

**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
(NASA)**

**FINAL ENVIRONMENTAL ASSESSMENT**

***TEMPORARY OPTICAL TEST SITES***

**for the**

***W. M. KECK OBSERVATORY***

***TWIN KECK TELESCOPE INTERFEROMETER***

**Mauna Kea, Hawaii**

**September 1998**

**NASA CONTRACT NO. NASA-1260**

**NASA TASK ORDER NO. RF-306**

**FINAL ENVIRONMENTAL ASSESSMENT**

**PROJECT:** Temporary Optical Test Sites for the W. M. Keck Observatory

**LOCATION:** Mauna Kea Science Reserve  
Island of Hawaii  
State of Hawaii  
Tax Map Key 4-4-15:09

**RESPONSIBLE  
FEDERAL**

**AGENCY:** National Aeronautics and Space Administration  
(NASA)

**ACTION:** Finding of No Significant Impact

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## ACRONYMS AND ABBREVIATIONS

CARA	California Association for Research in Astronomy	MKSS	Mauna Kea Support Services
CEQ	Council on Environmental Quality	mph	miles per hour
CFR	Code of Federal Regulations	NASA	National Aeronautics and Space Administration
CZM	Coastal Zone Management	NEPA	National Environmental Policy Act
DLNR	Department of Land and Natural Resources (State of Hawaii)	NHL	National Historic Landmark
DOH	Department of Health (State of Hawaii)	NPDES	National Pollution Discharge Elimination System
EA	Environmental Assessment	NRHP	National Register of Historic Places
EIS	Environmental Impact Statement	OEQC	Office of Environmental Quality Control (State of Hawaii)
EPA	U.S. Environmental Protection Agency	SHPO	State Historic Preservation Officer
FEIS	Final Environmental Impact Statement	SRCDP	Mauna Kea Science Reserve Complex Development Plan
FONSI	Finding of No Significant Impact	UBC	Uniform Building Code
HRS	Hawaii Revised Statutes	UH	University of Hawaii
IRTF	NASA Infrared Telescope Facility	UH IfA	UH Institute for Astronomy
JPL	Jet Propulsion Laboratory	U.S.C.	U.S. Code
		USFWS	United States Fish and Wildlife Service
		WMKO	W. M. Keck Observatory

## 1.0 SUMMARY AND CONCLUSIONS

The California Association for Research in Astronomy (CARA)--in association with the National Aeronautics and Space Administration (NASA)--proposes to install two temporary optical test sites at the W. M. Keck Observatory (WMKO), Mauna Kea, Hawaii. The proposed sites will be used during the testing phase of the Keck Interferometer Project. They will be used to collect the starlight needed to integrate and test the instrumentation that will combine the light from the Keck I and Keck II 10-meter telescopes. Use of the temporary sites will allow most of the test and development work to be done efficiently without disturbing the important on-going research activities on the Keck telescopes. When the instrumentation is fully operational, the optical beams from the Keck telescopes will be used to do the final testing.

Each of the proposed sites will include a siderostat and an enclosure for weather protection--either a traditional dome or a shelter with a roll-off roof. Underground optical paths will connect the test sites to the instrumentation housed in the basement of the Keck II telescope building. All above-ground test facilities will be removed at the completion of the development testing--about three years and nine months after the start of site work--and the site will be restored to its original use as a parking area.

Alternatives considered in this environmental assessment (EA) were the proposed action, no action and using the two 10-meter Keck telescopes to align the interferometer optics. The no-action alternative would mean that the W. M. Keck Observatory would have no interferometer and that the scientific objectives would not be accomplished.

The option of using the Keck I and Keck II 10-meter telescopes--the world's largest--for aligning the optics is considered impractical because it would preclude astronomical observing for long periods of time. These telescopes are in high demand with astronomers from all over the world scheduled for months to years in advance to use them. This alternative would be too disruptive and too costly from a scientific point of view.

The environmental analysis indicates that the proposed action will have no significant impacts on the physical and human environment of the area. There will be no significant impact on vegetation, arthropod fauna habitat, surface and ground water resources and air quality if appropriate measures are taken to control dust and trash during the construction period.

No cultural remains were identified in the project area during a 1982 reconnaissance survey of the Mauna Kea Science Reserve or during the construction of the Keck I and Keck II telescopes. In addition, an ethnographic study of the summit area did not attribute any particular significance to the Observatory location. In his letter responding to a request for Historic Preservation Review (Chapter 6E, HRS and Section 106, National Historic Preservation Act), the State Historic Preservation Officer (SHPO) concurred that the proposed test sites will have "no effect" on significant historic sites.

Based on the evaluation presented in the EA, it appears that none of the potential environmental impacts associated with the proposed action will individually or cumulatively have a significant impact on the quality of the environment of the island of Hawaii and the Mauna Kea Science Reserve. A Finding of No Significant Impact (FONSI) is recommended.

## **2.0 PURPOSE AND NEED**

### **2.1 *PROJECT BACKGROUND***

The W. M. Keck Observatory (WMKO) on the summit of Mauna Kea, Hawaii, is the site of the two most powerful telescopes in the world--Keck I and Keck II. The next step in the development of WMKO is to combine the light from the two 10-meter telescopes so that they can operate as an interferometer. In order to facilitate the development of this interferometry capability, the California Association for Research in Astronomy (CARA)--in collaboration with the National Aeronautics and Space Administration (NASA)--proposes to install two temporary optical test sites on the WMKO site for use during the testing phase of the project. These optical test sites will be used to collect the starlight needed for integrating and testing the relay optics, delay lines, beam combiners and image sensors that will link together the Observatory's two 10-meter telescopes. When the instrumentation is fully operational, the optical beams from the Keck telescopes will be used to do the final testing.

The proposed test sites will be located on the WMKO subleased parcel within the Mauna Kea Science Reserve on the Island of Hawaii, the southernmost island of the State of Hawaii (Figure 1). They will be sited in the existing Observatory parking area, adjacent to Keck II. They will have underground optical paths connecting them to the instrumentation housed in the basement of the Keck II telescope building (Figure 2). It is proposed that each of the two test sites include a siderostat and an enclosure for weather protection--either a traditional dome or a shelter with a roll-off roof. Figure 3 shows a perspective view of the optical test sites--with dome enclosure concept--in relation to the existing telescopes on the observatory site.

All external test facilities will be removed at the completion of development testing--about three years and nine months after the start of the site work. The site will then be restored to its present use as a parking area.

The installation and operation of the proposed temporary optical test sites will be funded by NASA, which is responsible for compliance with the National Environmental Policy Act (NEPA) and other federal requirements.

### **2.2 *PURPOSE AND NEED FOR THE PROJECT***

The 10-meter Keck I and Keck II telescopes--the world's largest optical and infrared telescopes--are separately engaged in astronomical research addressing many of the fundamental questions about how our universe formed and evolved. The proposed temporary optical test sites will allow most of the development, testing and calibration activities of the interferometer to be done efficiently without disturbing the important on-going research activities on each of the two existing Keck telescopes.

### **2.3 *PURPOSE OF THE INTERFEROMETER***

NASA has recently established the "Origins Program" within its Office of Space Science. The goals of this program are to search for and detect planetary systems around other stars and to make a concerted scientific inquiry into the origins of planetary systems, stars and stellar systems, galaxies and galaxy clusters. The interferometry project is a significant aspect of NASA's Origins program, which seeks to capture direct images of Earth-like planets - if they exist - around neighboring stars.

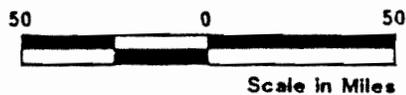
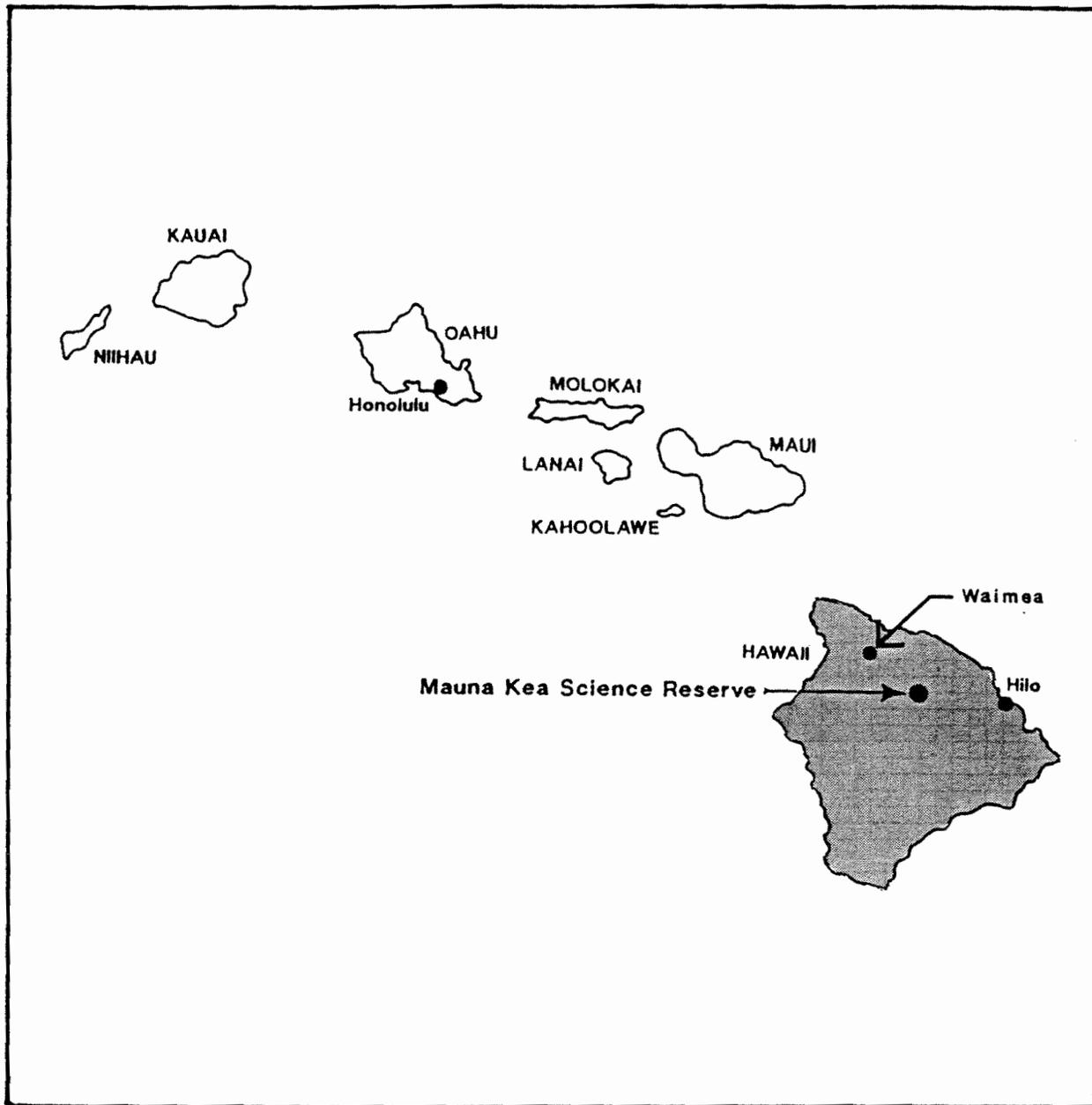
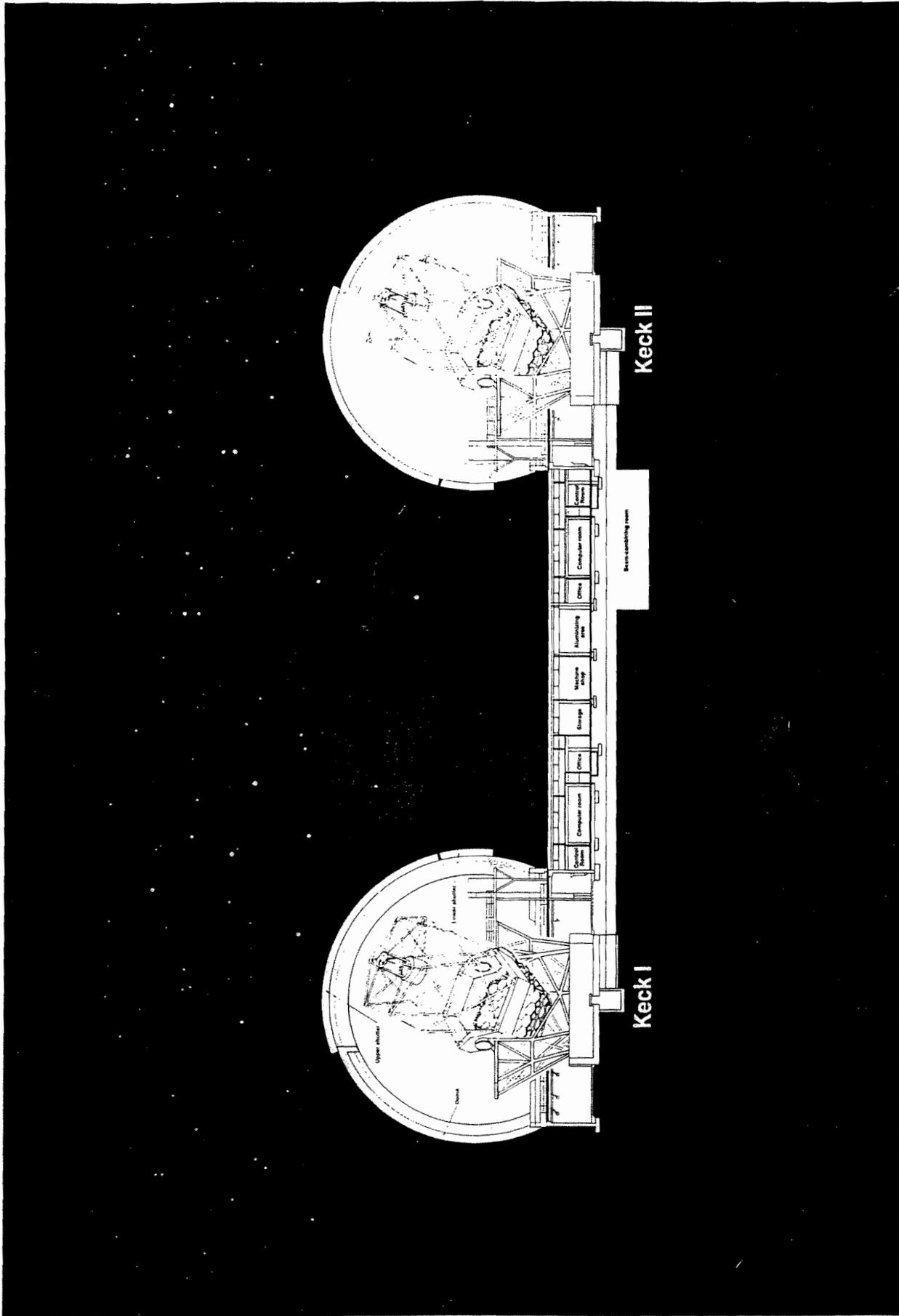


Figure 1  
STATE OF HAWAII





Source: W. M. Keck Observatory

Figure 2  
CUTAWAY VIEW OF THE W. M. KECK OBSERVATORY



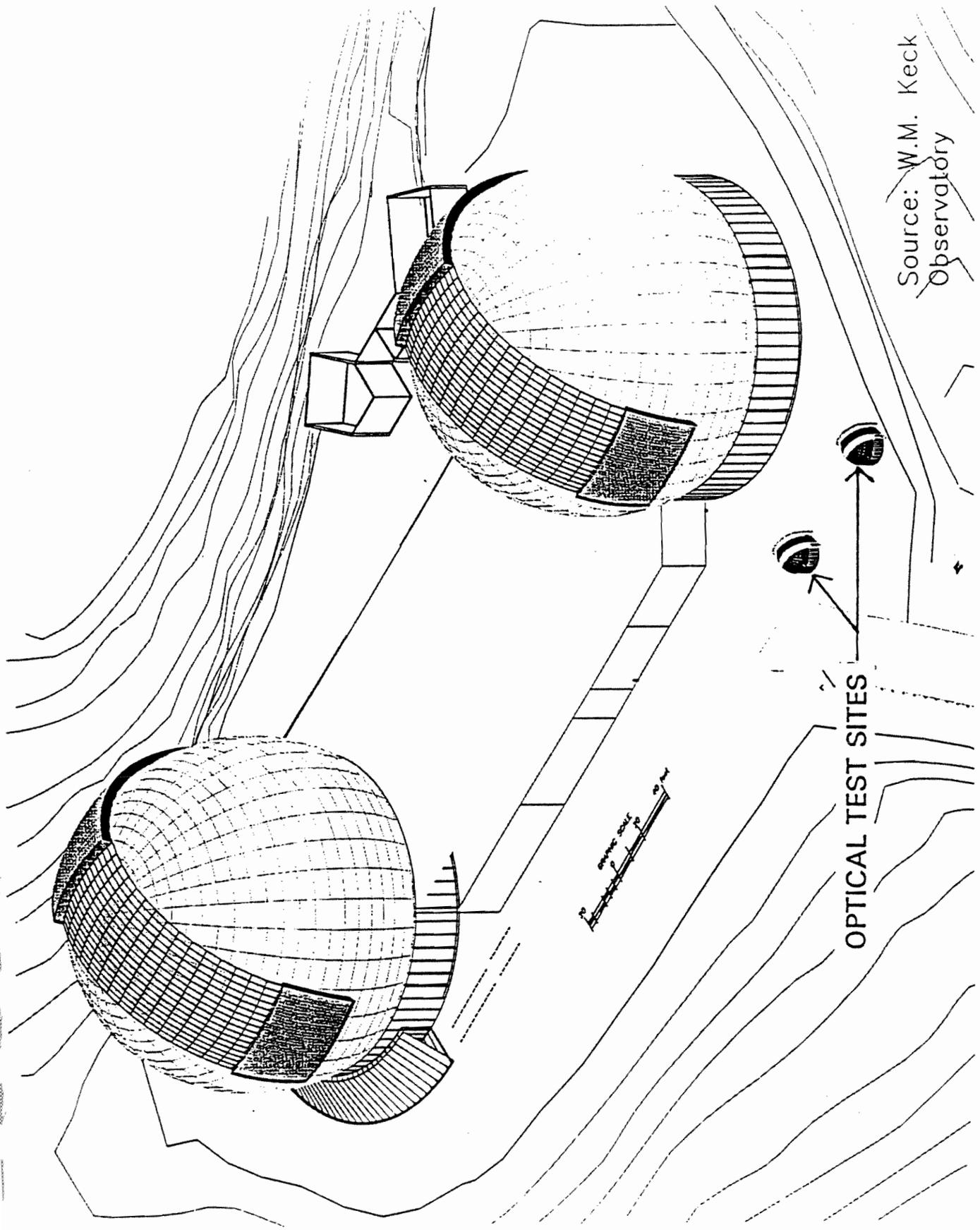


Figure 3  
PERSPECTIVE VIEW: W.M. KECK OBSERVATORY - OPTICAL TEST SITES

By utilizing the two largest ground-based apertures available for interferometry, the Keck Interferometer will provide unprecedented sensitivity for high resolution imaging and astrometry. The twin Keck telescope interferometer will have a spatial resolution ranging from 5 milliarcseconds at  $2\mu\text{m}$  wavelength to 25 milliarcsec at  $10\mu\text{m}$ , and will have the sensitivity to reach  $K = 21.8$  and  $N = 11.6$  magnitudes in 500 seconds of integration. Spatial resolution of 5 milliarcseconds corresponds to the size of a dime if viewed from about 500 miles away; the sensitivity figures are equivalent to detecting a candle at a distance of 10 million miles. A wide variety of new scientific goals will be achievable with this resolution and sensitivity.

The Keck Interferometer Project will be managed by NASA's Jet Propulsion Laboratory (JPL) and carried out as a collaborative effort of NASA and CARA.

#### **2.4 SCOPE OF THE ENVIRONMENTAL ASSESSMENT**

This EA addresses the environmental issues associated with the construction and installation of two temporary optical test sites at WMKO for the purpose of aligning the interferometer which will be installed within the basement of the existing observatory building. This EA was prepared in accordance with the 1969 NEPA, as amended (42 U.S.C. 4321 et seq.), the Council of Environmental Quality (CEQ) Regulations for implementing the Procedural Provisions of NEPA (40 CFR Parts 1500-1508), NASA's NEPA regulations (14 CFR Part 1216.1 and Subpart 1216.3) and NASA's implementing procedures (NASA Handbook 8800.11).

#### **2.5 STATE OF HAWAII ENVIRONMENTAL COMPLIANCE**

The proposed project will be located within an area which was assessed in the Final Environmental Impact Statement for the Mauna Kea Science Reserve Complex Development Plan (SRCDP FEIS, RCUH 1983a). A Project Description/Environmental Review (PD/ER) of the proposed project was prepared by the University of Hawaii, Institute for Astronomy (UH IfA). The PD/ER evaluated the construction and operating characteristics of the proposed temporary test sites in order to determine if the implementation of this project would modify the impacts disclosed in the SRCDP FEIS. The document was prepared to comply with Chapter 343, Hawaii Revised Statutes and with Sections 11-200-26 and 11-200-27 of Chapter 200 of Title 11, Administrative Rules, entitled "Environmental Impact Statement Rules."

After careful comparison of the potential impacts of the project with those disclosed in previous statements, UH IfA concluded that the environmental effects of the proposed temporary optical test sites would not differ significantly from those addressed in previous documents and does not expect new and/or different environmental impacts from those previously assessed for the Keck telescopes. UH IfA requested a determination from the State Office of Environmental Control (OEQC) that all pertinent environmental concerns were addressed in previous environmental impact statements and no further documentation was required for the project. A copy of the letter from OEQC concurring with this determination is incorporated into this assessment as Appendix A.

### **3.0 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES**

#### **3.1 W. M. KECK OBSERVATORY (WMKO), MAUNA KEA, HAWAII**

The Keck I and Keck II telescopes are operated by CARA at the WMKO on Mauna Kea, Hawaii. Each telescope stands eight stories tall and weighs 300 tons. The primary mirror of each Keck Telescope is ten meters in diameter and is composed of 36 hexagonal segments that work in concert as a single piece of reflective glass. When the light paths from the twin Keck telescopes are linked through optical interferometry, astronomers will have the resolving power of a telescope with a mirror 85 meters in diameter. Their location and extraordinary mirror collecting areas will make the two Keck telescopes uniquely qualified to detect planets around other stars and to make other high-resolution measurements of the universe.

The WMKO is funded by grants from the W. M. Keck Foundation. It is operated by the CARA--a consortium consisting of the California Institute of Technology and the University of California--and NASA, which became a partner in 1996. The Observatory base support facilities are located in Waimea, Hawaii, about a 1 1/2-hour drive from the Mauna Kea summit area.

#### **3.2 PROJECT LOCATION**

The WMKO is located within the Mauna Kea Science Reserve at the summit of Mauna Kea, a 13,796-foot-high shield volcano located on the Island of Hawaii (Figure 1). The Mauna Kea Science Reserve (Figure 4) encompasses an area of about 11,270 acres of State of Hawaii Conservation District land that is leased to the University of Hawaii (UH) and managed by UH IfA. It is regarded as one of the best sites in the world for optical/infrared telescopes. The capabilities of the twin Keck telescopes make full use of the site's excellent qualities for astronomical observation such as its high altitude, atmospheric dryness and minimal seasonal variation. Mauna Kea's attributes also include relatively light-pollution free skies which are the result of a County of Hawaii outdoor lighting ordinance which specifies the types of outdoor lighting that are permissible throughout the Island of Hawaii (Hawaii County Code, 1983, Chapter 14).

Currently, 12 telescopes are either in operation or under construction in the summit area. The Mauna Kea Observatories include 8 major optical/infrared telescopes, one 0.6-meter telescope; two single-dish millimeter/submillimeter-wavelength telescopes; and a submillimeter array. The Very Long Baseline Array Antenna Facility is located outside of the summit area at the 12,200-foot elevation of the Reserve. Table 1.0 lists the Mauna Kea Observatory telescopes and Figure 5 shows their location in the Mauna Kea Science Reserve.

#### **3.3 PROPOSED PROJECT**

##### **Project Site**

The proposed temporary optical test sites will be situated between the 13,588-foot and 13,603-foot elevations of the Pu`u Hau Oki cinder cone, within the boundaries of the  $\pm 5$ -acre parcel subleased for the WMKO (Figure 6). The Observatory site is located to the northwest of the Mauna Kea summit ridge, between the NASA Infrared Telescope Facility (IRTF) to the east and the Japanese Subaru Telescope to the west (Figure 7). The proposed project area is relatively flat and currently used for parking and vehicle turn-around. A new carport for observatory vehicles is currently under construction near the Keck I facility.

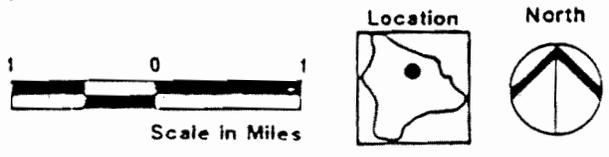
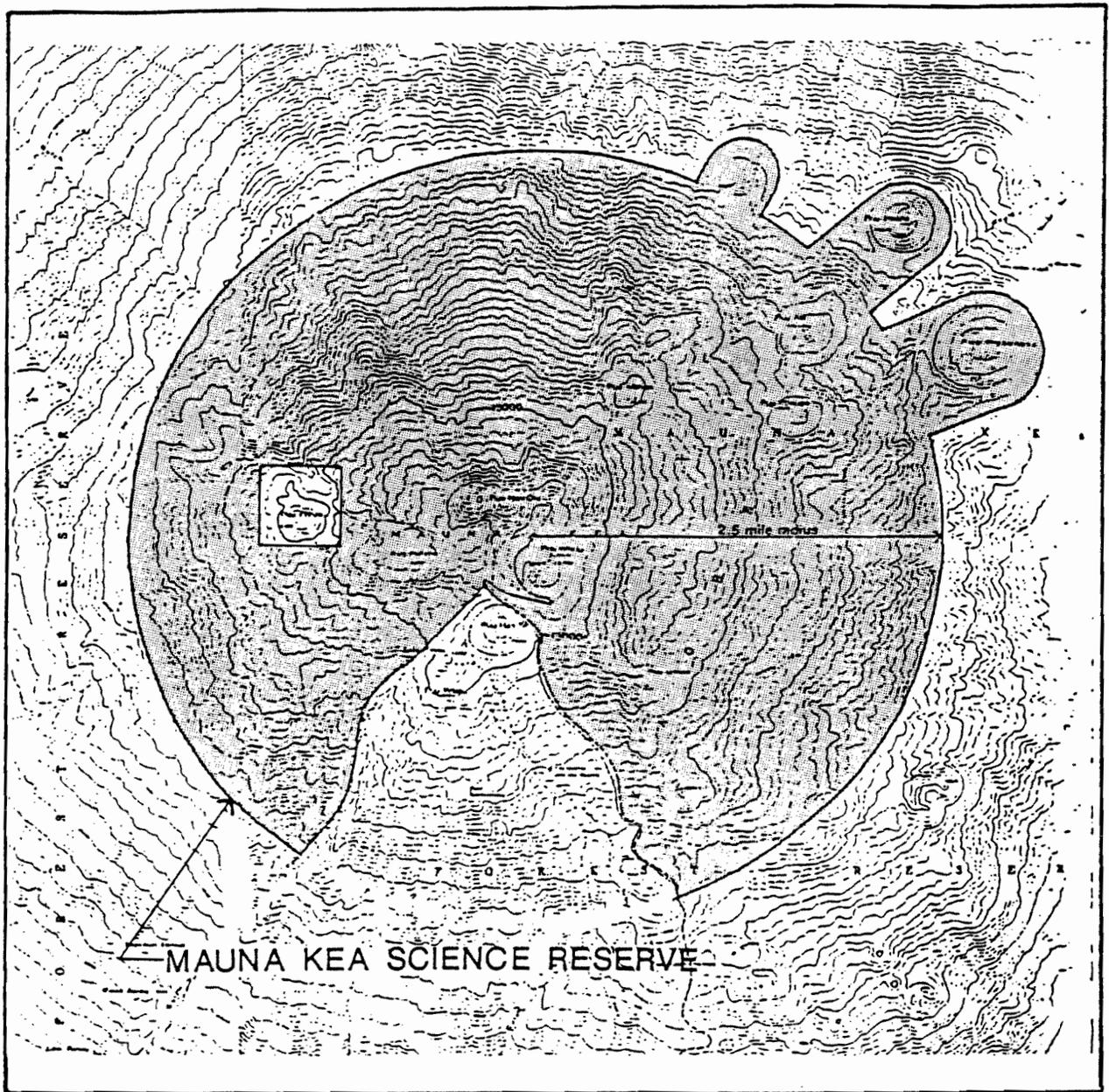


Figure 4  
 MAUNA KEA SCIENCE RESERVE

**Table 1.0 THE MAUNA KEA OBSERVATORIES**

Telescope	Size	Primary Use	Sponsors	Operational
<b>Optical and Infrared Telescopes</b>				
UH 0.6-m Telescope	0.6 m	Optical	UH	1968
UH 2.2-m Telescope	2.2 m	Optical/Infrared	UH/NASA	1970
NASA Infrared Telescope Facility (IRTF)	3.0 m	Infrared	NASA	1979
Canada-France-Hawaii Telescope (CFHT)	3.6 m	Optical/Infrared	Canada/France/UH	1979
United Kingdom Infrared Telescope (UKIRT)	3.8 m	Infrared	United Kingdom	1979
W. M. Keck Observatory (Keck I)	10 m	Optical/Infrared	Caltech/ Univ. of California	1992
W. M. Keck Observatory (Keck II)	10 m	Optical/Infrared	Caltech/ Univ. of California	1996
Subaru (Japan National Large Telescope)*	8 m	Optical/Infrared	Japan	1999
Gemini Northern 8-m Telescope	8 m	Optical/Infrared	USA/United Kingdom/ Canada/Argentina/Australia/ Brazil/Chile	1999
<b>Millimeter/Submillimeter Telescopes</b>				
Caltech Submillimeter Observatory (CSO)	10.4 m	Millimeter/ Submillimeter	Caltech/NSF	1987
James Clark Maxwell Telescope (JCMT)	15 m	Millimeter/ Submillimeter	United Kingdom/ Canada/Netherlands	1987
Submillimeter Array*	Eight 6-m antennae	Submillimeter	Smithsonian Astrophysical Observatory/Taiwan	1999
<b>Other Facilities</b>				
Very Long Baseline Array	25 m	Centimeter Wavelength	NRAO/AUI/NSF	1992

\*Under construction

Source: University of Hawaii, Institute for Astronomy

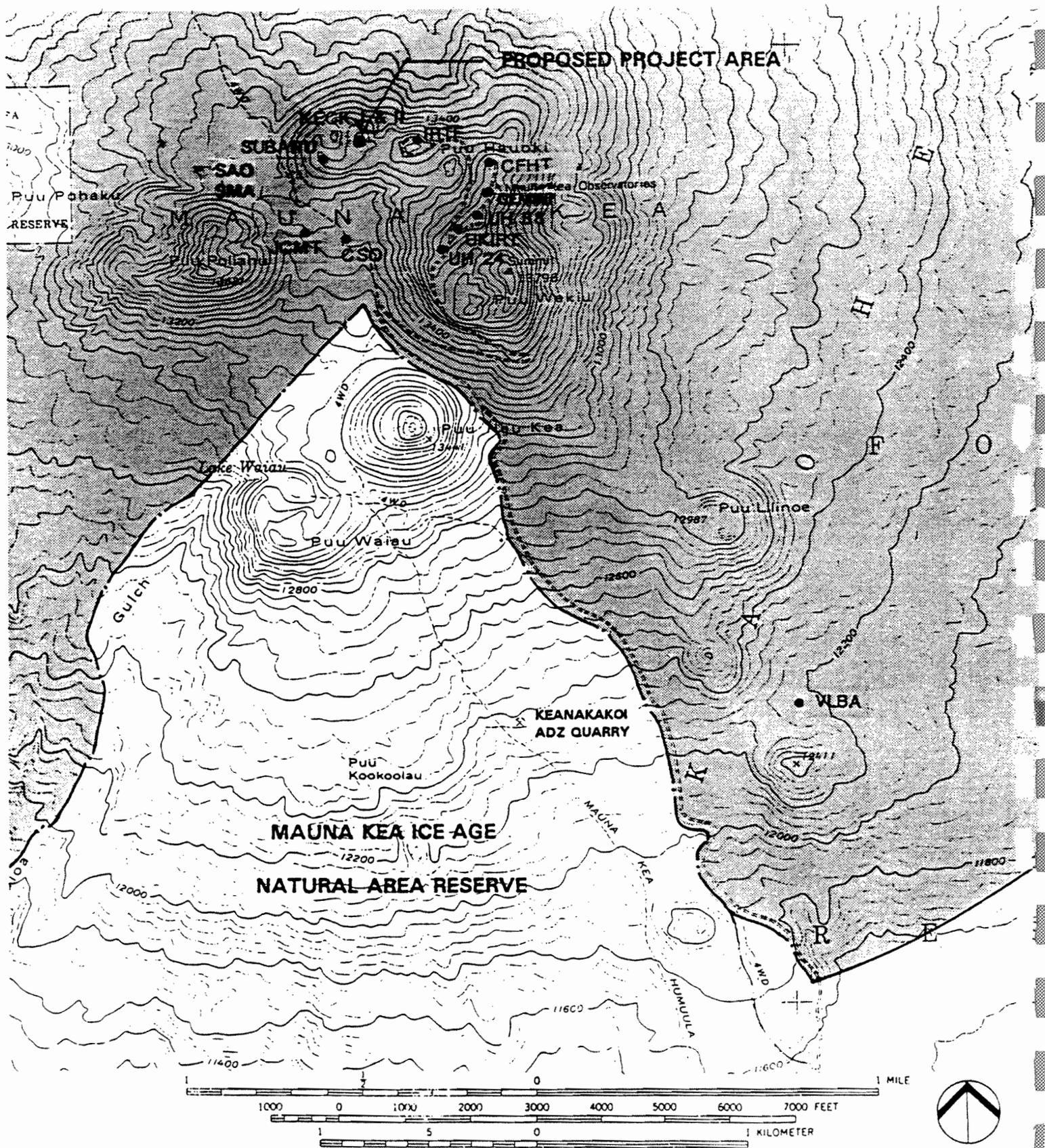


Figure 5  
**THE MAUNA KEA OBSERVATORIES**

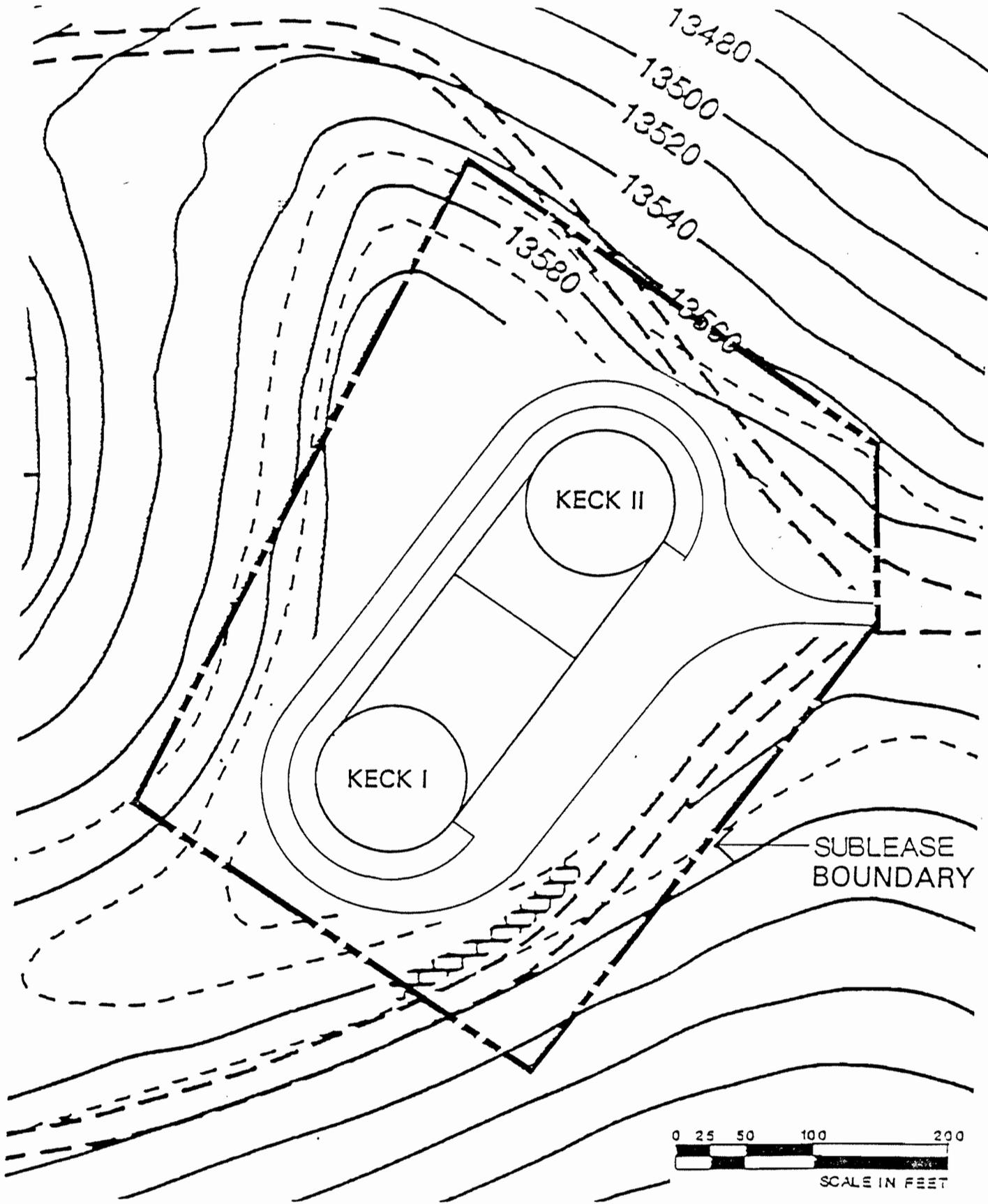


Figure 6  
SUBLEASED AREA



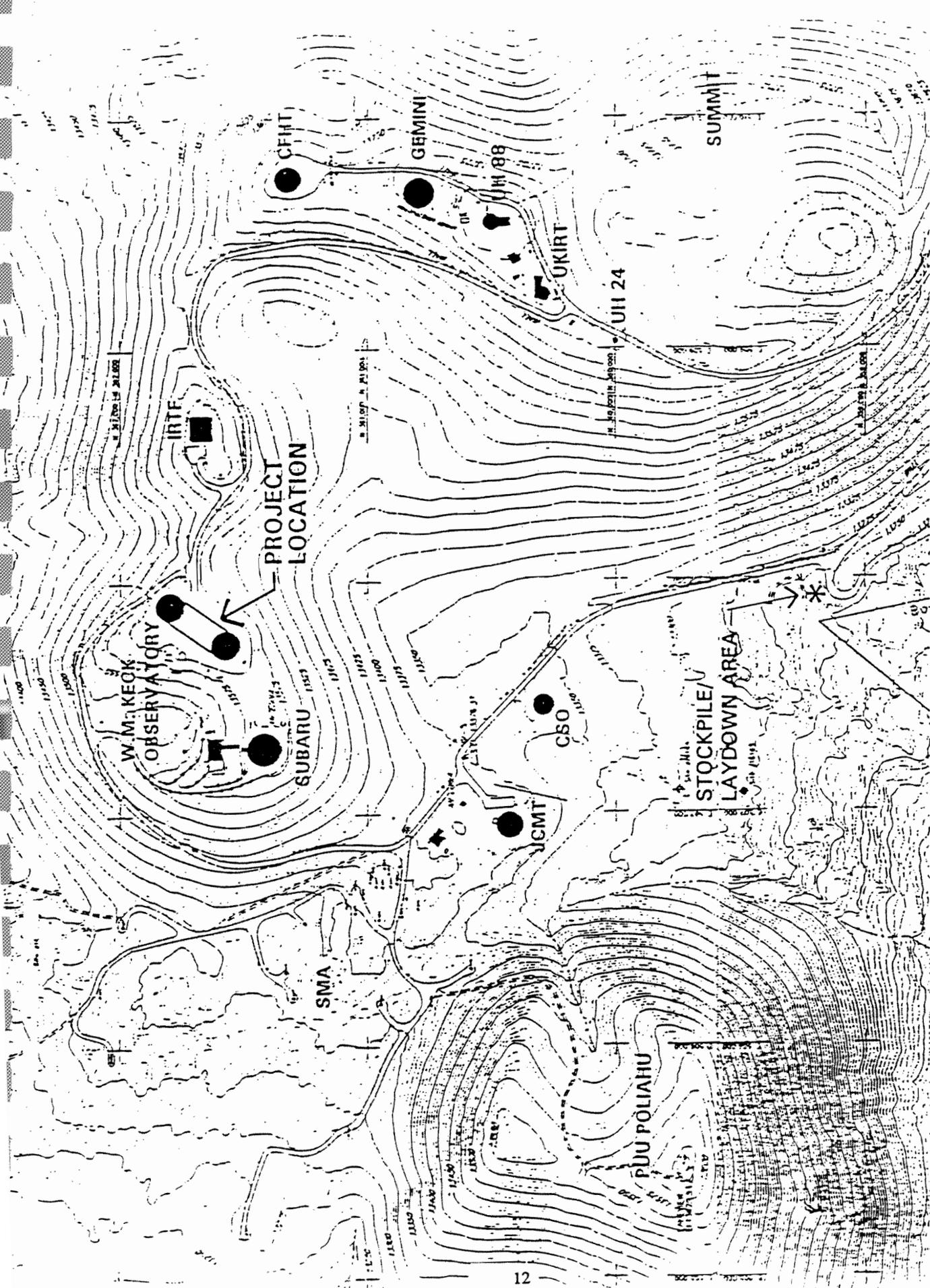


Figure 7  
**LOCATION OF THE PROPOSED PROJECT**



The proposed test sites will be installed on the southeast side of the Keck II dome because there is already a provision on this side of the basement for bringing in a tunnel. Light from the test sites will be transmitted into the beam combining room in the basement area of the telescope building (Figure 2) through the junction boxes and then through an underground pipe and tunnel. Figure 8 is a plan view of the project area showing the location of the proposed facilities.

The proposed project location--on the edge of the Keck parcel--will permit the fullest possible sky coverage and will minimize turbulence produced by the existing domes. The proposed location also avoids the existing entry road to the site and the underground cables between the two pull boxes on the edge of the site (Figure 9).

### **Siderostats and Enclosures**

The basic concept for getting starlight into the interferometer will be to use siderostat mirrors. Each siderostat will consist of a 20-inch-diameter gimbal-mounted flat mirror--to track a star--and a 16-inch-diameter beam reducer. The output from the beam reducer will be a 4-inch-diameter collimated beam which is folded down by a small flat mirror. Another small flat mirror, located in a junction box below the siderostat, will then be used to fold the beam down a tunnel toward the interferometer.

Each siderostat will have a shelter to protect it from the harsh conditions on Mauna Kea. Two types of shelter are being considered: (1) a traditional dome and (2) a rectangular enclosure with a roll-off roof. The dome enclosure will be approximately 13 feet in diameter and height; the roll-off roof enclosure will essentially be a 15-foot-wide by 10.25-foot-high rectangular box with peaked roof. The roof rolls back along two low walls that extend 17.5 feet behind the enclosure. Figures 10 and 11 are conceptual views of the dome and roll-off roof enclosures, respectively.

The space inside the enclosures will accommodate a 3-foot footprint for the gimbal mirror, a 1.5-foot separation between the gimbal and the beam reducer, 3 feet for the  $f/3$  beam reducer, 10 inches for the fold mirror, and 3 feet for personnel access. The enclosures will be mounted on concrete pedestals standing no higher than 15 inches above the ground.

An 8-foot-wide by 9.3-foot-deep (interior dimensions) "Junction Box" (basement) is located below each siderostat. Preliminary plans indicate that the junction box will have 1-foot-thick concrete walls and a 0.5-foot-thick concrete floor supported by 1-foot by 2-foot concrete footings. The final wall and floor thicknesses will be determined during final design. Figures 12 and 13 show cut-a-way side views of a typical siderostat with domed and roll-off roof enclosures, respectively.

### **Underground Tunnel and Pipe**

The interferometer instrumentation will be located in the existing basement of the building joining the two Keck telescopes (Figure 2). An existing passageway from the Keck basement to the southeast side of the building will be extended by excavating a 10-foot-wide by 9-foot-high (interior dimensions) tunnel a distance of approximately 41 feet from the main building to the western terminus of the pipe. The tunnel floor will be level with the floor of the Keck basement--about 11.25 feet below grade. Figure 9 shows the location and dimensions of the tunnel in relation to the proposed test sites and existing utilities.

A 42-inch-diameter pipe will connect the junction box under each siderostat to the tunnel. Light from the siderostats is proposed to be beamed through the pipe to the tunnel and from there to the instrumentation in the Keck building. The proposed pipe is similar to the existing pipes



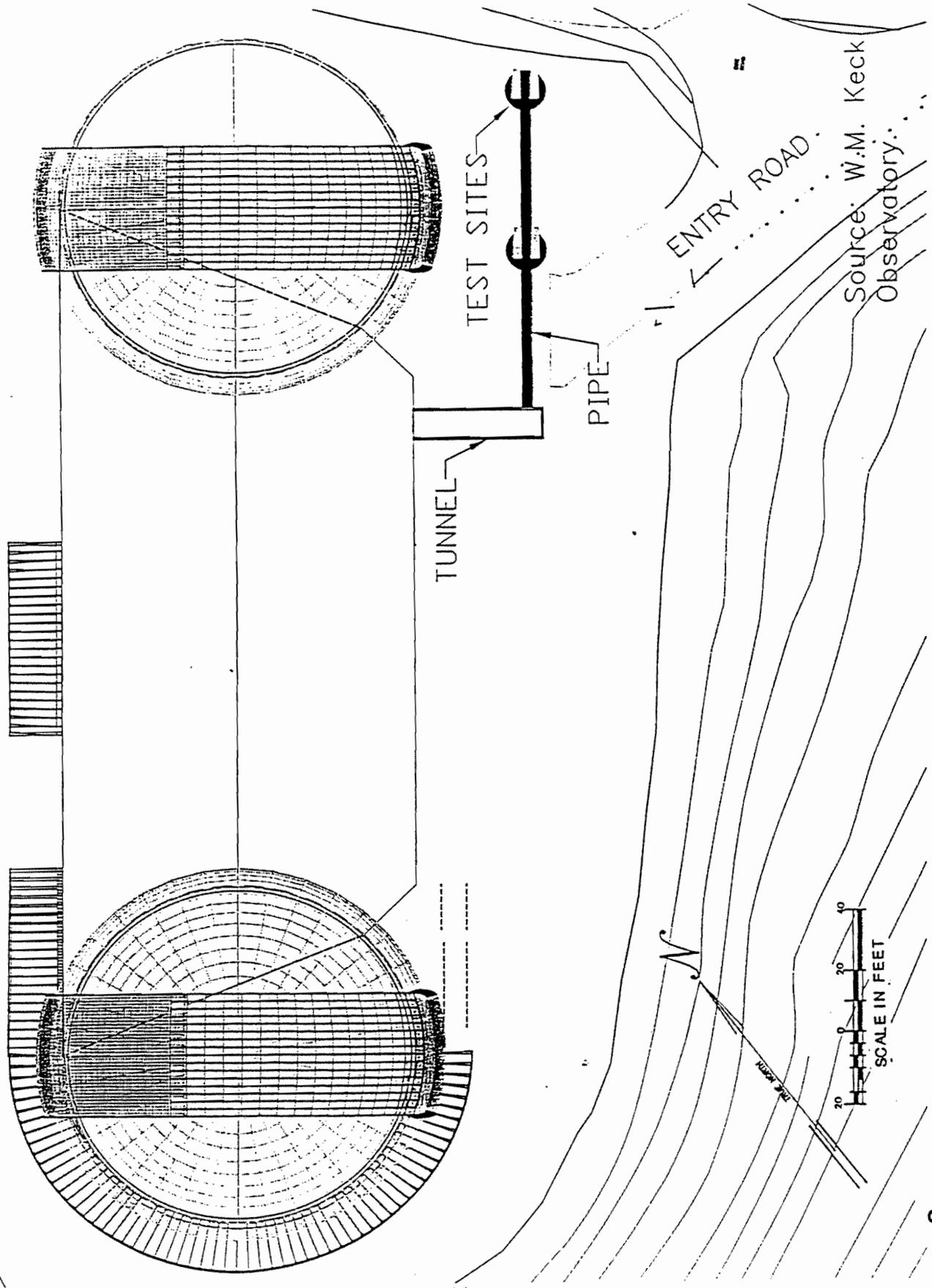


Figure 8  
 PLAN VIEW: TEMPORARY OPTICAL TEST SITES ON OBSERVATORY SITE



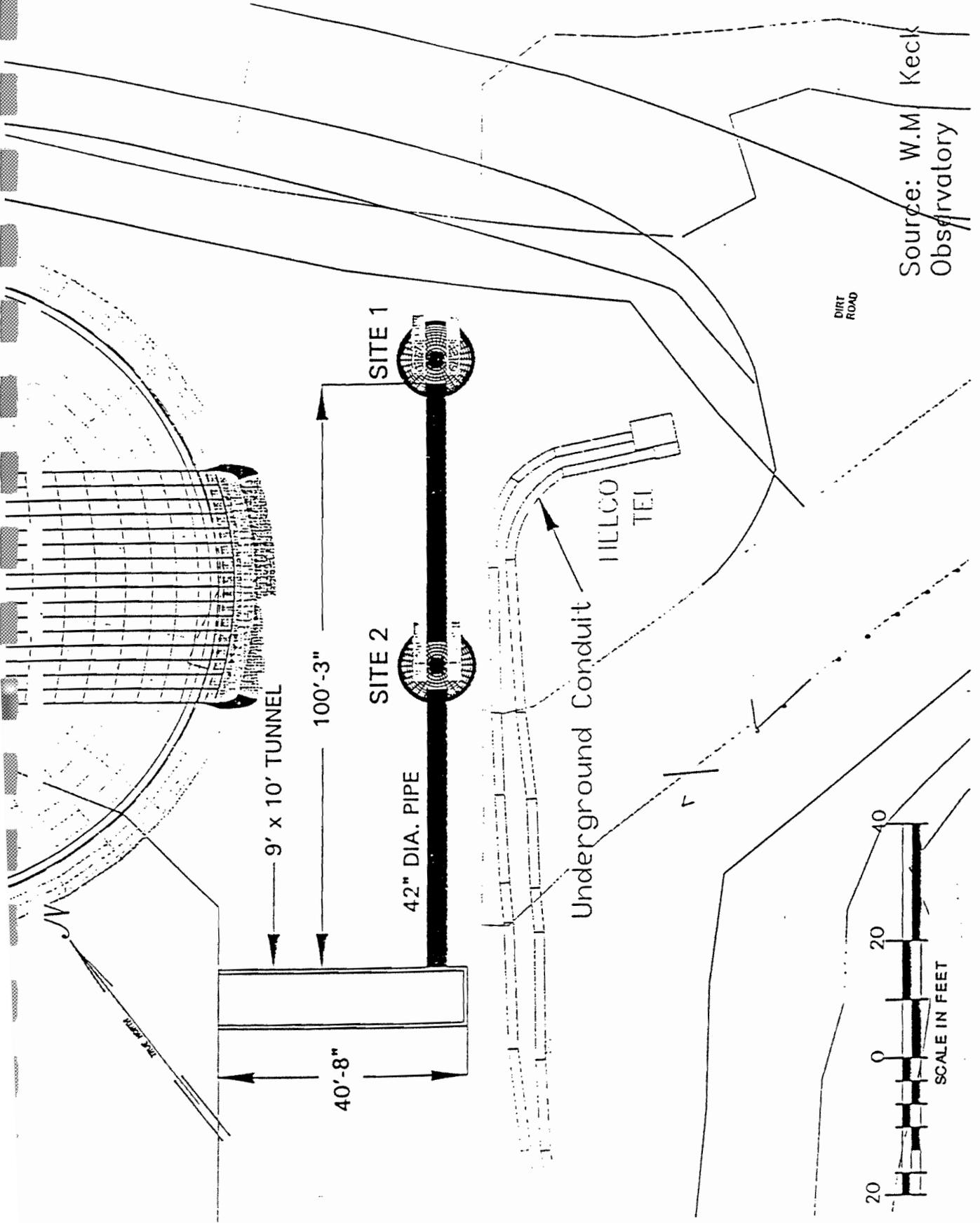
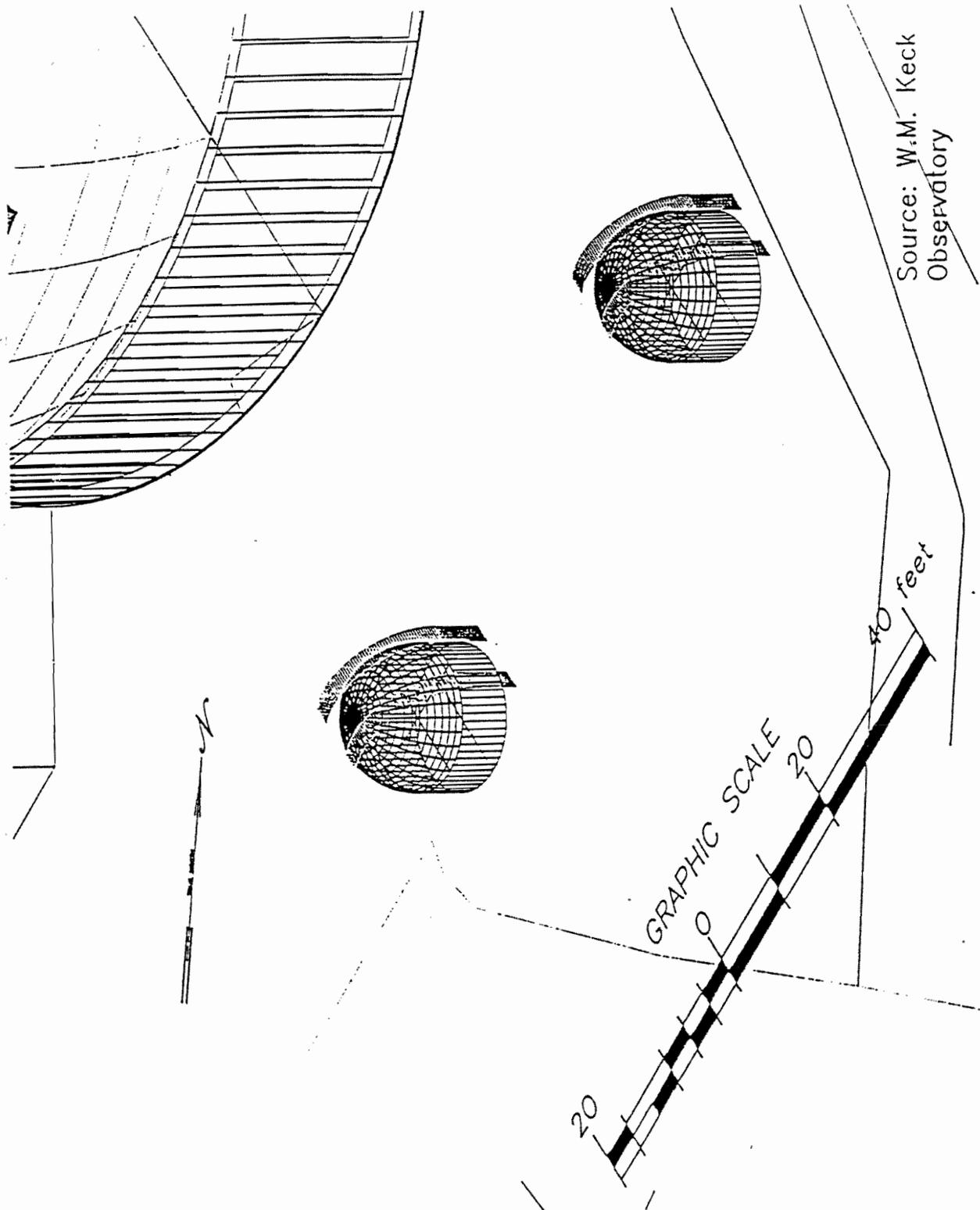


Figure 9  
 LOCATION OF PROPOSED OPTICAL TEST SITES IN RELATION TO EXISTING UTILITIES

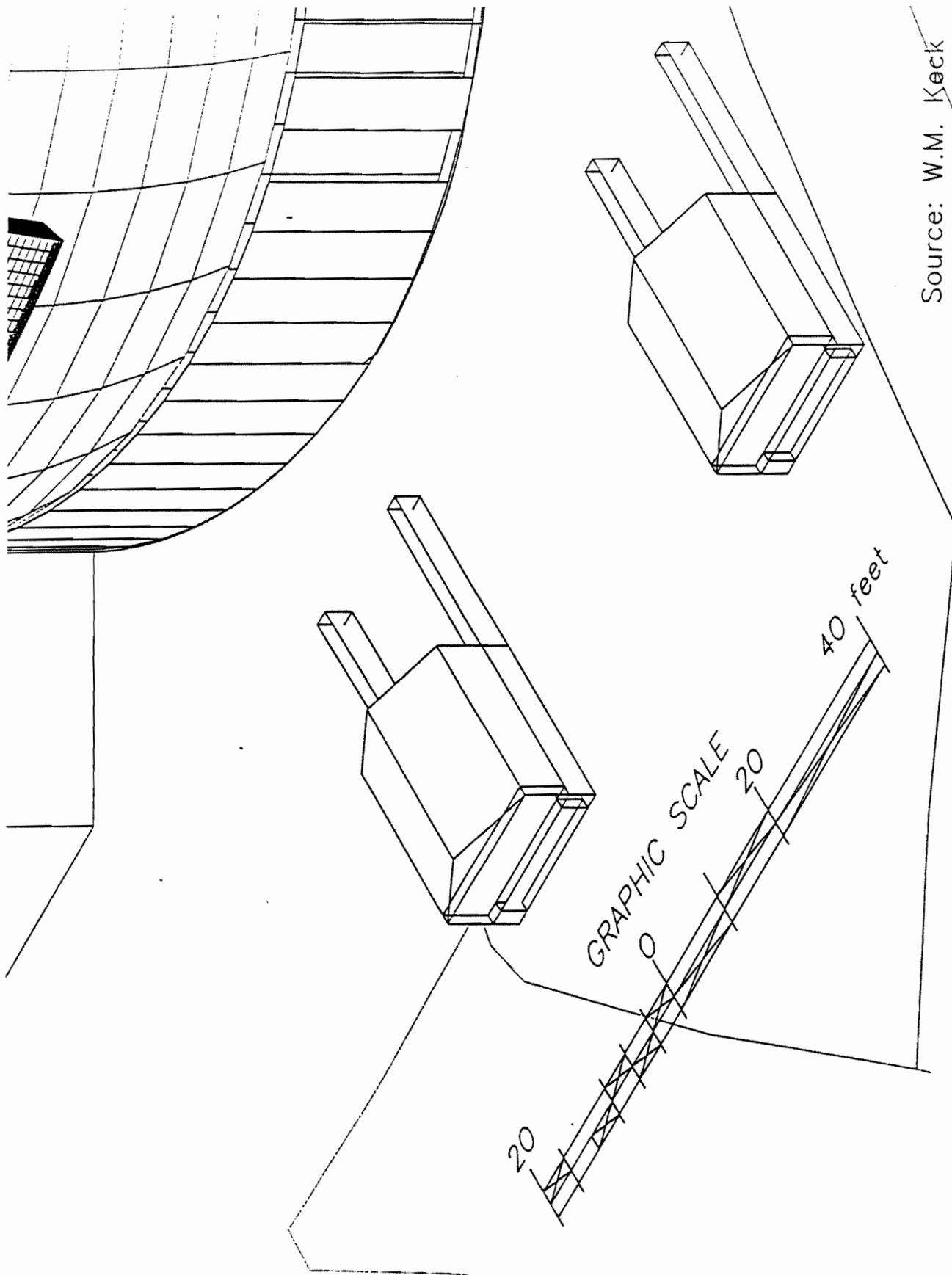




Source: W.M. Keck  
Observatory

Figure 10  
CONCEPTUAL VIEW: OPTICAL TEST SITES WITH DOME ENCLOSURES





Source: W.M. Keck  
Observatory

Figure 11  
CONCEPTUAL VIEW: OPTICAL TEST SITES WITH ROLL-OFF ROOF ENCLOSURES

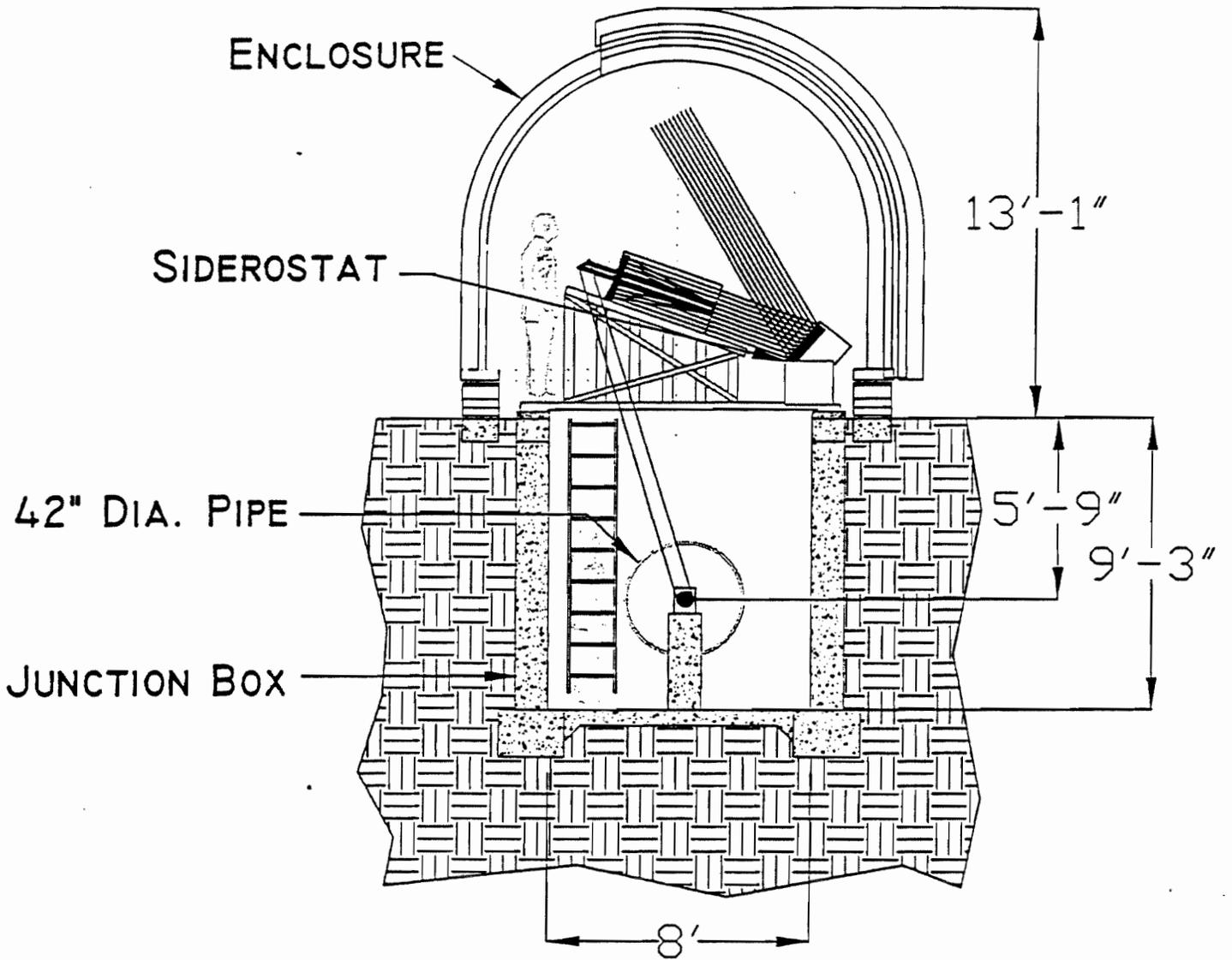


Figure 12  
 CUT-A-WAY SIDE VIEW:  
 OPTICAL TEST SITE WITH DOME ENCLOSURE

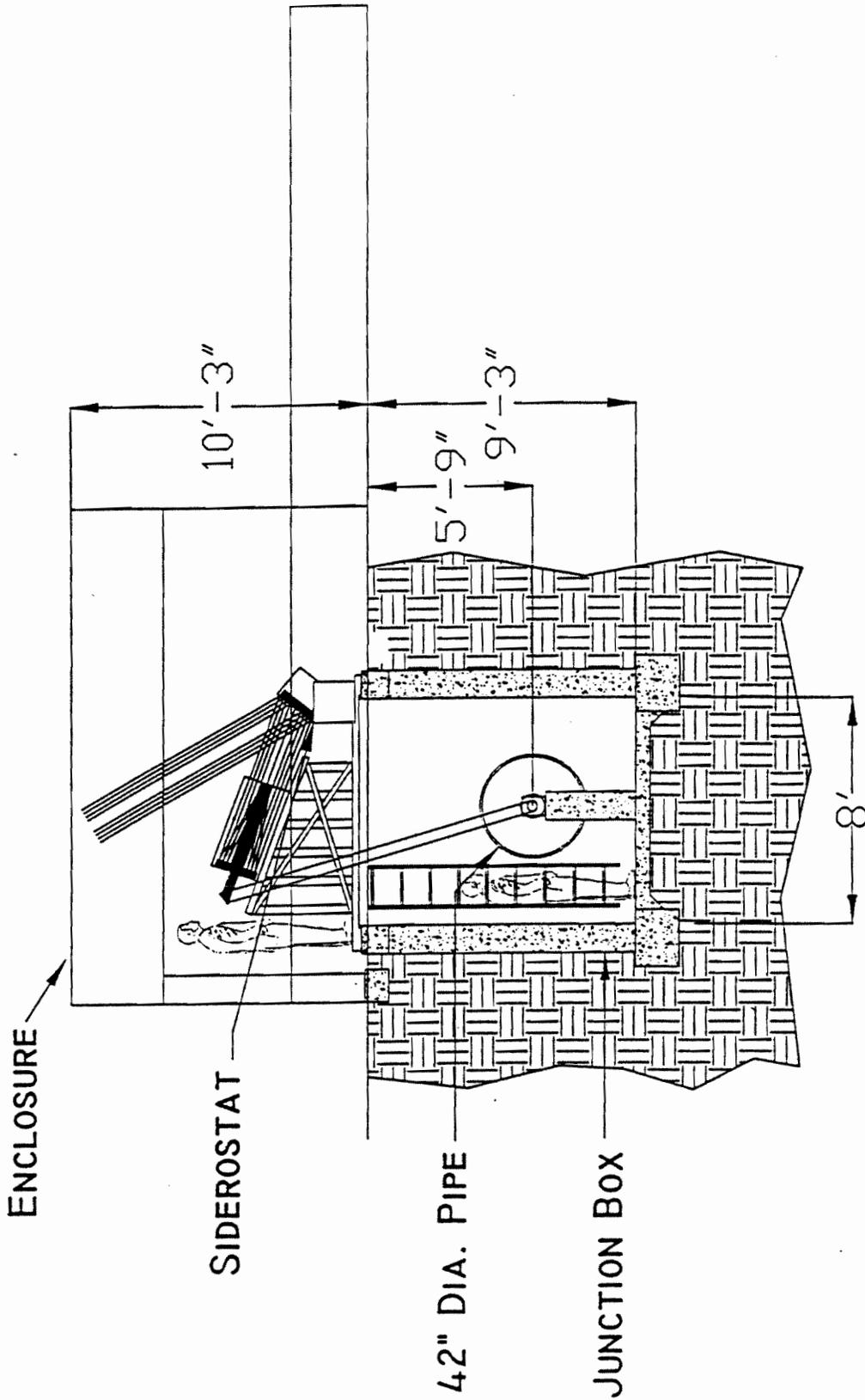


Figure 13  
 CUT-A-WAY SIDE VIEW:  
 OPTICAL TEST SITE WITH ROLL-OFF ROOF ENCLOSURE

Source: W.M. Keck  
 Observatory

that are used to transport the light from the Keck telescopes to the Keck basement. The pipe may be encased in a concrete conduit; this will be determined before the engineering drawings are complete. The pipe will be installed in a 4-foot-wide by 7.5-foot-deep by 100-foot-long (more or less) trench. Figures 12 and 13 show the location of the pipe in relation to the siderostats.

### **Infrastructure and Utilities**

Access will be via the existing observatory driveway. All utilities will be provided from the existing observatory which has all necessary power, communications, and sewage facilities. Any required power, cooling or signal or communications cables will be brought to the siderostat enclosures through the tunnel and pipe. Electric power requirements are estimated to be less than 5 kW and can be provided from the existing electrical service which has 1000 kW capacity.

### **Construction**

*Construction Facilities/Equipment.* A trailer to be used as a temporary office for construction management may be on site throughout the construction period. At various times during construction--not necessarily at the same time--two water trucks, two back-hoes, a loader, two or three dump trucks, a forklift, three or four cement trucks, one or two flat-bed trucks and a crane of approximately 20-ton capacity may be present on site.

*Construction Activities.* The construction and installation of the proposed temporary optical test sites will be performed in two phases over a period of about 18 to 21 months. A description of the construction activities by phase follows.

Phase I. The first phase--which will begin in 1998--will be to: (1) excavate about 1,350 cubic yards of material for the tunnel, junction boxes and light-pipe trench; (2) pour about 85 cubic yards of concrete for foundations, the tunnel and junction boxes; (3) install the light-pipe in the trench; (4) bring the trench and tunnel up to grade by backfilling with about 1,100 cubic yards of excavated material; and (5) compact, level and rake the areas above the tunnel and trench. Concrete will be mixed on site as required. If feasible, some concrete structures will be prefabricated off site. All excavation and concrete work is expected to be completed by the end of 1998.

It is not anticipated that the existing approved off-site stockpile/laydown area (Figure 7) will be used for materials staging during construction of the proposed temporary optical test sites. The area will be used, however, to store about 10 truck loads of excess excavated material--not necessary for back-fill--for future use in Science Reserve road maintenance activities.

Phase II. The second phase will be the installation of the enclosures, before or after the winter season. The siderostats will be fabricated off site and assembled inside the enclosures. Installation of the interferometer instrumentation is expected to be completed in late 1999.

*Construction Costs/Employment.* On site construction activities and equipment costs are estimated to be approximately \$100,000. A maximum of 10 construction workers will be on the site for up to three months at a time. These workers will either commute from communities at lower elevations or use the existing construction camp facilities at Hale Pohaku, if available.

## **Operations**

Testing of the interferometer with the proposed test sites is expected to begin in 1999. At that time, two additional staff will be needed to support the summit activities.

First, the interferometer will be made operational with the two siderostats. A single siderostat will then be used with each Keck telescope individually to perform further debugging and integration until the two Keck telescopes can be reliably combined. This work is scheduled to take approximately two years. At the end of this period the twin Keck telescope interferometer will be completely operational, and the proposed siderostats will no longer be required. Two additional full-time staff will then be required at the observatory during operations.

## **Demolition/Restoration**

All above-ground structures of the proposed temporary optical test sites will be removed at the completion of the development testing--in early 2002 at the latest. These structures include the siderostats, enclosures and concrete pedestals down to ground level. The dismantled equipment and enclosures are planned to be trucked to the Keck facilities in Waimea and then stored or shipped off-island. The top of the junction box at the test site furthest from the tunnel (identified as Site 1 on Figure 9) will be capped--with a manhole cover for access--and covered with cinder up to grade. This will allow it to be used in the future, if necessary. It is not expected that Site 2 (Figure 9) will be used again; therefore, the ends of the light pipe connecting this site with the tunnel on one side and Site 1 on the other side will be joined together and the junction box will be filled with about 22 cubic yards of cinder. The area will then be compacted and leveled and the site restored to its previous use as a parking area. The junction boxes and pipe connections are shown on Figures 12 and 13.

### **3.4 REVIEWS, PERMITS, AND/OR APPROVALS**

Table 2.0 lists applicable reviews, permits and/or approvals required for the proposed project by responsible federal, state or county agency. A copy of the completed Hawaii CZM Program assessment forms and a letter from Mr. Rick Egged concurring with NASA that the activity is consistent with the Hawaii CZM program are attached (Appendix B).

### **3.5 ALTERNATIVES NO LONGER UNDER CONSIDERATION**

Alternatives considered in this environmental assessment were no action and using the two 10-meter Keck telescopes to align the interferometer optics. The no-action alternative would mean that the W. M. Keck Observatory would have no interferometer and that the scientific objectives would not be accomplished.

The option of using the Keck I and Keck II 10-meter telescopes--the world's largest--for aligning the optics is considered impractical because it preclude astronomical observing for long periods of time. These telescopes are in high demand with astronomers from all over the world scheduled for months to years in advance to use them. This alternative would be too disruptive and too costly from a scientific point of view.

Table 2.0 APPLICABLE REVIEWS, PERMITS, AND/OR APPROVALS  
 Temporary Optical Test Sites  
 W.M. Keck Observatory

Agency and Permit or Approval	Legislation or Regulation	Applicability
<b>Federal</b>		
<u>Office of Environmental Policy</u>	National Environmental Policy Act (42 USC 4321 <i>et seq.</i> ) 40 CFR Parts 1500-1508 Guidelines NASA NEPA Regulations 14 CFR Part 1216.1, Subpart 1216.3	Federal funds
<b>State</b>		
<u>Board of Land &amp; Natural Resources</u>		
Site Plan Approval	Chapter 183, HRS DLNR Administrative Rules, Title 13 Chapter 2	Required under Conservation District Permits HA-1646 and HA-2509
State Historic Preservation Office Approval	Section 106, National Historic Preservation Act (16 USC 470) 36 CFR 800 Regulations Chapter 6E, HRS	Protection of historic sites
<u>Business, Economic Development &amp; Tourism</u>		
Office of Planning,	Section 307, National Coastal Zone Management Act (16 USC 1451 <i>et seq.</i> ) Chapter 205A, HRS	Federal determination of consistency with Coastal Zone Management Program
<u>Department of Health</u>		
Office of Environmental Quality Control	Chapter 343, HRS	Review for compliance with 343
Air Pollution Control	Chapter 342B, HRS DOH Administrative Rules, Title 11 Chapters 60 and 60.1	Fugitive dust
Community Noise Control	Chapter 342F, HRS DOH Administrative Rules, Title 11 Chapter 46	Noise from construction or operations
<b>Hawaii County</b>		
Grading, Grubbing and Stockpiling Permit	Hawaii County Code, 1983 Chapter 10, Articles 2 and 3	Earth-moving activities
Building Permit	Hawaii County Code, 1983 Chapter 5	Construction activities

## 4.0 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION

### 4.1 NATURAL HAZARDS

#### Volcanic Hazards

*Setting.* Mauna Kea is in an advanced stage of its volcanic life cycle, a stage characterized by short and stubby flows, larger and more numerous cinder cones and less frequent eruptions. The last eruption on Mauna Kea occurred approximately 3,600 years ago (Porter 1973), however, future eruptions are possible. Volcanic hazards on Hawaii were mapped by Mullineaux et. al. (1987). Nine zones were defined, with Zone 9 being the least hazardous.

*Potential Impacts/Mitigations.* Mullineaux et. al. (1987) classified the summit and upper flanks of Mauna Kea as Zone 7 for lava flow hazards and judged the risk of the volcanic eruptions in the zone to be very low. It is highly unlikely that proposed test sites will be affected in the three years and 9 months that they are present on the site. No mitigation is required.

#### Earthquakes

*Setting.* The geology of Mauna Kea has been mapped in detail (Porter, 1979); no tectonic faults have been observed. The greatest number of earthquakes on the island of Hawaii originate beneath the summit areas and along or near the rift zones of Kilauea and Mauna Loa. Dames & Moore (1966) performed a geological/soils investigation of the summit in order to determine whether observatory operations would be feasible there. They concluded that an observatory could operate successfully with a foundation system designed to minimize the magnitude of ground vibrations transmitted to the telescope.

*Potential Impacts/Mitigations.* The Uniform Building Code (UBC) locates Mauna Kea in Seismic Hazard Zone 3, a zone of moderate to high risk of seismic activity. Adherence to seismic standards for foundation and building design identified in the UBC for Zone 3 should adequately mitigate potential seismic hazards.

### 4.2 BIOTIC RESOURCES

#### Vegetation

*Setting.* Severe climatic conditions at the altitude of the project site limit the types of vegetation that can survive. An assessment of the botanical resources within the summit area was conducted by the Bishop Museum for the SRCDP (RCUH 1983b). Six species of vascular plants and about 25 different lichen species were located; about half of the lichens were endemic (Ibid.).

*Potential Impacts/Mitigations.* There will be no impact. The WMKO site is located on cinder, a poor substratum for the growth of most plants because of its instability and high porosity (RCUH 1983a). The proposed temporary optical test sites will be located in a highly disturbed area which is devoid of any kind of vegetation.

#### Arthropod Fauna

*Setting.* Aeolian invertebrates were initially discovered on Mauna Kea in 1977 by Howarth and Montgomery (1980). Further work by Howarth and Stone (1982) revealed 11 native species in the

area, all of which are unique to Hawaii. Of particular interest is the "wekiu bug" (*Nysius* sp.)--a flightless lygaeid bug that preys on moribund insects that are carried upslope and deposited in crevasses in the lava.

The 1982 arthropod study identified the Pu`u Hau Oki cinder cone (location of the Keck site) as having a high density of *Nysius*; however, aeolian species are typically absent from areas that have been disturbed (Howarth and Montgomery 1980). It can be inferred from these studies that it is likely that construction of the Keck Telescopes has disturbed the area to such an extent that the bug is no longer present. The 1982 arthropod fauna study is currently being updated by the same scientists who conducted the original survey. One objective of the present study is to determine whether this assumption about disturbed areas is true in all cases.

*Potential Impacts/Mitigations.* The principal investigator of the current arthropod fauna study was contacted during the preparation of this document. He stated that "the area that has already been graded and currently used for parking appears unsuitable for native aeolian species." He reported, however, that he had found a few bugs active on the cinder slopes immediately below the planned construction site as well as within Pu`u Hau Oki crater. Indirect disturbance could occur if construction material or spoils is pushed or falls over the side of the slope or if such material is blown around the mountain (F. G. Howarth, personal communication).

In order to mitigate potential impacts during the construction period, the construction contract will stipulate the following: a) no construction material or spoils will be pushed or allowed to fall over the slope; b) contractors will control all trash resulting from construction activities and remove it on a regular basis; c) all dust-generating activities will be suspended and all equipment and materials will be secured during high winds and storms; and, d) excavated cinder or dirt will either be immediately taken to the stockpile area or the pile will be covered with a tarp that is tied down. These conditions will be monitored regularly by personnel of the Mauna Kea Support Services--an organization funded by the telescope users.

No impacts on arthropod fauna are expected during the operation of the proposed project.

### **4.3 WATER RESOURCES/PERMAFROST**

#### **Surface Water**

*Setting.* The only perennial surface water present on the summit is Lake Waiau, located at about the 13,020-foot elevation, a little over one mile south of the project site. The lake is approximately 240 feet in diameter and 8 feet deep at overflow stage (RCUH 1983b).

*Potential Impacts/Mitigations.* Windblown dust from project construction activities could cause an increase of siltation in the lake, however, the effect would be infinitesimal in comparison to natural processes and human activity occurring in the area. The proposed test sites will be a very small project compared to other recent construction projects in the area. Less than 1,500 square feet of land will be disturbed, excavations will be shallow, and construction time will be short. The dust control measures described previously in relation to arthropod fauna, will also serve to minimize any potential adverse impacts to the lake. Operation of the proposed test sites will not impact Lake Waiau.

#### **Groundwater**

*Setting.* The Island of Hawaii is underlain by a basal fresh water lens which is floating on sea water. On Mauna Kea this water would be 13,000 to 14,000 feet below ground surface; too deep

to be tapped economically by wells. Because of the very limited precipitation and high permeability of the soils at the summit, the only groundwater known to exist on Mauna Kea consists of perched water in the center of some of the cinder cones, including the area immediately east of Lake Waiau (Woodcock 1974).

*Potential Impacts/Mitigations.* Construction and operation of the proposed project will not negatively impact groundwater resources as the fresh water lens is too deep to be affected and the only known groundwater is nearly a mile south of the site. Borings for the Keck telescopes did not encounter groundwater. No mitigation is required.

### **Permafrost**

*Setting.* Localized zones of permafrost have been reported within the volcanic cinder deposits at two of the cones at the summit of Mauna Kea, roughly 3,000 to 4,000 feet southeast of the Observatory site. Woodcock (1974) speculates that permafrost might exist 60 meters below the top of the summit cone. In general, the climate on Mauna Kea is considered to be slightly too warm for permafrost.

*Potential Impacts/Mitigations.* None. Borings for the two Keck telescopes did not encounter permafrost and none is expected during excavation for the proposed test sites.

## **4.4 DRAINAGE AND EROSION**

*Setting.* The WMKO site is located on the eastern summit of Pu`u Hau Oki, a geologically young volcanic cinder cone. The proposed project area is flat and is currently used for parking and vehicle turn-around. Borings for the Keck I and Keck II telescopes revealed that the subsurface materials consist of volcanic cinder deposits at depth. Volcanic cinder is highly porous, however, during winter months, the upper layers of soil may solidify due to ice formation. Runoff from uncompacted natural surfaces is rare; most can be attributed to snow melt (ES 1993).

*Potential Impacts/Mitigations.* Rainwater and snowmelt on the proposed test site enclosures will be directed onto the ground. The area surrounding the proposed test sites will be graded to allow runoff from impervious surfaces to percolate into the subsurface and thereby prevent surface erosion. During construction activities the construction contractor must strictly adhere to County of Hawaii regulations concerning grading and excavation (Hawaii County Code, 1983, Chapter 10). Because the disturbed area is less than five acres, a NPDES permit for stormwater associated with construction is not required.

The present drainage system at the observatory site drains onto the cinder with no flooding or erosion problem. The volume of run-off from the proposed enclosures will be considerably less than that experienced by the existing facilities.

## **4.5 AIR QUALITY**

*Setting.* The summit area of Mauna Kea is well above the 7,000-foot altitude of atmospheric temperature inversions for the area. Air pollutants generated below this inversion layer--smog, smoke, dust and salt spray, etc.--do not cause air quality problems in the summit area of Mauna Kea. Locally-generated atmospheric pollutants at the summit are primarily emissions from combustion engines and fugitive dust from construction activities and unpaved surfaces.

Winds in the summit area aid in the dispersion of air pollutants. Winds at the summit follow a diurnal pattern of prevailing west/northwest daytime and east/southeast nighttime wind direction. Wind velocity usually ranges from 10 to 30 miles per hour (mph). High winds, with speeds occasionally exceeding 100 miles mph, can also arise during severe winter storms (RCUH 1983b). Although steady winds promote dispersion of air pollutants, high winds can contribute to increased concentrations of dust from wind erosion of exposed areas (ES 1993).

Air quality has not been monitored at the Mauna Kea Science Reserve. Mauna Kea, however, has the reputation of being among the finest astronomical sites in the world, which implies exceptional air quality.

#### *Potential Impacts/Mitigations.*

Dust: Dust is the primary pollutant of concern on Mauna Kea. Excavation and grading will generate dust. Heavy construction equipment operations at the site will also lead to the temporary generation of small dust particles. In addition, dust will be generated by the abrasive action of construction equipment on rocks. Control of dust is imperative at an observatory site as it is detrimental to the telescope mirrors and sensitive equipment. It can also affect any resident flora and fauna in the vicinity of the construction site.

Mitigation will be attained through strict compliance by the contractor with State Department of Health (DOH) rules and regulations (Chapter 43, Section 10) and the County of Hawaii grading permit. Normally, dust emissions are controlled by the application of water or a chemical fixative mixed with water. Water is in short supply at the summit and must be trucked in from Hilo. Therefore--in addition to the controls specified in the County grading permit and by DOH regulations--conditions in the construction contract will include: suspending all dust-generating activities and securing equipment and materials during high winds and storms; moving cinder or dirt immediately to the stockpile area or covering the pile with a tarp that is tied down; and, insuring that no construction material is pushed or allowed to fall over the slope and that trash is tightly controlled.

Emissions from Construction Equipment: Combustion emissions from the diesel emission of heavy construction equipment include carbon monoxide, hydrocarbons, nitrogen oxides, sulfur oxides and particulates. There will also be motor vehicle emissions from concrete mixers, trucks transporting materials to the site, trucks transporting excess material to the stockpile area and automobiles used by construction personnel. Due to the atmospheric conditions at the summit, all emissions except particulate emissions are expected to be dispersed and to not result in significant air quality impacts. Engine emissions will be mitigated by the use of properly functioning emission control devices as required by law. Strict compliance by the contractor with DOH rules and regulations (Chapter 43, Section 10) will mitigate the effects. Other mitigation measures include: proper maintenance of construction equipment and electrification of equipment when possible, and keeping equipment idling to a minimum when equipment is not in use.

Operations. No significant operations-related air quality impacts were identified, therefore, no mitigation measures are needed.

Demolition/Restoration. Dust and additional truck traffic will be generated during the demolition of the facilities. These negative effects will be short-term and will cease when the site is restored to its previous condition. Contractual conditions during this phase will include all previously mentioned dust and trash control measures.

#### **4.6 AESTHETICS**

*Setting.* Two 10-meter telescopes (Keck I and Keck II) are located on the project site. Although these telescopes are not visible from Hilo, they can be seen from some areas along the Hamakua Coast Highway, from South Kohala (including the town of Waimea) and from portions of North Kona and Mauna Loa (UH IfA 1991). In addition to existing telescopes, the landscape consists of unvegetated slopes.

*Potential Impacts/Mitigations.* During the construction period, construction equipment, construction materials and temporary structures will be present on the project site. The visual quality of the summit area will be affected during this time. This effect will be temporary since these items will be removed when the project is completed. Strict control of trash--daily cleanups will be enforced by MKSS--will minimize visual impact during the construction period.

The completed enclosures will only be visible from within the summit area. The structures are so small in comparison to the adjacent Keck telescopes that no additional visual impact will be generated by their presence.

#### **4.7 HISTORICAL/CULTURAL RESOURCES**

*Setting.* The Mauna Kea Ice Age Natural Area Reserve is located between the 10,400-foot and 13,200-foot elevations on Mauna Kea (Figure 5), outside of the Science Reserve. The main ice age features located in the reserve are Pohakuloa Gulch (formed by glacial meltwater), glacial moraine and meltwater deposits of fine sediments and the glacially sculptured features of cinder cones and lava flows. Lake Waiau, one of the highest lakes in the United States, and the Keanakakoi Adze Quarry, an ancient Hawaiian Historic Place, are other features of the Reserve. The complex was placed on the National Register of Historic Places and designated a National Historic Landmark in 1962. The quarry site is listed on the National Register of Historic Places (McCoy 1979).

Reconnaissance surveys of portions of the Science Reserve were conducted by Bishop Museum in conjunction with the SRCDP (McCoy 1982 in RCUH 1982). Forty sites were located within the telescope development area of the summit, none were on cinder cones.

*Potential Impacts/Mitigations.* The Keanakakoi Adze Quarry is over a mile from the project site and would not be impacted by the proposed test sites.

No cultural remains were identified in the project area during the 1982 reconnaissance survey and none were uncovered during the construction of either the Keck I or Keck II telescopes. In addition, an ethnographic study of the summit area--which was conducted in conjunction with the 1982 reconnaissance survey--did not attribute any particular significance to the Pu`u Hau Oki cinder cone. In his letter responding to a request for Historic Preservation Review (Chapter 6E, HRS and Section 106, National Historic Preservation Act), the State Historic Preservation Officer concurs that the proposed test sites will have "no effect" on significant historic sites (Appendix C).

#### **4.8 UTILITIES AND SERVICES**

*Setting.* All necessary power, communications, and sewage facilities will be provided by the WMKO. Electric power requirements are estimated to be less than 5 kW and can be provided from the existing electrical service which has 1000 kW capacity.

*Potential Impacts/Mitigations.* Existing utilities and infrastructure will not be impacted during construction or operations.

#### **4.9 TRAFFIC**

*Setting.* Access to the WMKO is via the Saddle Road (Route 200), to Pu`u Huluhulu and from there via a 6-mile-long, 20-foot-wide paved portion of the Mauna Kea Access Road to Hale Pohaku, at the 9,200-foot elevation of the mountain. From Hale Pohaku, the Mauna Kea Access Road continues 8.3 miles to the summit. It is a gravel road to approximately the 11,800-foot elevation and paved from this elevation to the summit. Traffic on this road is associated with telescope personnel and visitors.

*Potential Impacts/Mitigations.* Construction of the proposed test sites will involve transferring about 10 truck loads of excavated material from the site to the stockpile area 12,700-foot elevation to the Science Reserve (Figure 7). In addition, construction traffic will include heavy truck loads and flat-bed trailer loads of enclosure and siderostat components from either Hilo or Waimea for assembly on the project site.

The increase in traffic in the area during construction will be minimal as most heavy construction equipment will be stored on site during the construction period. Some delay of traffic on the summit access road can be expected when the enclosures are trucked up the mountain. There may be minimal obstruction of observatory traffic for a short period of time when dump truck loads of excess excavated material are hauled to the stockpile area. At the maximum, construction worker traffic will only add about ten trips each during the AM and PM peak periods. This traffic will only occur intermittently and should not interfere with normal traffic flow.

Some negative traffic impacts are unavoidable during construction of the project. These are normal for any construction project and will diminish considerably after the first year and will end when the siderostat installation is complete. In order to minimize negative effects, all trips of heavy trucks, such as those transporting the enclosures, will be scheduled during off-peak hours so as not to interfere with normal traffic flow in Hilo, Waimea or along the Saddle Road. The same will hold true when the enclosures and siderostats are transported from the mountain to Waimea upon completion of the testing phase.

No appreciable increase in traffic is anticipated during the operations phase of the proposed project.

#### **4.10 ENVIRONMENTAL JUSTICE**

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires Federal agencies to identify and address the potential for their programs, policies, and actions to have disproportionately high and adverse human health or environmental effects on minority or low income populations. The companion Presidential Memorandum signed February 11, 1994, directs Federal agencies to include in their NEPA documents and analysis of the effects of their actions on minority and low-income communities, along with mitigation measures for significant and adverse effects.

As addressed in the previous sections, the proposed action will comply with all applicable environmental statutes and regulations. The proposed project will be located at the summit of Mauna Kea within the Mauna Kea Science Reserve, a scientific complex set aside for astronomical observatories. The proposed temporary optical test sites will be used solely to facilitate the scientific work currently being conducted on the W. M. Keck Observatory site. The closest residential areas to the proposed project are Hilo and Waimea, each between one and one and half hours away. Insofar as the proposed construction and operation of the temporary optical test sites at the W. M. Keck Observatory is not anticipated to have adverse environmental or socioeconomic effects--and given the nature of the land use in the area--it does not appear that environmental justice is a potential concern for the proposed project.

## 5.0 REFERENCES

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**6.0 AGENCIES AND ORGANIZATIONS  
CONTACTED IN THE PREPARATION OF THE EA**

Dr. Robert McLaren, Interim Director  
University of Hawaii Institute for Astronomy  
Honolulu, Hawaii

Mr. Gary Gill, Director  
Hawaii State Office of Environmental Quality Control  
Honolulu, Hawaii

Mr. Michael Wilson, State Historic Preservation Officer  
Hawaii State Department of Land and Natural Resources  
Honolulu, Hawaii

Mr. Frank Howarth, Entomologist  
Bishop Museum  
Honolulu, Hawaii

**7.0 AGENCIES AND ORGANIZATIONS THAT RECEIVED  
THE DRAFT ENVIRONMENTAL ASSESSMENT**

***FEDERAL***

**Advisory Council on Historic Preservation**

**Department of Interior**  
Fish and Wildlife Service

**Environmental Protection Agency**  
Region IX

***STATE OF HAWAII***

**Department of Business, Economic Development and Tourism**  
Office of Planning--Coastal Zone Management Program

**Department of Land and Natural Resources**  
Historic Preservation Division  
Land Division

**Office of Environmental Quality Control**

**Public Libraries**  
Hilo Public Library  
Kailua-Kona Public Library  
Thelma Parker Memorial Public/School Library (Kamuela)

***STATE OF HAWAII (Continued)***

**University of Hawaii**  
Institute for Astronomy

***COUNTY OF HAWAII***

**Office of the Mayor**

**Planning Department**

***ORGANIZATIONS***

**Bishop Museum**

**Mauna Kea Advisory Committee**  
Nelson Ho

**8.0 COMMENTS ON THE DRAFT ENVIRONMENTAL ASSESSMENT.**

The agencies and organizations listed in Section 7.0 reviewed the draft EA. A notice of availability of the assessment was also published in the Kailua-Kona and Hilo, Hawaii newspapers and in the OEQC Environmental Notice. One comment letter--from the U.S. Fish and Wildlife Service--was received. This letter and NASA's response is reproduced on the following pages of this Section.



## United States Department of the Interior

### FISH AND WILDLIFE SERVICE

Pacific Islands Ecoregion  
300 Ala Moana Boulevard, Room 3-122  
Box 50088  
Honolulu, Hawaii 96850

JUL 16 1998

In Reply Refer To: JMB

Richard J. Howard  
Origins Program Executive  
Office of Space Science  
National Aeronautics and Space Administration  
300 E Street, SW  
Washington, DC 20546-0001

Re: Draft Environmental Assessment, Temporary Optical Test Sites for the W.M. Keck Observatory, Mauna Kea, Hawaii

Dear Mr. Howard:

The U.S. Fish and Wildlife Service (Service) has reviewed the June 1998 Draft Environmental Assessment: Temporary Optical Test Sites for the W.M. Keck Observatory, Mauna Kea, Hawaii (Draft EA). The proposed project is sponsored by the National Aeronautics and Space Administration (NASA) and the California Association for Research in Astronomy. This letter has been prepared under the authority of and in accordance with provisions of the National Environmental Policy Act of 1969 [42 U.S.C. 4321 *et seq.*; 83 Stat. 852], as amended, the Endangered Species Act of 1973 [16 U.S.C. 1531 *et seq.*; 87 Stat. 884], as amended, and other authorities mandating Service concern for environmental values. Based on these authorities, the Service offers the following comments for your consideration.

The proposed project includes the installation of two temporary structures near the Keck telescope structures for the purpose of testing interferometry techniques. Construction will involve excavation of a trench approximately 11 feet deep and 140 feet long, and between 5 and 10 feet wide, as well as erection of two small buildings. The above-ground structures will be removed after approximately 3 years and the site restored to its present use as a parking lot.

No Federally listed endangered or threatened species occur at the project site. However, as noted in section 4.2: Arthropod Fauna, the community of rare, endemic arthropods near the site could be negatively affected by the project, principally by distribution of dust and cinder during trenching, cinder stockpiling, and site restoration. The measures to minimize this potential impact, as they are proposed in the Draft EA, should be adequate if they are consistently employed.

The Service does not anticipate significant impacts to fish and wildlife resources due to this project. Therefore, the Service concurs with the recommended Finding Of No Significant Impact and determination that a supplemental Environmental Impact Statement is not required for the project.

We appreciate the opportunity to comment on this project. If you have questions regarding these comments, please contact Fish and Wildlife Biologist Jeff Burgett at 808/541-3441.

Sincerely,



Robert P. Smith  
Pacific Islands Manager

cc: USEPA, Honolulu  
MCM Planning, Honolulu

National Aeronautics and  
Space Administration

**Headquarters**

Washington, DC 20546-0001



Reply to Attn of

SM

JUL 23 1998

Robert P. Smith  
Pacific Islands Manager  
Fish and Wildlife Service  
US Department of the Interior  
Box 50088  
Honolulu, HI 96850

Dear Mr. Smith:

Thank you for your thoughtful letter of July 16, 1998,  
regarding our draft Environmental Assessment, Temporary  
Optical Test Sites for the W. M. Keck Observatory, Mauna Kea,  
Hawaii. We appreciate your interest and will include your  
letter in the final document.

Sincerely,

A handwritten signature in black ink, appearing to read "Richard J. Howard, for".

Richard J. Howard  
Program Executive



**APPENDIX A**  
**STATE OF HAWAII**  
**ENVIRONMENTAL COMPLIANCE**



BENJAMIN J. CAYETANO  
GOVERNOR



GARY GILL  
DIRECTOR

STATE OF HAWAII  
OFFICE OF ENVIRONMENTAL QUALITY CONTROL

235 SOUTH BERETANIA STREET  
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TELEPHONE (808) 586-4186  
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RECEIVED

MAR 17 1998

DIRECTOR  
INSTITUTE FOR ASTRONOMY

March 12, 1998

Mr. Robert A. McLaren, Interim Director  
Institute of Astronomy  
University of Hawaii at Manoa  
2680 Woodlawn Drive  
Honolulu, Hawaii 96822

Dear Mr. McLaren:

Subject: Temporary Optical Test Sites for the W. M. Keck  
Observatory, Hawaii

This is in response to your letter of March 2, 1998 requesting our determination on the need for a supplemental environmental impact statement for the installation and use of two temporary optical test sites for the W. M. Keck Observatory.

After staff review of the information presented to OEQC, we believe that a supplemental EIS is not required for this project.

**Facts**

1. The California Association for Research in Astronomy has asked the University of Hawaii, Institute for Astronomy for permission to install two temporary optical test sites next to the W. M. Keck Observatory within the summit area of the Mauna Kea Science Reserve.
2. Each of the sites will include a siderostat, an enclosure for weather protection and underground optical paths connecting to the basement of the Keck II telescope building.
3. All above-ground test facilities will be removed at the completion of the development testing and the site will be restored to its original use as a parking area.
4. All of the area to be affected by the proposed optical test sites is located within Sitting Area I, which was fully assessed in the Final EIS for the Mauna Kea Science Reserve Complex Development Plan, 1983.

Mr. McLaren  
Page 2

5. The site has already been graded and is currently used for parking. There will be no additional visual impact from the presence of the siderostats and enclosures. The test sites will be visible only from within the summit area.
6. Bishop Museum scientists and State Historic Preservation Division were consulted to assess whether or not the project would have adverse effects on arthropod fauna and historic sites. Both concurred that the project would have "no adverse effect."
7. The University of Hawaii Institute for Astronomy has reviewed the project and found that the environmental effects of the proposed temporary optical sites would not differ significantly from those addressed in previous documents and does not expect new and/or different environmental impacts from those previously assessed for the Keck telescopes.

#### Analysis

According to the EIS rules, applicants shall prepare supplemental environmental impact statements whenever the proposed action for which a statement was accepted has been modified to the extent that new or different environmental impacts are anticipated. A supplemental statement shall be warranted when the scope of an action has been substantially increased, when the intensity of environmental impacts will be increased, when the mitigating measures originally planned are not to be implemented, or where new circumstances or evidence have brought to light different or likely increased environmental impacts not previously dealt with.

After reviewing the March 1998, Project Description and Environmental Review, discussing this matter with the Institute for Astronomy and analyzing the facts in accordance with the above regulations, OEQC has concluded that no new or different environmental impacts are anticipated and that a supplemental environmental impact statement is not required for this project.

Should you have any questions, please call Jeyan Thirugnanam at 586-4185.

Sincerely,

  
Gary Gill  
Director

**APPENDIX B**  
**HAWAII COASTAL ZONE MANAGEMENT**  
**FEDERAL CONSISTENCY REVIEW**





**DEPARTMENT OF BUSINESS,  
ECONOMIC DEVELOPMENT & TOURISM**

**OFFICE OF PLANNING**

235 South Beretania Street, 6th Flr., Honolulu, Hawaii 96813  
Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804

BENJAMIN J. CAYETA  
GOVERNOR  
SEIJI F. NAKAGAWA  
DIRECTOR  
BRADLEY J. MOSSM  
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RICK EGG  
DIRECTOR, OFFICE OF PLANNING

Tel.: (808) 587-28  
Fax: (808) 587-28

Ref. No. P-7592

July 21, 1998

Mr. Richard J. Howard  
Origins Program Executive  
National Aeronautics and Space Administration  
300 E Street, SW  
Washington, DC 20546-0001

Dear Mr. Howard:

**Subject: Hawaii Coastal Zone Management (CZM) Program Federal Consistency  
Review for Temporary Optical Test Sites for the W.M. Keck Observatory  
Twin Keck Telescope Interferometer, Mauna Kea, Hawaii**

Your proposal to install and use two temporary optical test sites for the W.M. Keck Observatory Twin Keck Telescope Interferometer, Mauna Kea, Hawaii, has been reviewed for consistency with Hawaii's CZM Program. It is our understanding that all above-ground test facilities will be removed at the completion of the development testing--early 2002--and the site will be restored to its original use as a parking area. We concur with your CZM consistency determination that the activity is consistent to the maximum extent practicable with Hawaii's CZM Program.

CZM consistency concurrence is not an endorsement of the project nor does it convey approval with any other regulations administered by any State or County agency. Thank you for your cooperation in complying with Hawaii's CZM Program. If you have any questions, please call John Nakagawa of our CZM Program at (808) 587-2878.

Sincerely,

  
Rick Egged  
Director  
Office of Planning

cc: U.S. Fish and Wildlife Service, Pacific Islands Ecoregion  
Department of Land & Natural Resources,  
Planning & Technical Services Branch  
Planning Department, County of Hawaii  
Ms. Marilyn C. Metz, MCM Planning

FEDERAL CONSISTENCY  
SUPPLEMENTAL INFORMATION FORM

Project/Activity Title or Description: Proposed Installation of Two Temporary  
Optical Test Sites at the W. M. Keck Observatory, Mauna Kea

Island Hawaii Tax Map Key No. 4-4-15: 09 Est. Start Date: 8/98

APPLICANT OR AGENT

Name & Title Richard J. Howard, Origins Program Executive, Office of Space

Agency/Organization NASA Headquarters Telephone 202-358-0898 <sup>Science</sup>

Address Code SM, 300 E St SW Washington, DC Zip 20546

TYPE OF APPLICATION (check one only)

I. Federal Activity  
(statement "a")

"The proposed activity is consistent with and will be conducted in a manner consistent to the maximum extent practicable with the Hawaii Coastal Zone Management Program."

Signature  Date 5/19/98

II. Permit or License  
(statement "b")

"The proposed activity complies with Hawaii's Coastal Zone Management Program and will be conducted in a manner consistent with such a program."

Signature \_\_\_\_\_ Date \_\_\_\_\_

III. OCS Plan/Permit

IV. Grants & Assistance

HAWAII CEM PROGRAM  
ASSESSMENT FORM

RECREATIONAL RESOURCES

Objective: Provide coastal recreational opportunities accessible to the public.

Policies

- 1) Improve coordination and funding of coastal recreation planning and management.
- 2) Provide adequate, accessible, and diverse recreational opportunities in the coastal zone management area by:
  - a) Protecting coastal resources uniquely suited for recreational activities that cannot be provided in other areas;
  - b) Requiring replacement of coastal resources having significant recreational value, including but not limited to surfing sites and sandy beaches, when such resources will be unavoidably damaged by development; or requiring reasonable monetary compensation to the State for recreation when replacement is not feasible or desirable;
  - c) Providing and managing adequate public access, consistent with conservation of natural resources, to and along shorelines with recreational value;
  - d) Providing an adequate supply of shoreline parks and other recreational facilities suitable for public recreation;
  - e) Encouraging expanded public recreational use of County, State, and Federally owned or controlled shoreline lands and waters having recreational value;
  - f) Adopting water quality standards and regulating point and non-point sources of pollution to protect and where feasible, restore the recreational value of coastal waters;
  - g) Developing new shoreline recreational opportunities, where appropriate, such as artificial reefs for surfing and fishing; and
  - h) Encouraging reasonable dedication of shoreline areas with recreational value for public use as part of discretionary approvals or permits by the land use commission, board of land and natural resources, County planning commissions; and crediting such dedication against the requirements of section 46-6.

Check either "Yes" or "No" for each of the following questions.

	<u>Yes</u>	<u>No</u>
1. Will the proposed action involve or be near a dedicated public right-of-way?	—	<u>X</u>
2. Does the project site abut the shoreline?	—	<u>X</u>
3. Is the project site near a State or County park?	—	<u>X</u>
4. Is the project site near a perennial stream?	—	<u>X</u>
5. Will the proposed action occur in or affect a surf site?	—	<u>X</u>
6. Will the proposed action occur in or affect a popular fishing area?	—	<u>X</u>
7. Will the proposed action occur in or affect a recreational or boating area?	—	<u>X</u>
8. Is the project site near a sandy beach?	—	<u>X</u>
9. Are there swimming or other recreational uses in the area?	—	<u>X</u>

Discussion

See Attachment

HISTORIC RESOURCES

Objective: Protect, preserve, and where desirable, restore those natural and man-made historic and pre-historic resources in the coastal zone management area that are significant in Hawaiian and American history and culture.

Policies

- 1) Identify and analyze significant archaeological resources;
- 2) Maximize information retention through preservation of remains and artifacts or salvage operations; and
- 3) Support State goals for protection, restoration, interpretation, and display of historic resources.

Check either "Yes" or "No" for each of the following questions.

	<u>Yes</u>	<u>No</u>
1. Is the project site within a historic/cultural district?	—	<u>X</u>
2. Is the project site listed on or nominated to the Hawaii or National register of historic places?	—	<u>X</u>
3. Does the project site include undeveloped land which has not been surveyed by an archaeologist?	—	<u>X</u>
4. Has a site survey revealed any information on historic or archaeological resources?	—	<u>X</u>
5. Is the project site within or near a Hawaiian fishpond or historic settlement area?	—	<u>X</u>

Discussion

See Attachment

SCENIC AND OPEN SPACE RESOURCES

Objective: Protect, preserve and, where desirable, restore or improve the quality of coastal scenic and open space resources.

Policies

- 1) Identify valued scenic resources in the coastal zone management area;
- 2) Insure that new developments are compatible with their visual environment by designing and locating such developments to minimize the alteration of natural landforms and existing public views to and along the shoreline;
- 3) Preserve, maintain and, where desirable, improve and restore shoreline open space and scenic resources; and
- 4) Encourage those developments which are not coastal dependent to locate in inland areas.

Check either "Yes" or "No" for each of the following questions.

	<u>Yes</u>	<u>No</u>
1. Does the project site abut a scenic landmark?	—	<u>X</u>
2. Does the proposed action involve the construction of a multi-story structure or structures?	—	<u>X</u>
3. Is the project site adjacent to undeveloped parcels?	—	<u>X</u>
4. Does the proposed action involve the construction of structures visible between the nearest coastal roadway and the shoreline?	—	<u>X</u>
5. Will the proposed action involve construction in or on waters seaward of the shoreline? On or near a beach?	—	<u>X</u>

Discussion

See Attachment

## COASTAL ECOSYSTEMS

Objective: Protect valuable coastal ecosystems from disruption and minimize adverse impacts on all coastal ecosystems.

### Policies

- 1) Improve the technical basis for natural resource management;
- 2) Preserve valuable coastal ecosystems of significant biological or economic importance;
- 3) Minimize disruption or degradation of coastal water ecosystems by effective regulation of stream diversions, channelization, and similar land water uses, recognizing competing water needs; and
- 4) Promote water quantity and quality planning and management practices which reflect the tolerance of fresh water and marine ecosystems and prohibit land and water uses which violate State water quality standards.

Check either "Yes" or "No" for each of the following questions.

	<u>Yes</u>	<u>No</u>
1. Does the proposed action involve dredge or fill activities?	___	<u>X</u>
2. Is the project site within the Shoreline Setback Area (20 to 40 feet inland of the shoreline)?	___	<u>X</u>
3. Will the proposed action require some form of effluent discharge into a body of water?	___	<u>X</u>
4. Will the proposed action require earthwork beyond clearing and grubbing?	<u>X</u>	___
5. Will the proposed action include the construction of special waste treatment facilities, such as injection wells, discharge pipes, or cesspools?	___	<u>X</u>
6. Is an intermittent or perennial stream located on or near the project site?	___	<u>X</u>
7. Does the project site provide habitat for endangered species of plants, birds, or mammals?	___	<u>X</u>
8. Is any such habitat located nearby?	___	<u>X</u>
9. Is there a wetland on the project site?	___	<u>X</u>
10. Is the project site situated in or abutting a Natural Area Reserve?	___	<u>X</u>

11. Is the project site situated in or abutting a Marine  
Life Conservation District?

— X

12. Is the project site situated in or abutting an estuary?

— X

Discussion

See Attachment

ECONOMIC USES

Objective: Provide public or private facilities and improvements important to the State's economy in suitable locations.

Policies

- 1) Concentrate in appropriate areas the location of coastal dependent development necessary to the State's economy;
- 2) Insure that coastal dependent development such as harbors and ports, visitor industry facilities, and energy generating facilities are located, designed, and constructed to minimize adverse social, visual, and environmental impacts in the coastal zone management area; and
- 3) Direct the location and expansion of coastal dependent developments to areas presently designated and used for such development and permit reasonable long-term growth at such areas, and permit coastal dependent development outside of presently designated areas when:
  - a) Utilization of presently designated locations is not feasible;
  - b) Adverse environmental effects are minimized; and
  - c) Important to the State's economy.

Check either "Yes" or "No" for each of the following questions.

	<u>Yes</u>	<u>No</u>
1. Does the project involve a harbor or port?	___	<u>X</u>
2. Is the project site within a designated tourist destination area?	___	<u>X</u>
3. Does the project site include agricultural lands or lands designated for such use?	___	<u>X</u>
4. Does the proposed activity relate to commercial fishing or seafood production?	___	<u>X</u>
5. Does the proposed activity relate to energy production?	___	<u>X</u>
6. Does the proposed activity relate to seabed mining?	___	<u>X</u>

Discussion

See Attachment

COASTAL HAZARDS

Objective: Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion, and subsidence.

Policies

- 1) Develop and communicate adequate information on storm wave, tsunami, flood erosion, and subsidence hazard;
- 2) Control development in areas subject to storm wave, tsunami, flood, erosion, and subsidence hazard;
- 3) Ensure that developments comply with requirements of the Federal Flood Insurance Program; and
- 4) Prevent coastal flooding from inland projects.

Check either "Yes" or "No" for each of the following questions.

	<u>Yes</u>	<u>No</u>
1. Is the project site on or abutting a sandy beach?	___	<u>X</u>
2. Is the project site within a potential tsunami inundation area as depicted on the National Flood Insurance Program flood hazard map?	___	<u>X</u>
3. Is the project site within a potential flood inundation area according to a flood hazard map?	___	<u>X</u>
4. Is the project site within a potential subsidence hazard area according to a subsidence hazard map?	___	<u>X</u>
5. Has the project site or nearby shoreline areas experienced shoreline erosion?	___	<u>X</u>

Discussion

See Attachment

MANAGING DEVELOPMENT

Objective: Improve the development review process, communication, and public participation in the management of coastal resources and hazards.

Policies

- 1) Effectively utilize and implement existing law to the maximum extent possible in managing present and future coastal zone development;
- 2) Facilitate timely processing of application for development permits and resolve overlapping or conflicting permit requirements; and
- 3) Communicate the potential short- and long-term impacts of proposed significant coastal developments early in their life cycle and in terms understandable to the general public to facilitate public participation in the planning and review process.

Check either "Yes" or "No" for each of the following questions.

	<u>Yes</u>	<u>No</u>
1. Will the proposed activity require more than two (2) permits or approvals?	—	<u>X</u>
2. Does the proposed activity conform with the State and County land use designations for the site?	<u>X</u>	—
3. Has or will the public be notified of the proposed activity?	<u>X</u>	—
4. Has a draft or final environmental impact statement or an environmental assessment been prepared?	<u>X</u>	—

Discussion

See Attachment

## ATTACHMENT

### *DISCUSSION FOR CZM ASSESSMENT FORM*

#### RECREATIONAL RESOURCES

The proposed project is located within the Mauna Kea Science Reserve at the summit of Mauna Kea, a 13,796-foot-high shield volcano. The seasonally snow-covered slopes of Mauna Kea, above the 10,000-foot elevation, are used for skiing and snow play. Hiking, sightseeing and photography are also popular uses of the mountain.

The temporary optical test sites will be installed within the area subleased for the W. M. Keck Observatory on the Pu`u Hau Oki cinder cone, at about the 13,600-foot elevation of the mountain. The previously disturbed area is presently used for parking. The proposed project will not interfere with existing recreation uses of the mountain. In addition, there are no stream, shorelines, surf areas, fishing or boating areas within a 1 1/2 hour drive of the site. There will be no impact on recreational resources.

#### HISTORIC RESOURCES

As stated in the EA, reconnaissance surveys of portions of the Science Reserve were conducted by Bishop Museum in 1982. Forty sites were located within the telescope development area of the summit, none were on cinder cones. No cultural remains were identified in the project area during the 1982 survey and none were uncovered during the subsequent construction of either the Keck I or Keck II telescopes. In addition, an ethnographic study of the summit area--which was conducted in conjunction with the 1982 reconnaissance survey--did not attribute any particular significance to the Pu`u Hau Oki cinder cone.

In his letter responding to a request for Historic Preservation Review (Chapter 6E, HRS and Section 106, National Historic Preservation Act), the State Historic Preservation Officer concurs that the proposed test sites will have "no effect" on significant historic sites. This letter is incorporated into the EA as Appendix B.

#### SCENIC AND OPEN SPACE RESOURCES

The Mauna Kea Science Reserve encompasses an area of about 11,270 acres of State of Hawaii land that is leased to the University of Hawaii (UH) and managed by the Institute for Astronomy (UH IfA). Only a small portion of this vast area is developed. Currently, 12 telescopes are either in operation or under construction in the summit area.

Two 10-meter telescopes (Keck I and Keck II) are located on the project site. Although these telescopes are not visible from Hilo, they can be seen from some areas along the Hamakua Coast Highway, from South Kohala (including the town of Waimea) and from portions of North Kona and Mauna Loa. In addition to existing telescopes, the landscape consists of unvegetated slopes.

The enclosures of the proposed temporary optical test sites will only be visible from within the summit area. The structures are so small in comparison to the adjacent Keck telescopes that no additional visual impact will be generated by their presence and there will be no effect on scenic and open space resources.

## COASTAL ECOSYSTEMS

The construction activities required for the installation of the proposed temporary optical test sites include: (1) excavation of about 1,350 cubic yards of material for the tunnel, junction boxes and light-pipe trench; (2) pouring of about 85 cubic yards of concrete for foundations, the tunnel and junction boxes; (3) installation of the light-pipe in the trench and bringing the trench and tunnel up to grade by backfilling with about 1,100 cubic yards of excavated material; and (5) compacting, leveling and raking the areas above the tunnel and trench. Construction activities will not include installing special waste facilities or producing effluent or discharge of any kind.

There are no endangered, threatened, or candidate species of flora or fauna in the vicinity of the project site.

Severe climatic conditions at the altitude of the project site limit the types of vegetation that can survive. The proposed temporary optical test sites will be located in a highly disturbed area which is devoid of any kind of vegetation.

In 1982, 11 native species of aeolian invertebrates were discovered in the summit area of Mauna Kea, all of which are unique to Hawaii. Of particular interest is the "wekiu bug" (Nysius sp.)--a flightless lygaeid bug that preys on moribund insects that have been carried upslope and deposited in crevasses in the lava. The Pu`u Hau Oki cinder cone (location of the Keck site) was identified as having a high density of Nysius, however, aeolian species are typically absent from areas that have been disturbed.

The 1982 arthropod fauna study is currently being updated by the same scientists who conducted the original survey. The principal investigator of the current arthropod fauna study was contacted during the preparation of the EA. He stated that "the area that has already been graded and currently used for parking appears unsuitable for native aeolian species." Because the study findings are not final, he recommended the following measures to mitigate potential impacts during the construction period: a) no construction material or spoils will be pushed or allowed to fall over the slope; b) contractors will control all trash resulting from construction activities and remove it on a regular basis; c) all dust-generating activities will be suspended and all equipment and materials will be secured during high winds and storms; and, d) excavated cinder or dirt will either be immediately taken to the stockpile area or the pile will be covered with a tarp that is tied down. These conditions will be incorporated into the construction contract and compliance will be monitored regularly by personnel of the Mauna Kea Support Services--an organization funded by the telescope users.

No impacts on arthropod fauna are expected during the operation of the proposed project.

The site is not within the Shoreline setback area. There are no streams, wetlands or estuaries within the vicinity of the site and the site is not located near a Marine Life Conservation District.

## ECONOMIC USES

The summit of Mauna Kea is regarded as one of the best sites in the world for optical/infrared telescopes. The W. M. Keck Observatory--which consists of the worlds' two most powerful telescopes (Keck I and Keck II)--makes full use of the site's excellent qualities for astronomical observations. Mauna Kea's superior attributes include its high altitude, atmospheric dryness, minimal seasonal variation and relatively light-pollution free skies. Because of these qualities, UH IfA's Mauna Kea Observatories attract millions of dollars of investment in state-of-the-art telescope facilities to Hawaii. There is no other comparable site in the state.

The project site is not located near any harbor or port and does not relate to commercial fishing, seafood production or seabed mining. The site is not on agricultural land and is not associated with energy production of any kind. All utilities will be provided from the existing observatory which has all necessary power, communications, and sewage facilities. Electric power requirements can be provided from the existing on-site electrical service.

## COASTAL HAZARDS

The project site is located on the summit of Mauna Kea. The shoreline is miles away in any direction. Potential flooding, tsunamis and subsidence are therefore not a concern in relation to the site.

## MANAGING DEVELOPMENT

The project is located within the Resource Subzone of the State Conservation District. UH IfA will request approval for the test sites from the Department of Land and Natural Resources as an accessory use to the previously approved Conservation District Use Applications (CDUAs) for the Keck I and Keck II telescopes (HA-1646 and HA-2509, respectively). In addition, County of Hawaii building permits will be obtained.

The proposed project will be located within an area which was assessed in the Final Environmental Impact Statement for the Mauna Kea Science Reserve Complex Development Plan (SRCDP FEIS). A Project Description/Environmental Review of the proposed project was prepared by UH IfA. This review evaluated the construction and operating characteristics of the proposed temporary test sites in order to determine if the implementation of this project would modify the impacts disclosed in the SRCDP FEIS. The document was prepared to comply with Chapter 343, Hawaii Revised Statutes and with Sections 11-200-26 and 11-200-27 of Chapter 200 of Title 11, Administrative Rules, entitled "Environmental Impact Statement Rules."

After careful comparison of the potential impacts of the project with those disclosed in previous statements, UH IfA concluded that the environmental effects of the proposed temporary optical test sites would not differ significantly from those addressed in previous documents and does not expect new and/or different environmental impacts from those previously assessed for the Keck telescopes. UH IfA requested a determination from the State Office of Environmental Control (OEQC) that all pertinent environmental concerns were addressed in previous environmental impact statements and no further documentation was required for the project. A copy of the letter from OEQC concurring with this determination is incorporated into this EA as Appendix A.

The National Aeronautics and Space Administration (NASA)--who will fund the proposed project--anticipates a FONSI for the project. The draft EA will be available for public review.

**APPENDIX C**  
***HISTORIC PRESERVATION REVIEW***





DEPUTIES

GILBERT COLOMA-AGARAM

AQUACULTURE DEVELOPMENT  
PROGRAM

AQUATIC RESOURCES  
CONSERVATION AND

RESOURCES ENFORCEMENT  
CONVEYANCES

FORESTRY AND WILDLIFE  
HISTORIC PRESERVATION

DIVISION

LAND DIVISION

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

REF:HP-AMK

JAN 30 1998

Dr. Robert A. McLaren, Interim Director  
University of Hawaii at Manoa  
Institute for Astronomy  
2680 Woodlawn Drive  
Honolulu, Hawaii 96822

LOG NO: 20880 ✓  
DOC NO: 9801PM09

Dear Dr. McLaren:

**SUBJECT: Request for Historic Preservation (Chapter 6E, HRS) and National Historic Preservation Act (Section 106) Review--Proposed Temporary Optical Test Sites for the W.M. Keck Observatory Twin Keck Telescope Interferometer within the Mauna Kea Science Reserve Ka'ohe, Hamakua, Hawaii Island  
TMK: 4-4-15:09**

Thank you for your letter of January 6, 1998 and the opportunity to review and comment on the above referenced project.

Your letter and the attached Project Description and Environmental Review document were forwarded to our Historic Preservation Division (HPD) for comment. No evidence of historic sites was found in this area during an archaeological survey in 1982. HPD staff thus concur with your finding that the proposed test sites will have "no effect" on significant historic sites.

Aloha,

  
MICHAEL D. WILSON, Chairperson and  
State Historic Preservation Officer

PM:amk





