offer the broadest possible range of observing conditions to the scientific community.

Finally, despite the fact that the worldwide scientific community is well aware of the excellent seeing conditions available on Haleakala, no organization or institution has approached the University with proposals for use of the proposed AEOS site whose benefits to the University or the scientific community would equal or exceed those provided by AEOS. On the contrary, the lease extension that is being negotiated between the IfA and the U.S. Government would guarantee University researchers access to new facilities that would otherwise be unavailable to them, furthering the State's efforts to insure that Astronomy remains one of the University's centers of excellence. Astronomical research programs that are planned for AEOS will provide new and potentially unique data to University astronomers and will provide opportunities for training students in such diverse fields as astronomy, optics, atmospheric sciences, and electronics.

The University of Hawaii Institute for Astronomy is playing a central role in developing the research plan for AEOS and will be allocated instrument time and space within the complex in order to carry out its work. IfA anticipates that the superb optical performance provided by the AEOS image-compensating system will allow the telescope to generate images whose resolution equals or surpasses those available from other facilities. Moreover, AEOS's design makes it extremely well-suited to act as an equipment test-bed, a feature which will facilitate the conduct of research at other astronomical facilities in the state. This, in turn, will attract leading researchers and help insure that the University continues as a leading research institution.

Comment Concerning Health and Safety

Comment. *No detailed information regarding the type, power, or wavelength of the lasers is included in the draft EA, which makes it difficult to evaluate the human health risk or the safety measures that may be needed. Section 2.5.6.6 states that eye damage would result to viewers who look directly down the axis of the beam. While the procedures to avoid damage to humans appears to be adequate, as presently described, it would be difficult for state agencies to determine whether the proposed procedures would be implemented during AEOS operation or whether environmental regulations are being followed. Will a safety officer be on site to oversee the operations? While the health risk may be low, the consequences to the affected individuals are great.*

Response. No detailed information is yet available concerning the types, power, or wavelengths of lasers that will be used in conjunction with AEOS. However, it is anticipated that the lasers projected through the AEOS optics will be very similar to the types of low-power pulsed and continuous wave systems currently used at the MSSS and UH/IfA Lure Observatory.

We are pleased that you concur that the operational procedures described in the EA are adequate to avoid injury to humans. We do not agree that it will be difficult to insure that necessary safety measures are actually taken. The Air Force, University, and visiting experimenters will be required to incorporate laser safety procedures in all of their operational plans, as has been the case at Haleakala Observatories for more than twenty-five years. An on-site laser safety officer will be responsible for insuring that the safety procedures described in the operational plans are implemented. Current safety requirements will be extended to the new facility. This means that Air Force Space Command safety/environmental personnel, Hickam Air Force Base support base experts, and Air Force Environmental Compliance and Assessment Program (ECAMP) inspectors will routinely inspect any new AEOS laser operations and equipment to insure compliance with all Air Force Occupational Health and Safety regulations, State and Federal OSHA regulations, and State and federal environmental regulations and statutes.

Comment Concerning Protection of Wildlife

Comment. *Page 4-16 lists the chukar partridge, mongoose, roof rat, Polynesian rat, dog, and feral goat as fauna occurring in the vicinity of MSSS. Page 5-8 on the other hand indicates that the presence of these animals is unlikely because of the harsh environment. These subtle contradictions should be eliminated in the Final EA.*

The statement of Page 5-8 regarding the possibility that feral animals could be attracted to wastes produced on site is an appropriate concern. We urge that waste be stored in rat-proof containers and removed daily so as to discourage the presence of mongoose, cats, dogs, and rats that are all known predators of the endangered "'ua'u" or dark-rumped petrel. The statement on page 5-11 does not specify storage facilities or frequency of removal.

Response. As indicated by the reference at the end of the second paragraph in Section 4.6.2.1 of the Draft Environmental Assessment, the information that is presented on page 4-16 is drawn from a general discussion of the area's fauna prepared by the National Park Service. The discussion on page 5-8 focused only on the AEOS site; a subset of the larger area being referred to in the National Park Service source document. This difference accounts for the subtle (and potentially confusing) differences noted in your comment. The wording of the Final Environmental Assessment has been revised to clarify this.

At present, all solid waste generated at MSSS is stored in walled and screened storage areas; it is collected twice-weekly for off-site disposal. The rat population at the facility has remained low throughout the three decades that MSSS has been occupied. A pest-prevention program is in place at MSSS and will be extended to the new AEOS facility. Detailed waste removal specifications have been prepared for AEOS construction in order to insure that contractors know how to avoid attracting rodents to the construction site. Further, the National Park Service has agreed to provide pest prevention instruction to contractor personnel prior to the start of construction activities.

Comments on Facility Access and Ownership

Comment. *AEOS is to be developed by the U.S. Air Force on lands leased from the IfA, owned by the University of Hawaii. Plans were developed in coordination with the IfA both to conduct military surveillance activities and to support research. While the document states the U.S. Air Force is "committed to developing AEOS as a shared use facility," no specifications are outlined for the degree of access researchers would have to the facility. An access agreement should be clearly defined in the Final EA given the commitment of resources required by the Air Force on land owned by the University.*

It appears that inconsistencies in policies exist for UH research on Haleakala and Mauna Kea. On page 3-16 of the Draft EA states (sic) that the policy on research activities does not permit lasers or classified research on Mauna Kea. Page 3-6 clearly states that "AEOS is expected to use and collect data that will be classified up to Top Secret level." The UH policy prohibiting classified research and the use of lasers on Mauna Kea but not at Haleakala should be clarified in the Final EA. In the past we understand that the conduct of classified research was permitted at Haleakala since no UH faculty or students were involved. It appears from the Draft EA that this is not to be the case for the project where UH personnel, including students, are specifically cited users (p.2-15). It is important to have clear and concise understandings between the Air Force and UH since UH has the right to terminate the lease after 15 years from the commencement date if the educational demands of the lessor so dictate.

Response. As indicated in the Draft EA, the University and Air Force have agreed in concept to the terms under which use of the facility would be shared between the two parties. The terms include both office and storage space within the facility and the amount of observational time that would be made available. The details of their agreement are currently being worked on and will be incorporated in a Memorandum of Agreement (MOA) between the Air Force and the University. This MOA will be comparable to the agreements that the University has negotiated with the operators of facilities at Mauna Kea Observatories. Moreover, before the proposed new facilities can be constructed the State Board of Land and Natural Resources must grant a Conservation District Use Permit for the project. We believe this process is more than adequate to protect the public interest.

The University policy concerning the use of lasers and the conduct of classified research differs between Mauna Kea and Haleakala. This is not an inconsistency, simply a recognition that: (*i*) it is appropriate to prohibit lasers from a location (Mauna Kea) where their use could interfere with other, higher priority, uses and (*ii*) the different characteristics of the two areas make them suitable for different types of activities. The Research Development Plans for the two locations take these factors into account, and the RDP for Haleakala Observatories includes laser activities among the activities that are deemed appropriate for that location.

Present agreements between the IfA and the Air Force allow classified activities to be conducted at MSSS. Moreover, this permission is not linked to the absence of UH students or faculty. While classified research has been conducted by UH personnel for other programs, IfA has no intention of conducting classified research at AEOS. A Memorandum of Understanding between the Air Force and the IfA is now being prepared which will permit the classified research at AEOS insofar as it will not interfere with research during UH operational windows or with the publication of UH research. AEOS is being designed so that the Air Force's needs to keep certain data secure can be achieved without compromising the facility's usefulness for scientific purposes.

<u>Conclusion</u>

We appreciate the time you and other members of the University of Hawaii faculty and staff took to review the Draft Environmental Assessment and to prepare your comments. If you have any further questions, please call Wayne Lu at 1-878-1215.

Sincerely,

1. Corri for D.N.B. Hall

Donald N. B. Hall
Director

DNBH:nll

Maui Electric Company, Ltd. • 210 West Kamehameha Avenue • PO Box 398 • Kahului, Maui, HI 96732-0398 • (808) 871-8461

faxed 2/1

RECEIVED

FEB 1 1994

January 28, 1994

Dr. Donald N.B. Hall, Director
Institute for Astronomy
University of Hawaii
2860 Woodlawn Drive
Honolulu, HI 96822

Dear Dr. Hall:

Subject: Expansion of the U.S. Air Force
Maui Space Surveillance Site (MSSS)
Draft Environmental Assessment
(TMK: 2-2-07:8)

Thank you for allowing us to comment on the above subject.

In reviewing the information transmitted, Maui Electric Company (MECO) has the following comments:

1. In reference to Section 3.2.4 Power/Communications. MECO recommends that the project's electrical consultant meet with us as soon as practical to plan for the project's electrical requirements. This will insure that long lead time items can be ordered well in advance and work crews can be scheduled.

2. In reference to Section 4.8.3 Power/Communications. "*The transformer at the Kula Substation reduces the voltage to 23 KV.*" To correct this statement, "*The Kula Substation transforms the voltage from 69 KV to 23 KV via two transformers. The first transformer being a 7500 KVA, 69 KV to 12 KV transformer and the second a 1500 KVA, 12 KV to 23 KV transformer.*"

3. In reference to Section 5.2.9.2 Electrical Power. MECO will require specific electrical data (load, voltage, etc.) to determine the probable impact to our electrical system. Again, MECO recommends that the project's electrical consultant meet with us as soon as practical so that service can be provided on a timely basis.

If you have any questions or concerns, please call Fred Oshiro at 872-3202.

Sincerely,

Edward Reinhardt

Edward Reinhardt
Manager, Engineering

FO:rt

An HEI Company

University of Hawaii at Manoa

Institute for Astronomy
2680 Woodlawn Drive • Honolulu, Hawaii 96822
Telex: 723-8459 • UHAST HR

Office of the Director

March 2, 1994

Mr. Edward Reinhardt
Manager, Engineering
Maui Electric Company
P.O. Box 398
Kahului, Maui, Hawaii 96731-0398

Dear Mr. Reinhardt:

Subject: Comments On *Draft Environmental Assessment/Negative Declaration Advanced Electro-Optical System (AEOS) Telescope and Related Improvements At The Maui Space Surveillance Site (MSSS), Haleakala, Maui, Hawaii*

Dear Mr. Reinhardt:

Thank you for your January 28, 1994 letter concerning the Draft Environmental Assessment for the AEOS project. We appreciate the time you and your staff spent reviewing the document. Responses to your comments follow below.

(1) The Air Force and their contractor have already held preliminary meetings have already been held with members of the MECO engineering staff. We have asked the project engineers to follow up with further meetings as soon as possible to insure that MECO has the kind of lead time requested in your letter.

(2) The discussion in Section 4.8.3 of the Final Environmental Assessment will incorporate the wording you suggested.

(3) The design engineers understand your need for the specific electrical data listed in your letter. As indicated in item No. 1, above, I expect they will be contacting MECO shortly to discuss the project further.

If you have any problems regarding requested electrical data, please call Wayne Lu at 878-1215.

Sincerely,

Donald N. B. Hall
Director

DNBH:nll

APPENDIX A

A REVIEW OF THE ARTHROPOD FAUNA AT THE PROPOSED AIR FORCE FACILITY CONSTRUCTION SITE AT THE SUMMIT AREA OF HALEAKALA VOLCANO, MAUI, HAWAI'I

A REVIEW OF THE ARTHROPOD FAUNA AT THE PROPOSED AIR FORCE FACILITY CONSTRUCTION SITE AT THE SUMMIT AREA OF HALEAKALA VOLCANO, MAUI, HAWAI'I

A.C. Medeiros and L.L. Loope
Research Division, Haleakalā National Park, P.O. Box 369, Makawao, HI 96768

INTRODUCTION

Despite the sparsity of vegetation, the highest elevations of Haleakalā volcano and non-weathered substrates of its crater support a unique and surprisingly substantial fauna of insects and spiders. Barren high mountain ecosystems are called "aeolian," a term which describes ecosystems largely devoid of vegetation and fueled primarily by windblown organic material. The term was originally applied to include snow, meltwater, and barren rock. In Hawai'i, however, "aeolian" is primarily applied to non-weathered lava substrates, mostly but not exclusively at high elevations.

Aeolian and sub-aeolian ecosystems of Haleakalā volcano are located above 2300 m elevation in the cinder-dominated crater, above 2600 m on the older, outside, western slope, and extend to the mountain's summit at 3056 m. These areas are characterized by little vegetation (generally 0-5% cover), widely varying daily temperatures, generally dry surface conditions, and an apparent lack of food. Haleakalā National Park contains approximately 50-60% of the aeolian and sub-aeolian areas found on Haleakalā volcano; the remainder is owned by the State of Hawai'i and private landowners. Because of drier climate on the leeward slopes, aeolian systems extend to lower elevations when compared to wetter windward slopes.

The seasonal upslope movement of insects to the summits of high mountains of Hawai'i is a critical source of food for the native predator-scavenger arthropods restricted to aeolian areas. This phenomenon has been relatively well documented on Mauna Loa and Mauna Kea volcanoes, where taxa in several arthropod orders have made adaptive shifts to exploit windblown organic matter.

The climate of the summits of the high volcanic mountains in Hawai'i is one where extremes of temperature and moisture act in concert with high radiation to produce a unique and sparsely colonized ecosystem. Precipitation at the summit (primarily rain and mist, rarely snow) ranges from 1000 to 1500 millimeters annually with the majority occurring in the winter months from December through April. Freezing occurs on many nights, often followed within hours by relatively high daytime temperatures. Tropical alpine zones have been described as having "summer every day and winter every night." This applies also to Hawai'i's high mountains which are exposed to tremendous daily fluctuations. These areas are extremely xeric, a condition created by relatively low rainfall, very porous lava substrates with little water retaining capacity, low plant cover, and high solar radiation compounded by predominantly dark (heat-absorbing) volcanic substrates. Thermal and moisture regulation are critical factors guiding the adaptation of arthropods to this unique habitat.

SITE DESCRIPTION AND METHODS

Observations were made in June and July of 1992. The site consists of a gentle slope intersected by a rock outcrop. The slope is covered with loose cinder with scattered rocks. The site has been impacted previously in construction of adjacent sites (C. Fein, Rockwell Power Systems, pers. comm.). Damage to the site included compaction and removal of cinder substrates by heavy equipment which in turn has caused changes in water drainage patterns and erosion, as well as the presence of cables, foot paths, and discarded items in the study area. Visual surveys were made under rocks that were appropriate for colonization by invertebrates. Twenty pitfall traps, glass jars sunk in the substrate, were left in the study site for one month (June 22-July 23, 1992). With a bait of fermenting fish paste spread on the upper inside of each jar just below the ground surface, the jars contain a water-preservative mix with surfactant and comprise an excellent method for sampling many invertebrates. Identification to species level for all specimens collected was not feasible within the time frame of this project. However, specimens belonging to key invertebrate groups, especially Coleoptera, were forwarded to the B.P. Bishop Museum Entomology Department for identification and curation.

DISCUSSION OF INVERTEBRATE FAUNA AT THE PROPOSED SITE

Discussion of the arthropod fauna of the study site will be organized along phylogenetic groups.

ARANEIDA - Spiders

Spiders, especially *Lycosa*, are a dominant component of the arthropod fauna. The dominant invertebrate predator of Haleakalā's aeolian ecosystem is the endemic wolf spider, *Lycosa hawaiiensis* Simon (Lycosidae) whose size (3.5-5.0 cm length) makes it one of largest of true spiders (Suborder Labidognatha). Occurring only near and at the mountain's summit at 2400-3056 m, these ground-hunting spiders construct shallow burrows under rocks cementing windblown *Dubautia* leaves and other detritus together with silk to form a circular refuge that protects them from the extremes of desiccation and cold. They are notable among spiders for their maternal care, carrying the silk egg sac (larger than their own body) beneath them attached to their spinnerets. As the young hatch, they climb atop their mother's back while she hunts. As spiderlings become larger (> 1 cm), they disperse widely on the open cinder plains colonizing unoccupied under-rock habitats.

Lycosa spiders were relatively common at the study site. A number of large adult females were taken in pitfall traps and several nests were observed in under-rock surveys.

Other spiders noted belonged primarily to the family Linyphiidae. Although few individuals were taken in pitfall traps, this method may provide an underestimate of their true abundance at the site. Though the webs of these species are small and inconspicuous, a number were noted between and under rocks at the study site. Factors that could account for low numbers in pitfall traps could include their lack of movement away from established web sites and low attraction of fermented baits.

COLEOPTERA - Beetles

Carabidae - Carabid beetles

Ten species of native ground beetles have been recorded within the aeolian zone of upper Haleakalā (Table 1), with nine of these (including two monotypic genera) endemic to the volcano. Of these, five are entirely restricted to the upper 150 m elevation occurring just below the summit. In his unpublished field notes, the noted Hawai'ian naturalist R.C.L. Perkins noted this greater abundance: "...I began to work for Coleoptera, which I found most plentiful from 9500 [feet elevation] to the top, or to within 100 to 200 ft. short of the top." One species, *Pseudobroscus lentus*, is the sole member of this endemic genus which has only been collected at the very summit of the mountain at 3050 m. (G.A. Samuelson, *in litt.*). The five aeolian carabid beetle species are flightless scavenger-predator specialists that are extremely rare; little is known of their current status or biology. The other five species are found both in aeolian as well as lower elevation habitats. Due to the degradation of lower elevation habitats, some of these species are now apparently restricted to aeolian or sub-aeolian sites; their lower elevation distribution is confirmed only by historical collections.

At the study site, the only carabid beetle species encountered was *Baryprintus rupicola*. This is the largest of the native carabids and is the most common of the native carabid species on upper Haleakalā (ACM, pers. observation).

Other Coleoptera

Of other Coleoptera, a single species of dermestid beetle (*Dermestes* sp.; Dermestidae) was taken in pitfall traps. Low numbers of several species of small native rove beetles (Family Staphylinidae) were collected in pitfall traps in the study area. Staphylinid specimens have been forwarded to Dr. Al Samuelson, coleopterist at the B.P. Bishop Museum.

LEPIDOPTERA - Moths

Noctuid moths (Noctuidae: undescribed *Agrotis* species) seasonally constitute a large proportion of the biomass of the native arthropod fauna on upper Haleakalā volcano. These are biologically unique species that have radically modified their diet to exploit the peculiar characteristics of the nearly vegetationless lava and cinder plains of upper Haleakalā. The abundance of the larval form of these endemic moths is especially surprising considering the sparsity of vegetation in these areas.

Throughout the world with very few exceptions, Lepidoptera larvae are plant feeders. However, examination of the alimentary canals of these large (to 5 cm length) larvae has revealed a partially carnivorous diet, an extraordinary adaptation. Foraging actively at night, the noctuid moth larvae are eating other arthropods (either dead or in a stupor

Table 1. List of high-elevation carabid beetles (Carabidae) of Haleakalā volcano, East Maui, Hawai'i, and their status within their entire range and at the study site.

1) *Baryprinus rupicola* Blackburn - Haleakalā, 4200-10,000 ft. Relatively common locally, not collected at study site.
2) *Mauna frigida* (Blackburn) - Haleakalā, 4000-10,000 ft. Relatively common locally, not collected at study site.
3) *Mecyclothorax apicalis* (Sharp) - Haleakalā, 9500-10,000 ft - Status unknown, perhaps extinct, not collected at study site.
4) *Mecyclothorax micans* (Blackburn) - Haleakalā, 6400-10,000 ft. - Rare but extant, not collected at study site.
5) *Mecyclothorax montivagus* (Blackburn) - Haleakalā, 4000-10,000 ft. - Rare but extant, not collected at study site.
6) *Mecyclothorax pusillus* Sharp - Haleakalā, 9500-10,000 ft. - Status unknown, perhaps extinct, not collected at study site.
7) *Mecyclothorax rusticus* Sharp - Haleakalā, 9500-10,000 ft. - Status unknown, perhaps extinct, not collected at study site.
8) *Mecyclothorax subconstrictus* (Sharp) - Haleakalā, 9500-10,000 ft. - Status unknown, perhaps extinct, not collected at study site.
9) *Mecyclothorax micans* (Blackburn) - Haleakalā, 4000-9500 ft.. - Status unknown, perhaps extinct, not collected at study site.
10) *Pseudobroscus lentus* Sharp - Haleakalā, 10,000 ft.. - Status unknown, perhaps extinct, not collected at study site.

due to the low temperatures), as well as leaves of the few plants that occur in the area. The substantial biomass comprised by these noctuid larvae in their relatively barren environment leave little doubt that their carnivorous adaptation plays a crucial role in the ecology of this species.

Although common at the study site, the larvae of noctuid moths collected in pitfall traps were not found in the abundance nor in the larger size classes as at nearby Red Hill site within Haleakalā National Park. At the Air Force study site, an average of 5.9 specimens of noctuid larvae were collected in each pitfall trap, while in the nearby Red Hill site, 28.8 specimens were collected in each trap. Gravid females and deposited eggs of these moths were found in the study area. The explanation for the lower number and smaller size of noctuid moths encountered is most likely due to lower quality of the habitat of the study site, perhaps due to past grading and compaction.

One of the most famous invertebrates of Haleakalā volcano is the endemic flightless moth *Hodegia apatela* (Howarth 1976). This small ½-inch moth has dagger-shaped wings, cannot fly (but rather walks and hops), is restricted in distribution only to the upper barren lava slopes of Haleakalā, and is the sole member of an endemic genus. It was rare at the study area and only a single adult specimen was collected in pitfall traps.

HYMENOPTERA - Bees & Wasps

Hymenoptera were relatively uncommon at the study site. Few parasitoid wasps were captured in pitfall traps. No Argentine ants (*Iridiomyrmex humilis*) were encountered in pitfall traps or in ground checking. Western yellowjacket (*Vespula pensylvanica*) populations were quite low; however, this species is highly seasonal and may be a local hazard in September through November. None were seen on ground checking; a single worker was caught in pitfall traps. The endemic bees *Nesoprosopis* spp., which are important pollinators, were seen at low numbers in the study site; none were caught in pitfall traps and no nests found in under-rock surveys.

DIPTERA - Flies

Compared to comparable sites at nearby Red Hill within Haleakalā National Park, the study site yielded many more individuals and species of large alien flies, especially in the families Muscidae, Tachinidae, and Calliphoridae. In pitfall traps 5 to 10 times the number of large alien fly individuals were collected at the study site compared to those within Haleakalā National Park.

In addition, some native species of *Drosophila* were present in the pitfall traps.

SUMMARY OF THE INVERTEBRATE FAUNA OF THE PROPOSED SITE

The study site is basically a typical but somewhat depauperate example of Haleakalā's aeolian zone. The reduced diversity of key invertebrate groups such as carabid beetles and noctuid larvae is presumably due to the compaction and degradation of the site previously. No locally unique taxa were encountered in this survey.

CONCLUSIONS

Until recently, barren areas in Hawai'i such as bare lava flows and mountaintops, devoid of vegetation, were considered lifeless and abiotic. Recent research has revealed a unique locally endemic arthropod fauna on otherwise barren lava flows and mountaintops. The native ecosystem of upper Haleakalā volcano is currently one of the least degraded ecosystems in the Hawai'ian Islands. Despite some apparently serious threats (ants, rodents, parasitoids), the native arthropod fauna of the aeolian and sub-aeolian zone appears to still be relatively intact. This integrity is due to its harsh environment which makes it relatively resistant to invasions of alien species which have decimated the endemic arthropods of Hawai'i's lowlands.

The primary threats to the long term conservation of aeolian ecosystems are the direct actions of man and the invasion of alien species into this habitat. Increasingly, the perpetuation of this ecosystem's near-pristine status will depend on careful management to mitigate accelerating Park visitation and (outside the Park) the increasing demand for summit areas as sites for observatories and communication structures.

RECOMMENDATIONS FOR PROTECTION OF NATIVE ARTHROPODS AND PREVENTION OF SPREAD OF ALIEN ARTHROPODS AND PLANTS

1. Take precautions to prevent transport of alien ant species into the site. One of the greatest threats to native arthropods on upper Haleakalā is the gradual spread and establishment of the Argentine ant (*Iridomyrmex humilis*) in high elevations (Cole *et al.* 1992). This invasive species establishes high population densities on Haleakalā, devastating native insect populations, and has the potential to completely change the ecology of the subalpine shrublands and sub-aeolian regions by eliminating most native arthropod species including essential pollinators of the silversword (*Argyroxiphium sandwicense* subsp. *macrocephalum*) and other locally endemic plant species.
The Argentine ant has established a population on the edge of the Haleakalā aeolian zone at 2880 m. Experimental control of these populations with a carefully selected insecticide has promise, but has not yet been realized, since no effective chemical is approved for use against ants in wildland situations in Hawai'i.

Recommendations:

1) Pressure wash all equipment prior to entering the National Park and inspect and remove any remaining organic matter.

2) Do not import fill material to the site.

2. Take precautions to prevent transport of alien plant species into the site. Certain alien plant species that do not currently occur on the island of Maui but do occur on neighbor islands (especially the Big Island) and on the continental United States could pose a serious threat to all native ecosystems on Haleakalā. Fountain grass (*Pennisetum setaceum*), mullein (*Verbascum thapsus*), and cheat grass (*Bromus tectorum*) are alien plant species warranting special concern.

Recommendation:

1) Pressure wash all equipment (prior to entering the National Park) and inspect and remove any remaining organic matter.

3. Remove imported organic materials and foodstuffs. Importation of food and garbage may act to keep rodent (especially the house mouse, *Mus domesticus*) populations at artificially high levels. On sparsely vegetated Hawai'ian volcanoes, these small alien mammals have highly insectivorous diets and reach high population densities during warm dry summers (Cole, Loope, and Medeiros in press). Peak mouse populations levels coincide with the time when native arthropods are in their adult actively-reproducing stages and at their most active and conspicuous. Although mouse populations are lower in winter months, arthropods comprise most of the diet during this period. Such predation can have a devastating effect on all native arthropods, but especially so for rare and/or flightless species.

Recommendation:

1) Remove all foodstuffs and organic materials imported to the site.

4. Minimize substrate compaction and modification of nearby areas. Compacting lava substrates and disturbing crucial microhabitats (under rock surfaces) by construction, vehicle usage, and even walking can cause permanent degradation to these sites. The sensitivity of these cinder areas requires adequate information conveyed to construction workers to avoid permanent degradation of the areas that surround the construction site.

Recommendations:

1) Well-conceived worker awareness must be in place before work begins to minimize unnecessary impacts.

2) Parking of heavy equipment and storage of construction materials prior to use should not be on adjacent cinder surfaces that are not being directly used for construction.

3) After construction is finished, remove excess materials to reduce overall biological impacts.

5. Institute an ongoing monitoring program. Such a program should insure that precautions taken are effective in preventing establishment of alien species, especially ants and weeds of concern.

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APPENDIX B

SECTION 106 HISTORIC PRESERVATION REVIEW OF THE PROPOSED AEOS PROJECT

University of Hawaii at Manoa

Institute for Astronomy
2680 Woodlawn Drive • Honolulu, Hawaii 96822
Telex: 723-8459 • UHAST HR

Office of the Director

March 31, 1993

Mr. Keith Ahue, Chairperson
Department of Land and Natural Resources
1151 Punchbowl Street
Honolulu, HI 96813

Attention: Historic Preservation Division

Dear Mr. Ahue: Keith

Subject: Request for Historic Preservation (Chapter 6E, HRS) and National Historic Preservation Act (Section 106) Review -- Expansion of the Maui Space Surveillance Site, Science City, Haleakala, Island of Maui (TMK: 2-2-07:08)

The University of Hawaii, Institute for Astronomy (UH IfA), intends to submit a Conservation District Use Application (CDUA) on behalf of the U. S. Air Force for expansion of the Maui Space Surveillance Site within the UH Science City at the summit of Haleakala (Figure 1). UH will lease about 1.7 additional acres to the federal government in order to allow construction and operation of a 4-meter advanced electro-optical telescope (AEOS) and appurtenant facilities.

An archaeological reconnaissance survey of the UH Science City site was conducted by J. C. Chatters and A. Griffin on December 10, 1990. As shown on the attached Figure 1, four sites (50-11-2805 through 50-11-2808) were located around the rim of Kolekole Hill in the vicinity of the proposed AEOS project.

Sites 50-11-2805 and 50-11-2806, temporary shelters built into the cliff face, are located about 150 feet and 70 feet, respectively, from the AEOS project area. Although construction and operation of the AEOS project will not directly impact these or other archaeological resources, Sites 50-11-2805 and 2806 will be fenced with rebars and flagged to prevent inadvertent damage from construction activities.

By this letter we request Historic Preservation review of the proposed project and a finding of no significant impact. As this project involves the use of federal funds, please coordinate your review with the National Council on Historic Preservation to obtain Section 106, National Historic Preservation Act, compliance for the modified project.

UH IfA is in the process of preparing a Research Development Plan (RDP) for its property on Haleakala. The Maui Space Surveillance Site and the AEOS project are incorporated into this plan. Subsequent to the approval of the RDP by the UH Board of Regents, a Complex Development Plan and Master EIS will be prepared. An archaeological preservation/management plan, which will be prepared in coordination with the Historic Preservation Division, will be an integral part of this planning process.

Sincerely yours,

Donald N. B. Hall
Director

DNBH:nll
attachment

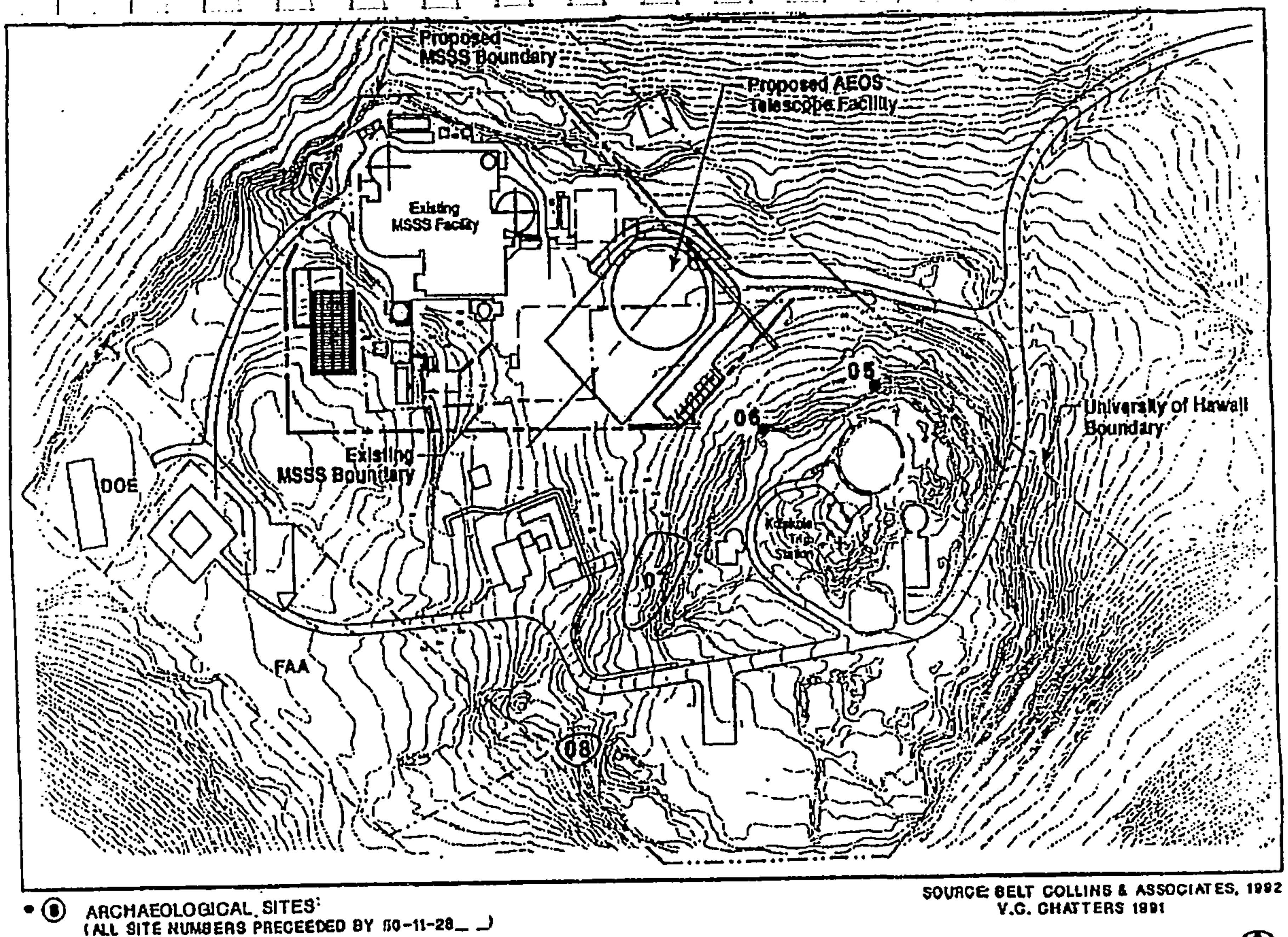

FIGURE I

LOCATION OF ARCHAEOLOGICAL SITES IN SCIENCE CITY

JOHN WAIHEE
GOVERNOR OF HAWAII

KEITH AHUE, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES

JOHN P. KEPPELER II
DONA L. HANAIKE

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION DIVISION
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 6TH FLOOR
HONOLULU, HAWAII 96813

7

REF:HP-AMK

LOG NO: 7977
DOC NO: 9304AG47

Mr. Donald N.B. Hall, Director
University of Hawaii at Manoa
Institute for Astronomy
2680 Woodlawn Drive
Honolulu, Hawaii 96822

Dear Mr. Hall:

SUBJECT: **Section 106, NHPA and Chapter 6E (H.R.S.) Compliance -- Expansion of the Maui Space Surveillance Site, Science City, Haleakala, Maui**
TMK: 2-2-07: 08

Thank you for the opportunity to comment on the effect of the proposed construction and operation of a 4-meter advanced electro-optical telescope (AEOS) on historic sites.

Your letter states that your proposed project will have no effect on any of the four previously identified significant historic sites located in the vicinity of the AEOS project. After reviewing the map attached to your letter and the report by J.C. Chatters entitled Cultural Resources Inventory and Evaluation for Science City, Conducted for Expansion of the Maui Space Surveillance Site, Haleakala, Maui (1991), we concur with your determination of "no effect". However, two sites (2805 and 2806, temporary shelters) are in close proximity (150 feet and 70 feet respectively) to the construction area. You propose to fence these sites with rebars and have them flagged to prevent inadvertent damage during construction. It appears that this is an adequate protective measure.

Regarding the preparation of a preservation plan, please have your staff or consultant coordinate with Ms. Annie Griffin, Staff Archaeologist handling Maui County, at 587-0013.

Very truly yours,

KEITH W. AHUE, Chairperson and
State Historic Preservation Officer

c: Claudia Nissley, ACHP

APPENDIX C

BIOLOGICAL ASSESSMENT FOR MAUI SPACE SURVEILLANCE SITE EXPANSION AND U.S. FISH AND WILDLIFE CONSULTATION LETTER

BIOLOGICAL ASSESSMENT FOR MAUI SPACE SURVEILLANCE SITE EXPANSION

INTRODUCTION

This report addresses the potential for impacts on federally listed or proposed threatened and endangered species resulting from implementation of the proposed activities at the Maui Space Surveillance Site (MSSS). These proposed changes include boundary alteration, access road expansion, construction and operation of maintenance facilities, and installation and operation of a carbon dioxide (CO_2) laser within the existing U.S. Air Force Maui Optical Station (AMOS) building.

Currently, MSSS supports three basic U.S. Department of Defense missions: the Maui Optical Tracking and Identification Facility (MOTIF), the Ground-Based Electro-Optical Deep Space Surveillance (GEODSS) System, and the AMOS. Facilities are shown in Figure 1.

MOTIF - The MOTIF is a primary sensor of the U.S. Air Force SPACETRACK network. The objectives of MOTIF are to 1) detect, track, and identify all artificial objects in space; 2) maintain a catalog of all artificial objects in space and provide ephemerides on these objects as required; 3) collect, process, analyze, and display space information for threat evaluation; 4) provide information and data on space objects to authorized agencies; and 5) support space research and development operations.

GEODSS - The GEODSS facility performs passive searching/tracking for data collection from space objects out to, and beyond, the geosynchronous orbital distance (about 35,000 km).

AMOS - The objectives of the AMOS program are to 1) provide state-of-the-art measurement support to various government agencies and the scientific community for research and development programs; and 2) serve as a test

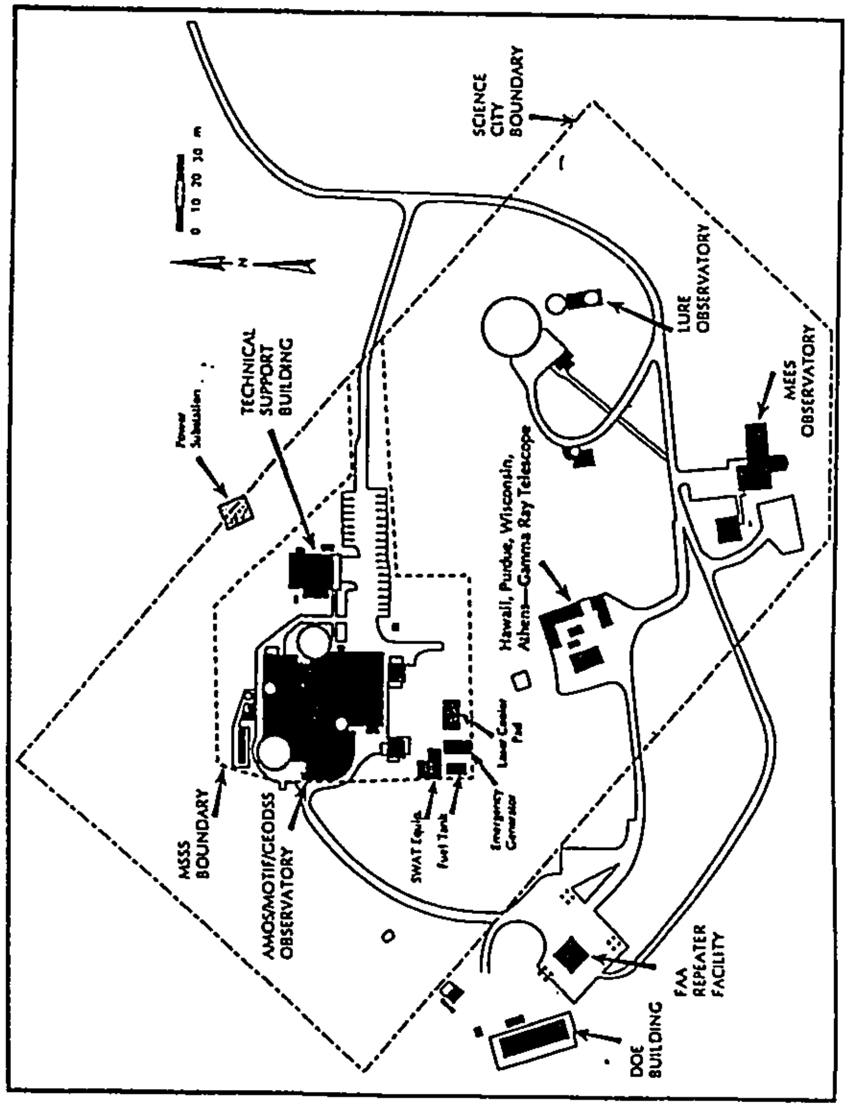

FIGURE 1. Science City, Maui Hawaii

bed for newly developed and/or evolving electro-optical sensors. Included in these objectives are the laser operations and research conducted or sponsored by AMOS.

Equipment currently at the MSSS includes observation and acquisition telescopes; laser beam directors; infrared sensors; low to moderate power lasers; photometers; various imaging systems; low light level TV systems; video, alpha-numeric and graphic display equipment; data processing systems; communications equipment; utilities and coolant facilities; and repair and maintenance facilities and equipment.

Present operations at the MSSS include both passive and probe operations. Passive operations are observations using only passive photon collection. This function requires the capabilities of target location, telescope tracking and control, and data acquisition and data analyses. Capabilities to conduct passive observations are determined by 1) physical and technical limits of the telescope and data acquisition systems, and 2) site characteristics related to astronomical viewing. Probe operations use a laser to illuminate an object and subsequently detect the returning photons.

PROJECT DESCRIPTION

The U.S. Air Force proposes to meet the need for state-of-the-art space observation, illumination, and ranging capabilities by construction and expansion of a number of facilities at the MSSS. These are described below and shown in Figure 2.

Expand MSSS Boundaries

Current MSSS site boundaries limit expansion of facilities and operations and would essentially preclude future new installations at the site. Therefore, the U.S. Air Force proposes to expand the current land lease to include approximately 3.1 ha (7.7 acres) of additional land. This land will be used to support additional facilities, install new telescopes, and improve site access. The areas to be added under the proposed action are currently owned by the State of Hawaii.

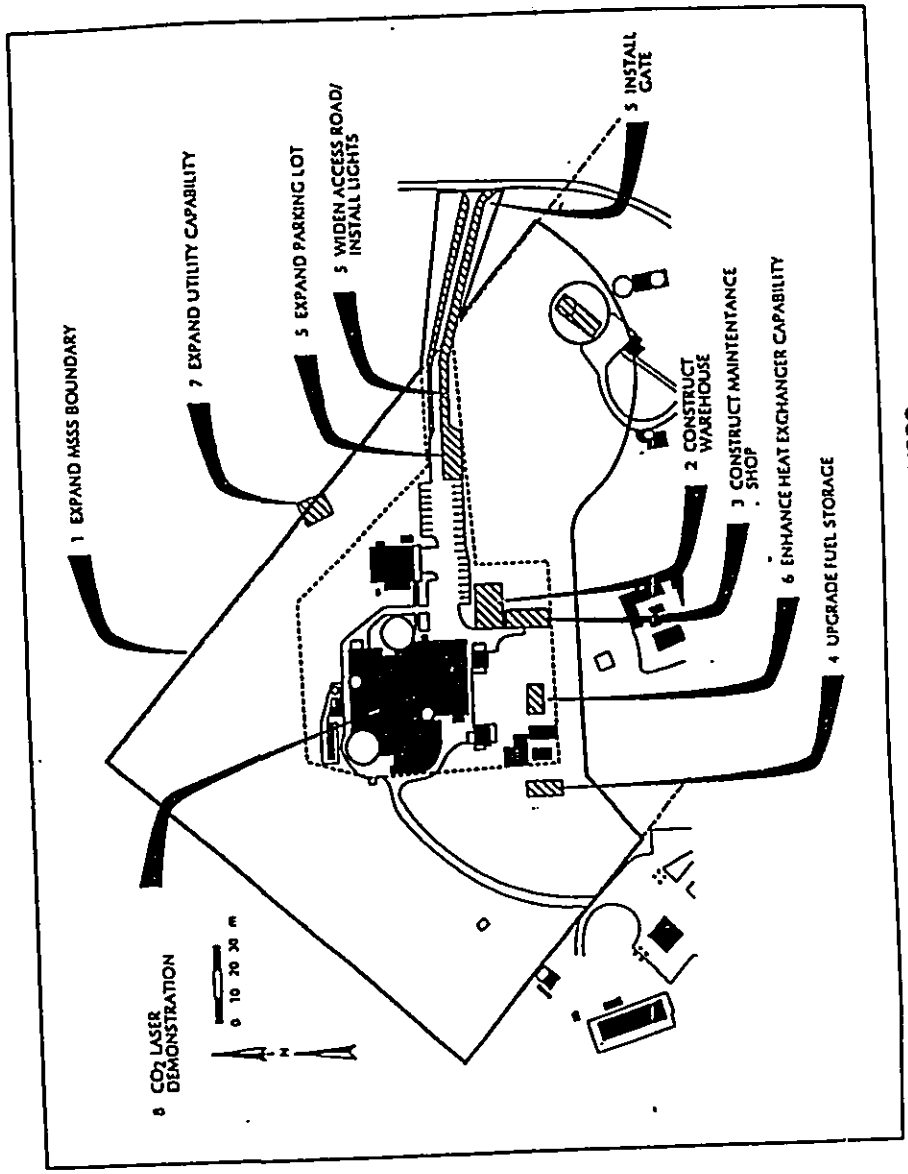

FIGURE 2. Proposed Actions at MSSS

Construct Warehouse

The U.S. Air Force proposes to construct a warehouse facility of approximately 220 m^2 (2400 ft^2) adjacent to the southern edge of the present parking lot. There is currently no centralized storage facility serving the site. The warehouse will be a pre-engineered metal building measuring approximately 12 by 18 m (40 by 60 ft) with a minimum interior wall height of 5 m (16 ft). The building will be constructed on a 15-cm (6-in.) reinforced concrete slab to be cast on grade. The warehouse may include a wood shop, paint shop, and lavatory in addition to a general storage area and office space.

Construct Maintenance Shop

The U.S. Air Force proposes to construct a civil engineering maintenance shop of approximately 170 m^2 (1800 ft^2) south of the warehouse. The maintenance shop building will be of similar construction to the warehouse and will include an administration office, lavatory, small changing area, and shower, along with a shop area. Some metal-working machinery will be operated in this building to fabricate one-of-a-kind items in support of research activities. Maintenance is currently conducted within part of the ground floor of the technical support building. Current accommodations lack space and facilities for safely performing all the maintenance and fabrication needs of the MSSS.

Upgrade Fuel Storage

Diesel fuel is required at the MSSS to power the emergency electrical power generators. Existing storage for diesel fuel on the site consists of a 15,000-L (4,000-gal) steel tank located in the southwest corner of the present boundary of the property. The quantity of fuel currently available is insufficient to maintain full operations of the facility on emergency power for the 30 days required by the U.S. Air Force. Consequently, the U.S. Air Force proposes to upgrade the fuel storage capability by replacing the existing tank with a 41,600-L (11,000-gal) fuel tank with containment. The tank will be installed in a concrete-lined pit to contain fuel spills.

Im: ove Site Access

Be :se of the nature of the work at the MSSS, personnel arrive at and depart from the site around the clock. Use of headlights is prohibited within the Science City boundary at night. The existing roadway is narrow [3.3 m (11 ft)] with a steep ledge, making nighttime ingress/egress hazardous. The U.S. Air Force proposes to improve site access by widening the access road, installing road marker lights, expanding the car park, and installing a traffic control gateway at the property entrance. Marker lights will be 40-watt, down-focused mushroom lights powered from underground wiring. The roadway will be paved with asphalt to a final width of 6 m (20 ft) with 1.2-m (4-ft) shoulders, using the existing roadway as a base. The western end of the current roadway will be expanded southward to accommodate parking for an additional 6 vehicles. The access gate will be a vertical arm gate controlled by entry card.

Enhance Heat Exchanger Capability

Laser operations require controlled temperatures, but generate waste heat. Furthermore, the nature of the observations conducted at the MSSS requires limitation of external heat sources and consequent viewing distortions in the vicinity of the observatories. Waste heat from laser operations is currently dissipated at the chiller pad south of the main building. Because of the proposed expansion of laser operations at the site, the U.S. Air Force proposes to expand laser cooler capacity by installing additional heat exchangers on the existing chiller pad.

Expand Utility Capability

Electrical power is supplied to the MSSS by aerial transmission lines owned and maintained by Maui Electric Company. A substation on the boundary of the MSSS, also owned by Maui Electric Company, provides sufficient power for existing needs, but limits implementation of future programs. The proposed expansion of programs and consequent increased power needs by the U.S. Air Force will necessitate construction or expansion of the substation. Expanded facilities will be located on the current substation site. The U.S. Air Force also proposes to relocate the existing main building chiller from the northwest to : southwe :orner of the building.

Demonstrate CO_2 Laser

The U.S. Air Force proposes to construct a closed-loop CO_2 laser system within the existing building. This laser would provide ranging information for space objects. The laser would utilize the existing beam expander and laser coolant capabilities at MSSS. Power output is expected to be in the range of 10 kW.

Potential Effluents

Routine operations at the MSSS will use a variety of solvents and other chemicals for purposes such as cleaning of mirrors used in the laser systems, chemical stripping of the reflective coating from the telescope and laser mirrors, and other miscellaneous uses. Chemical inventories under the proposed action are not expected to differ from current inventories, and uses are not expected to be more than 10% above current uses.

All laser systems have an "effluent" of coherent electromagnetic radiation of a given wavelength or set of wavelengths that results from the laser's operation. Such electromagnetic radiation may be a concern for eye and skin safety of humans and other species. However, all lasers are operated in accordance with national standards for safe operation (the American National Standard for the Safe Use of Lasers, ANSI Z136.1, and the U.S. Air Force. AFOSH Standard 161.10). Chemical reaction lasers, such as the hydrogen fluoride laser, have routine chemical effluents while in use. Gas and solid-state lasers have no chemical effluents. The dye lasers utilize coumarin as the pigment and water as the carrier. No adverse environmental impacts have been identified from the use of existing laser systems or their use in various functions and experiment (USAF 1987, 1988; MIT 1988). Use of these lasers at the MSSS as a result of implementation of the proposed action is expected to be within 10% of the range of current operations.

DESCRIPTION OF THE AFFECTED ENVIRONMENT

The following sections provide a general biological characterization of the potential project site. Included are common and typical species, state and federally listed threatened or endangered species, and candidates for federal listing. Federally listed species are discussed more fully in Chapter 4.0 of the main report.

The MSSS is located within the area known as Science City at the southwestern edge of Haleakala crater at an elevation of 3064 m (10,054 ft). The site is underlain by coarse cinders without soil development. A volcanic outcrop known as Kolekole Hill occurs at Site A (Figure 3). Occasional basaltic boulders and stones litter the area, especially around Kolekole Hill and the access roadway. The Science City area lies at the edge of a basalt scarp falling away from the site to the north, west, and southwest.

The plant community at the site is an alpine dry shrubland characterized by sparse plant cover. Primary native plants within this community are the forbs ahinahina (Argyroxiphium sandwicense macrocephalum), kupaoa (Dubautia menziesii), Silene struthioloides, and Tetramolopium humile. Native grasses of the community are Deschampsia nubigena and mountain pili (Trisetum glomeratum).

A plant survey of the proposed project area was initiated on October 22 and 25, 1990, by Dr. C. A. Brandt of the Pacific Northwest Laboratory after discussions with Mr. R. J. Nagata, Chief of Resources Management at Haleakala National Park, and Mr. W. R. Kramer of the U.S. Fish and Wildlife Service, Honolulu. The survey consisted of first scanning the area to determine the general classification of vegetation and the location of impediments to the survey, then walking parallel east-west transects spaced approximately 10 m apart. The area to each side of the transect was carefully surveyed for all occurrences of plants. A detailed plant listing was derived from these surveys, and voucher photographs were taken of each species encountered. Areas where line-of-site vision was obscured by rocks were searched in a zig-zag fashion. The area surveyed is shown in Figure 3.

Endemic flowering plants identified in the project area include ahinahina, kupaoa, kawa'u (Styphelia tameiameiae), Tetramolopium humile, Ohelo (Vaccinium reticulatum), hinahina (Geranium cuneatum), He'upueo (Agrostis avenacea), Deschampsia nubigena, and mountain pili. Four ahinahina were located within the project area (Figure 4). A 20-cm-size plant between the 1.6-m telescope dome and

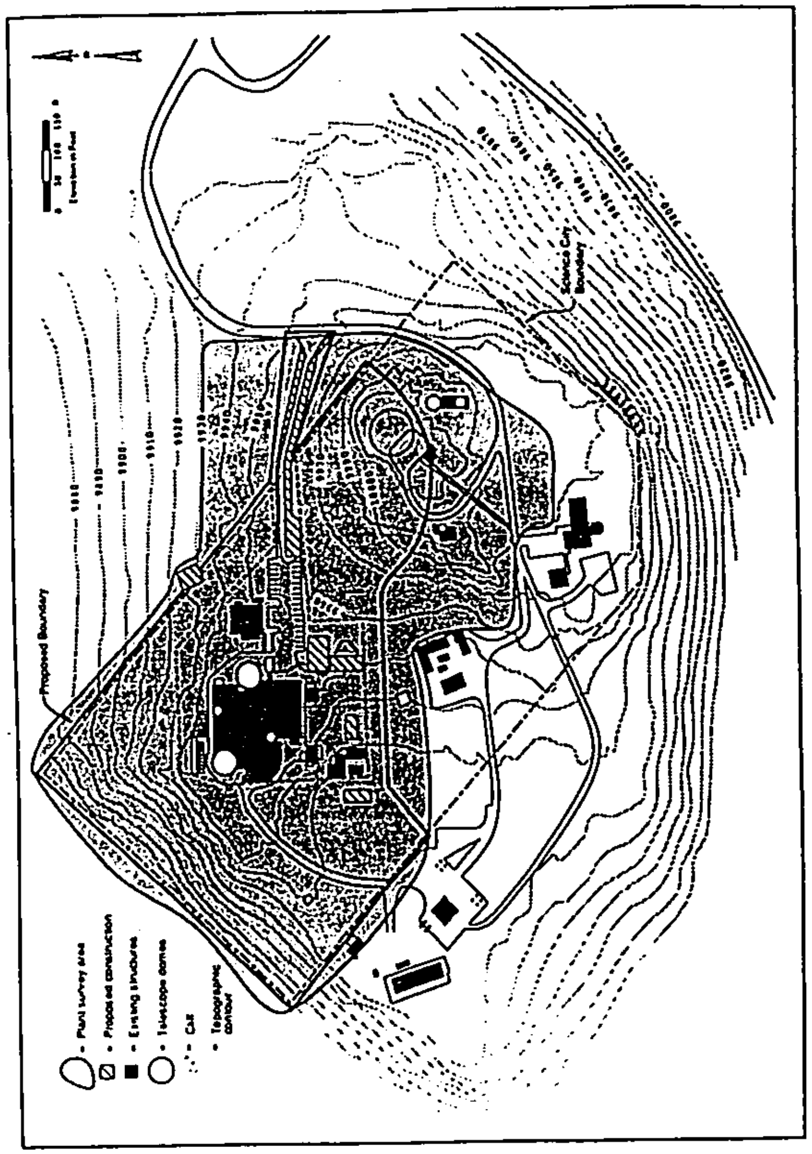

FIGURE 3. Area Covered by Plant Survey

the building to the east was transplanted to its present location as mitigation for a previous action (COE 1980). Two 2 4-cm-size plants located between the south entrance to the 1.6-m telescope dome and the AMOS/GEODSS/MOTIF building entrance were recent transplants from stock grown by National Park Service personnel. The fourth ahinahina is located on the southeast slope of Kolekole Hill between Site A and the LURE observatory. All plants are endemic to the region save for He'upueo, which occurs in a variety of habitats.

Non-native flowering plant species in the proposed project area were found primarily in disturbed regions near buildings, roadways, and other graded sites. Non-native species include gosmore (Hypochoeris radicata), common groundsel (Senecio :garis), dandelion (Taraxacum officinale), swinecress (Coronopus didymus), cheese-weed (Malva parviflora), evening primrose (Oenothera stricta), buckhorn (Plantago lanceolata), and common velvet grass (Holcus lanatus). All are weedy opportunist species introduced to the island in recent times. Many of these species occupy or spread from an experimental plot of grasses approximately 20 m southeast of the AMOS/GEODSS/MOTIF building. This plot was planted by the University of Hawaii in 1972 (COE 1980).

Wildlife known to occur in the project area include the Hawaiian dark-rumped petrel or 'ua'u (Pterodroma phaeopygia sandwichensis), chukar partridge (Alectoris chukar), goat (Capra hircus hircus), roof rat (Rattus rattus rattus) and Polynesian rat (Rattus exulans hawaiiensis) (Tomich 1986; Pratt et al. 1987). During the transect survey, droppings were found of goats and feral dogs (Canis familiaris). A complete skeleton of a chukar was discovered south of the LURE observatory, and the skull and limb bones of a roof rat was found between Site A and the cosmic ray telescope. The mongoose (Herpestes auropunctatus) is generally assumed not to be a resident of the summit area of Haleakala, although mongoose droppings were identified within 500 m of Science City during a survey of 'ua'u habitat (see Section 5). None of these is a native species.

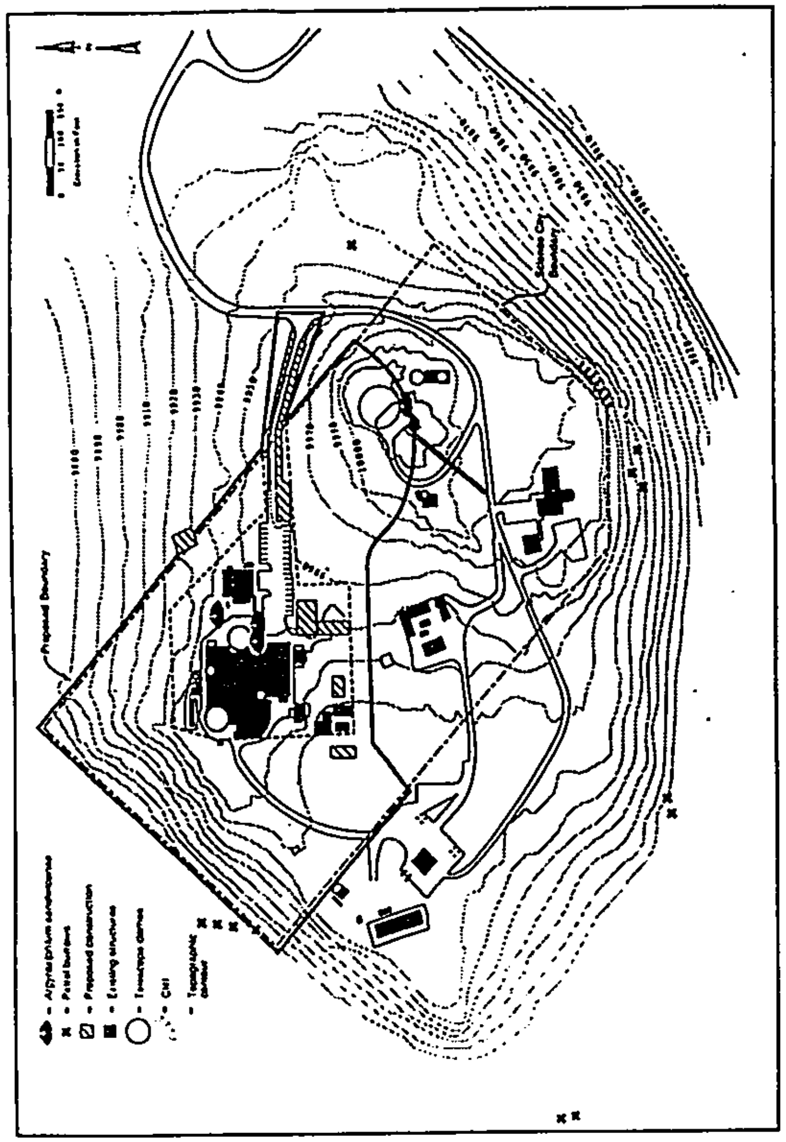

FIGURE 4. Locations of Ahinahina and 'ua'u Burrows in Science City Vicinity

The Hawaiian hoary bat (Lasiurus cinereus semotus) has been reported near the summit of Haleakala (NPS 1989b). Haleakala Park records indicate that bats are occasionally found in fences around the perimeter of the park at the 2800-m (9200-ft) level (USAF 1988).

Arthropods in the project region are few and sparse. They include an endemic wolf spider, sowbugs, Barypristus rupicola, Cyrtopeltus hawaiiensis, Sarona sp., and three species of Nysius (USAF 1988). Two other endemics are a flightless lacewing (Pseudopsectra cookeorum) and a flightless moth (Hodegia apatela).

A survey of the proposed project area and vicinity was conducted March 5 and 6, 1991, for the purpose of locating all petrel burrows within the proposed project area (a minimum of 150 m (490 ft) of the AMOS/GEODSS/MOTIF building) and the burrows nearest the site in general. The surveyed area is shown in Figure . 5. Before conducting the survey, the timing, objective, and protocol were discussed with Mr. R. J. Nagata, Chief of Resources Management at Haleakala National Park, Ms. C. N. Hodges, endangered species biologist at Haleakala National Park, and Mr. W. R. Kramer of the U.S. Fish and Wildlife Service, Honolulu. The survey was conducted by Dr. C. A. Brandt of the Pacific Northwest Laboratory, Dr. J. R. Parrish of the University of Washington, and Ms. C. N. Hodges.

The survey protocol consisted of first scanning the entire area to determine potential burrow habitat and locations of potential impediments to the survey. Transects were then walked at 10-m distances parallel to topographic contours searching the uphill portion for evidence of burrows or 'ua'u activity, such as droppings or tracks. Areas where observation was hindered by boulders were searched intensively. Areas of potential burrow habitat were searched using a 5-m transect separation. All possible burrows were verified for recency of use by Ms. Hodges. Burrows were located relative to visible landmarks using Suunto™ MC-1 compass and Ranging™ 1200 and 620 optical rangefinders. The rangefinders were calibrated to manufacturer's accuracy before use by adjusting to known (chained) distances. Locations were transferred to scale maps.

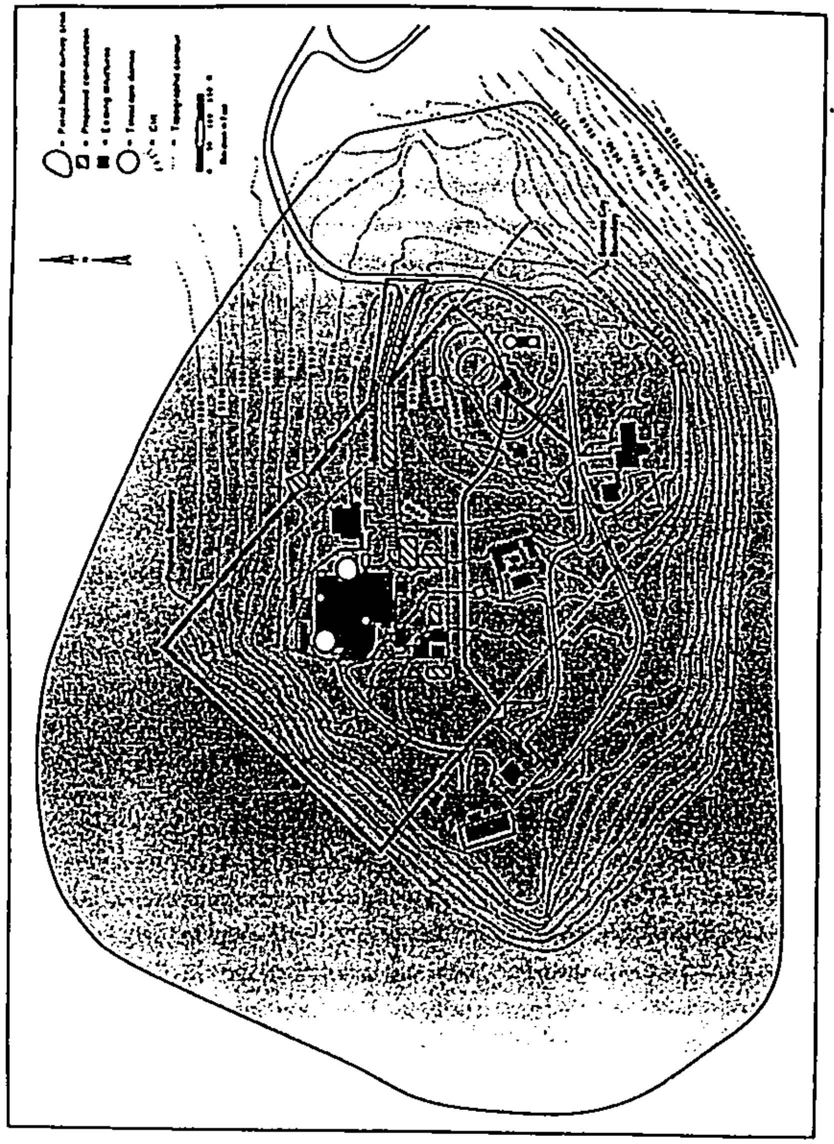

FIGURE 5. Area Covered by 'ua'u Burrow Survey

No 'ua'u burrows were located at any of the construction sites or within the proposed boundary of the MSSS. One of four burrows located 120 m (390 ft) downslope west of the AMOS/GEODSS/MOTIF building lies on the proposed northwestern boundary (Figure 4). These burrows showed evidence of recent activity (droppings and some recent excavation), and the characteristic (fishy) odor of 'ua'u was present at one of the burrows, indicating the presence of an adult bird within the burrow. Active burrows were also found approximately 300 m (990 ft) southwest of the AMOS/GEODSS/MOTIF building. Other active burrows were located to the south approximately 225 m (740 ft). Another burrow was located approximately 40 m (130 ft) from the eastern end of the access road to the facility, although no evidence was found indicating the burrow had been recently used by 'ua'u. Except for the burrows to the southwest, none of the discovered burrows was currently monitored by the National Park Service's endangered species program. However, all will be added to the program survey list (C. N. Hodges, personal communication, March 6, 1991).

SPECIES DESCRIPTIONS

Descriptions are presented for those federally listed or proposed species known to occur in the vicinity of the proposed project site and that could conceivably be affected by the project. These species are the 'ua'u, the nene, the Hawaiian hoary bat, and the ahinahina. The information summarized below was obtained from published literature, field analysis, species recovery plans (USFWS 1983) and discussions with Mr. R. J. Nagata, Ms. C. N. Hodges, and Mr. W. R. Kramer.

Hawaiian Dark-Rumped Petrel ('Ua'u)

The Hawaiian dark-rumped petrel, or 'ua'u, is a gadfly petrel of the central subtropical Pacific. In early Polynesian times, the 'ua'u nested in large colonies on all the main islands (Olson and James 1982). Predation by Polynesian rats, dogs, and pigs, as well as by the Polynesians themselves extirpated those birds nesting in lowland areas before the arrival of European explorers. This decline accelerated after the European introduction of cats, black rats, Norway rats, dogs, disease-bearing mosquitoes, and the mongoose. The only known breeding site remaining is atop Haleakala.

where approximately 700 nests have been found by Haleakala Park personnel. Simons (1985) estimated the population at 1800, of which 860 were breeding adults.

The 'ua'u nests at elevations above 2500 m (8200 ft) in burrows that the birds excavate generally beneath stones or at the base of rock outcrops (Simons 1985). Burrows generally occur in groups or colonies located mainly on the east-facing slope of Haleakala Crater. Additional colonies have been found on the west-facing and north-facing slopes of the crater, as well as on the crater rim, the west slope of Haleakala, and on the south slope of Haleakala below the Science City area (Simons 1983; C. N. Hodges, personal communication, March 6, 1991).

The nesting cycle has been described by Simons (1985). Adult birds return to the breeding sites in late February to March, during which time pair-formation occurs, burrows are cleaned or enlarged, and copulation takes place. In late March to late April, breeding birds return to sea, although nonbreeding birds may remain at the colonies. In late April through May, returning birds lay a single egg, with incubation continuing until mid-July. Both sexes share incubation in shifts, with the relieved adult returning to sea, presumably to forage. Adults leave the nest within 6 days of hatching to forage at sea. *Adults return at 2- to 3-day intervals during the first 90 days after hatching,* bringing food to the chicks. *During late September to early October, adults return* much less frequently. The fledging period extends throughout October. The age of first breeding for the 'ua'u is 6 years (Simons 1984).

'Ua'u fly to and from their burrows only in the early morning before sunrise or in the evening after sunset. The birds are thought to approach the crater from the west and leave through Koolau Gap to the north (USAF 1987), though accounts of flyways have not been published.

Nene

The nene (Nesochen sandvicensis) or Hawaiian goose, is endemic to the sparsely vegetated volcanic slopes of Hawai'i and Maui. At present, the largest numbers of birds (approximately 1000) occur on Mauna Loa and Hualalai volcanoes on Hawai'i (Pratt et al. 1987). Although native to Maui, the population was extirpated sometime before 1890 (USAF 1988). Since 1957, birds propagated at Pohakuloa on Hawai'i and at the Wildfowl Trust in England have provided stock for an introduced population in Haleakala National Park (Shallenberger 1986). The nene sanctuary is located on the northeast side of Haleakala between 1500 and 2133 m (5000 to 7000 ft). The nene is nonmigratory; nesting is generally from October through February. During this time, adults molt and are flightless.

Hawaiian Hoary Bat

The Hawaiian hoary bat is a resident of lowland forests (Tomich 1986), where it occurs as solitary individuals. Preferred habitat is open vegetation or mixed forest/open areas in dry or wet areas (Barbour and Davis 1969). The species is insectivorous, foraging after dusk primarily on flying insects. Studies of the hoary bat indicate no gleaning from foliage or preying on ground species (Whitaker and Tomich 1983). The hoary bat forages in groups of eight or less at established feeding territories. Flight is generally between 7 to 10 m (23 to 33 ft) above the ground when chasing intruders and 5 m (16 ft) when foraging. Feeding has been observed in all weather except *heavy rains and at temperatures down to 13°C (55°F) (Barbour and Davis 1969).* Continuous flight during feeding has been documented at over 3 h *and a distance of at* least 120 km (75 mi) (Bellwood and Fullard 1984).

The population size on the islands is estimated to be several thousand, with the largest population on the main island of Hawai'i. The bat also occurs on Kauai, but is *rare or absent elsewhere* (Tomich 1986). Several sitings of the bat have been *recorded* along the rim of Haleakala Crater as well as in Kaupo Gap (NPS 1989b). National Park Service records indicate that one was found in the south park boundary fence at an elevation of 2800 m (9200 ft) on September 2, 1986, and an injured one was recovered from a fence at 2800 m near Kalahaku Overlook on November 12, 1987. None has been recorded in the vicinity of Science City. Cold temperatures and the lack of flying insects in the Haleakala summit area make it unlikely that the bat is a resident there (USAF 1988).

Ahinahina

The ahinahina, or Haleakala silversword, is a greyish rosette shrub of the composite family (Asteraceae) endemic to the alpine dry shrublands of Haleakala. The ahinahina can be found on cinder cones within the crater and around the rim of Haleakala between 2133 and 3048 m elevation (7000 to 10,000 ft). The ahinahina was once probably much more widespread on Haleakala, but predation by goats has almost destroyed the species (Carlquist 1980). Goats were removed from Haleakala Park and are currently fenced out. The absence of goats has resulted in the recovery of ahinahina there. Another subspecies (sandwicense) that was once widespread on Mauna Kea in Hawai'i currently is limited to only 30 plants in the Wailuku River basin (Wagner et al. 1990).

The ahinahina is adapted to the cold, dry, high ultraviolet (UV) exposures of the mountaintop. As a rosette plant, most of its life is spent close to the ground. Leaves are narrow and protected by a felt of silvery, hygroscopic hairs that both protect the plant from the damaging UV radiation and collect moisture from the frequent fogs. The hairs also provide a boundary layer in which relative humidity may be retained at a high level even in the normally windy environment. The leaves also store water in a gel located between leaf cells.

The ahinahina forms a massive flower stalk or inflorescence in May to June that reaches a height of 1 to 2.5 m (3 to 8 ft) by July or August. The flower stalk supports several hundred yellow to reddish-purple flower heads, which set seed in August and September. As the seeds mature, the plant dies; by late October, only a dry skeleton remains. Plants may have a life span of 5 to 15 or 20 years, although no longitudinal studies have been made to verify this estimate (Carlquist 1980).

IMPACTS OF THE PROJECT

As described in Section B.3, surveys of the proposed project area were conducted to determine the presence of endangered species. Four ahinahina were located within the proposed boundary of the MSSS. Three are transplanted individuals located near the existing AMOS/GEODSS/MOTIF building and well outside any areas of proposed construction (Figure B.4). Two of these were recently transplanted to the site by Mr. R. J. Nagata of the Haleakala National Park. Because of the recency of transplanting, their immediate potential for survival is not known. A fourth plant was found growing downslope from the location of a proposed observatory on Site A (see Figure B.3). All plants are outside proposed construction boundaries.

Although the alpine dry shrubland plant community has been remarkably resistant to invasion by non-native plants, continued disturbance of the landscape would provide conditions suitable for expansion of the non-native species already present in the area. Concern has been expressed regarding the inadvertent introduction of alien plant species, especially wooly mullein (Verbascum thapsis) to the area from sources on the main island of Hawai'i or elsewhere. Alien species are seen as potential competitors with the ahinahina and as detriments to the native community atop Haleakala.

Concern regarding the effects of alien plant species on the continued survival of the ahinahina is probably unwarranted. Alien species have fared poorly in the alpine dry shrublands (NPS 1989b). The distribution of alien species within the Science City area is limited to the margins of pavement or buildings; few non-native plants have moved into the undisturbed habitat. The importance of competition in the sparsely vegetated environment of the area is likely to be insignificant.

Field studies were initiated to address probable habitat requirements of the 'ua'u and to assess use of the MSSS airspace by 'ua'u, the Hawaiian bat, and other potential species. Field surveys were conducted October 23 to 25, 1990, and March 6 to 13, 1991, by Dr. C. A. Brandt in company with Ms C. N. Hodges and Dr. J. R. Parrish. Habitat requirements were assessed by measuring habitat-related variables on three ecological scales: within 10 m of burrows (referred to as "burrow-scale"), between 19 and 59 m of burrows (referred to as "colony-scale"), and along 1 km transects across areas inhabited by 'ua'u (referred to as "landscape-scale"). Airspace use was assessed by pre-dawn and post-sunset sky watches by two observers at Science City.

Sky watches were conducted on eight 2-h watches in October 1990 and two 2-h watches in March 1991 by two observers (Brandt and Parrish). No birds or bats were seen on any watch.

Burrow habitat measurements were taken at 58 burrows selected using a stratified random scheme. Six colonies were visited on the west side of Haleakala Crater, on the west slope of Haleakala, around Science City, and on the south slope of Haleakala. Scale photographs and habitat measurements were taken at each burrow. Measurements included rock sizes at 1-m intervals along two transects paralleling the topographic contour. Transect termini were at the burrow and 10 m upslope from the burrow. The average size of the rock atop each burrow was recorded. Distance to nearest shrub and the shrub species were recorded, as well as distance to the nearest burrow. Slope and aspect measurements were taken for each burrow and for the general field at each burrow. Soil color and average particle size were also recorded at each burrow.

Colony-scale and landscape-scale measurements used the same set of parameters as the burrow-scale measurements. Sampling locations for colony-scale measurements were obtained by generating random compass directions and distances (between 19 m and 59 m), using the random-number-generation feature of the Hewlett-Packard 32S calculator, from each previously surveyed burrow. The rock (>10 cm) nearest the random point was identified as the "hit rock" or potential burrow rock, and habitat measurements were taken accordingly. Landscape-scale sampling points were located by generating random compass directions from five artificial features along the west crater crest roadway. Directions were constrained to produce 1-km transects that would lie within the area bounded north-south by the 58 surveyed burrows. The starting points selected were the AMOS/GEODSS/MOTIF building, the first switchback on the Sliding Sands trail, the Park Visitor's Center, the Kilohana cairn, and halfway along the roadway between the Visitor's Center and Kilohana. The first measurement was taken 100 m (determined by pacing) along the transect from the starting point. The rock nearest the 100-m point was identified as the "hit rock" and habitat measurements were taken accordingly.

Summary statistics were computed for habitat variables [slope; aspect; nearest shrub; burrow rock size; soil particle size; number (out of 10) of points along the 10-m burrow transect and the 10-m transect upslope hitting rock or soil of size class 0 to 10 cm, 10 to 50 cm, 50 to 100 cm, 100 to 150 cm, and >150 cm] at each scale. Data were subjected to multivariate discrimination analysis to determine if 'ua'u burrows and colonies differed from the generally available habitat in mean value. Principal components were computed from standardized data and observations were plotted on the first two components to indicate whether burrows or colonies differed from generally available habitat in mean or variability.

'Ua'u burrows were found in areas where the principle cover consisted of rocks over 80 cm in diameter. All but one burrow was situated beneath rocks greater than 150 cm in diameter; many were at the foot of extensive basalt outcrops. Average soil texture at the burrows was classed as very fine pebble (2 to 4 mm diameter), with color varying from brown to black and red. Burrows were within 1 m of shrub cover, on average. The primary shrub species was <u>Dubautia menziesii</u>. The nearest burrow could be found within 12 m on average. Field slope at burrows averaged 27° below horizontal, while the slope at the burrow entrance averaged 15° less.

Multivariate analysis found significant differences among the three scales on the 15 habitat variables described above (Wilks' Lambda=0.303, $F_{30,298}=8.127$, $P<0.0001$). Plotting data for the three ecological scales on the first two principal component axes (Figure 6) shows that burrow habitat was less variable than colony or mountain habitat, and that all three differed in average condition. Habitat variables that differed significantly among the three scales were slope ($F_{2,163}=15.360$, Bonferroni $P<0.001$), nearest shrub ($F_{2,163}=16.165$, Bonferroni $P<0.001$), burrow or "hit" rock ($F_{2,163}=83.183$, Bonferroni $P<0.0001$), number of rocks on transects 1 and 2 (burrow and upslope, respectively) that were 10 to 50 cm in size ($F_{2,163}=35.987$, Bonferroni $P<0.0001$ and $F_{2,163}=27.821$, Bonferroni $P<0.001$, respectively), and number of rocks on transects 1 and 2 that were greater than 150 cm in size ($F_{2,163}=41.446$, Bonferroni $P<0.0001$ and $F_{2,163}=24.185$, Bonferroni $P<0.001$, respectively). Means and ranges for these variables are shown in Figure 7. In

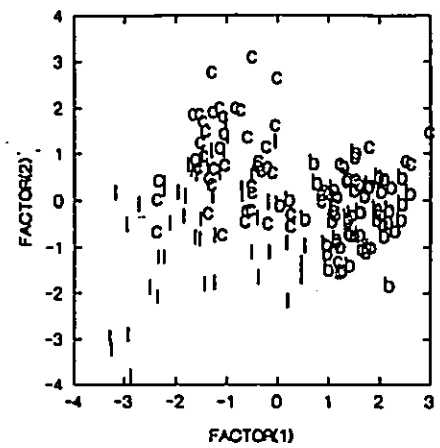

FIGURE 6. Plot of Habitat Scale Scores in Principal Component Space. Factor 1 shows increasing burrow or "hit rock" size and decreasing number of rocks in the 10-50 cm range. Factor 2 shows increasing slope and decreasing distance to shrubs. "b" = burrow measurement; "c" = colony measurements; and "l" = landscape measurements.

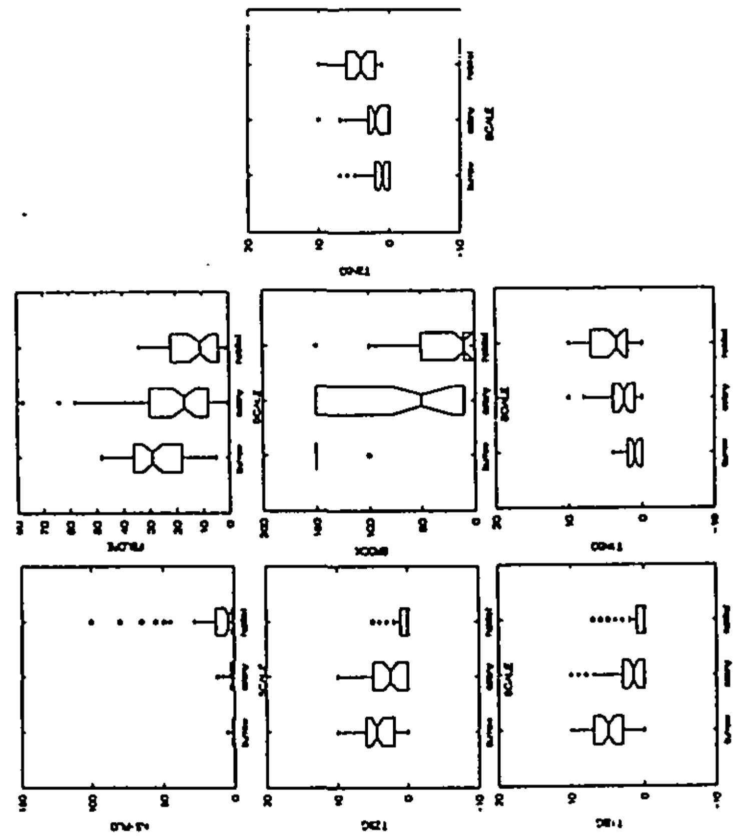

FIGURE 7. Interscale Comparisons of Burrow, Colony, and Landscape (Habitat) According to Number of Rocks 10 to 50 cm in Size (T150 and T250), Number of Rocks >150 cm (TIBIG and TZBIG), Hit Rock or Burrow Rock (BROCK), and Area Slope (FSLOPE). Whiskers correspond to range less outliers, boxes correspond to the interquartile range, and the median bar corresponds to the median. Notches indicate the 95% confidence interval.

general, burrow rocks were larger in size than "hit rocks" in the surrounding colony, and "hit rocks" were larger in the colony than in the landscape. Rocks greater than 150 cm in size were more numerous in the vicinity of burrows than in the colony, and more numerous in the colony than in the landscape. Burrows were located, on average, in steeper conditions than those found in the colony area or the landscape. Finally, burrows were relatively nearer to shrubs than were average rocks in the landscape, but not for rocks in the colony area.

The implications of these analyses are that 'ua'u show habitat selection on at least two ecological scales: burrows are located in the steeper portions of areas that are themselves steeper than the general landscape. 'Ua'u dig burrows beneath rocks greater than 150 cm in size, but in areas where such rocks are more common than in the general landscape. However, rocks above burrows are not random with respect to size even within the colony area. 'Ua'u burrows are located near shrubs, but this feature may not be used by the birds in selecting a location in which to burrow. It seems to be a feature common within the colony area. Also, 'ua'u locate colonies in portions of the landscape where rubble-sized rocks are less common, and locate burrows in areas with even fewer such rocks.

Proposed construction sites at the MSSS do not occur in habitat normally used by 'ua'u for burrow construction based on the habitat analysis described above; they also do not occur in colony-type habitat. None of the construction sites contain sufficient rock cover, or any rocks over 150 cm in diameter. Some large rocks have been pushed to the north of the existing access road during original construction of the site, but the area is without shrub cover, of shallow slope, and too small in scale to be likely to ever contain 'ua'u. Furthermore, there has been no evidence that 'ua'u would nest in artificially constructed habitat.

Operations of the CO_2 laser would have no effect on any listed species on the ground because no beams would be directed at the ground. Operation of lasers could have adverse effects on birds flying through the beam. These species could suffer retinal damage through such exposure, although no damage to birds is expected from body exposure because of the short potential exposure time and reflection from feathers. Bats may suffer both body and retinal damage. The likelihood of such an encounter between flying animals and laser beams is vanishingly small. This is consequence of the relatively small diameter of the laser beams, the infrequent use of the lasers, and the rarity of birds or bats flying in the area. The addition of the CO_2 laser to the lasers currently in use at the MSSS would not result in more than a 10% increment in laser use. Pre-dawn/post-dusk aerial watches of the Science City area identified no birds or bats flying in the airspace over Science City. Furthermore, no birds or bats have intercepted any laser beam since such operations began on the site. Impacts to endangered species from existing lasers have been found to be insignificant (USAF 1987, 1988).

The nene has been mentioned in previous Biological Assessments covering proposed activities at the Science City site as being potentially at risk from development at Science City (e.g., USAF 1988). Nene have reportedly been seen flying over the Science City area (COE 1980), though there are no documented sitings of such an occurrence. The Science City area, and indeed the entire summit of Haleakala, is outside the known range of the nene (R. J. Nagata, Chief of Resources Management, Haleakala National Park, personal communication, October 27, 1990).

Although documented at the summit, the Hawaiian hoary bat is considered only a rare visitor to the area. The abundance of flying insects, the primary prey of the bat, at the summit is very low. Laser operations will not attract insects in any quantity (USAF 1988). Furthermore, the proposed lighting additions to the MSSS roadway are down-focused, of very low intensity, and located within 1 m of the ground. Insects are thus not expected to aggregate at these lights, and any insects attracted to the lights would be well below the operational reach of the lasers. Also, the Hawaiian hoary bat forages within 5 m of the ground, whereas beams from the CO_2 laser would exit the AMOS/GEODSS/MOTIF building through the beam director located over 6 m above the ground. Consequently, implementation of the proposed action is not expected to attract bats to the area, or to increase their mortality as a consequence of lasers or lights.

Procellariiform birds on the Hawaiian Islands, including the 'ua'u, are attracted to or disoriented around bright lights, and crash into buildings, wires, tall vegetation, and vehicles (Telfer et al. 1987). Such collisions are a documented source of mortality for 'ua'u (Reed et al. 1985). 'Ua'u have been found dead along the roadway to the Visitor's Center at Haleakala, presumably hit by cars after being attracted to and blinded by headlights (NPS 1989a). Light sources to be added by the proposed action include roadway mushroom lights, nighttime traffic headlights, and collateral light from the CO_2 laser. As noted above, the roadway lights are shielded to focus on the ground. Shielding of lights significantly reduces attraction of birds (Reed et al. 1985). Similar lights are already in use at the MSSS parking lot, and no birds have been grounded at the site since operations began in 1965. These lights would thus not be a source of impact to the 'ua'u.

Nighttime traffic to and from the MSSS would increase slightly above present levels as a consequence of implementation of the proposed action. Construction-related traffic would be during daylight hours; therefore, this traffic would be of no consequence as far as light-attraction is concerned. Operation of the CO_2 laser is not expected to require more than five personnel at the MSSS at a time. Traffic associated with this operation would be a very small fraction (<1%) of the nighttime traffic to the Haleakala Visitor's Center and the Puu Ulaula overlook. Bird collisions with nighttime traffic at Haleakala are a very minor source of mortality; traffic from the proposed action would not significantly increase this mortality.

During operation, the CO_2 laser would emit electromagnetic energy in the infrared range (11 µm). This wavelength is not visible to humans or birds (Terres 1980). Consequently, there would be no attraction of the 'ua'u to light from operation of the CO_2 laser.

Increased traffic associated with the proposed construction and operation at the MSSS poses a potential danger because of collisions with the nene, 'ua'u, and possibly the hoary bat. The road to the Haleakala Visitor's Center cuts across a portion of the nene's range, and nene are grounded during October to February. The maximum number of construction workers at the site at any time would be 40, or approximately 1% of the daily visitation to Haleakala Park. Consequently, impacts are expected to be extremely unlikely.

Garbage would be generated during construction and operation that could attract mongoose, cats, dogs, and rats. All these species are known predators of 'ua'u and are attracted to trash left by humans. Furthermore, buildings and storm drains provide cover for rats. Burrows of nesting 'ua'u occur in the vicinity of Science City. Scats of mongoose and feral dog were collected in the near vicinity of Science City during the plant survey described earlier, as was the skeleton of a roof rat. Implementation of the proposed action could result in a temporary increase in trash and garbage in the Science City area during construction. Operations would have little effect on current generation of trash at the site because of the small number of persons to be added to the site staff.

Construction activities would produce noise and ground vibrations that could disrupt egg-laying, incubation, or feeding of the young, or collapse burrows of the 'ua'u. No data on the resilience of 'ua'u burrows to ground vibrations are available. Construction of the two maintenance buildings and modifications to the roadway would be over a short term (several months). The nearest active burrows to the building construction sites lie approximately 170 m (550 ft) to the west.

No data have been collected regarding the effects of noise and/or ground vibrations on 'ua'u; however, there have been studies of the effects of simulated aircraft noise on other sea birds. Nesting crested terns (Sterna bergii) exposed to recorded prop-aircraft noise were found to exhibit startle or escape behavior only when noise levels were above 90 dB(A). All members of the nesting colonies were aware of the noise at levels above 65 dB(A), and 50% of the colony members exhibited scanning behavior when the noise level was 70 dB(A) (Brown 1990).

Depending upon the construction activity, noise levels at 15 m may be from 85 to 105 dB(A). This would result in a maximal noise level at the nearest burrow of from 64 to 84 dB(A). Based on the findings of Brown (1990), no effects on reproductive success would be anticipated from construction noise.

Operation of the CO_2 laser would require gas venting once per day. The majority of the gas would be innocuous: helium, nitrogen, and carbon dioxide. However, as much as 0.056 m^3 of carbon monoxide would be released as a CO_2 breakdown product. Releases of gases would be made once per day over no more than a 5-min interval. Conservative diffusion calculations indicate that the greatest concentration of carbon monoxide at a point 50 m downwind from the release would not be over 3 ppm in 1-m^2 air.

No effects on 'ua'u or other wildlife would occur as a result of carbon monoxide emissions. The maximum concentration of carbon monoxide in the plume would be three orders of magnitude below the LC_{50} (concentration at which 50% of birds died after a 24-h exposure) for wild birds and one order of magnitude below the lowest concentration with any effects on mice during a 24-h exposure (NIOSH 1986).

Exposure to the vented gas plume would be of short duration (<5 min), intermittent, and sporadic as a result of the varying wind direction at the MSSS. Releases would take place during the day when no bats would be in the area and when 'ua'u would be in burrows. Birds in burrows would be exposed to much lower concentrations than those present in the plume.

CUMULATIVE IMPACTS

Construction activities would have no significant cumulative impacts on federally listed species. Construction traffic would slightly increase the risk of traffic collisions with nene during the commute up to the Science City area. However, the incremental risk would be extremely small. Operation of the CO_2 laser would constitute a small increase to the existing laser usage on the MSSS, because lasers would not be operated simultaneously. This would constitute a small incremental increase in the risk of impacts to the 'ua'u as a result of encounters with the beam. The potential for impacts to the hoary bat and the ahinahina would not be increased by the project.

MITIGATION MEASURES

Although there is little potential for impacts to the ahinahina as a result of the inadvertent transport of alien species to the area, precautions against this eventuality would be taken. Equipment transported to the site from off the island would be carefully cleaned of all caked mud and thoroughly washed before transport up Haleakala.

The risk of collisions between birds and artificial objects would be limited by burial of all new utility lines. The only new structures would be large and without lights that might attract birds.

The attractiveness of the site to potential nest predators would be limited by storing all garbage in sealed metal containers to be removed at the end of each day. Furthermore, the ongoing rodent control program (RPS 1990) would be expanded to include baited traps at materials depots and new structures.

Construction of the warehouse on the MSSS would result in a decrease of traffic needed to restock supplies and equipment. Currently, supplies are warehoused down the mountain and are transported to the site as needed. Fewer, larger loads of supplies would be transported to the site after construction of the warehouse. This would decrease the risk of vehicle collisions with nene.

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Office
P.O. Box 50167
Honolulu, Hawaii 96850

SEP 0 8 1993

In Reply Refer To: CMR

Kathy Dadey
BCA, Belt Collins and Associates
680 Ala Moana Boulevard
Honolulu, HI 96813

Dear Ms Dadey:

This responds to your September 7, 1993, request for comments on the Draft Environmental Assessment/Negative Declaration for the Advanced Electro-Optical System (AEOS) Telescope and Related Improvements at the Maui Space Surveillance Site (MSSS) Haleakala, Maui, Hawaii, dated September, 1993.

It is our opinion that the above mentioned document presents an accurate analysis of the expected impacts on biological resources of the project area. The mitigation measures presented should be adequate to minimize any adverse impacts caused by this project.

We appreciate the opportunity to comment on this document.

Sincerely,

Robert P. Smith

Robert P. Smith
Field Supervisor

APPENDIX D

CALCULATIONS OF FUEL OIL SPILL

CALCULATIONS OF FUEL OIL SPILL

This appendix gives the information used in calculating the effects of a 11,000-gal fuel-oil spill at the surface of the Maui Space Surveillance Site (MSSS). Step-by-step calculations of the extent and effect of the hypothetical spill are included.

Organic chemicals at the MSSS include diesel fuel, ethylene glycol, hydraulic fluid, solvents, oil-based paint, and miscellaneous chemicals. The calculations evaluate the consequences to groundwater of a spill of 11,000 gal of diesel fuel; this accident was chosen over other possible accidents because of the relatively large volume involved. This evaluation includes consideration of the following factors affecting migration of a liquid to depth: soil texture, soil structure, soil moisture, and the depth to the water table (Hillel 1989).

The diesel fuel spill would be initially confined to the immediate vicinity of the site because the fuel tank is in a topographic depression. Thus, no bulk transport of spilled oil through water runoff can occur during even the most violent storms. As fuel oil migrates in the subsurface, it would be dispersed by mechanical dispersion during gravity-driven bulk flow (Eastcott et al. 1989). Residual saturation, the degree of bonding of oil to soil particles, would be controlled by capillary forces. This dispersed, bound oil would then be dissolved by percolating water (Dragun 1969). Forces acting to retard oil flow to the groundwater table may thus be classified as acting in systems involving liquid-liquid and liquid-solid interaction. In addition, the evaporative effects of liquid-gas (oil-atmosphere) contact would remove some fuel-oil components. Therefore, the migration of diesel fuel into the subsurface may be viewed as having three components: surface binding of oil under bulk-flow conditions, evaporation of some or all components of bound oil, and dissolution of some or all components of bound oil by percolating rainwater during its infiltration through the unsaturated zone. Bounding conditions for migration of diesel fuel to depth would include the effectiveness of evaporation in the vadose zone, the surface area of rock available to bind the oil, and the solubility of the oil in water.

To estimate the impact of a chemical spill on ground-water quality, it is necessary to determine the depth to the water table. Stearns and Macdonald (1942) estimated the elevation of the water table confined by dikes within the heart of Maui to be 450 m (1500 ft) to 900 m (3000 ft). A survey of available water-resources reports for the island of Maui (Takasaki 1970; Takasaki 1972; Takasaki and Yamanaga 1970; Yamanaga 1975) indicates that the highest utilized perched water table is at an elevation of 1250 m (4100 ft) (Yamanaga 1975). This represents a depth-to-water of approximately 1830 m (6000 ft) below the MSSS. In the calculations below, depth-to-water is taken to be 1524 m (5000 ft), as a conservative estimate.

Rainfall on Haleakala ranges from 51 to 128 cm annually within a 6.4-km radius of the summit (Yamanaga 1975). The average annual rainfall at the summit is 64 cm (NPS 1978). As much as 20% of the annual average rainfall may fall in a single storm (C. Fein, personal communication 1989). Because of the porosity of the strata around the MSSS (see below), there is little if any bulk surface runoff to lower elevations. In the calculations, rainwater is assumed to infiltrate without runoff and to mix in the subsurface by mechanical dispersion.

Surface soil texture at the MSSS consists of brown silty sand and weathered cinders to a depth of at least 7 m (24 ft) (Dames and Moore 1989). Ash and cinder are components of all formations on Haleakala, and highly permeable lava flows make up the bulk of the volcano (Yamanaga 1975). The brown color is an expression of an iron oxyhydroxide coating that is formed from leaching of iron from primary basaltic minerals. Iron oxide or oxyhydroxide is a common product of leaching of iron-bearing rocks (Henmi et al. 1980; Carlson and Schwertmann 1981). Hana rocks (the stratigraphically uppermost basalts at Maui) contain an average of 13.8 wt% FeO (Chen 1987).

In estimating the loss of fuel oil to evaporation, the effectiveness of evaporation from the vadose zone and the fraction of volatile compounds in the fuel oil must be determined. Hydrocarbons, both paraffinic and aromatic, containing from 1 to 12 carbons (C_1-C_{12}) are rapidly lost from petroleum products after a spill. In general, these components are found to be almost entirely gone 24 h after a spill on water (McAuliffe 1977). The fraction of C_1-C_{12} hydrocarbons in crude oil is about 15% (Bean et al. 1980) and may be assumed to be about 20% higher in diesel fuel, a refined oil. The C_1-C_{12} components, in addition to being volatile, are also the most water-soluble constituents. The solubility of hydrocarbons in water decreases logarithmically with molecular volume (McAuliffe 1966). Thus, the removal of the lower molecular weight components by evaporation dramatically alters the portion of spilled oil that can dissolve in water. The evaporation of these compounds from the vadose zone at Haleakala may be expected to occur as a result of "mountain breathing"--the circulation of air into the mountain's subsurface as it warms and cools. Woodcock and Friedman (1979) measured the daily flow of air at Mauna Kea (which may be treated as an analogue of Haleakala) to be 20 kg/m²/d at the mountain's surface. This air carried water vapor from the mountain's interior in the amount of 6.6 g/kg. This hypothetical spill may be reduced volumetrically by 20% as a result of evaporation.

The depth of migration and the subsurface volume occupied by diesel fuel migrating to depth are dependent on properties of solid and liquid phases. A general empirical relationship exists between grain size and surface area, as presented by Levorsen (1967): an average grain diameter of 0.5 cm (which probably overestimates the average grain diameter of Haleakala) yields a conservative subsurface solid surface area of 8200 m²/m³. A hypothetical degree of dispersion with depth must also be assumed in order to calculate the depth of penetration of a fuel oil spill. Published estimates of spill extent typically hypothesize a shallow, broad pattern of contamination [e.g., 0.004 ha (430 ft²) and 10 cm thick (Shields and Brown 1989)] in typical soil. Haleakala cinder is much coarser than typical soil; therefore, much less dispersion with depth will be considered. A purely hypothetical dispersion of 1:8 for horizontal dispersion versus vertical movement was adopted for these calculations. This value represents dispersion to define a right circular cone with an angle of divergence from the vertex of 15°. The mean thickness of a grain-coating oil film is also required to determine the hypothetical depth of penetration for a fuel oil spill. For the following calculation, this thickness was taken to be 0.7 μm, the thickness of crude-oil films on Tensleep sandstone, Wyoming (Levorsen 1967). In addition, the formation of liquid droplets trapped by capillary forces was not considered. The volume occupied by diesel fuel migrating to depth is thus conservatively overestimated.

Depth of penetration of 10,000 gal of diesel fuel was calculated as follows.

- Loss to evaporation (20%):

$$37.85 \text{ m}^3 \times 0.8 = 30.28 \text{ m}^3 \quad (1)$$

- Remainder to coat all subsurface grains 0.7 μm thick:

$$30.28 \text{ m}^3 / (0.7 \times 10^{-6}) \text{ m} = (4.326 \times 10^7) \text{ m}^2 \quad (2)$$

- Volume of rock to yield necessary surface area:

$$(4.326 \times 10^7) \text{ m}^2 / 8200 \text{ m}^2/\text{m}^3 = 5275 \text{ m}^3 \quad (3)$$

- Depth of penetration:

volume of a cone:

$$V = 1/3\pi r^2 h \quad (4)$$

r in terms of h:

$$r = TAN(7.5) \times h \quad (5)$$

$$= 0.132\ h$$

substitute Eq. (5) into Eq. (4):

$$V = 1.047 \times 0.0174 \times h^3 \quad (6)$$

rearrange:

$$h = (V / 0.01825)^{.333} \quad (7)$$

$$= (5275 \text{ m}^3 / 0.01825)^{.333}$$

$$= 66.1 \text{ m}$$

$$r = 8.8 \text{ m}$$

Given the assumptions discussed above, 10,000 gal of diesel fuel would penetrate to a depth of 66 m below the surface. A further assumption that the spill covers an area equivalent to a 4-m radius at the surface reduces the depth of penetration to 38.8 m.

Dissolution and transport of diesel fuel by rainwater percolating to depth may bı estimated given the solubility of diesel fuel or its components. Eastcott et al. (1989) give the bulk solubility of diesel fuel as 0.2 mg/L. Therefore, water at the base of the infiltrating cone ($r = 8.8$ m, $r = 8.85$ m in the $r_{surface} = 4$ m case) may be assumed to contain 0.2 mg/L diesel fuel. Dilution by dispersive mixing of rainwater may be assumed to be identical to spreading by dispersion, as given above. The mixed concentration at the top of the water table would be the ratio of the surface area of the circular conic section at the bottom of the dispersed plume (i.e., the area of the cone's base) to the area of the conic base at the top of the water table. These areas and thei ratios are

- area of a circle:

$$A = \pi r^2 \quad (\text{[illegible]}$$

$$= \pi(8.8)^2 = 239\ m^2$$

- r at the water table (5000 ft. = h):

$$r = 0.132\ h \quad (\text{[illegible]}$$

$$= 0.132 \times 1524\ m = 201\ m$$

$$A = \pi(201)^2 = 127100\ m^2 \quad (\text{[illegible]}$$

Dilution of dissolved diesel above the water table is 0.2 mg/L x (239 m^2/127,100 m^2) = 0.3 µg/L of dissolved diesel fuel at the top of the water table. This figure is very conservative because it is not corrected for the decrease in bulk water solubility brought about by loss of light hydrocarbons during evaporation. Because these volatile, water soluble constituents can be expected to be rapidly lost by evaporation before percolation to the water table, the dilution of dissolved oil above the water table can be expected to be less than one-tenth the calculated value, or <0.03 µg/L. Consideration of a "bounding case," using a published solubility of low-solubility hydrocarbons, illustrates the reasonableness of this further reduction in concentration. The mean solubility of the four-component group of compounds within diesel fuel including the n-alkanes, iso-alkanes, isoprenes, and polar compounds (i.e., exclusive of aromatic compounds), as estimated by Shields and Brown (1989), is 4 µg/L. Calculation of dilution above the water table using this solubility value gives a dissolved concentration at the top of the water table of 0.008 µg/L. Also ignored in these calculations are the effects of further dilution by mixing, during lateral movement of water from the point of contact with the water table to a hypothetical point of surface expression and the biogenic degradation of petroleum in the subsurface environment.

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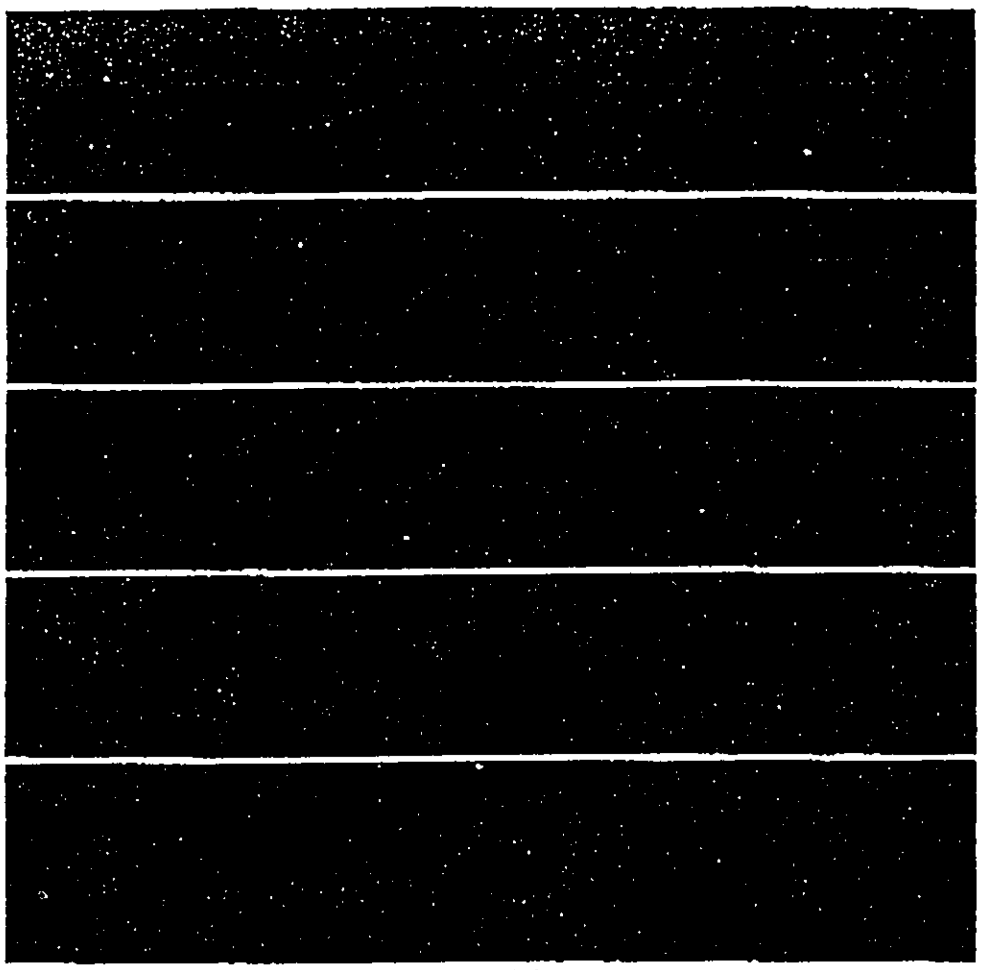
APPENDIX E

FINAL REPORT
GROUND VIBRATION MEASUREMENTS DURING SOIL CEMENT TEST PAVING
MSSS ACCESS ROAD, HALEAKALA, MAUI, HAWAII



FINAL REPORT

GROUND VIBRATION MEASUREMENTS DURING SOIL CEMENT TEST PAVING MSSS ACCESS ROAD HALEAKALA, MAUI, HAWAII

Job Number 01016-361-011

May 3, 1993

DAMES & MOORE

DAMES & MOORE

1050 QUEEN STREET, SUITE 204, HONOLULU, HAWAII 96814
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May 3, 1993

Mr. Walt Randle
Rockwell Power Systems
Premier Place
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Final Report
Ground Vibration Measurements During
Soil Cement Test Paving
MSSS Access Road
Haleakala, Maui, Hawaii
Job Number 01016-361-011

Dear Mr. Randle:

Dames & Moore is pleased to submit this final report presenting the results of our measurements of ground vibrations observed during the test paving of the soil cement section of the MSSS access road. Measurement of vibrations generated by operation of construction equipment used in the test paving program are reported, as are vibration measurements obtained for operation of one of the MSSS existing domes and for tourist related activities which take place in National Park areas near the summit of Mount Haleakala.

The purpose of this investigation was to evaluate likely ground vibration which may occur at petrel burrow sites during future construction, and to compare these with vibrations which have been occurring in burrow areas on an ongoing basis.

If you have any questions concerning the findings presented in this report, please feel free to contact this office at your convenience. We appreciate this opportunity to have been of service to you.

Yours very truly,
DAMES & MOORE

Thomas E. Jensen
Principal Geophysicist

TEJ/MJF
(3 copies submitted)

(01016-361-011:208A)

OFFICES WORLDWIDE

FINAL REPORT
GROUND VIBRATION MEASUREMENTS DURING
SOIL CEMENT TEST PAVING
MSSS ACCESS ROAD
HALEAKALA, MAUI, HAWAII

1.0 INTRODUCTION

The proposed Advanced Electro-Optical System (AEOS) is to be constructed as a part of the Maui Space Surveillance Site (MSSS) at the summit of Haleakala, Maui. The U.S. Air Force - Phillips Laboratory, Rockwell Powers Systems, and the National Park Service have a concern over the possibility of construction operations causing disturbance to an endangered bird, the dark rumped petrel, which inhabits burrows in the vicinity of the summit of Haleakala.

To quantify an estimate of the vibrations which will be caused by future construction activities and their possible disturbance of the petrel, this ground vibration study was undertaken jointly by Rockwell Power Systems, the National Park Service, and Dames & Moore in January, 1993.

This report presents findings which indicate that vibrations from probable future construction activity at the proposed AEOS site are within the range of vibration magnitudes, and can be controlled with proper planning to not exceed the vibration levels that these birds are currently experiencing.

During the vibration study, we took measurements of various pieces of representative construction equipment to simulate probable vibrations to be generated during full construction operations. These measurements of ground vibrations were observed during the test paving of a soil cement section of the MSSS access road.

In addition to measurement of vibrations generated by operation of construction equipment used in the test paving program, vibration recordings were also obtained for operation of one of the existing domes and for tourist related activities which take place in National Park areas near the summit of Mount Haleakala. The location of the MSSS facility and the ground vibration observation locations in the National Park area are shown on the Map of Area, Plate 1.

Vibration recordings related to construction activities were obtained on January 20, 1993 during the test paving of the access road. Vibrations related to operation of the existing facility dome were also obtained on that date. Recordings made in the National Park area were obtained on January 25, 1993. Assistance in obtaining the recordings in the park area and designation of locations in the park where recordings were to be made was provided by National Park Service personnel.

2.0 PROJECT CONSIDERATIONS

The proposed telescope facility which is to be located at the summit of Mount Haleakala is planned for construction in an area situated to the east and southeast of the existing facilities. Additionally, appurtenant facilities for the proposed telescope will be located immediately adjacent and south of the existing facilities. Some known petrel burrows are located approximately 225 feet to the west of the existing facilities. These burrows lay in openings in the basalt lava outcrops. Their location is annotated as Observatory Monitoring Site on the Plot Plan, Plate 2. At the time the vibration recordings were made, the petrel burrows were unoccupied, as they are reported to be during each winter season.

The construction activities undertaken to place a test strip of soil cement access road provided the opportunity to measure ground vibrations generated by those activities. The roadway test strip is located approximately 600 to 650 feet distant from the burrows, as shown on the Plot Plan, Plate 2. The proposed telescope site is about 100 feet west of the test strip.

In addition to the burrow sites located in the vicinity of the MSSS facilities, other burrow sites are found in National Park areas where activities related to the tourist industry take place nearby to the burrow sites. Such activities include the operation of large tour buses along the roadway and in the parking area at the crater overlook.

3.0 EQUIPMENT USED DURING TEST STRIP CONSTRUCTION

The primary purpose of the roadway test strip was to test soil cement pavement methods and the durability of such pavement. The soil cement pavement is believed to be more environmentally compatible than is conventional asphaltic concrete pavement.

A secondary purpose of test strip construction was to record the vibrations generated by various equipment to be used during construction. The construction equipment used is listed as follows:

- 1 - 12 Ton Smooth Vibratory Roller, 8 feet wide
- 1 - 10 Ton Pneumatic Tire Roller
- 1 - Grader with ripper
- 1 - 4,000-gallon Water Truck
- 1 - 950E Loader
- 1 - Paving Spreader
- 1 - Tandem End Dump Truck
- 1 - Pug Mill with Hopper
- 1 - Screen All

Of the equipment listed, we believe that the 12 ton vibratory roller and the pug mill are the 2 pieces of equipment most likely to generate the largest vibrations during construction. The roller can be operated at adjustable vibration energy levels. For this study, the roller was operating at the maximum vibration level. We note that this 12 ton vibratory roller is one of the largest on Maui and is normally used for highway construction.

Other equipment that we anticipate may be used during construction includes rotary drilling equipment, erection cranes, ready-mix cement trucks, bulldozers, and possibly a hoe-ram. Based upon our experience in monitoring vibrations at other construction sites, we anticipate that this equipment will generate lower vibrations than the vibratory roller.

4.0 METHODS

Ground vibration recordings were obtained using a three-component transducer connected to a signal conditioning amplifier with output made to a strip chart recorder and to an analog magnetic tape recorder. The transducer, a Sprengnether model S6000, is a velocity transducer with a natural frequency of 2 Hertz. The transducer is configured to measure vibrations along each of three mutually orthogonal axes. The signal conditioner, a Sprengnether model VS1200, provides calibrated output with the amplitude of signal directly related to the particle velocity of ground motion. The VS1200 processes each of the three input signals corresponding the three axes of the transducer.

Hard copy records were obtained using three channels on a Gulton Industries four-pen strip chart recorder. The strip chart recorder was configured with Gulton model TSC-801 amplifier plug-in modules. Both chart sensitivity and paper speed are selectable. Vibration time-histories were made at a chart speed of 1 mm per second. Archive recordings were made on magnetic tape using a TEAC model R61 four-channel portable tape recorder.

At each recording location, the velocity transducer was buried and covered with sandbags to ensure good coupling with the ground. In each location, the transducer was oriented such that the longitudinal (radial) component of motion was aligned towards the source of vibration energy. Thus, for the observatory site, the longitudinal axis was towards the roadway test strip. At the overlook, the longitudinal axis was towards the parking area. At the roadway location, the longitudinal axis was set perpendicular to the road.

The observatory transducer location was 600 to 650 feet from the access road test strip, with the transducer placed at an elevation 20 feet below the elevation of the MSSS facility. This location was approximately 200 to 225 feet from the observatory dome located at the northwest corner of the facility. The overlook transducer location was selected to be over the edge of the crater rim at a spot below the overlook observation building. The transducer was about 25 feet below and 15 to 20 feet east of the eastward wall of the building. The roadway transducer location was selected to be on the crater side of the roadway, with the transducer approximately 75 feet off of the centerline of the road and about 5 to 10 feet below the road elevation.

Recordings were obtained at each of the locations on an intermittent basis. The records were made to obtain recordings of representative vibration generating activities and sources. For construction activities, the equipment described earlier was in operation. For activities at the overlook, records were made of bus traffic in the parking lot and of the activities by people in and around the overlook building. For the roadway location, records were obtained for passing automobiles, trucks, and buses. During the period when recordings were made along the roadway, work was underway by a contractor to resurface the road. A grader and a front-end loader were intermittently in the area of the recordings.

5.0 RESULTS

Representative time-histories of the vibrations recorded at each of the locations included in this study are presented in the Appendix. These time-histories demonstrate the level of vibrations observed for the various sources included in the study. Following is a description of the findings for each of the locations. All vibration amplitudes are reported as single amplitude, in units of inches per second (ips).

A comparison of maximum vibrations from time histories with distance from the vibration source, and human perception levels is shown on Plate 3, Recorded Maximum Vibrations Related to Various Activities at Haleakala Summit.

5.1 OBSERVATORY

The vibration records obtained during work on completion of the test strip paving indicated that operation of the vibratory smooth-drum roller produced greater vibrations than did any other piece of equipment. The smooth-drum roller resulted in peak vibrations of about 0.0032 ips (transverse), 0.0010 ips (vertical), and 0.0020 ips (longitudinal) when operating at maximum vibration energy. Vibration levels were much smaller when the smooth-drum roller was operated at a static condition. Other activities yielded peak events ranging from about 0.0004 ips to about 0.0018 ips. Horizontal motions typically exceeded vertical motions. Sustained motions during equipment operation ranged from about 0.0004 ips to 0.0015 ips.

During operation of the existing telescope dome, recordings showed that as the speed of dome rotation was increased from a low of about 2 revolutions per minute (RPM) to a maximum of about 10 RPM, vibration amplitudes typically increased. Peak motions at 2 RPM were about 0.0003 ips to 0.0012 ips (transverse), 0.0004 ips to 0.0010 ips (vertical), and 0.0008 ips to 0.0020 ips (longitudinal). At 10 RPM, peak values increased to maximums of 0.0040 ips (transverse), 0.0024 ips (vertical), and 0.0040 ips (longitudinal).

Motions were not significantly different when the dome was rotated counter clockwise as opposed to clockwise. Neither was there a consistent variation for rotation with the observation slot open as opposed to being closed. Sustained motions during dome operation typically reached a maximum of about 0.003 ips or less on the horizontal axes.

5.2 OVERLOOK

Our review of data at the overlook site indicates that while the objective of monitoring was to observe vibrations related to tourist buses operating in the summit area, the largest vibrations measured were related to footsteps and opening and closing of the visitor center doors. Peak vibrations of about 0.0040 ips (transverse), 0.0032 ips (vertical), and 0.0024 ips (longitudinal) occurred with the hard closing of the sliding doors on the overlook building. Buses operating in the parking area yielded peak vibrations of about 0.0004 ips to 0.0015 ips on the horizontal axes and about 0.0010 ips on the vertical axis.

5.3 ROADWAY

Vibrations along the roadway were seen to range from peaks of about 0.0002 to 0.0022 ips (horizontal axes) and 0.0004 ips (vertical) for automobiles; to 0.0009 ips to 0.0025 ips (horizontal axes) and 0.0007 ips to 0.0008 ips (vertical) for larger trucks and tour buses. The considerable variation in these vibration ranges was related to not only vehicle size, but also to the speed of passing of the vehicles. Faster moving cars and lighter trucks, in some cases, yielded vibrations equal to or even greater than those from slower moving heavier vehicles.

6.0 CONCLUSIONS

1. Vibration amplitudes as measured at the observatory, overlook, and roadside sites are well below the typical human perception threshold level for transient type vibrations which is about 0.033 ips.

2. The 12-ton vibratory roller operating at maximum energy, when measured at a distance of 600 feet, had a peak vibration of about 0.003 ips. This vibration level is lower than the normal vibrations that petrel birds have been experiencing due to the opening and closing of visitor center doors at overlook, and due to rotation of the telescope dome. It is only slightly higher than vibration levels from vehicular traffic along the roadway and in the parking lot at the crater overlook.

3. Because the 12-ton vibratory roller will likely be the most severe vibration generator among all the construction equipment that will be used in the telescope construction, we conclude that the future vibrations associated with the telescope construction can be controlled with proper planning to be lower than the vibration levels that petrels are already experiencing.

4. Since the vibration energy of the 12-ton roller is adjustable, when compaction is required close to any known petrel burrows, the vibration mode of the roller can switched off and compaction can be performed under the static mode in order to minimize disturbance.

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The following Plates and Appendix are attached and complete this report:

Plate 1-Map of Area
Plate 2-Plot Plan
Plate 3-Recorded Maximum Vibrations Related to Various Activities at Haleakala Summit

Appendix - Representative Vibration Time-Histories

SIN-KONG DJOU REGISTERED PROFESSIONAL ENGINEER No. 3587-C HAWAII, U.S.A.

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.

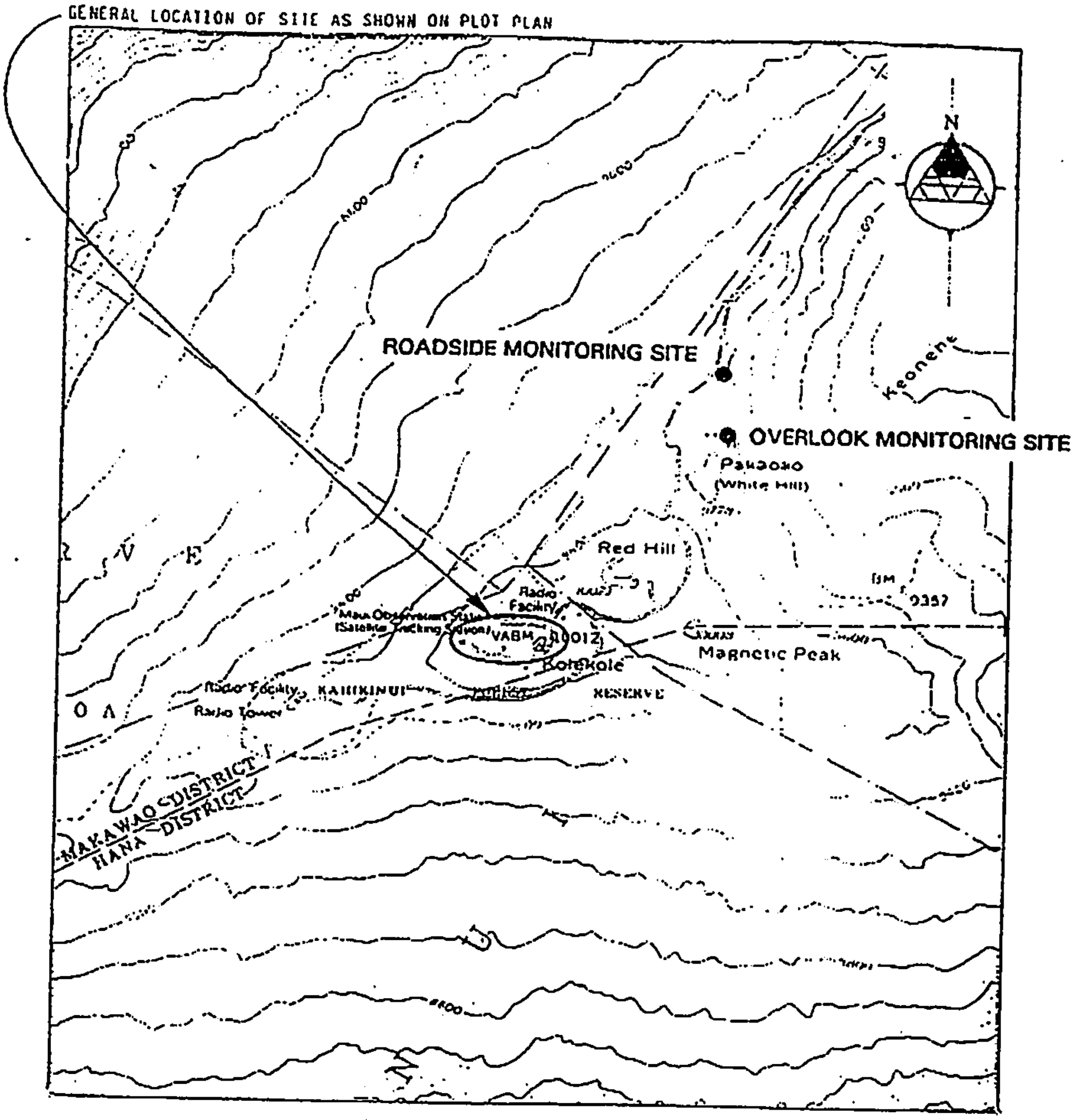
Respectfully Submitted,

DAMES & MOORE

Thomas E. Jensen
Principal Geophysicist

S.K. Djou, P.E.
Managing Principal

TEJ/SKD/MJF



MAP OF AREA

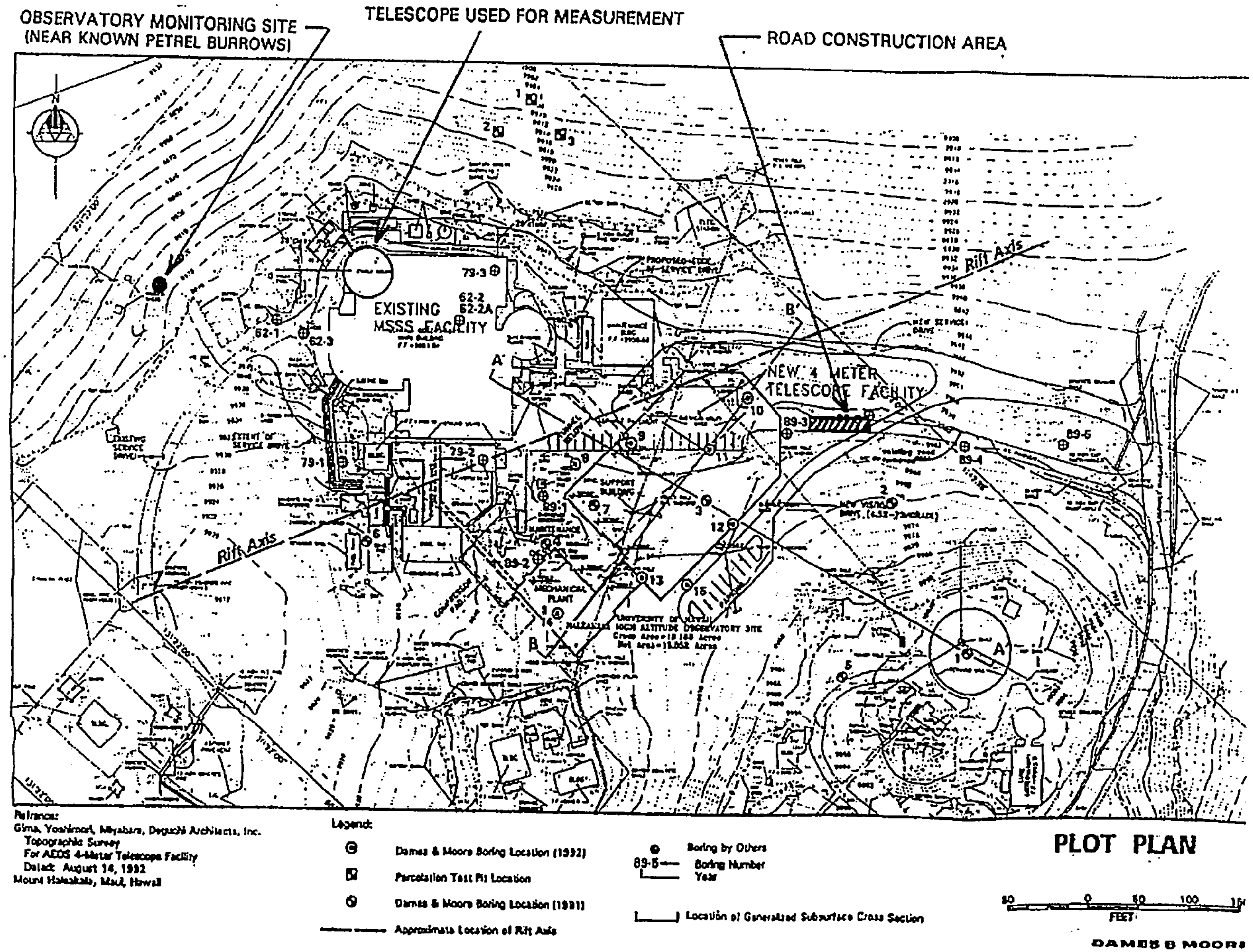
SCALE 1:24000

CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 20-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

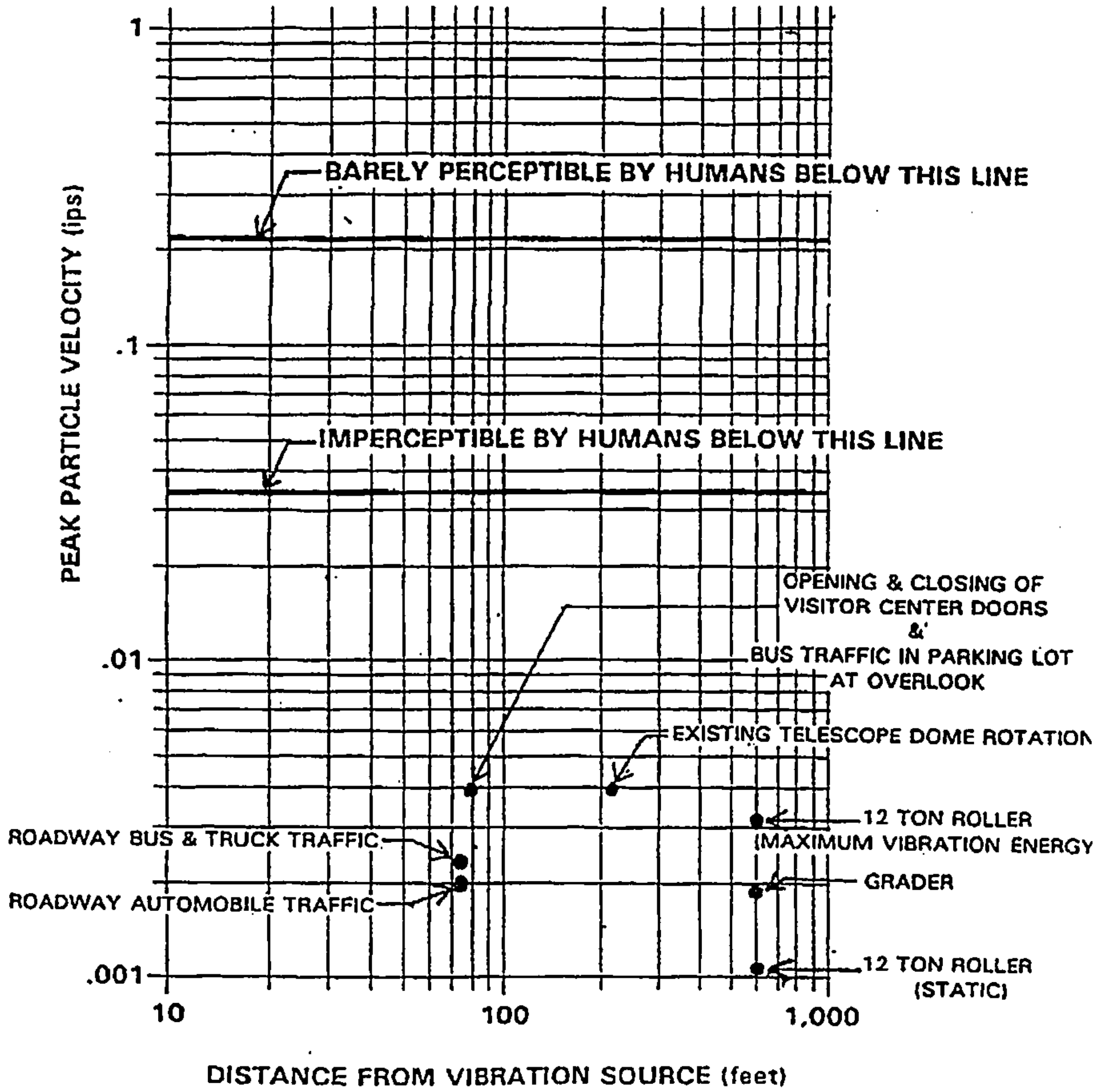
Reference:
U.S.G.S. Topographic Map
Kilohana, Maui, Hawaii (1983)

DAMES & MOORE

PLATE 1



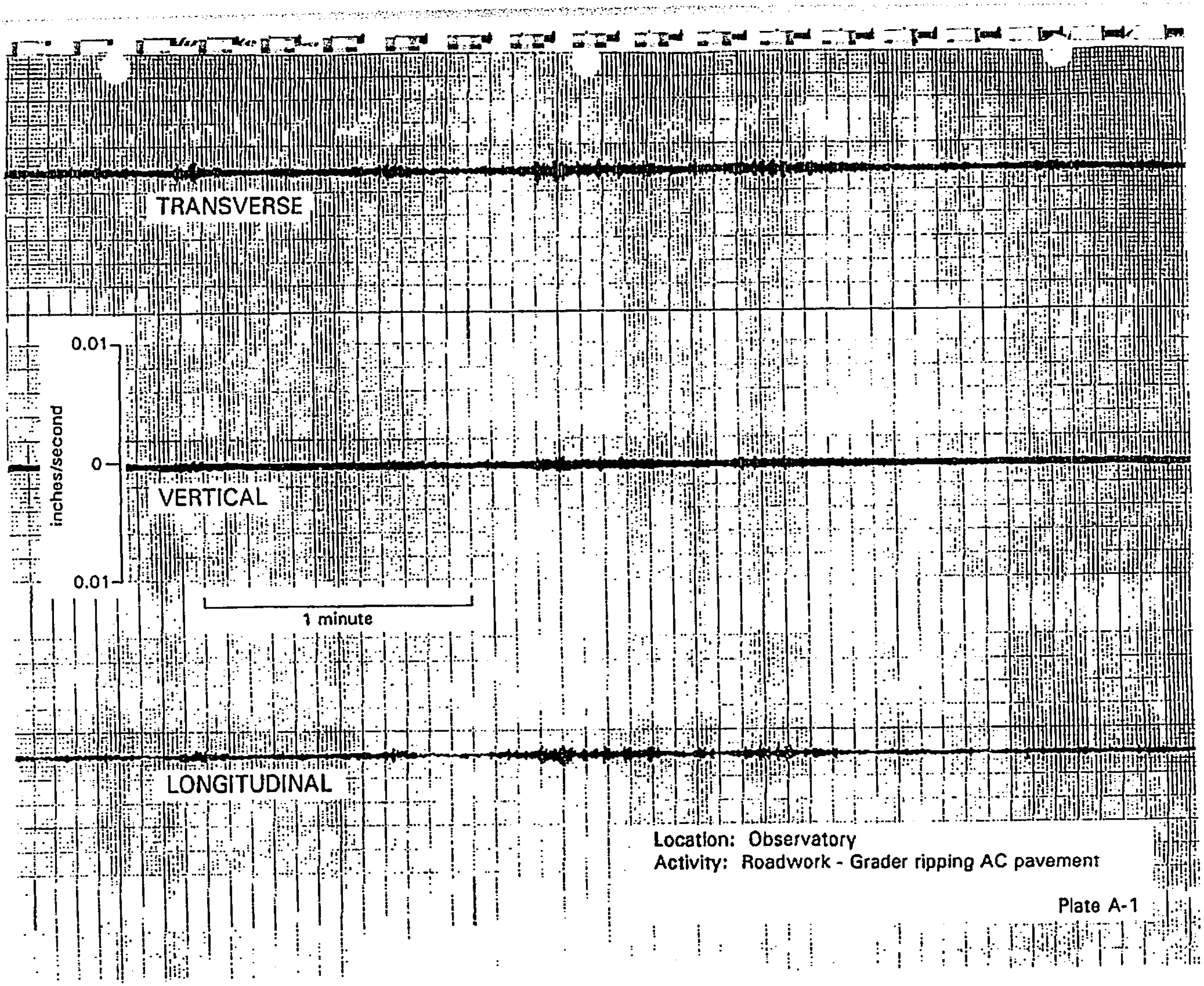
OBSERVATORY MONITORING SITE (NEAR KNOWN PETREL BURROWS)
TELESCOPE USED FOR MEASUREMENT
ROAD CONSTRUCTION AREA
N
EXISTING MSSS FACILITY
NEW 4 METER TELESCOPE FACILITY
Rift Axis
Rift Axis
79-3
62-2
62-2A
62-1
62-3
79-1
79-2
89-3
89-4
89-5
89-2
A
A'
B
B'
MECHANICAL PLANT
SUPPORT BUILDING
UNIVERSITY OF HAWAII HALEAKALA HIGH ALTITUDE OBSERVATORY SITE
Reference:
Gima, Yoshimori, Miyabara, Deguchi Architects, Inc.
Topographic Survey
For AEOS 4-Meter Telescope Facility
Dated: August 14, 1992
Mount Haleakala, Maui, Hawaii
Legend:
Dames & Moore Boring Location (1992)
Percolation Test Pit Location
Dames & Moore Boring Location (1991)
Approximate Location of Rift Axis
Boring by Others
89-5 Boring Number
Year
Location of Generalized Subsurface Cross Section
PLOT PLAN
0
50
100
FEET
DAMES & MOORE



RECORDED MAXIMUM VIBRATIONS RELATED TO VARIOUS ACTIVITIES AT HALEAKALA SUMMIT

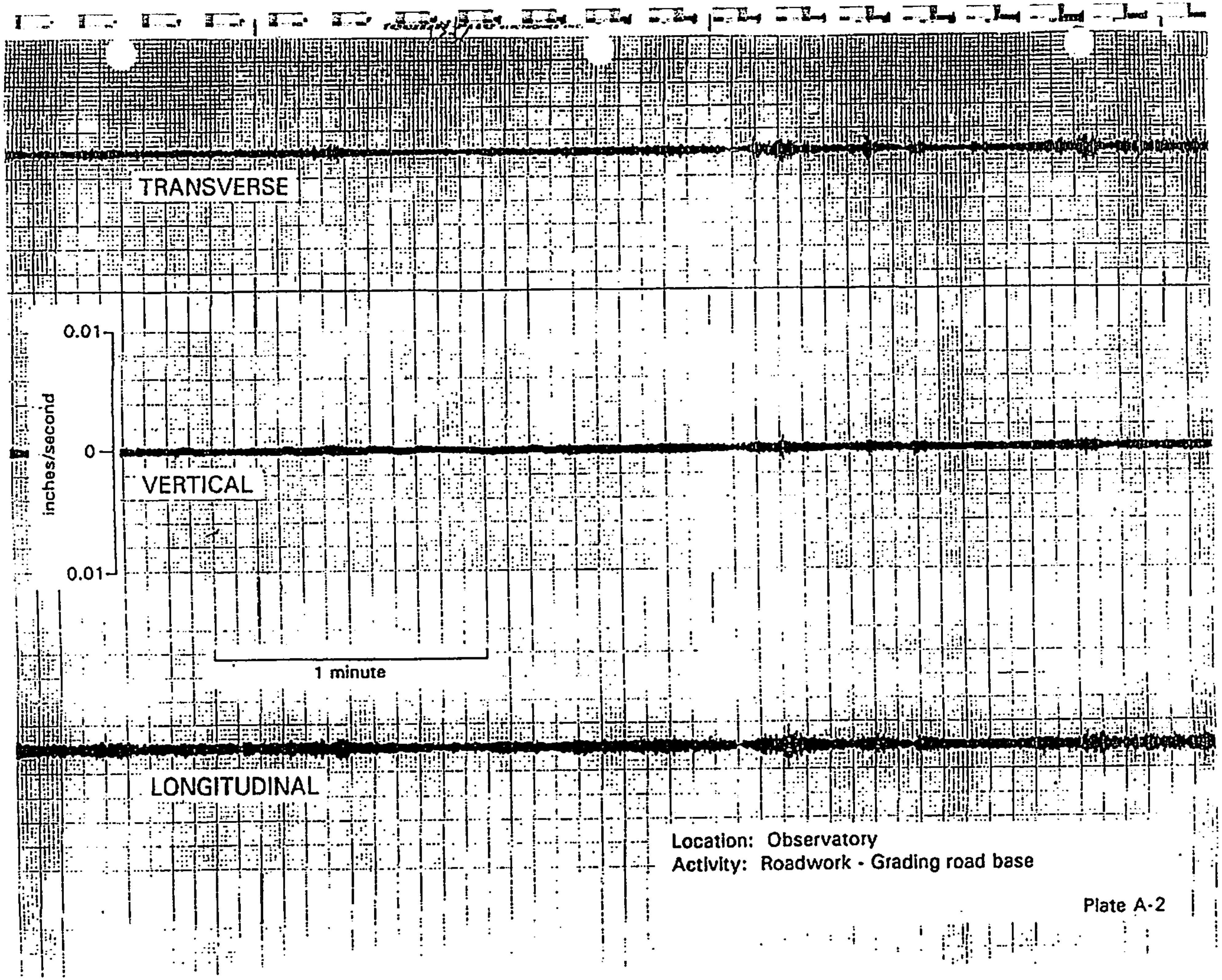
Dames & Moor

Plate 3



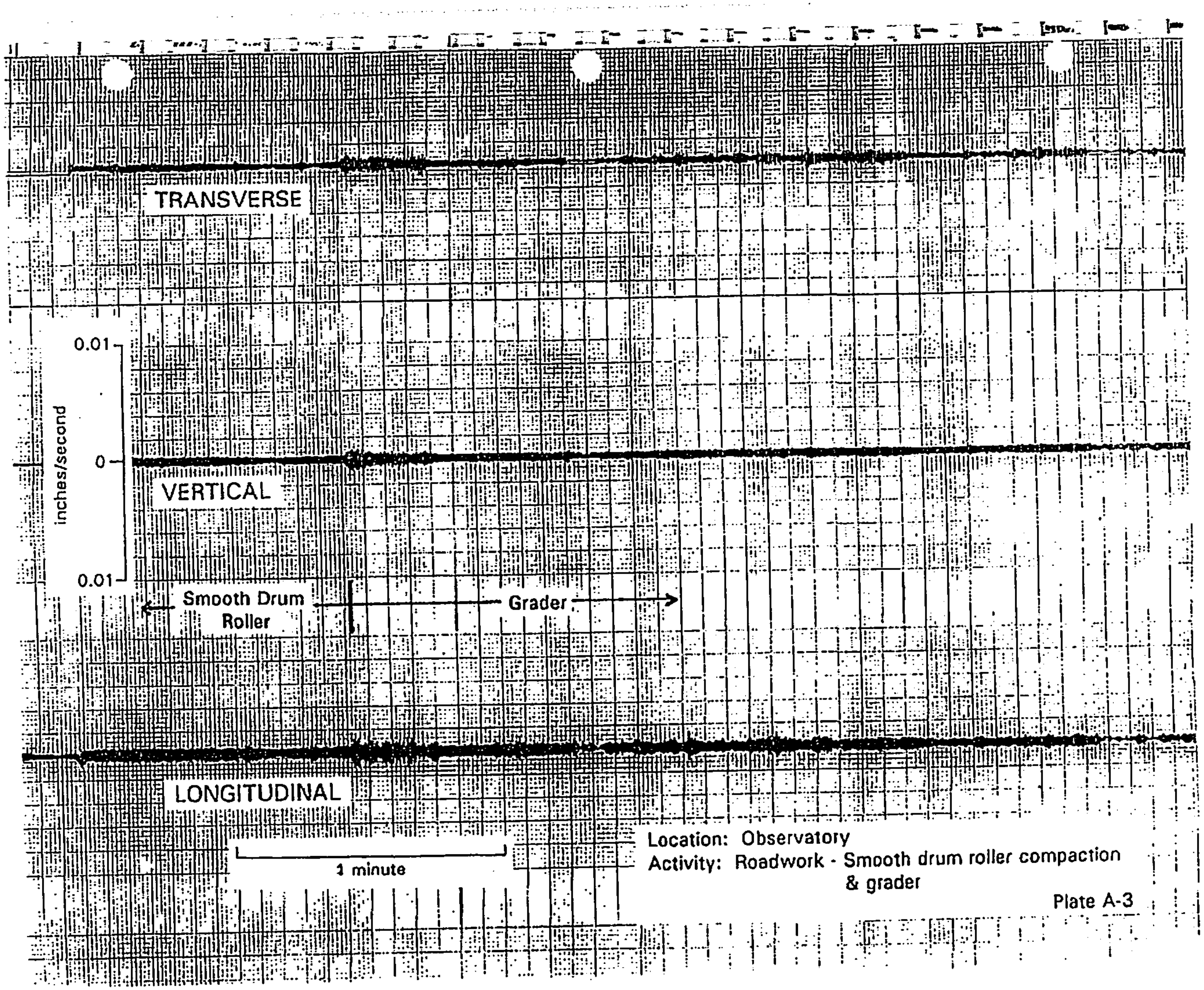
Location: Observatory
Activity: Roadwork - Grader ripping AC pavement

Plate A-1



Location: Observatory
Activity: Roadwork - Grading road base

Plate A-2



Location: Observatory
Activity: Roadwork - Smooth drum roller compaction & grader

Plate A-3

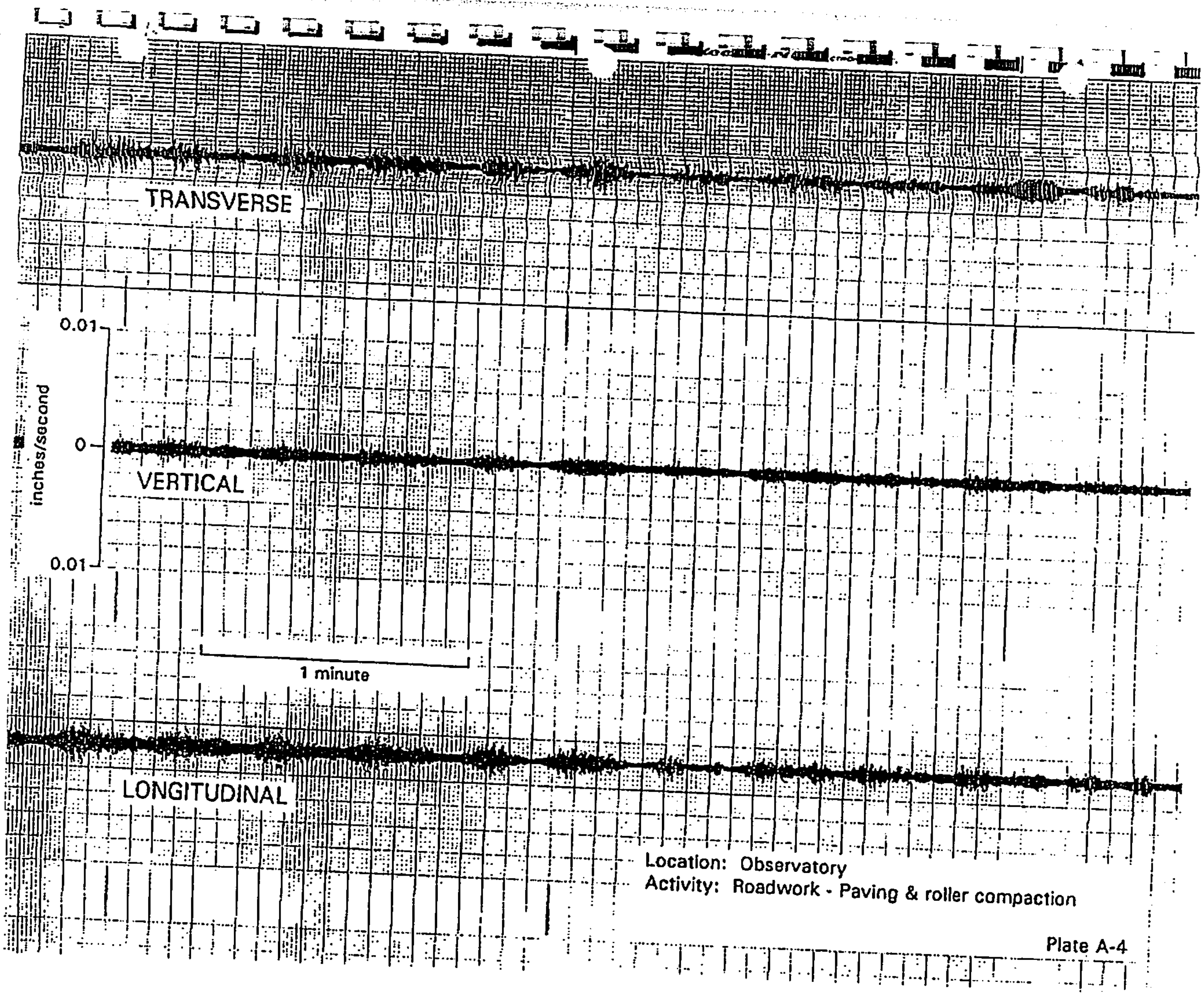
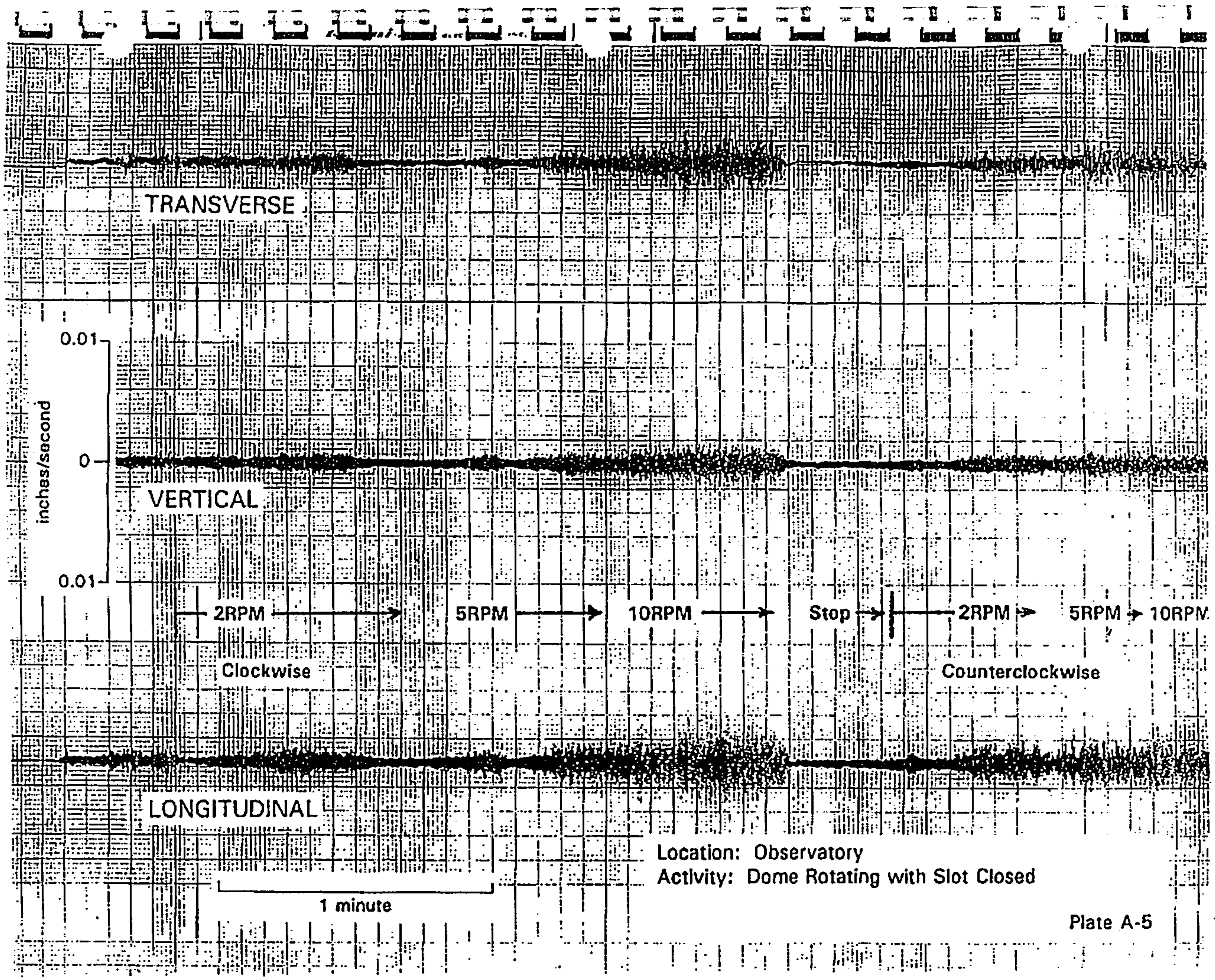

TRANSVERSE
0.01
0
0.01
inches/second
VERTICAL
1 minute
LONGITUDINAL
Location: Observatory
Activity: Roadwork - Paving & roller compaction

Plate A-4



Location: Observatory
Activity: Dome Rotating with Slot Closed

Plate A-5

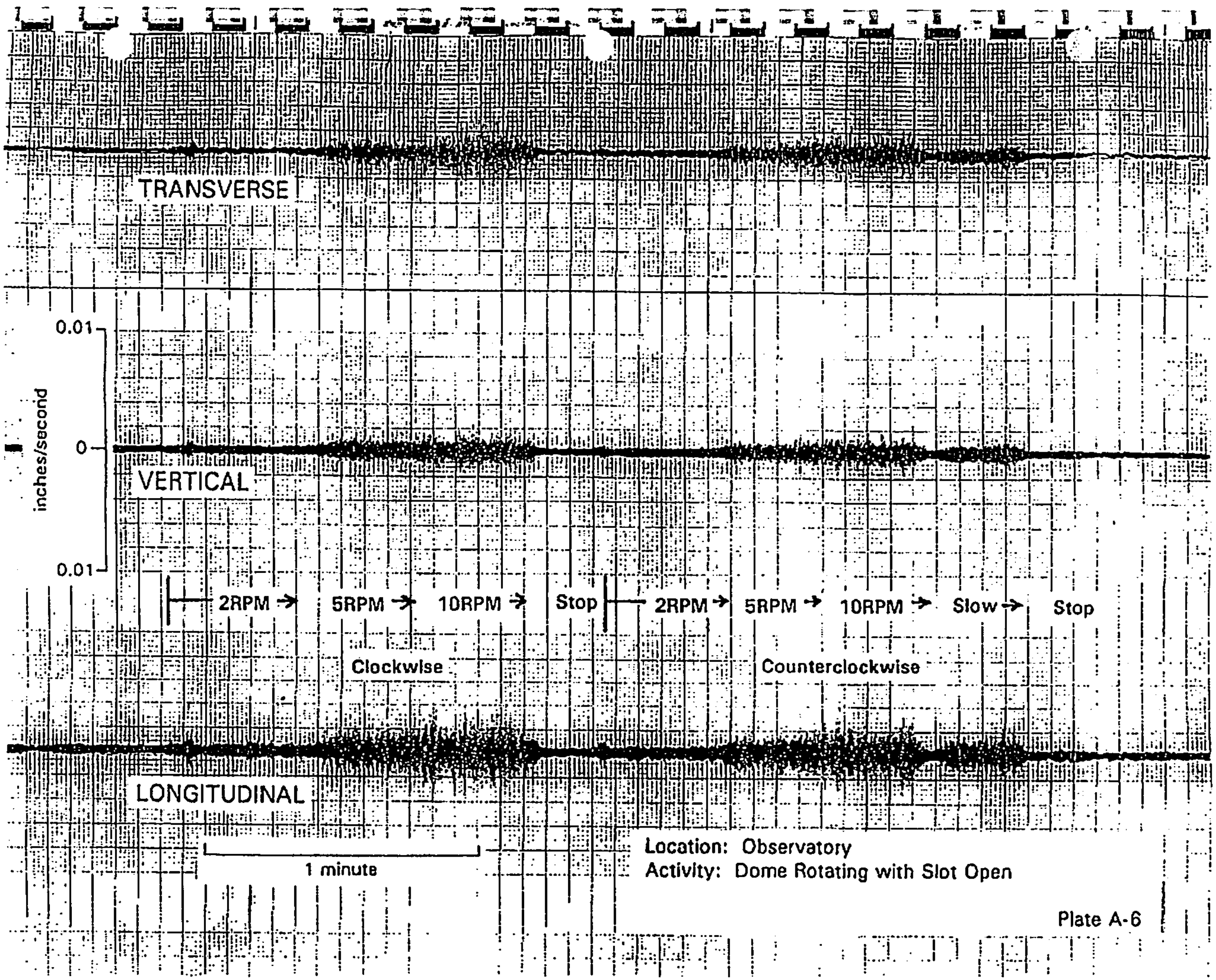

TRANSVERSE
0.01
0
0.01
inches/second
VERTICAL
2RPM → 5RPM → 10RPM → Stop
2RPM → 5RPM → 10RPM → Slow → Stop
Clockwise
Counterclockwise
LONGITUDINAL
1 minute
Location: Observatory
Activity: Dome Rotating with Slot Open

Plate A-6

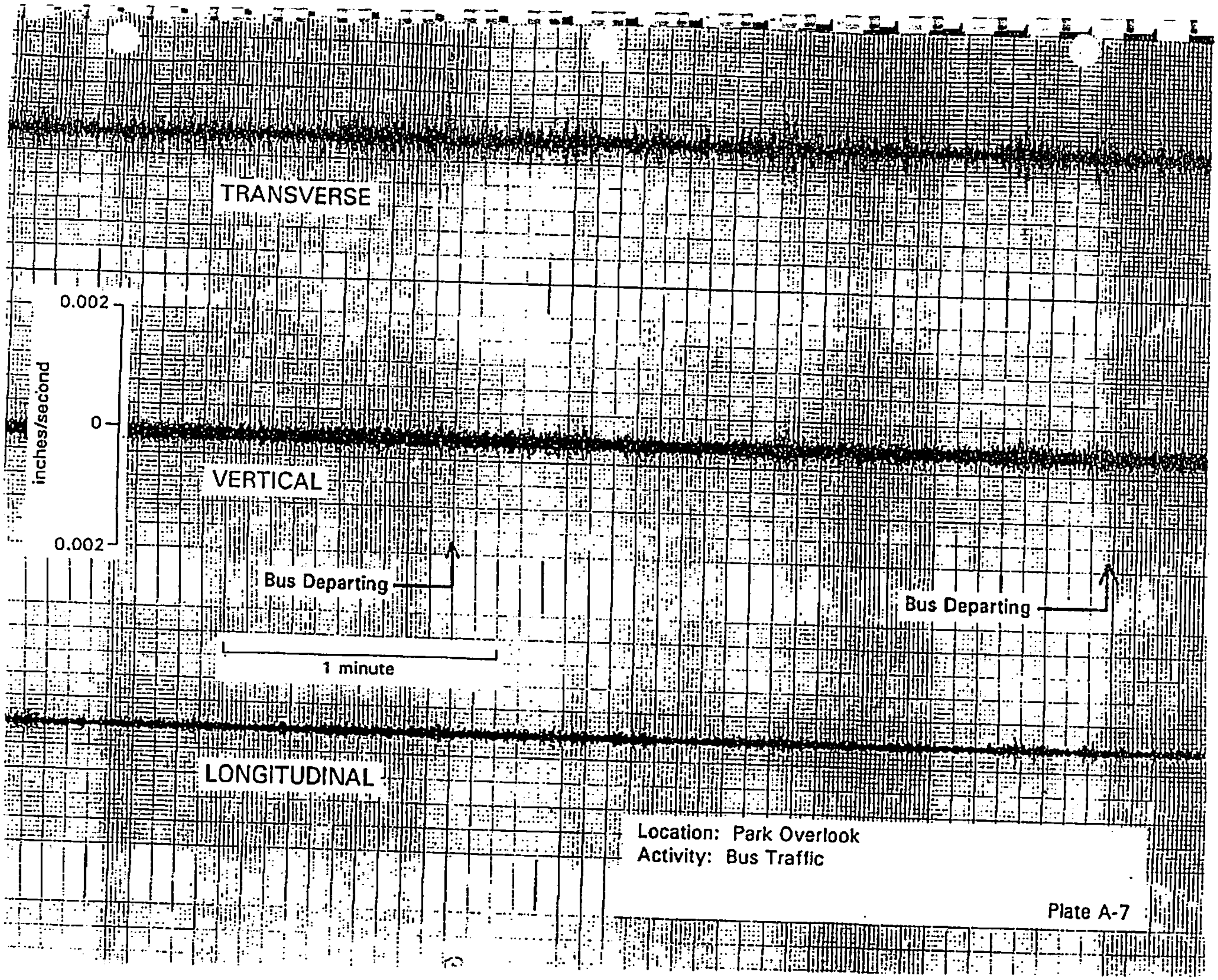
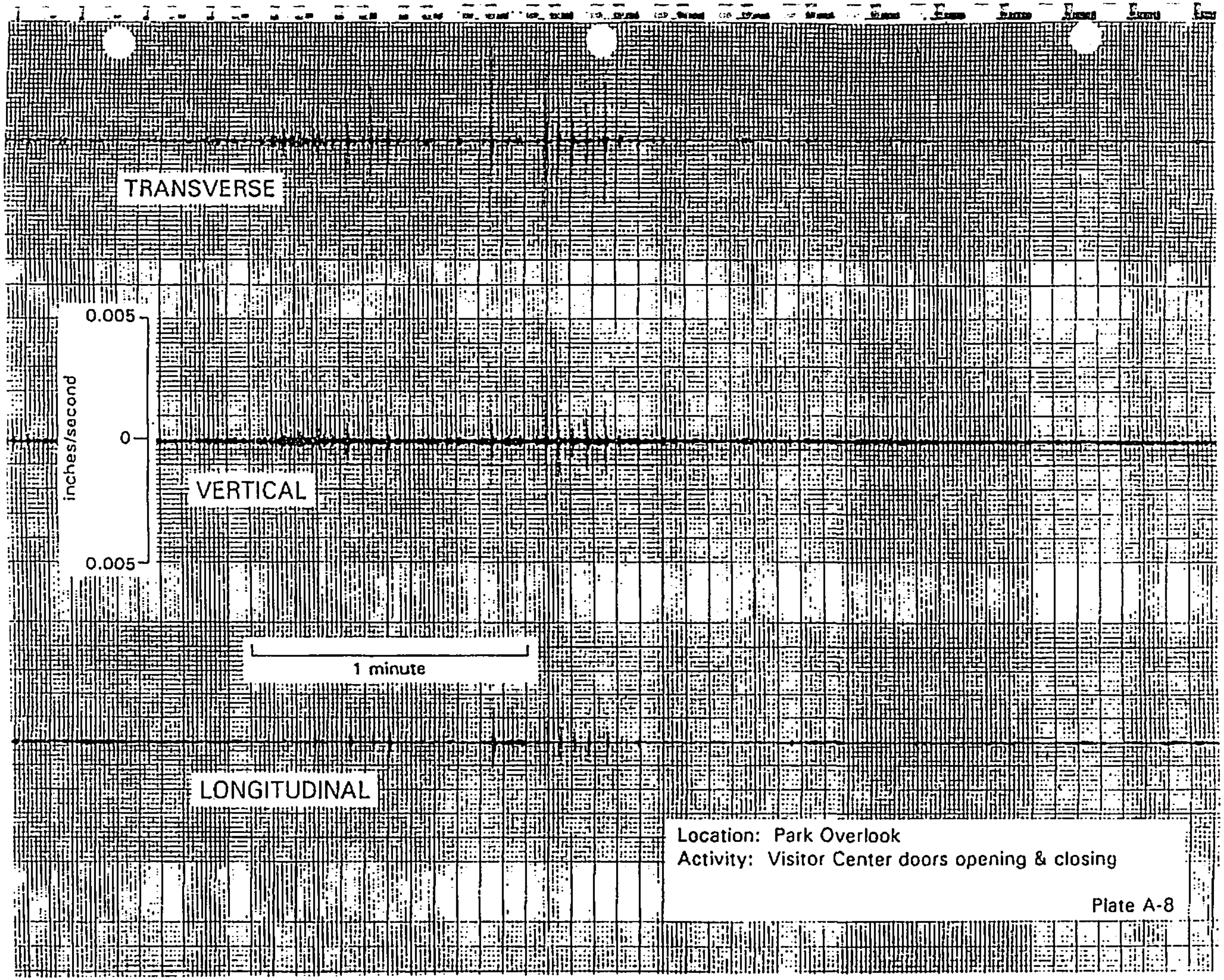
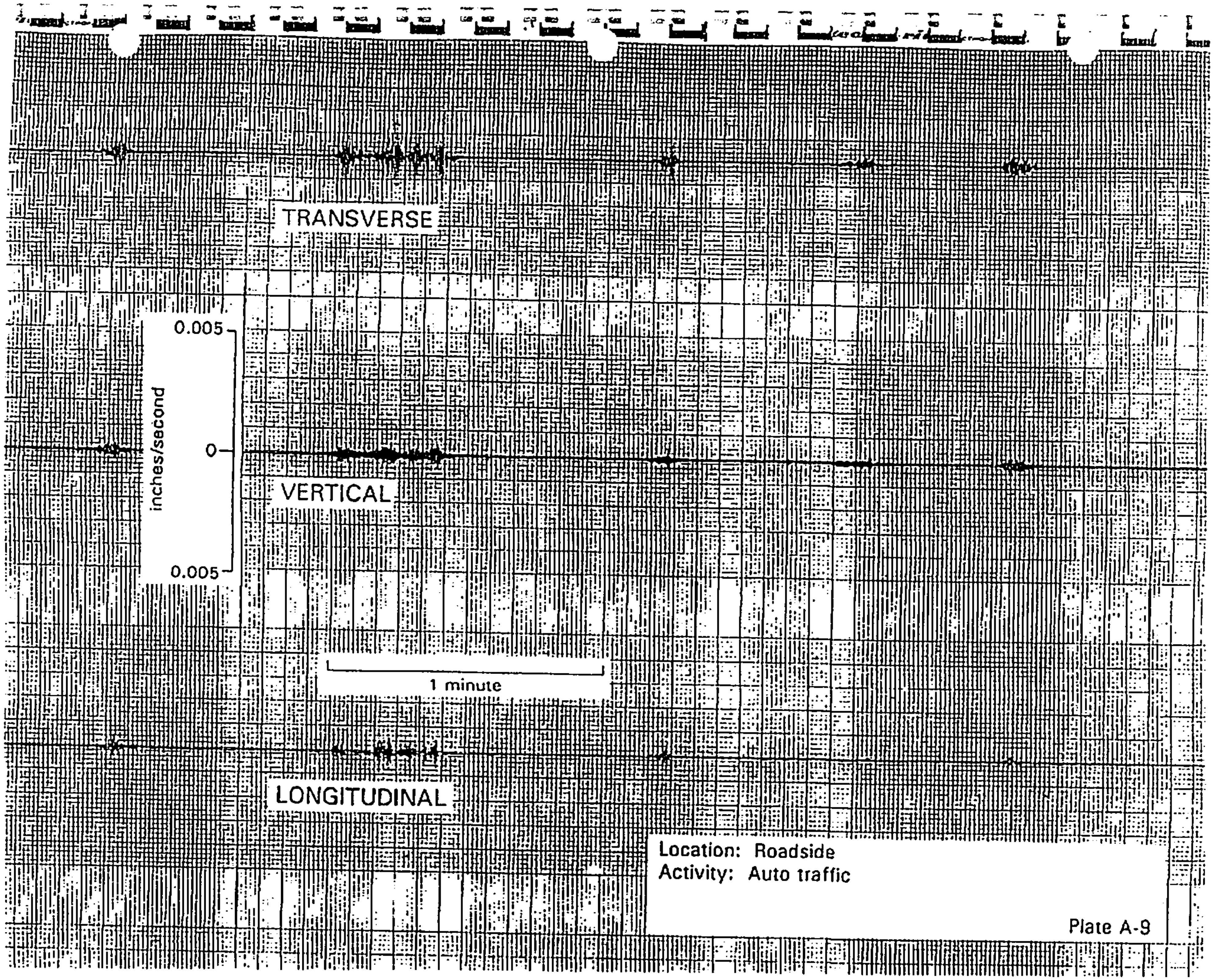

TRANSVERSE
0.002
0
0.002
inches/second
VERTICAL
Bus Departing
Bus Departing
1 minute
LONGITUDINAL
Location: Park Overlook
Activity: Bus Traffic

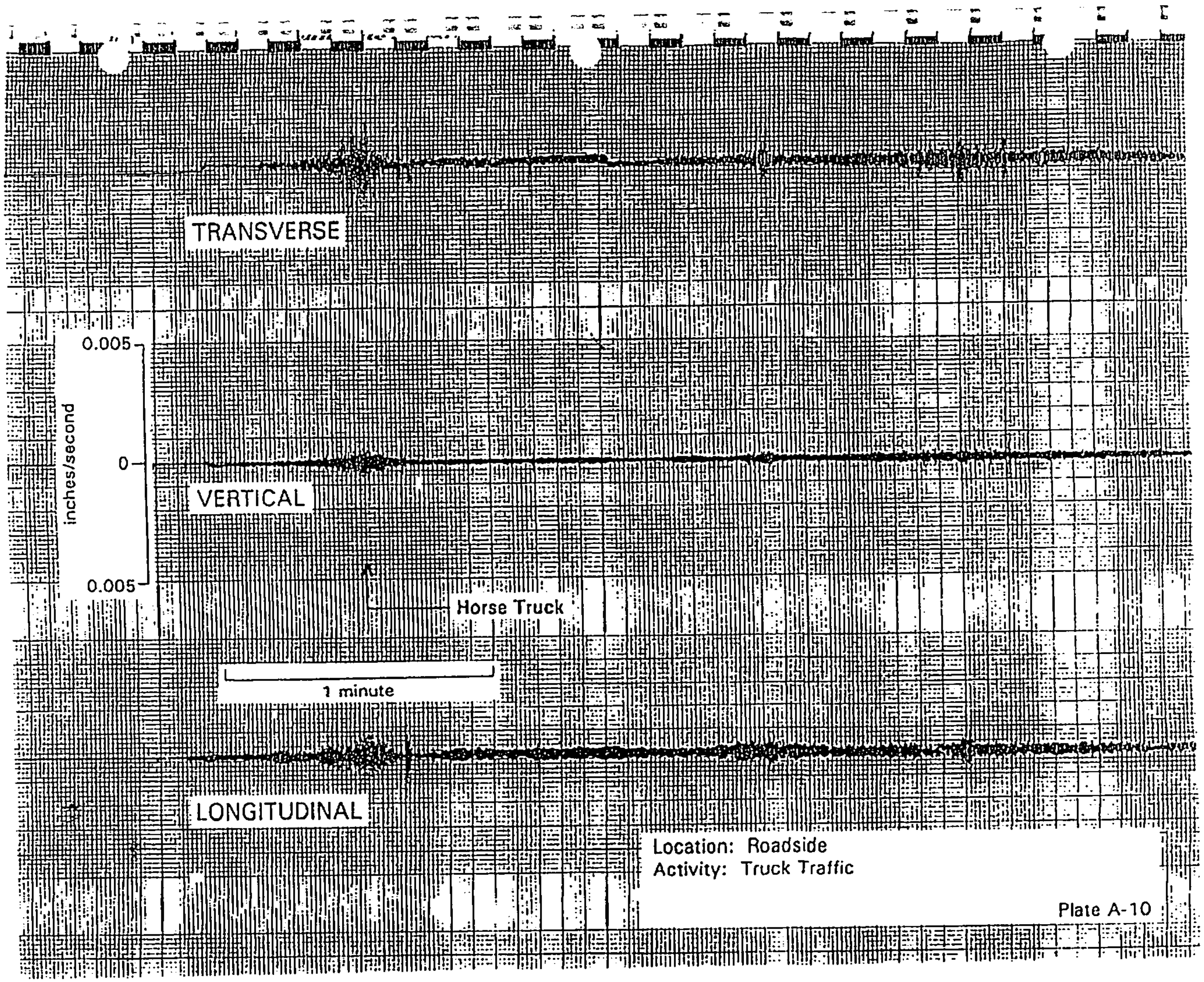
Plate A-7



Location: Park Overlook
Activity: Visitor Center doors opening & closing

Plate A-8


TRANSVERSE
0.005
0
0.005
inches/second
VERTICAL
1 minute
LONGITUDINAL
Location: Roadside
Activity: Auto traffic
Plate A-9


TRANSVERSE
0.005
0
0.005
inches/second
VERTICAL
Horse Truck
1 minute
LONGITUDINAL
Location: Roadside
Activity: Truck Traffic
Plate A-10

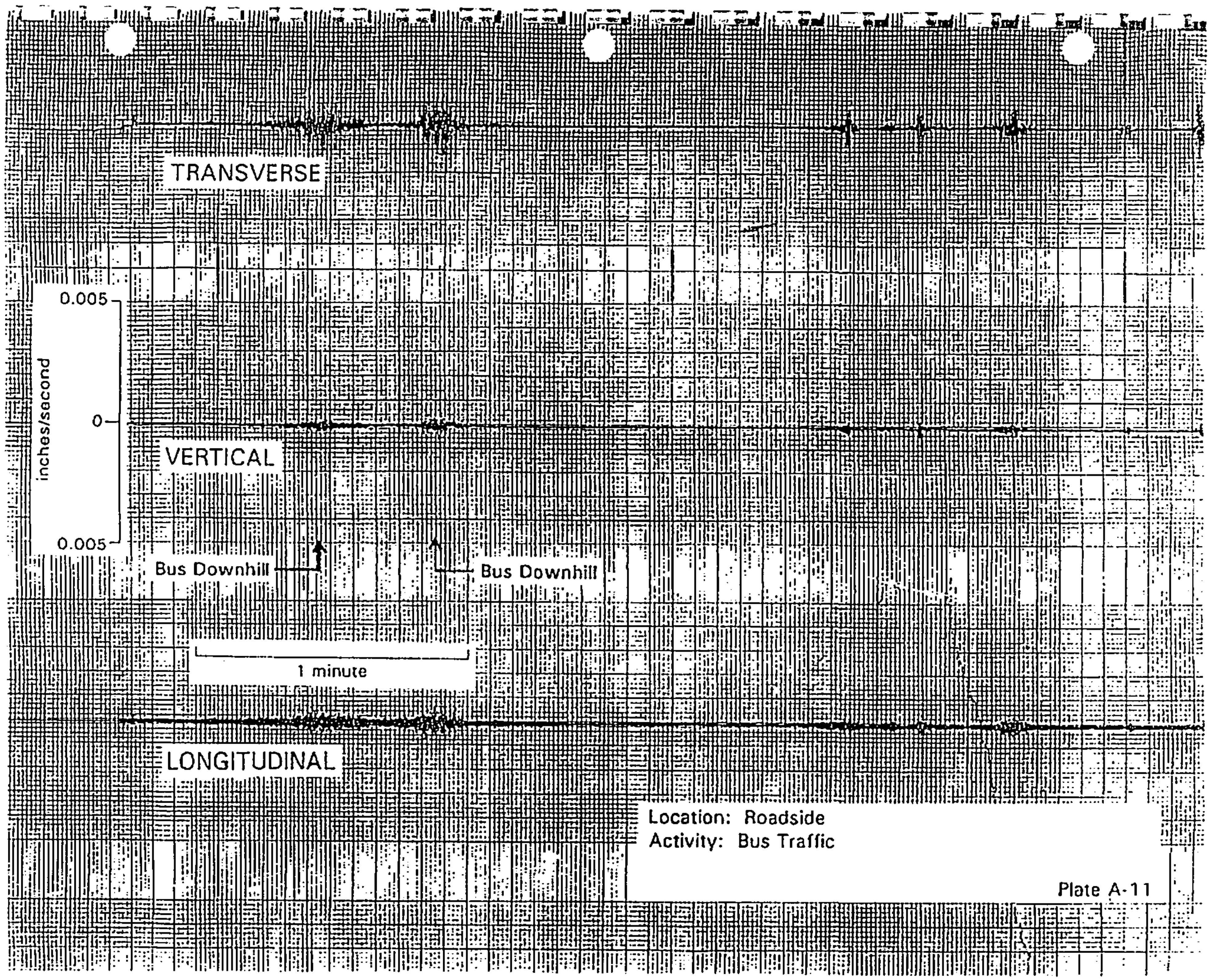

TRANSVERSE
0.005
0
0.005
inches/second
VERTICAL
Bus Downhill
Bus Downhill
1 minute
LONGITUDINAL
Location: Roadside
Activity: Bus Traffic

Plate A-11