

EXECUTIVE SUMMARY

This Environmental Assessment (EA) has been prepared in accordance with the National Environmental Policy Act of 1969 (NEPA), as amended (42 U.S.C. §4321 *et seq.*); the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (40 CFR Parts 1500-1508); and the National Aeronautics and Space Administration's (NASA) policy and procedures (14 CFR Subpart 1216.3) to support decision-making regarding whether to fund the on-site construction, installation, and operation of the Outrigger Telescopes Project. This Federal NEPA process is distinct from the State environmental process currently underway by the University of Hawai'i (UH) in accordance with applicable State of Hawai'i environmental laws and regulations. No final action will be taken on the Proposed Action until the decision-making process under NEPA has been completed. On-site construction would not begin until all State and local permits and approvals have been obtained.

Purpose and Need. The Outrigger Telescopes Project is a key element in NASA's Origins program which is directed at answering two basic questions: (1) How do galaxies, stars, and planets form (or, "Where do we come from?"); and (2) Are there other planets aside from ours, that have the conditions necessary to support life (or, "Are we alone?"). To find answers to these questions, NASA has developed a set of goals. Meeting these goals requires the use of a technique called interferometry, for which NASA has defined six specific ground-based interferometry objectives (see Section 1.3). The first two of the six objectives can be achieved using the Keck-Keck Interferometer, at the W.M. Keck Observatory (WMKO) on Mauna Kea, on the island of Hawai'i.

Meeting the final four interferometry objectives requires higher resolution of astronomical objects by allowing the objects to be studied from different angles. NASA has determined that the best way to achieve this is by the construction and operation of four to six Outrigger Telescopes used in conjunction with one or more large telescopes. A number of scientific and technical factors were considered in determining the number and required capabilities of these telescopes (see Section 2.3).

Proposed Action. NASA proposes funding the on-site construction, installation, and operation of six Outrigger Telescopes at the WMKO. The WMKO, located within the Astronomy Precinct on the summit of Mauna Kea, is the site of the two most powerful optical telescopes in the world—Keck I and Keck II. The light from the two telescopes was combined on March 12, 2001, forming the Keck-Keck Interferometer.

The proposed Outrigger Telescopes would be placed strategically around the existing Keck Telescopes on the area of the cinder cone, Pu'u Hau `Oki, that was previously

TERMS TO KNOW

Outrigger Telescope refers to any of the 6 1.8-meter (6-foot) diameter telescopes.

Keck Telescope refers to a single 10-meter (33-foot) diameter telescope.

Keck-Keck Interferometer refers to the Keck I and Keck II Telescopes used together as an interferometer (without the Outrigger Telescopes).

Keck Interferometric Array refers to any combination of some or all of the Outrigger Telescopes with one or both Keck Telescopes.

disturbed for construction of the two Keck Telescopes. A complex optical system is proposed to combine the light received simultaneously by various combinations of the Outrigger Telescopes and the Keck Telescopes to create a high resolution synthesized image. The Outrigger Telescopes would be a permanent addition to the WMKO. Four of the Outrigger Telescopes are currently budgeted and proposed for on-site construction and installation beginning in 2002, if all permits have been obtained, with start of operations anticipated in 2003. If funding is available, NASA intends to complete the on-site construction, installation, and operation of Outrigger Telescopes 5 and 6, with on-site construction and installation likely to begin in 2007.

As proposed, each Outrigger Telescope would consist of a 1.8-meter (6-foot) diameter, f/1.5 primary mirror, a secondary mirror, a tertiary mirror, a dual star module and a starlight beam on the telescope yoke. A dome, measuring 9.1 meters (30 feet) in diameter at its widest point and 8 meters (26 feet) in diameter at its base, would enclose each telescope to protect it from the harsh conditions on Mauna Kea. Each dome would be large enough to accommodate both a telescope and a dual star module and have a slit width adequate for unobstructed viewing with a 1.8-meter (6-foot) diameter primary mirror. The proposed domes would stand less than 10.7-meters (35-foot) high as measured from the top of the level grade at elevation 4,146 meters (13,603 feet). By comparison, each of the Keck domes is 37 meters (121 feet) in diameter at its widest point and 33.9-meters (111-foot) high. Each proposed telescope would be supported by an underground concrete telescope instrument room, which would serve as a telescope pier. Junction boxes would house the mirrors that direct the starlight beams through underground light pipes to the basement of the Keck II Telescope building, where the interferometer instrumentation will be located.

Potential Environmental Impacts That Could Result from the Proposed Action. The on-site construction, installation, and operation of the Outrigger Telescopes could result in environmental impacts. The principal areas of potential environmental impact addressed in this EA are summarized below. Mitigation measures to address environmental impacts resulting from the Proposed Action are also discussed in this EA.

Arthropod Fauna: The Wekiu bug (*Nysius wekiuicola*) is a candidate for listing under the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*). The Pu`u Hau `Oki cinder cone was identified in 1982 as having a high density of the Wekiu bug. In 1982, and again in 1999, the Wekiu bug population was surveyed in certain areas. Based on those surveys, the Wekiu bug population in those areas apparently experienced a 99.7 percent decline (Howarth and Stone 1982; Howarth and others 1999).

The proposed Outrigger Telescopes would be located at the existing WMKO site primarily within the approximately 1.1-hectare (2.8-acre) area leveled in 1985 and 1991, respectively, for the Keck I and Keck II Telescopes. A small amount of previously disturbed Wekiu bug habitat (0.009 hectare (0.022 acre)) along the sloped crater wall would be directly affected by on-site construction of the proposed project. A Wekiu Bug Mitigation Report has been developed by a natural resource management consulting firm (Pacific Analytics 2000). This report made recommendations for how to protect the Wekiu bug and its habitat within and immediately surrounding the WMKO site. The Wekiu Bug Mitigation Plan developed from that report is incorporated into this EA in Appendix D. A monitoring plan has been developed and is referenced in Appendix E.

A key element of this Wekiu Bug Mitigation Plan is restoration of Wekiu bug habitat at and near the WMKO site. The habitat restoration portion of the Plan has been developed in consultation with the U.S. Fish and Wildlife Service (USFWS), and would restore previously disturbed habitat on the WMKO site and at the bottom of the Pu`u Hau `Oki crater. The proposed restoration effort would encompass an area totaling about 0.028 hectares (0.069 acres) resulting in a habitat restoration ratio of about 3:1 relative to the amount of habitat area that would be disturbed by on-site construction and installation of Outrigger Telescopes 2 and 3. The intent is to restore the habitat in these areas to make it possible for the Wekiu bug to establish resident populations within the restored areas. The restored habitat would be monitored by a qualified entomologist for about 18 months following completion of the proposed habitat restoration to determine if the bug reestablishes itself in those areas. In addition, as part of project implementation, NASA will fund a graduate student to study Wekiu bug autecology, to gather more information about habitat requirements, life cycle, nutritional requirements, and breeding behaviors.

Operation of the Outrigger Telescopes would have little, if any, impact on Wekiu bug habitat. Many of the measures that would be implemented to protect Wekiu bug habitat during on-site construction and installation would be carried into the facility operation phase. These include, but are not necessarily limited to, measures that: reduce generation of fugitive dust, maintain strict housekeeping practices to avoid accumulation of trash on the habitat, restrict access of observatory personnel to Wekiu bug restoration areas, and ensure that foreign arthropods are not inadvertently introduced to the Mauna Kea summit environment.

Cultural Resources: In a letter dated May 3, 1999, the Hawaii State Historic Preservation Division (SHPD) stated that they “have come to believe that the cluster of cinder cones which merge and collectively form the summit of Mauna Kea is an historic property and that this single landscape feature probably bore the name Kūkahau`ula. This single landscape feature is now called Pu`u Hau `Oki, Pu`u Kea, and Pu`u Wekiu”. In addition, the SHPD believes that the summit region of Mauna Kea is eligible for inclusion in the National Register of Historic Places as a historic district, and the summit cluster of cones has been given the State site number 21438. The SHPD also noted that, given the conclusion that Pu`u Hau `Oki is part of a historic district, the proposed project would have an “adverse effect” on the historic property and historic district, but that these “adverse effects” can be mitigated if appropriate measures are adopted (SHPD 1999).

Because the proposed Outrigger Telescopes Project would be Federally-funded, Section 106 of the National Historic Preservation Act (NHPA) applies. Pursuant to NHPA, NASA undertook consultation with Hawaiian groups concerning the proposed project and its effects. NASA initially consulted with and invited the State Office of Hawaiian Affairs, and the following Native Hawaiian organizations—the Hawai`i Island Burial Council, the Royal Order of Kamehameha I, and Hui Mālama I Nā Kūpuna O Hawai`i Nei—to be Consulting Parties. Thereafter, two more Native Hawaiian organizations requested and were given Consulting Party status—Ahahui Ku Mauna and Mauna Kea Anaina Hou. In addition, NASA consulted with and invited the Office of Mauna Kea Management, the Mauna Kea Management Board, and Kahu Ku Mauna to also participate in the development of the Memorandum of Agreement (MOA).

As an integral part of the Section 106 consultation process, NASA prepared on-site and off-site cultural mitigation measures for consideration by the SHPD, the Advisory Council on Historic

Preservation (ACHP), and the other participating Consulting Parties. On-site mitigation measures that were proposed include stabilization of the cinder cone slopes, prevention of accidental dispersal of debris during and after on-site construction, disposition of excavated material, and reduction of noise during on-site construction, installation, and operation of the Outrigger Telescopes. Also included were monitoring and other measures that would prevent or minimize deterioration of the visual integrity (*i.e.*, shape and contour) of the cinder cone and its crater. One such measure also included the commitment to provide the Consulting Parties the opportunity to review and comment on the grading and site development drawings for the proposed project. As an off-site mitigation component of the Outrigger Telescopes Project, NASA, in consultation with the Office of Mauna Kea Management, will fund, out of funds for the Outrigger Telescopes Project, an initiative that deals with preservation and protection of historic/cultural resources on Mauna Kea and educational needs of Hawaiians.

A formal Section 106 meeting was held on February 1, 2001. In addition, NASA held another formal Section 106 meeting in Hilo on January 16 and 17, 2002. NASA held two Open House meetings in February 2001 in Hawai'i (Hilo and Kona) and held four Town Hall meetings in October 2001 (Kona, Waimea, and Hilo). The Open House and Town Hall meetings were attended by Native Hawaiian individuals, organizations, and members of the general public who stated their position, asked questions, expressed concerns and support, and learned more about the Outrigger Telescopes Project.

NASA representatives have met, formally and informally, with Native Hawaiian groups that have expressed interest in this project. Tables 5.1 and 5.2 in Chapter 5 of this Environmental Assessment provide a listing of the consultations/informal meetings that have occurred between NASA and interested parties concerning the Outrigger Telescopes Project.

The final cultural mitigation measures have been stipulated in the MOA (see Appendix C).

Archaeological Properties: No archaeological sites were located in the project area during past surveys, and none were uncovered during the construction of Keck I or Keck II. Review of past grading plans for the site indicated that the entire project area, with the exception of a small area near Junction Box-5, has been altered to such an extent that the probability of discovering human burials or other subsurface artifacts during on-site construction activities associated with the Outrigger Telescopes would be unlikely. No area is assumed to be devoid of archaeological properties, however, simply on the basis of its history. NASA has proposed mitigation measures that assume that such properties could possibly be found anywhere on the site. One such measure includes having a qualified archaeologist present on site to monitor excavation to minimize damage to inadvertently disturbed remains or subsurface artifacts. Operation of the Outrigger Telescopes would have no impact on known archaeological sites.

Cultural Values/Traditional Cultural Practices: Traditional cultural practices on Mauna Kea are associated with resource locations, trails, individual topographic features, burial locations, and cultural landscapes. Contemporary cultural practices include prayer and ritual observances, the construction of new altars; subsistence and recreational hunting; and collection of stone from quarry sites. Concerns include the importance of maintaining access to the summit area for spiritual purposes and maintaining the integrity of the spiritual and sacred quality of the summit landscape.

Visual Aesthetics: The existing Keck I and Keck II Telescopes, as well as the other existing telescope facilities within the Astronomy Precinct, are generally visible from within the summit area. The Outrigger Telescopes also would be visible from most locations within the summit area. Like the Keck domes, the Outrigger Telescope domes would be white. Proper design and grading practices—such as using natural materials obtained from the project site for fill and surfacing—would minimize the visual impact. The dome ring wall and any necessary retaining walls would be colored to blend into the existing terrain.

Below the summit, the view of the existing astronomy facilities on the summit from the access road is typically blocked by the topography of the mountain. This would also be the case for the Outrigger Telescopes. Some of the existing facilities are visible from lower elevation areas such as Hilo, Honoka`a and Waimea. The proposed Outrigger Telescopes would be barely perceptible from areas where the Keck domes are visible.

Consideration of Alternative Sites. NASA developed two tiers of criteria to determine the location for the Outrigger Telescopes which would meet the scientific objectives. Eleven sites were considered. All of the alternative sites, other than the WMKO site, failed to meet one or more of the criteria and, therefore, were not evaluated further.

Tier 1 criteria were based on physical conditions for a site. The primary Tier 1 criterion was the presence of at least one large telescope (at least 8 meters (26 feet) in diameter) with which the Outrigger Telescopes can act as an interferometer. Other Tier 1 criteria involved having enough land available to achieve adequate separation, orientation of the telescopes, and site observing quality. Other than the WMKO site, only two other sites met the Tier 1 criteria (Cerro Paranal, Chile; Mt. Graham, Arizona). Tier 2 criteria included maximizing sky coverage and programmatic feasibility factors including technical, additional facilities, and cost. Only the WMKO site met all the Tier 1 and Tier 2 criteria.

No-Action Alternative. Under the No-Action Alternative NASA would not fund on-site construction, installation, or future operation of the Outrigger Telescopes Project proposed for the WMKO site at Mauna Kea. The potential environmental impacts described for the Outrigger Telescopes Project in this EA would not occur. If the Outrigger Telescopes are not constructed and installed at the WMKO on Mauna Kea, the facilities at the WMKO site would consist of the two existing 10-meter (33-foot) Keck Telescopes which are capable of functioning as the Keck-Keck Interferometer. NASA would be able to attain only two of the science objectives discussed in Section 1.3. The remaining four science objectives would not be met. In addition, the No-Action Alternative would result in economic losses to the State of Hawai`i of the estimated \$10 to \$11 million for the on-site construction and installation of six Outrigger Telescopes. Further, the incremental revenues that would be associated with operation of the Outrigger Telescopes Project would also be lost to the State. NASA's funding for the Wekiu bug on-site mitigation, the autecology study, and the 18-month Wekiu bug monitoring activities would not occur. NASA's funding for the on-site and off-site mitigation activities proposed by NASA in the Section 106 process also would not occur.