FINAL ENVIRONMENTAL ASSESSMENT & FINDING OF NO SIGNIFICANT IMPACT, CALTECH SUBMILLIMETER OBSERVATORY DECOMMISSIONING

Volume 2: Appendices A, B, and C

PREPARED FOR:

California Institute of Technology

PREPARED BY:

PLANNING SOLUTIONS

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Appendix A. Site Decommissioning Plan

SITE DECOMMISSIONING PLAN FOR THE CALTECH SUBMILLIMETER OBSERVATORY

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LIST OF ACRONYMS

AA	Archaeological Assessment
AMP	Archaeological Monitoring Plan
BLNR	Board of Land and Natural Resources
BMP	Best Management Practices
BOR	Board of Regents
BSA	Biological Site Assessment
Caltech	California Institute of Technology
CBA	Cost-Benefit Analysis
CDUA	Conservation District Use Application
CDUP	Conservation District Use Permit
CIA	Cultural Impact Assessment
CIT	California Institute of Technology
CMP	Mauna Kea Comprehensive Management Plan
CMS	Center for Maunakea Stewardship
CSO	Caltech Submillimeter Observatory
DHHL	Department of Hawaiian Home Lands
DLNR	Department of Land and Natural Resources
DOCARE	Division of Conservation and Resources Enforcement, DLNR
DOFAW	Division of Forestry and Wildlife, DLNR
DOH	Department of Health, State of Hawaiʻi
DP	Decommissioning Plan For The Mauna Kea Observatories
EA	Environmental Assessment
EDD	Environmental Due Diligence
EIS	Environmental Impact Statement
ESA	Environmental Site Assessment
FONSI	Finding of No Significant Impact
HAR	Hawaiʻi Administrative Rules
HCFD	Hawaiʻi County Fire Department
HIOSH	Hawaii Occupational Safety and Health Division
HRS	Hawaiʻi Revised Statutes
IfA	Institute for Astronomy

JCMT	James Clerk Maxwell Telescope
KKM	Kahu Kū Mauna
LBP	Lead-Based Paint
LCP	Lead-Containing Paint
LEI	Lehua Environmental, Inc.
MEP	Mechanical, Electrical, and Plumbing
MKMB	Mauna Kea Management Board
MKO	Maunakea Observatories
MKSR	Mauna Kea Science Reserve
MKSS	Mauna Kea Observatory Support Services
NAR	Natural Area Reserve, DLNR
NARS	Natural Area Reserves System, DLNR
NOI	Notice of Intent to Decommission CSO
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places
NRL	Naval Research Laboratory
OCCL	Office of Conservation and Coastal Lands, DLNR
OHA	Office of Hawaiian Affairs
OMKM	Office of Mauna Kea Management
OSHA	Occupational Safety and Health Administration
PTA	Pōhakuloa Training Area, Army
RAP	Remedial Action Plan
REC	Recognized Environmental Conditions
SAP	Environmental Site Assessment Phase II Sampling and Analysis Plan
SDP	Site Decommissioning Plan
SDRP	Site Deconstruction and Removal Plan
SHPD	State Historic Preservation Division, DLNR
SIHP	State Inventory of Historic Places
SRP	Site Restoration Plan
Sublease	Sublease Agreement between UH and Caltech
SWPPP	Storm Water Pollution Prevention Plan
TMK	Tax Map Key
TMT	Thirty Meter Telescope

UH	University of Hawai‘i
UHH	University of Hawai‘i at Hilo
VIS	Visitor Information Station

CHAPTER 1: INTRODUCTION TO THE SITE DECOMMISSIONING PLAN

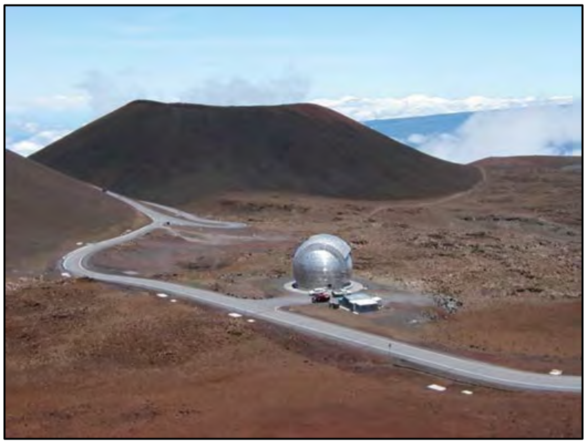
1.1 INTRODUCTION

The Caltech Submillimeter Observatory (CSO) facility is located on a small portion of TMK No. No. 4-4-015:009, which is known as the Mauna Kea Science Reserve (MKSR), near the summit of Maunakea in the Hāmākua District on the Island of Hawaiʻi (see Figure 1-1). This facility is owned and operated by the California Institute of Technology (henceforth referred to as "Caltech") on land subleased from the University of Hawaiʻi (UH), which in turn leases the MKSR from the State of Hawaiʻi, Board of Land and Natural Resources (BLNR). When the CSO was operational, it was a 10.4-meter (34 foot) diameter telescope engaged in astronomical observations in the terahertz radiation band (submillimeter wavelengths). The CSO saw first light in 1986 and was closed 29 years later on September 8, 2015. Caltech formally tendered its Notice of Intent (NOI) to decommission the CSO to the UH Office of Mauna Kea Management (OMKM, now the Center for Maunakea Stewardship) on November 18, 2015.[1] The current state of the CSO facility is shown in Figure 1.2.

This Site Decommissioning Plan (SDP) describes the steps and processes that Caltech intends to take to decommission the CSO and restore the area pursuant to the *Mauna Kea Comprehensive Management Plan* (CMP, 2009), and specifically to its component *Decommissioning Plan for the Mauna Kea Observatories* (DP, 2010). The DP provides a framework for observatories on Maunakea, to ensure that the State of Hawaiʻi, Department of Land and Natural Resources (DLNR) as landowner, the UH as lessee and permittee, and the observatories as sublessees all have clear expectations of the observatory decommissioning process and can plan appropriately for it. In principle, the DP: (*i*) defines decommissioning and the steps necessary to achieving it; (*ii*) outlines the terms of decommissioning contained in UH's master lease and existing sub-leases; (*iii*) provides information on financial planning for decommissioning; and (*iv*) offers guidance for the practical course of action needed to implement decommissioning.

[1] On August 20, 2020, the University of Hawaiʻi's Board of Regents approved restructuring of the management of Maunakea by merging Mauna Kea Observatory Support Services (MKSS) with the Office of Mauna Kea Management (OMKM) and other UH responsibilities under one management entity identified as the Center for Maunakea Stewardship (CMS). While this document makes references to OMKM related to past reviews and approvals, all future decommissioning activities will be coordinated with CMS.

Figure 1-1: Caltech Submillimeter Observatory

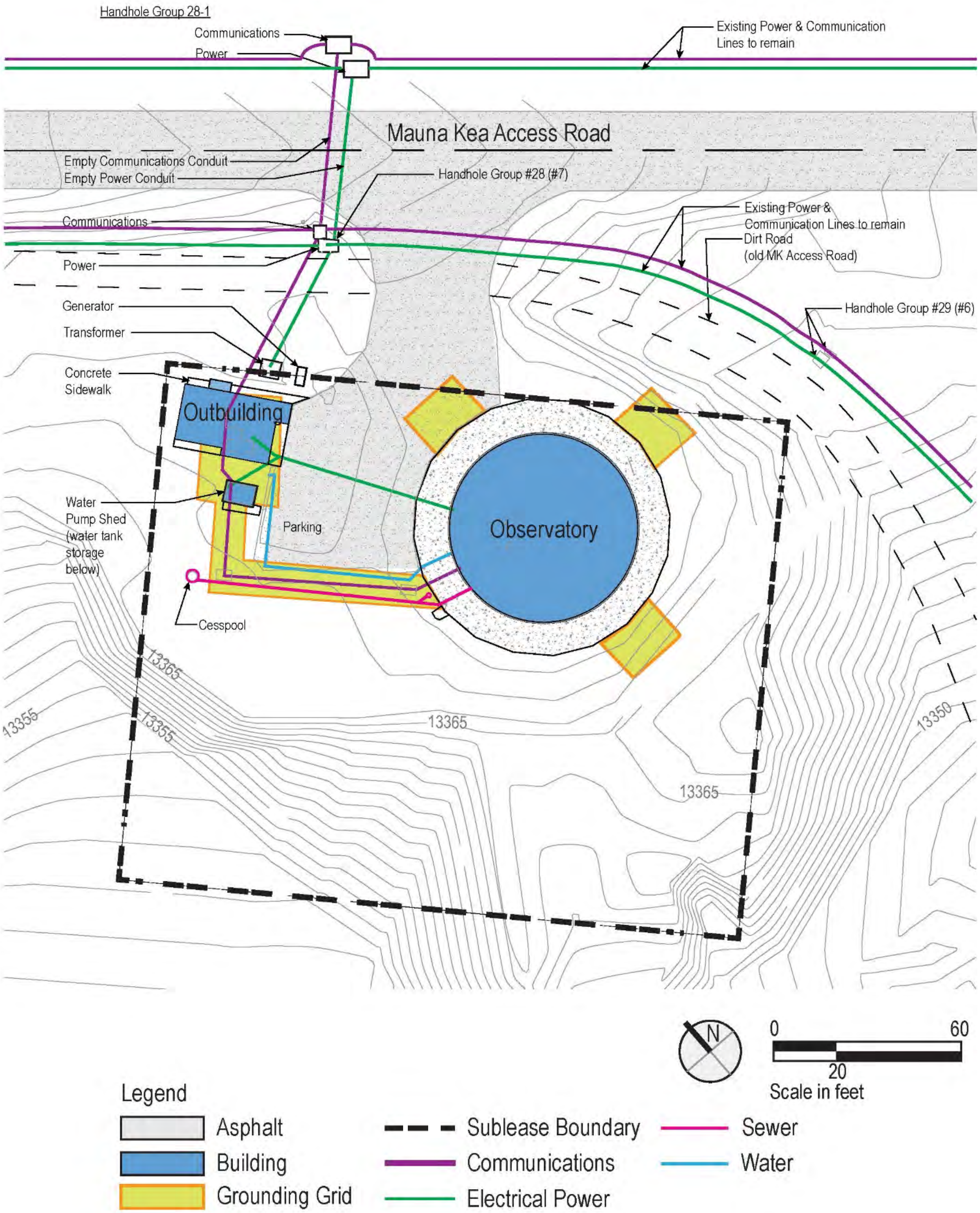


The CSO stands beside the Mauna Kea Access Road.

The CSO with dome open

Source: CSO

Figure 1-2: Current State of the CSO Facility



Source: M3 Engineering and Technology (2020)

As established in Section 4.2 of the DP, each observatory has unique circumstances, but the SDP must document the condition of the site to be decommissioned, outline the approach to decommissioning, and propose a plan for site restoration. In order to do that in an orderly way, the DP stipulates that an SDP shall be developed in stages, consisting of the following four sequential components:

1. Notice of Intent (NOI).
2. Environmental Due Diligence (EDD) review.
3. Site Deconstruction and Removal Plan (SDRP).
4. Site Restoration Plan (SRP).

Pursuant to Section 4.2.4 of the DP, an additional requirement is for a Cost-Benefit Analysis (CBA) across a range of viable alternative approaches to decommissioning, analyzing each alternative's potential benefits and impacts on natural and cultural resources during and after a facility's deconstruction, removal, and restoration of its site. Figure 1-4 presents the sequence of an SDP as a flow chart drawn from the DP.

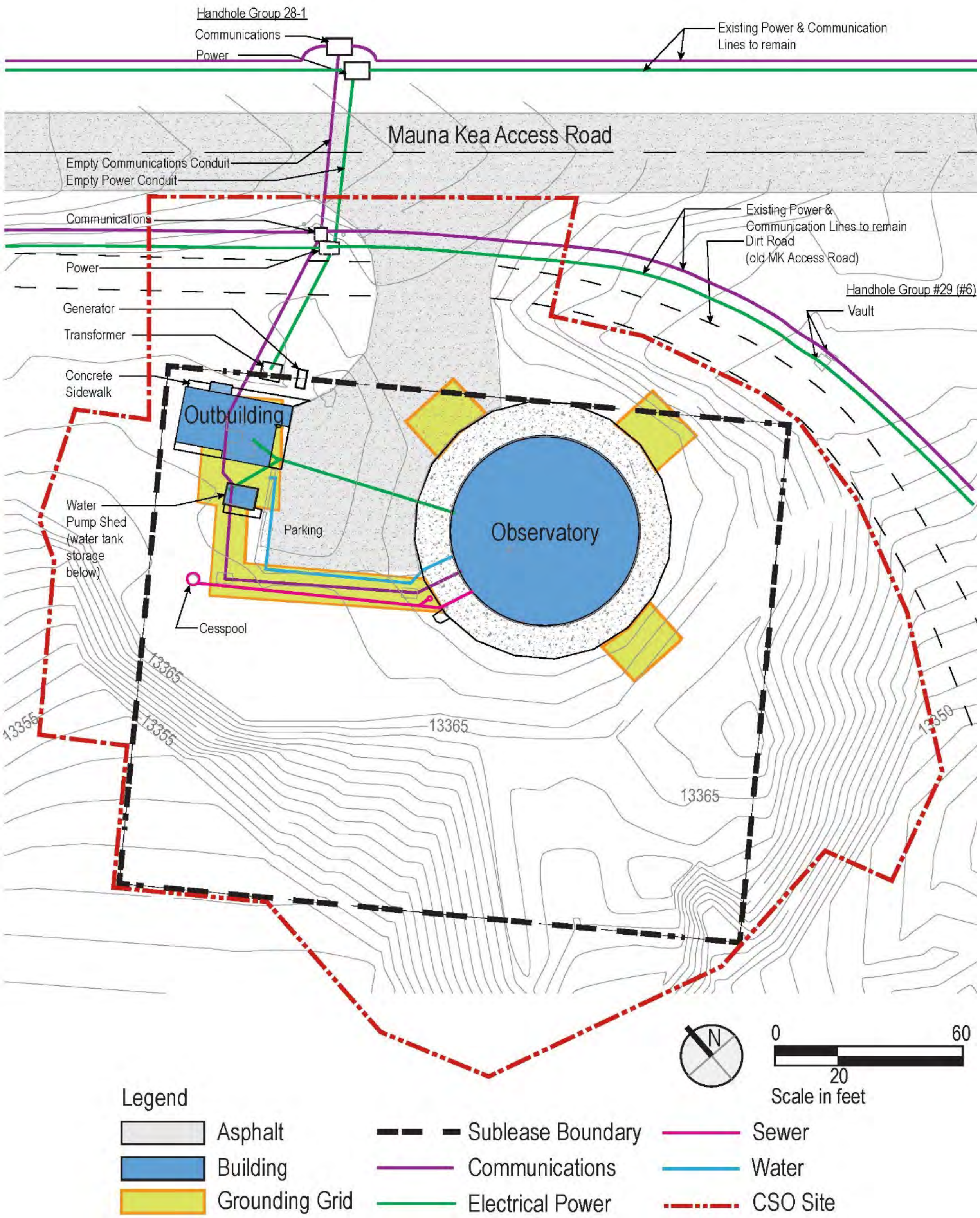
This SDP defines the CSO Site as the sublease area and other minor adjacent areas that were disturbed during the original construction or will be disturbed during the decommissioning of the CSO (Figure 1-3). This SDP also identifies a Preferred Alternative, which consists of complete facility and infrastructure removal and full restoration of the CSO Site.

All components of this SDP have been developed by Caltech in coordination with the Center for Maunakea Stewardship (CMS) and in accordance with the DP. CMS will, in turn, coordinate reviews by (*i*) Kahu Kū Mauna Council (KKM), an advisory group composed of members of the Native Hawaiian community, and (*ii*) the Mauna Kea Management Board (MKMB), an advisory group composed of members from the Hawai‘i Island community. Both KKM and MKMB advise CMS, and the Chancellor of the University of Hawai‘i at Hilo (UH Hilo) on matters related to Maunakea. In addition, CMS will coordinate reviews by its Environmental Committee and Decommissioning Review Committee. MKMB's recommendation is forwarded to the UH President. The Final SDP may require the approval of the UH Board of Regents (BOR). Lastly, the State of Hawai‘i Board of Land and Natural Resources (BLNR) issue a Conservation District Use Permit (CDUP) for the decommissioning.[2]

Based on the guidance contained in the DP, the following subsections briefly characterize the purpose(s) and content of the components of the SDP. Readers should note that the use of terms such as *deconstruction*, *demolition*, *facility*, *infrastructure*, *removal*, and *restoration* in this SDP are the same as defined in the DP.

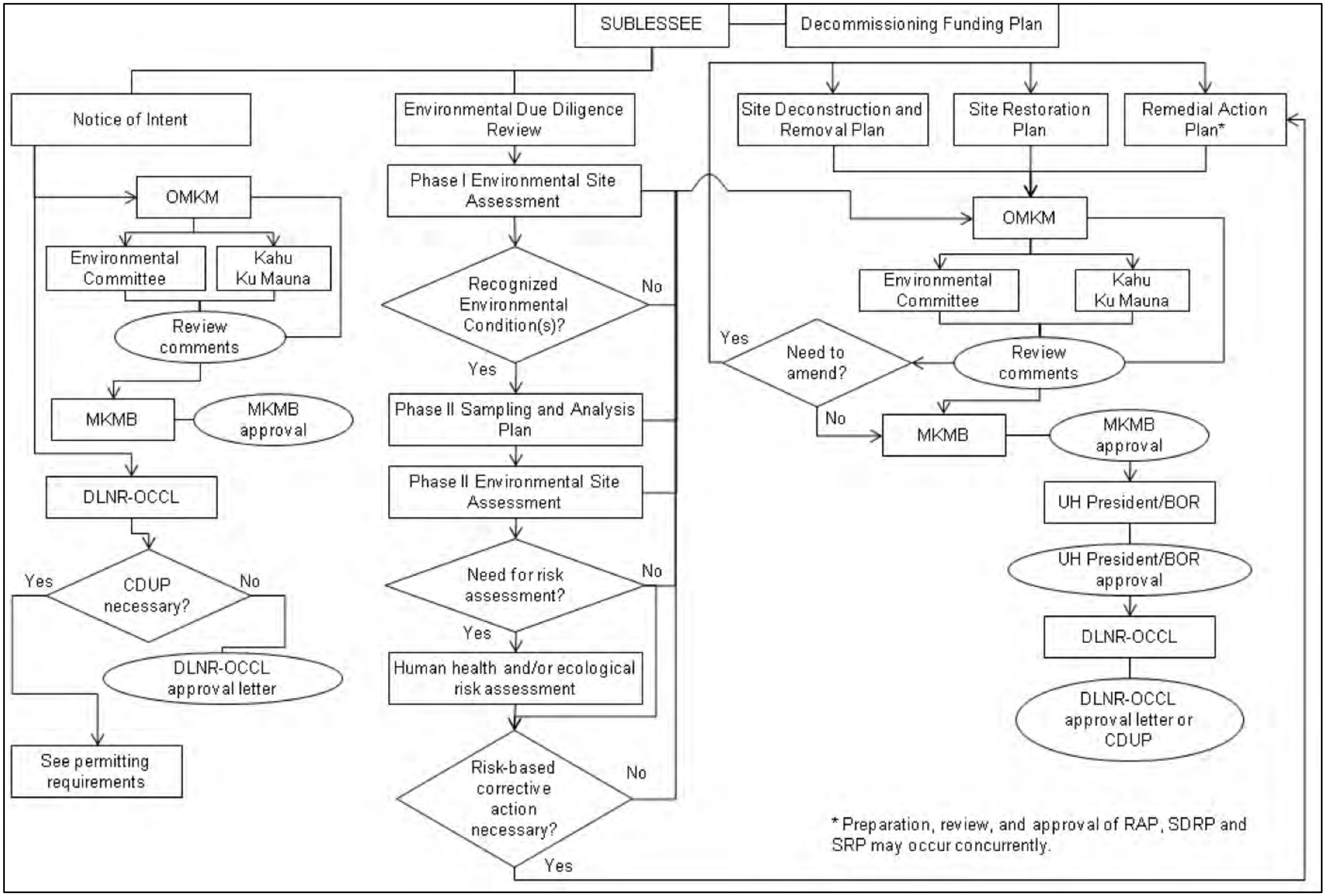
[2] The CDUP process is managed by DLNR's Office of Conservation and Coastal Lands (OCCL). In a letter dated February 19, 2016, OCCL indicated the CDUP for the decommissioning of CSO will be a Board Permit.

Figure 1-3: Extent of the CSO Site



Source: M3

Figure 1-4: Components of a Site Decommissioning Plan



Source: *Decommissioning Plan* (2010), Figure 1. Components of a Site Decommissioning Plan; page 19.

1.2 COMPONENTS OF THE SDP

1.2.1 Notice of Intent (NOI)

The DP stipulates that:

> *The first component of the decommissioning process is the preparation of a* Notice of Intent (NOI) ... *The purpose of the Notice of Intent is to propose whether a site will be removed, continued for use as an observatory by a third party, or retrofitted for a different use. Intentions for site restoration should also be described in the Notice of Intent.* (DP 2010, Section 4.2.1, p. 20)

Caltech submitted its *Notice of Intent to Decommission CSO* (NOI) to OMKM on November 18, 2015. On March 22, 2016, Caltech submitted an addendum to that NOI consisting of an updated site plan of CSO. The NOI stated that Caltech's intent with the decommissioning process was total removal of all structures and full restoration of the site, followed by surrender of the sublease to UH. The NOI is further discussed in Chapter 2 and the NOI, its addendum, and documentation of its formal acceptance by OCCL, OMKM, and UH are included in Appendix A.

1.2.2 Environmental Due Diligence Review (EDD)

A Phase I Environmental Site Assessment (ESA) to identify any recognized environmental conditions (RECs) is the first step in the EDD review. When a REC is identified, an additional investigative analysis in the form of a Phase II ESA is typically required and subsequent steps may be necessary. All steps are subject to evaluation by UH and OCCL.

Caltech conducted a Phase I ESA in 2016 that identified a REC: hydraulic oil residue below the telescope and slab foundations. This residue is the result of a spill reported to the State of Hawaiʻi Department of Health (DOH) in 2009 and possibly prior spills during the initial construction of CSO. Caltech has prepared a draft Phase II Sampling and Analysis Plan (SAP) per the DP-identified process. These are discussed in Chapter 3 and together make up the EDD review to date; the Phase I ESA is provided in Appendix B and the Phase II SAP is included in Appendix C.

1.2.3 Site Deconstruction and Removal Plan (SDRP)

The purpose of the SDRP is to document the proposed methods and activities for (*i*) demolishing, in part or total, the improvements on the subject site, (*ii*) grading and grubbing of the site, (*iii*) stockpiling of fill material(s), and (*iv*) all necessary waste recovery, reuse, and/or disposal operations. In its final form, the SDRP will include copies of required plans, drawings, permits, and authorizations required to implement it. The DP stipulates that the SDRP also include a CBA and schedule for implementation.

The CSO deconstruction and removal methods, activities, and schedule are outlined in Chapter 5. Because the DP stipulates that both the SDRP and SRP include a CBA, the CSO CBA is presented separately in Chapter 7 and addresses both the SDRP and SRP CBA requirements.

1.2.4 Site Restoration Plan (SRP)

The purpose of the SRP is to present specific targets for site restoration and to describe the methods planned for restoring disturbed areas after the deconstruction and removal activities characterized in the SDRP are complete. As with other components of the SDP, the SRP is unique to the observatory site, and considers the cultural, biological, and physical aspects of site being restored. The SRP must include provisions for monitoring the effectiveness of site restoration activities and characterizing the success and/or failure of restoration efforts. The DP indicates that principles of adaptive management are applicable to the SRP; however, there are no previous efforts that would inform the planned CSO effort on a lava substrate.

The DP indicates site restoration includes physical and ecological components. There are two integral objectives for site restoration: (*i*) restoring the look and feel of the site prior to construction of the observatory, and (*ii*) providing habitat for arthropod fauna. The CSO SRP in Chapter 6 provides and reviews available original observatory construction documents and presents the methods Caltech will use to restore the site to a condition consistent with pre-construction conditions and in harmony with adjacent areas. In support of the second objective noted above, the SRP in Chapter 6 evaluates the potential for native arthropod habitat restoration in consultation and coordination with CMS.

The DP indicates that the level of restoration attempted and the potential benefits and impacts of the restoration activities on natural and cultural resources during and post-activity are to be carefully evaluated, and a CBA provided. Because the DP stipulates that both the SDRP and SRP include a CBA, the all-inclusive CSO CBA is presented separately in Chapter 7.

1.3 PERMITTING, DISCLOSURE, AND ALTERNATIVES

This section provides an overview of land use requirements to implement the SDP. OCCL indicated in its letter dated February 19, 2016 (Reference No. HA-16-118), to OMKM that a Hawaiʻi Revised Statutes (HRS) Chapter 343 Environmental Assessment (EA) and a Conservation District Use Permit (CDUP) from the BLNR will be required. In that letter, it identified the EA and Conservation District Use Application (CDUA) as “next steps” in the decommissioning process and directed that the EA discuss the preferred alternative for deconstruction and removal of the CSO facility and restoration of the site. Caltech began consulting with other permitting authorities related to various aspects of the SDRP in early 2018.

1.3.1 Environmental Assessment (EA)

HRS Chapter 343 and its implementing regulations in HAR Chapter 11-200.1 govern EAs. UH has indicated that the CSO decommissioning project will be an “applicant action” with Caltech being the applicant and BLNR being the “approving agency.” The EA will assess and disclose project impacts, including whether the proposed project will have a significant impact in the context of the 13 significance criteria in the regulations.

The primary relevance of the EA to this SDP is that the alternatives included in this SDP are the same alternatives that will be considered in the forthcoming Draft EA (DEA), and that the specific proposal for total removal of CSO facilities and full restoration of the site will be the Preferred Alternative in that report. Readers should also note that the CBA in this SDP (Chapter 7) is different in nature and scope than the EA's analysis of potentially significant impacts, and the two should not be conflated.

1.3.2 Alternatives Included in the SDP

Table 1-1 briefly summarizes the potential alternatives that will be considered in detail in this SDP and the forthcoming EA. This range of alternatives is detailed in Chapter 4 and includes the Preferred Alternative[3], which consists of complete facility and infrastructure removal and full restoration of the CSO Site. Alternatives have been developed based on the scenarios contained in the DP, as well as the specific examples of alternatives recommended for inclusion in EAs and EISs contained in HAR § 11-200.1-24(h). These recommendations include a "No Action" alternative, which would not fulfill the objectives of the SDP, but is useful as a baseline for comparison of impacts with the action alternatives. The range of alternatives presented here will also be evaluated in the CBA presented in Chapter 7 of this report.

In addition to the scope of decommissioning outlined in Table 1-1, the future decommissioning of shared infrastructure is a component of all action alternatives. Shared infrastructure consists of utility improvements shared by multiple Maunakea observatories or uses (e.g., utility conduits and lines that serve both CSO and nearby James Clerk Maxwell Telescope (JCMT). Caltech cannot remove the shared infrastructure because it needs to remain in place to service the other facilities and uses it supports. As part of its CSO decommissioning, Caltech will provide funds to UH equal to its pro-rated portion of cost estimates for the removal of the shared infrastructure. Those costs are included in decommissioning cost estimates and funding commitments in Chapter 7 and Chapter 8.

[3] The Preferred Alternative is the proposed "action" as that term is defined in HAR § 11-200.1-2.

Table 1-1: Alternatives Included in the SDP and EA

Alt No.	Summary	Description
ALT-1	No Action	Nothing would change from the existing state of the site. The observatory and all other above-ground improvements would remain unchanged from their current condition. All above- and below-ground infrastructure (including foundation, cesspool, etc.) would remain unchanged. There would be no restoration of topography or habitat.
ALT-2	Preferred Alternative or Action; complete facility and infrastructure removal with full restoration	The observatory, outbuilding, and other above-ground facilities would be completely removed. In addition, all subsurface infrastructure within the CSO Site, including but not limited to foundations and cesspool, would be completely removed. The topography of the site would be restored to its pre-construction condition to the extent practicable. Native arthropod habitat would be restored to the extent practicable.
ALT-3	Complete facility and infrastructure removal with moderate restoration	The facility and infrastructure removal would be the same as ALT-2. This alternative addresses the circumstance in which unanticipated factors, only evident after removal begins, preclude full restoration of the CSO Site but moderate restoration is feasible. The topography would not match pre-construction conditions but would be restored to a natural look and feel to the extent practicable. Native arthropod habitat would be restored but full restoration of topography would not be achieved.
ALT-4	Facility removal, infrastructure capping, and moderate restoration	This alternative addresses the circumstance in which unanticipated conditions, only evident after removal begins, preclude complete removal of subsurface infrastructure and full restoration. The observatory, outbuilding, and other above-ground facilities would be completely removed. The observatory and outbuilding foundations, cesspool, and other subsurface infrastructure would be removed to the extent practicable, but some portions would remain. Subsurface utilities on the CSO Site would be capped and abandoned in place. The site would be regraded such that the effects of all removal activity, including trenching to remove subsurface infrastructure, are not visible. The topography would not fully match pre-construction conditions but would be restored to a natural look and feel. Native arthropod habitat would be restored but full restoration of topography would not be achieved.

Source: Caltech (2020)

1.3.3 Anticipated Permitting Associated with Preferred Alternative

The anticipated permitting process required for the current Preferred Alternative after the SDP and EA are complete includes a CDUP Board Permit from BLNR, a National Pollutant Discharge Elimination System (NPDES) construction activities permit from DOH, and ministerial construction activity permits from the County of Hawaiʻi. During the EA process Caltech will consult with these and other agencies to confirm what permits will be required.

CHAPTER 2: NOTICE OF INTENT (NOI)

The NOI advises UH of Caltech's intent to decommission the CSO. It provides a detailed inventory of all the above-ground structures, foundations, and subsurface structures on the site, including drawings detailing the foundations and cesspool. It states that Caltech's intent is *total removal* of structures and infrastructure on the site and *full restoration* of the site followed by surrender of the sublease to UH.

Submittals and actions related to NOI to date, all of which are included in Appendix A, are listed below:

1. Caltech submitted its 'Notice of Intent to Decommission' CSO to the Office of Mauna Kea Management on November 18, 2015.
2. Caltech submitted on March 22, 2016, to OMKM an addendum consisting of updated site plan provided by dlb & Associates (2016).
3. In a February 15, 2016, letter to OMKM, addressing the NOI, DLNR-OCCL indicated that the CSO NOI appears "to be in compliance with the requirements of the Decommissioning Plan."
4. Kahu Kū Mauna reviewed the CSO NOI on April 12, 2016.
5. MKMB unanimously approved the CSO NOI at its meeting on May 11, 2016.
6. UH approved it on December 20, 2019 (Memorandum from Stephanie Nagata, Director, OMKM to David Lassner, President, UH, via Bonnie Irwin, Chancellor, UH Hilo; signed by Lassner and Irwin to indicate approval).

The NOI has not been modified since the 2016 addendum (Item 2 above). The scope of the SDP's preferred alternative is consistent with the NOI. Since 2016, deconstruction details have come into sharper focus as subsequent steps in the decommissioning planning process have progressed. The NOI has not been and will not be further amended. The new information is reflected in the detailed plans concerning site decommissioning in subsequent chapters of this SDP.

CHAPTER 3: ENVIRONMENTAL DUE DILIGENCE (EDD) REVIEW

3.1 INTRODUCTION

The EDD review commences with a Phase I ESA. The goal of a Phase I ESA is to identify recognized environmental conditions (RECs), which is defined by *ASTM Standard E1527-13* as:

> *"the presence or likely presence of any hazardous substances or petroleum products on a property: (1) due to release to the environment; (2) under conditions indicative of a release to the environment; or (3) under conditions that pose a material threat of a future release to the environment.* De minimis *conditions are not recognized environmental conditions."*

If RECs are identified in the Phase I ESA, then a Phase II ESA is typically required. If sample collection is required, a Phase II Sampling and Analysis Plan (SAP) is prepared first. The DP outlines potential subsequent steps that may be required to address RECs if they persist.

Caltech conducted a Phase I ESA that identified a REC. Subsequently, Caltech prepared a Draft Phase II SAP. The Phase II SAP can only be implemented during the deconstruction of the CSO; sample results will inform a Phase II ESA that will be prepared during deconstruction. The Phase II ESA may recommend subsequent measures to address the REC; those measures would be implemented during site restoration. The following sections provide detail on each of these elements; the Phase I ESA is included in Appendix B and the draft Phase II SAP is included in Appendix C.

3.2 CSO PHASE I ENVIRONMENTAL SITE ASSESSMENT

Caltech contracted with ENPRO Environmental to conduct the Phase I ESA (Appendix B). The following sections summarize the Phase I ESA and its review and approval by UH.

3.2.1 Phase I ESA Summary

The Phase I ESA's §1.1 *Findings and Conclusions* states

> ***This assessment has revealed no evidence of* recognized environmental conditions (RECs) *in connection with the* property *except for the following:***
>
> > *REC 1 Hydraulic Fluid Release. This finding is considered a recognized environmental condition because, despite the release being cleaned up to the satisfaction of the Department of Health there is a No Further Action status pending further soil testing under the slab after the decommissioning of the observatory.*

The Phase I ESA indicates that there may have been two hydraulic fluid releases at the site. One release was identified in 2009, which was reported to the State of Hawaiʻi DOH. The Phase I report states, "Cleanup of the May 2009 hydraulic oil release has been completed to the satisfaction of the Department of Health. However, a *No Further Action* designation is pending additional investigation and cleanup to be undertaken when the observatory decommissions." During the remedial actions associated with 2009 release, evidence of an earlier release was observed and, as summarized in a letter from OCCL to CSO (OCCL, 2009), the second release possibly occurred, "during the construction phase before the slab was poured more than 20 years ago. It has been recommended that the cleanup of this material be deferred until the decommissioning of the CSO facility."

The Phase I ESA recommends that soil samples be collected and analyzed for contaminants associated with hydraulic fluid to assess whether the spill has been fully remediated. The implementation of this recommendation by Caltech is discussed in Section 5.1.11.

3.2.2 Phase I ESA Review and Approval by UH

Caltech submitted the Phase I ESA to OMKM on June 14, 2018.[4]

Following Kahu Kū Mauna, Environmental Committee, and Decommissioning Design Review Committee review and comment, MKMB considered the Phase I ESA at its September 27, 2019, meeting and approved it.

UH approved the Phase I ESA on December 20, 2019 (Memorandum from Stephanie Nagata, Director, OMKM to David Lassner, President, UH, via Bonnie Irwin, Chancellor, UH Hilo; signed by Lassner and Irwin to indicate approval).

3.3 REMAINING EDD REVIEW TASKS

The Phase I ESA identified a need for sampling and analysis of the region affected by the hydraulic spill during deconstruction when the ground under the foundation becomes accessible. A draft Phase II SAP is included in Appendix C, will be reviewed by the State of Hawai'i Department of Health (DOH), CMS, and UH, and then will be implemented during CSO deconstruction. The Phase II SAP objective related to the hydraulic oil release is to assess whether contaminants associated with it are present in soil beneath the CSO foundation slab. To achieve these objectives, soil samples will be collected per the Phase II SAP during the CSO deconstruction and removal phase of the decommissioning.

Stakeholders have indicated to Caltech a concern regarding the potential for the CSO cesspool to have adversely impacted the subsurface. Therefore, although the cesspool is not a REC and there is no regulatory or DP requirement to investigate the cesspool, Caltech has incorporated an investigation of it into the Phase II SAP. Soil samples will be collected beneath the cesspool per the Phase II SAP during the CSO deconstruction and removal phase of the decommissioning. Those samples will be analyzed for contaminants potentially present at film processing sites and mercury, even though film was never processed and mercury never used at CSO.

Each soil sample collected will consist of roughly 3.3 pounds (1.5 kilograms) of soil and will be shipped to certified laboratory on the U.S. mainland. The soil samples must be shipped, handled, and disposed of per the laboratory's permit and cannot be returned to Maunakea. It will take roughly two weeks for the samples collected during the deconstruction and removal phase to be analyzed by the laboratory and the results provided to Caltech's environmental consultant. The

4 Caltech submitted the Phase I ESA on March 30, 2016. OMKM raised concerns regarding the accuracy of its geology/hydrology review. The resubmission of the Phase I ESA incorporated a Letter of Clarification from ENPRO regarding this topic in response to this concern. The Phase I ESA itself remained unchanged.

consultant is expected to require two weeks from receipt of analytical results to prepare a Phase II ESA report summarizing the implementation of the SAP and assessing any remaining human health or ecological risks. To the degree possible, the deconstruction sequence will be managed such that the sampling can be done and then, while the samples are analyzed and results considered, other deconstruction activities can continue. The Phase II ESA will state whether a Remedial Action Plan (RAP) is necessary to mitigate any remaining risks to human health and/or the environment.

3.4 OTHER ENVIRONMENTAL CONCERNS

Caltech contracted with Lehua Environmental, Inc. (LEI) to conduct a survey of asbestos, lead paint and mold in the CSO structures (Lehua HazMat Report, 2019; Appendix D). LEI found:

- No asbestos in the samples collected.
- Lead was detected at less than 5,000 mg/kg in the majority of the paint chip samples collected, making them lead-containing paint (LCP). Lead in excess of the EPA/HUD guideline of 5,000 mg/kg was detected in some paint chip samples, which means paint represented by those samples is considered to be lead-based paint (LBP).
- No mold or fungi of concern.

The SDRP (see Chapter 5) includes Best Management Practices (BMPs) that will be implemented during deconstruction to address the LCP and LBP (Section 5.1.2.3).

CHAPTER 4: ALTERNATIVES

4.1 PURPOSE AND NEED

Caltech's purpose is to comply with end-of-sublease conditions in the sublease between Caltech and UH for the site where the CSO is located. The "Sublease Agreement among the California Institute of Technology, the University of Hawai'i, and the State of Hawai'i, Department of Land and Natural Resources, Sublease H09176" (CSO Sublease 1983) offers four options on termination or expiration of the sublease:

1. Sale to UH
2. Surrender with concurrence of UH
3. Sale to a third party acceptable to UH
4. Remove the property and restore the site to even grade at the expense of Caltech

In order to proceed with any end-of-sublease option, Caltech needs to address applicable CMP guidance, specifically its DP, so that it may obtain the necessary approvals and permits, which are government actions, that will allow for the decommissioning of the CSO to proceed. The DP outlines removal options and restoration levels and states that "For decision making purposes, the starting point for determining the scope and extent of removal shall be total removal" and "The starting point for determining the level to which a site is to be restored shall be total restoration to the pre-construction condition."

4.2 IDENTIFICATION OF FEASIBLE ALTERNATIVES

This section identifies a long list of potential alternatives based on the sublease conditions, the scenarios contained in the DP, as well as the specific examples of alternatives recommended for inclusion in EAs and EISs contained in HAR § 11-200.1-24.

Of the four end-of-sublease options outlined in the CSO Sublease, only the fourth, removal and restoration, is considered feasible because (*i*) UH has indicated they are not interested in purchasing the property in its entirety from Caltech, (*ii*) no third party has indicated an interest in buying the property in its entirety from Caltech, and (*iii*) although UH has not explicitly stated it, Caltech assumes that UH would not approve the surrender of the property in its entirety.[5]

The DP identifies two options for removal and three levels of restoration that can be considered:

- Removal options per the DP consist of:
  - Infrastructure capping (also referred to as "partial removal") involves removal of above ground facilities, with or without utilities, and leaves all or part of the underground portion of the facility in place. Under this option, varying degrees of infrastructure removal and capping can be considered.
  - Complete infrastructure removal (also referred to as "total removal" or "full removal") involves removal of the entire facility, including underground

[5] Surrendering is akin to the No Action alternative (ALT-1), except that it requires UH approval.

utilities, pilings, and foundation to the extent practicable under normal engineering deconstruction practices.

- Restoration levels per the DP consist of:
  - Minimal restoration is the removal of all manmade materials and grading of the site, leaving the area in safe condition.
  - Moderate restoration goes beyond minimal to include enhancing the physical habitat structure to benefit the native arthropod community.
  - Full restoration (also referred to as "total restoration") would return the site to its original pre-construction topography, as well as restoring arthropod habitat.

On behalf of Caltech, M3 Engineering and Technology Corporation (M3), which employs architects and engineers that specialize in observatories, has evaluated the feasibility of complete infrastructure removal and full restoration of the CSO Site. M3's analysis indicated a high level of confidence that complete infrastructure removal and full restoration is feasible and they have developed a plan to do so. Therefore, the full range of removal and restoration options is considered feasible, from complete infrastructure removal and full restoration at one end of the spectrum (the "starting point" per the DP) to infrastructure capping and minimal restoration at the other end. A simple integration of the options results in the following feasible alternatives:

1. **No Action**
2. **Complete facility and infrastructure removal with full restoration**
3. **Complete facility and infrastructure removal with moderate restoration**
4. Complete facility and infrastructure removal with minimal restoration (this DP alternative most closely parallels the CSO Sublease fourth option)
5. Complete facility removal, infrastructure capping, and full restoration
6. **Complete facility removal, infrastructure capping, and moderate restoration**
7. Complete facility removal, infrastructure capping and minimal restoration

OCCL and UH suggest alternatives that include retention of the outbuilding to support safety-related goals in the CMP also be considered. This introduces a third removal option and, when integrated with the restoration levels, results in the following feasible alternatives being added to those listed above:

8. Partial facility removal (outbuilding retention), infrastructure capping, and full restoration over about 80% of the Site
9. Partial facility removal (outbuilding retention), infrastructure capping, and moderate restoration over about 80% of the Site
10. Partial facility removal (outbuilding retention), infrastructure capping, and minimal restoration over about 80% of the Site

4.3 REASONABLE ALTERNATIVES FOR DETAILED CONSIDERATION

The full range of feasible alternatives (Section 4.2) was reduced to a reasonable set for detailed consideration in this SDP and the forthcoming EA. Those alternatives are in **bold** above, were introduced in Table 1-1, and are detailed in the sections below. The other alternatives listed in Section 4.2 were screened out and rejected from detailed consideration for the reasons described in Section 4.4.

4.3.1 ALT-1: No Action

Under the "No Action" alternative (i.e., ALT-1) nothing would change from the existing state of the site. No effort would be made to remove the improvements and infrastructure (the observatory, outbuilding, driveway, foundation, cesspool, utilities, etc.) and no effort would be made to restore any part of the site.

The No Action alternative does not address the purpose and need. It is only being considered in detail to provide a baseline for comparison with the other, action alternatives.

4.3.2 ALT-2: Complete Facility and Infrastructure Removal with Full Restoration

The complete facility and infrastructure removal with full restoration alternative (ALT-2) is, per the DP, the starting point for CSO decommissioning decision-making purposes. ALT-2 is consistent with the purpose and need (Section 4.1), Caltech's intent as outlined in the NOI (see Chapter 2 and Appendix A), and is the Preferred Alternative. Under this alternative, the following would be achieved at the CSO Site:

- Removal of the following using methods outlined in the SDRP presented in Chapter 5:
  - The observatory, outbuilding, and other above-ground facilities would be completely removed.
  - The observatory and outbuilding foundations, cesspool, and other subsurface infrastructure on the CSO Site would be completely removed. The bulk of the subsurface infrastructure did not require excavation into the existing lava flow during construction. That infrastructure, and the fill around it, can be readily removed. There are locations where excavation into the lava flow took place during CSO construction, for example, the cesspool. The cesspool and other infrastructure, and fill around them, where excavation into the lava flow occurred, can also be readily removed but doing so will create cavities that will be addressed in the restoration process.
- Site restoration, as follows, using the methods outlined in Chapter 6, the SRP:
  - The topography would be returned to its pre-construction condition to the greatest extent possible. This will be achieved by removing fill placed on the lava flow during construction to the greatest extent possible. Cavities in the lava flow, where excavation occurred during construction (e.g., the cesspool), will be filled with a portion of the fill placed on the lava flow during construction, which is native to Maunakea.

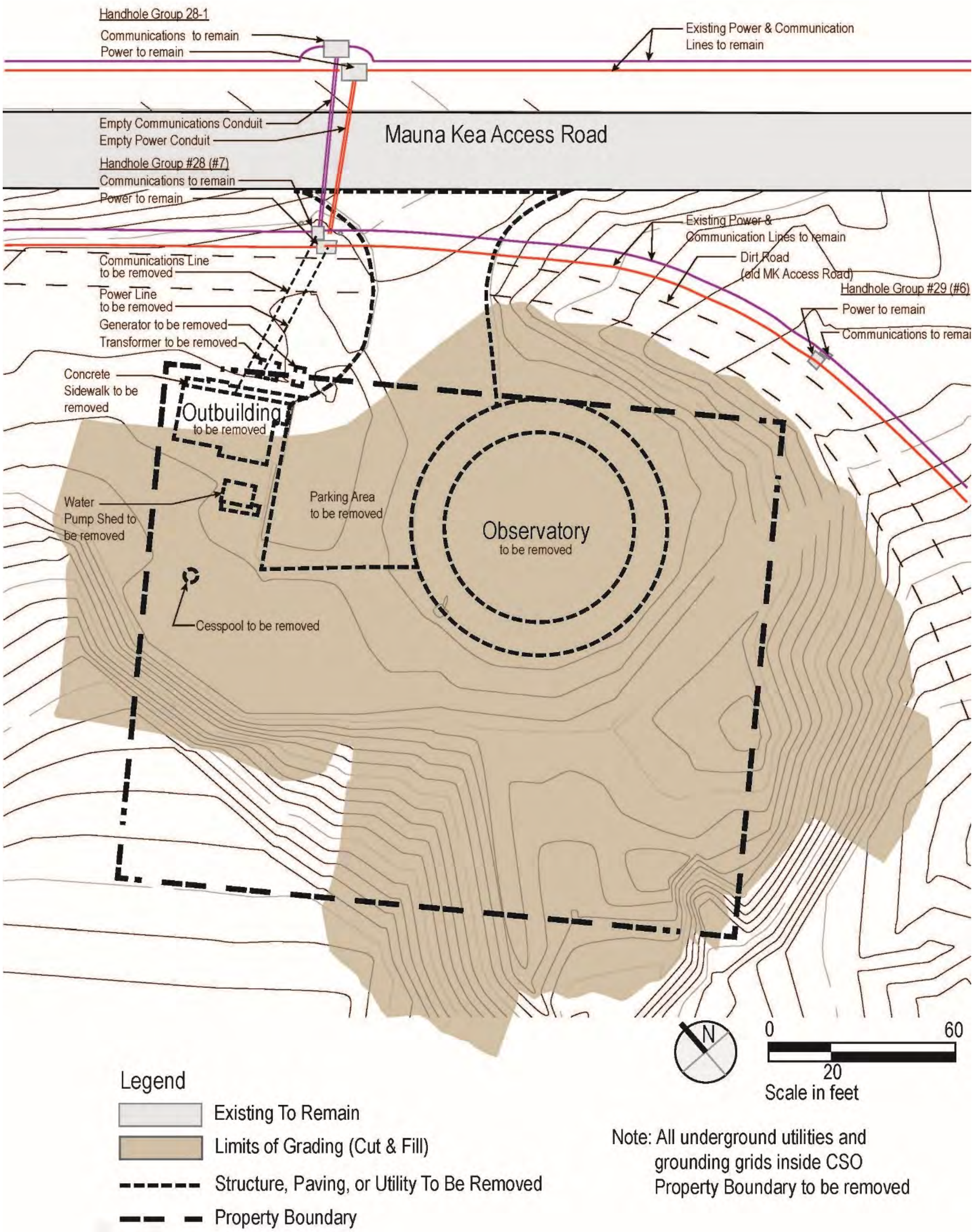
  - The habitat would be restored to accommodate arthropod fauna to the greatest extent possible. In areas where cavities in the lava flow have been filled, rocks will be piled instead of attempting to recreate the flow. This would return the entire site to a condition consistent with the surrounding environment.

- Biological monitoring to characterize the effectiveness of restoration efforts as discussed in Chapter 6, the SRP.

In addition, Caltech will provide funds to UH to support the future decommissioning of shared infrastructure. Shared infrastructure consists of utility improvements shared by multiple Maunakea observatories or uses. One example are the electrical and communication lines that cross under the CSO driveway between handhole #28 and #29 (Figure 4-1 and Figure 4-2). Caltech cannot remove the shared infrastructure because it needs to remain in place to service the other facilities and uses it supports. The funds Caltech will provide to UH equal its pro-rated portion of cost estimates for the removal of the shared infrastructure.

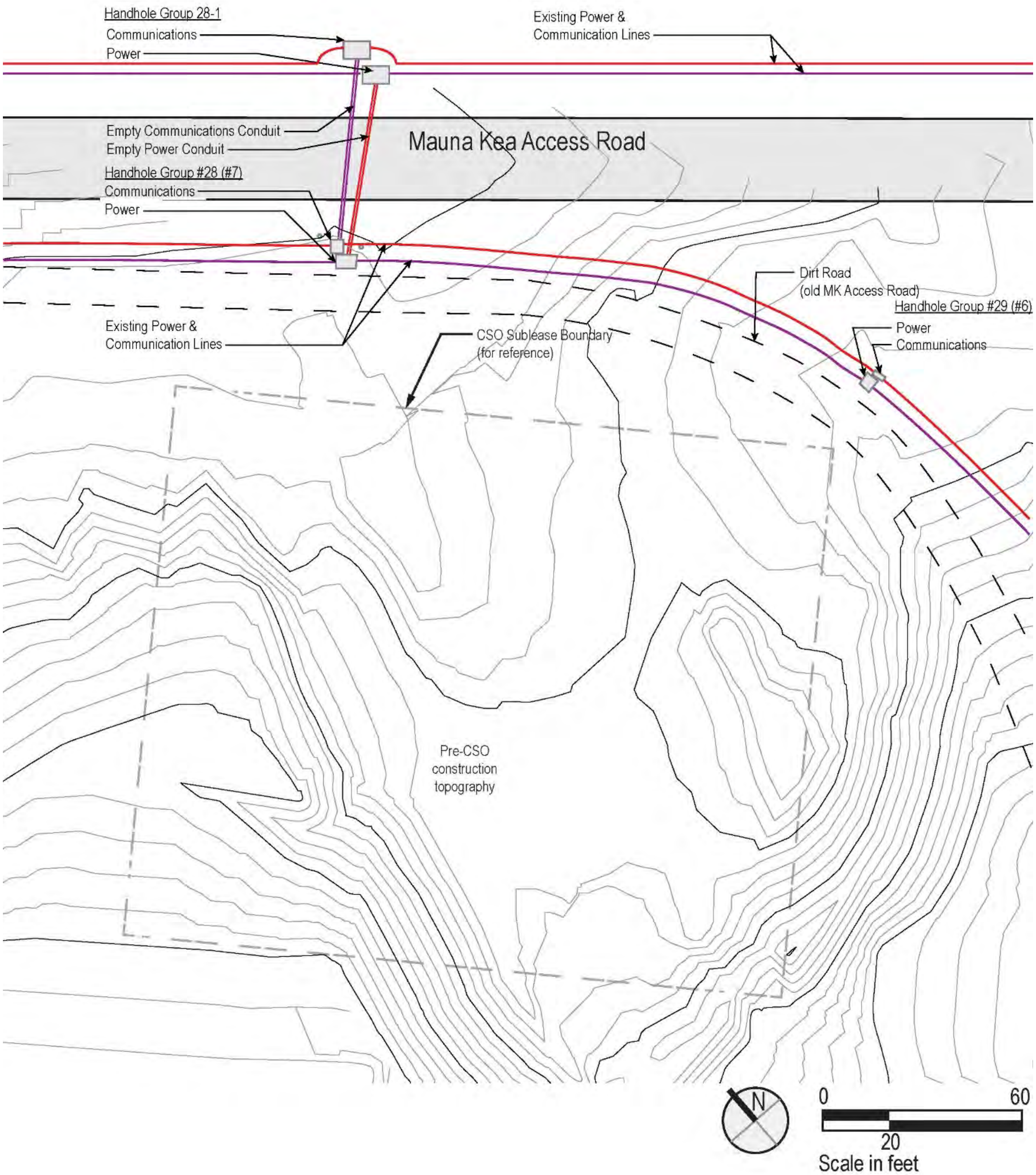
Figure 4-1 illustrates the ALT-2 scope of work and Figure 4-2 illustrates anticipated site conditions following the implementation of the ALT-2 removal and restoration scope of work.

Figure 4-1: ALT-2 Scope of Work



Source: M3

Figure 4-2: ALT-2 Post-Decommissioning



Source: M3

4.3.3 ALT-3: Complete Facility and Infrastructure Removal with Moderate Restoration

This alternative addresses the circumstance in which unanticipated factors, evident only after removal and restoration begins, preclude full restoration of the CSO Site. If such unanticipated factors or conditions are encountered during deconstruction or restoration activities, Caltech will coordinate with construction monitors (Section 5.1.1), CMS, and IfA due to its role as scientific cooperation lead. Caltech, in consultation with CMS and IfA, will select the appropriate course of action.[6] Because full restoration across the entire site would not be achievable, the restoration would be considered moderate. Even though only moderate restoration would be achieved on a portion of the site, Caltech would perform full restoration over the maximum extent of the site achievable. For example, if 40 percent of the site cannot be fully restored for some currently unanticipated reason, Caltech would conduct moderate restoration on that 40 percent and full restoration on the remaining 60 percent.

Under this alternative, the following would be achieved within the CSO Site:

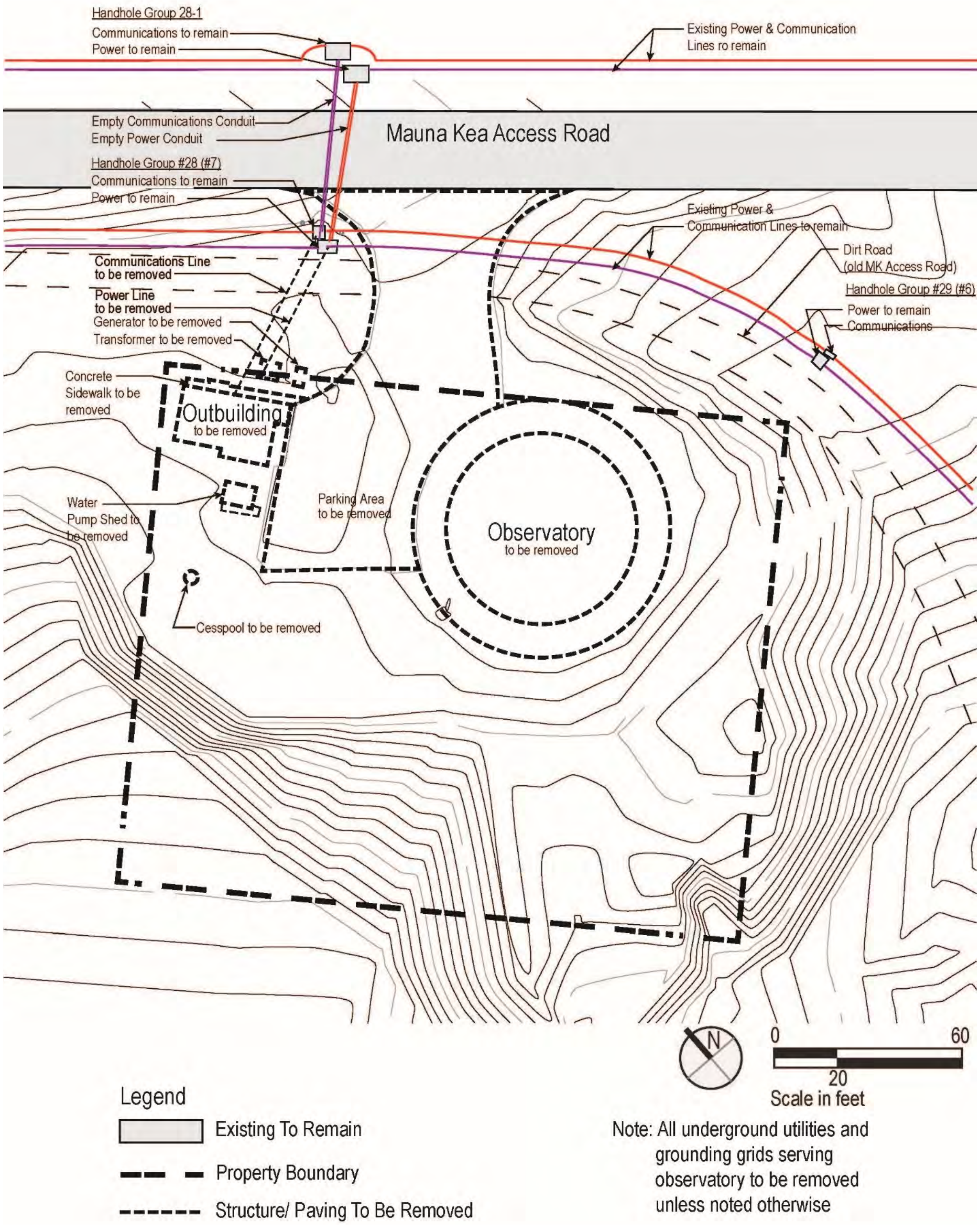
- Removal would be the same as ALT-2 and would use the methods outlined in Chapter 5, the SDRP:
    - The observatory, outbuilding, and other above-ground facilities would be completely removed.
    - The observatory and outbuilding foundations, cesspool, and other subsurface infrastructure on the CSO Site would be completely removed.
- Restoration as follows using methods outlined in Chapter 6, the SRP:
    - The portion of the site that could not be fully restored would be graded, leaving the area in safe condition, but not matching the pre-construction topography.
    - The portion of the site that could be fully restored, if any, would be returned to its pre-construction topography to the greatest extent possible.
    - The habitat would be restored across the entire site to accommodate arthropod fauna to the greatest extent possible.
- Biological monitoring to characterize the effectiveness of restoration efforts as discussed in Chapter 6, the SRP.

In addition, Caltech will provide funds to UH to support the future decommissioning of shared infrastructure. Shared infrastructure consists of utility improvements shared by multiple Maunakea observatories or uses. One example are the electrical and communication lines that cross under the CSO driveway between handhole #28 and #29 (Figure 4-3 and Figure 4-4). Caltech cannot remove the shared infrastructure because it needs to remain in place to service the other facilities and uses it supports. The funds Caltech will provide to UH equal its pro-rated portion of cost estimates for the removal of the shared infrastructure.

Figure 4-3 illustrates the ALT-3 scope of work and Figure 4-4 illustrates anticipated site conditions following the implementation of the ALT-3 removal and restoration scope of work, which is that the CSO fill remains and topography is not restored (e.g., the highly unlikely, worst-case possibility under this alternative).

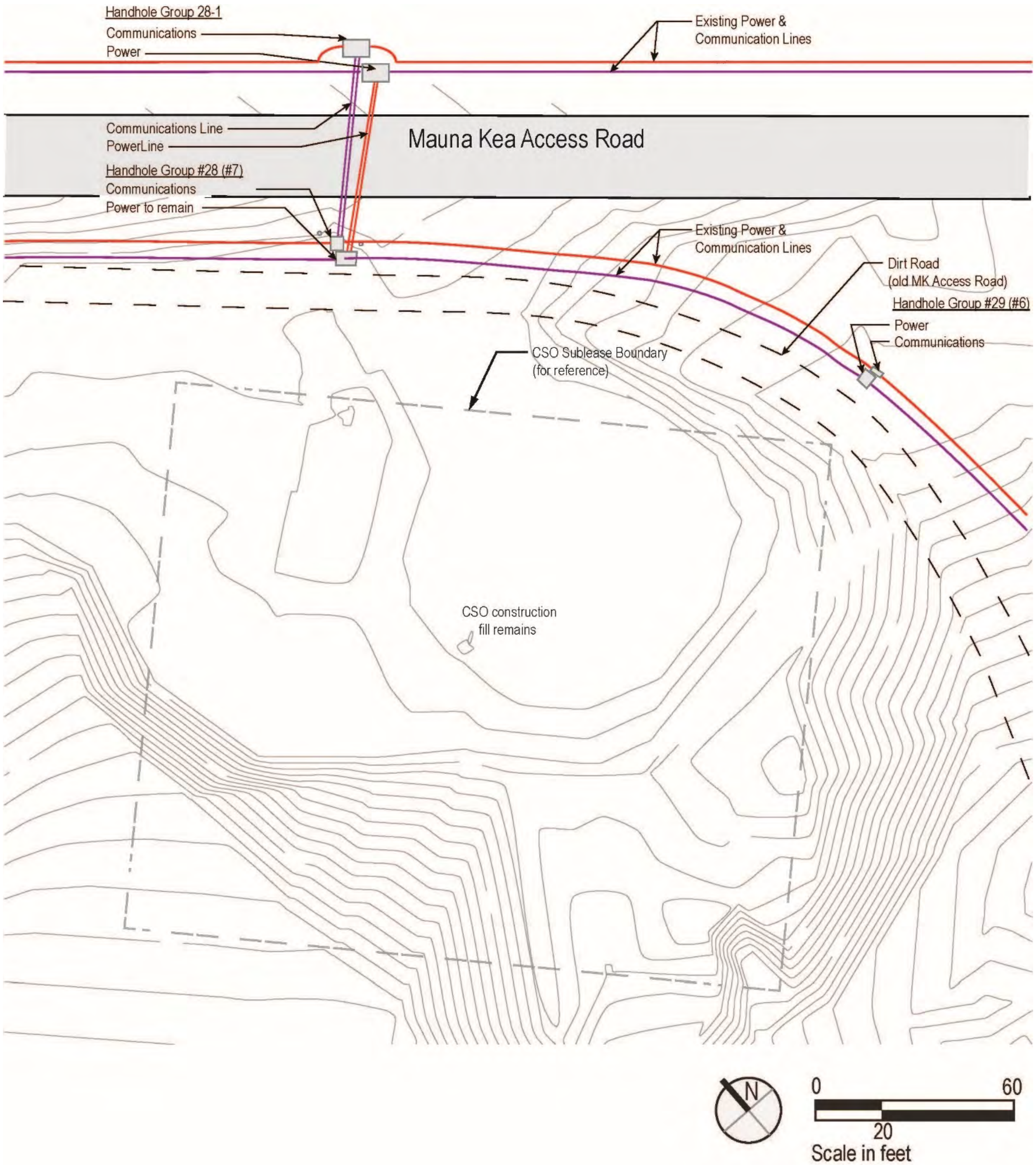
[6] The appropriate course of action will depend on the factor or condition encountered. Possible courses of action include, but are not limited to, (*i*) identifying a remedy that allows for complete removal and full restoration, (*ii*) implementing ALT-3, or (*iii*) implementing ALT-4.

Figure 4-3: ALT-3 Scope of Work



Source: M3

Figure 4-4: ALT-3 Post-Decommissioning



Source: M3

4.3.4 ALT-4: Facility Removal, Infrastructure Capping, and Moderate Restoration

This alternative addresses the circumstance in which unanticipated factors, evident only after removal and restoration begins, preclude complete removal and full restoration. Because complete removal would not be achievable, the removal would be considered infrastructure capping; and because full restoration across the entire site would not be achievable, the restoration would be considered moderate. Even though some infrastructure would be capped and left in place, Caltech would remove its infrastructure to the maximum extent achievable. Similarly, even though only moderate restoration would be achieved on a portion of the site, Caltech would perform full restoration over the maximum extent of the site achievable.

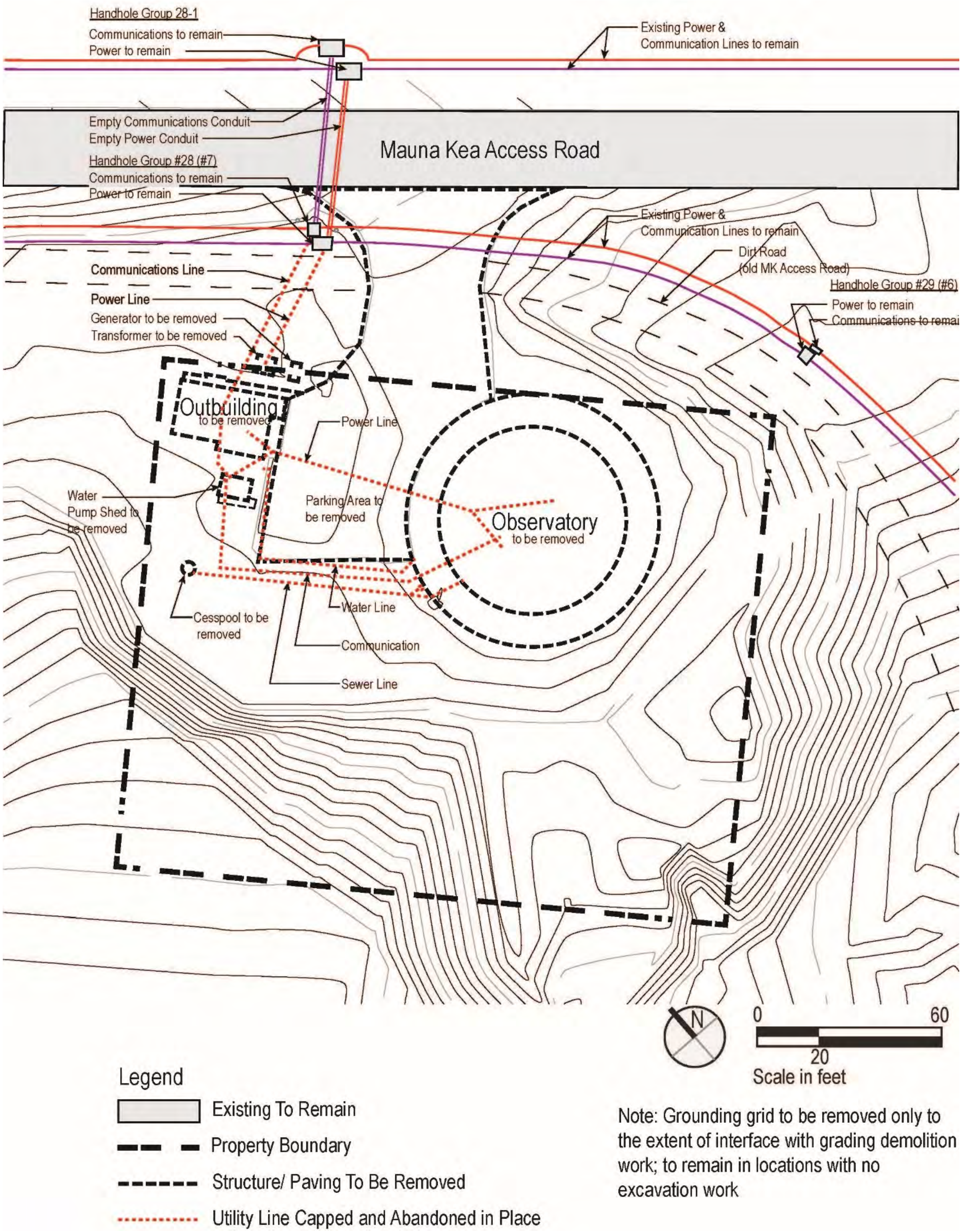
Under this alternative, the following would be achieved within the CSO Site:

- Removal would use the methods outlined in Chapter 5, the SDRP, and consist of:
  - The observatory, outbuilding, and other above-ground facilities would be completely removed.
  - The observatory and outbuilding foundations, cesspool, and other subsurface infrastructure at the CSO Site would be removed to the maximum extent achievable, but some portions would remain.
- Restoration would be similar to ALT-3 and use methods outlined in Chapter 6, the SRP:
  - The portion of the site that could not be fully restored would be graded, leaving the area in safe condition, but not matching the pre-construction topography.
  - The portion of the site that could be fully restored, if any, would be returned to its pre-construction topography to the greatest extent possible.
  - The habitat would be restored across the entire site to accommodate arthropod fauna to the greatest extent possible.
- Biological monitoring to characterize the effectiveness of restoration efforts as discussed in Chapter 6, the SRP.

In addition, Caltech will provide funds to UH to support the future decommissioning of shared infrastructure. Shared infrastructure consists of utility improvements shared by multiple Maunakea observatories or uses. One example are the electrical and communication lines that cross under the CSO driveway between handhole #28 and #29 (Figure 4-5 and Figure 4-6). Caltech cannot remove the shared infrastructure because it needs to remain in place to service the other facilities and uses it supports. The funds Caltech will provide to UH equal its pro-rated portion of cost estimates for the removal of the shared infrastructure.

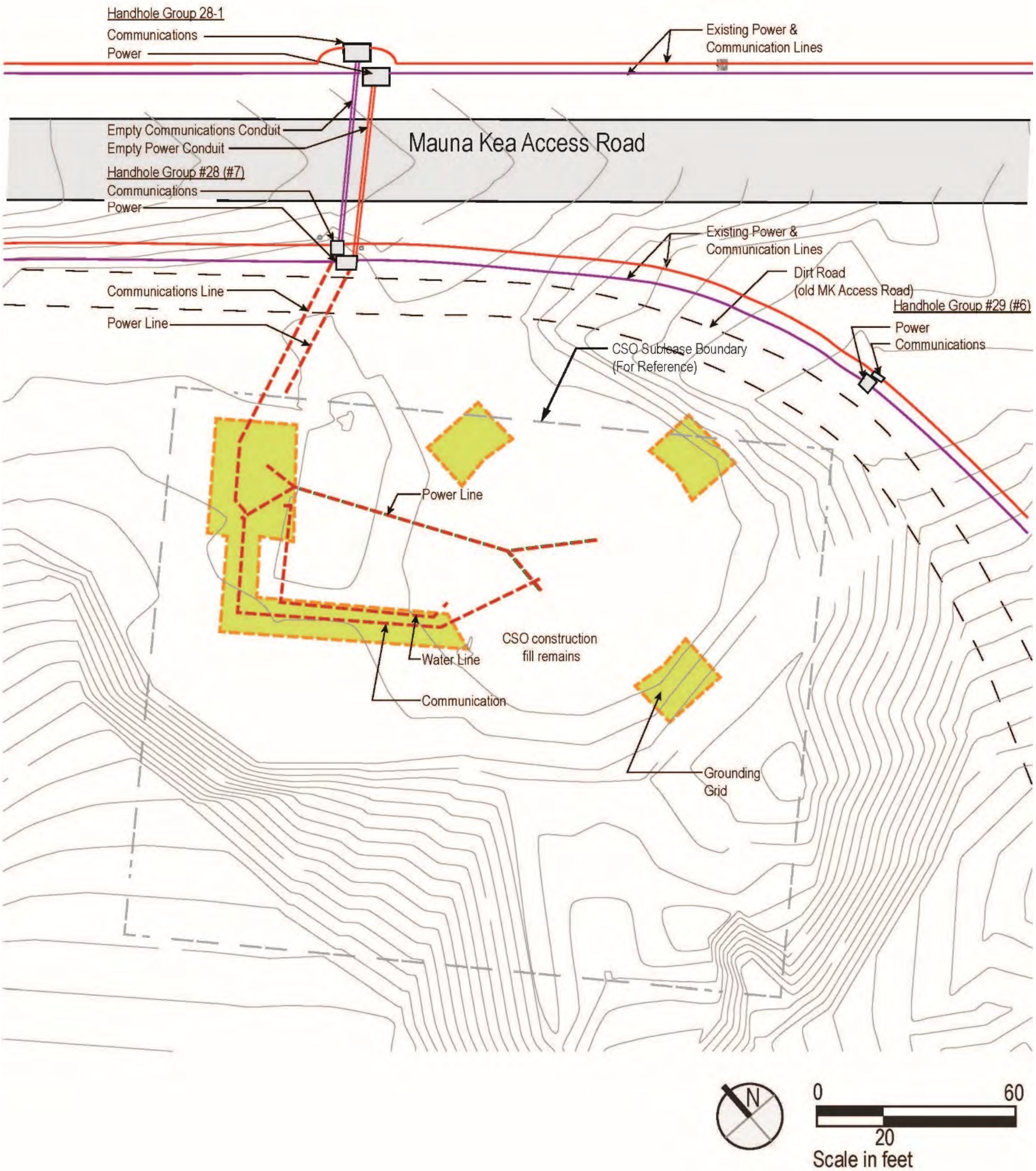
Figure 4-5 illustrates one example of the potential ALT-4 scope of work, which includes the removal of the cesspool and water tank, but utility conduits are capped and left in place. Figure 4-6 illustrates one possible site condition following the implementation of the ALT-4 removal and restoration scope of work, which is that the CSO fill remains and topography is not restored (e.g., the highly unlikely, worst-case possibility under this alternative).

Figure 4-5: ALT-4 Scope of Work Example



Source: M3

Figure 4-6: ALT-4 Post-Decommissioning Example



Source: M3

4.4 ALTERNATIVES CONSIDERED BUT REJECTED

Several of the alternatives considered feasible (Section 4.2) were screened out and will not be analyzed in detail in this SDP or the subsequent EA. They are:

- Complete facility and infrastructure removal with minimal restoration (this DP alternative most closely parallels the CSO Sublease fourth option)
- Complete facility removal, infrastructure capping, and full restoration
- Complete facility removal, infrastructure capping and minimal restoration
- Partial facility removal (outbuilding retention), infrastructure capping, and full restoration over about 80% of the Site
- Partial facility removal (outbuilding retention), infrastructure capping, and moderate restoration over about 80% of the Site
- Partial facility removal (outbuilding retention), infrastructure capping, and minimal restoration over about 80% of the Site

These alternatives were screened out because, although they address the purpose and need to varying degrees, they are inconsistent with Caltech's intent, which was clearly stated in the NOI (Chapter 2 and Appendix A) that was reviewed and accepted by UH and DLNR. In addition, early stakeholder consultations regarding their inclusion indicated limited support for or interest in them.

Specific to the three alternatives that include retention of the outbuilding to support safety-related goals in the CMP (those that include "partial facility removal"), UH has indicated that they believe these goals can be satisfied through other management actions. Contributing factors to the screening out of alternatives that included its retention included (*i*) it never had and is inappropriate to retrofit with restroom or water facilities, and (*ii*) it was designed to house specific equipment, not for human occupancy. Furthermore, assessments included in technical reports indicate that the benefits associated with CSO's decommissioning would be notably curtailed if the outbuilding were retained.

For these and other lesser reasons encountered during initial screening of the alternatives listed in Section 4.2, Caltech has rejected the six listed above and will not evaluate them in detail in this SDP or the subsequent EA.

CHAPTER 5: SITE DECONSTRUCTION AND REMOVAL PLAN (SDRP)

As introduced in Section 1.2.3, the purpose of this SDRP is to document the proposed methods and activities for (*i*) demolishing, in part or total, the infrastructure on the subject site, (*ii*) stockpiling of removed fill material(s), and (*iii*) all necessary waste recovery, reuse, and/or disposal operations. Per the DP, The SDRP will be augmented as planning progresses to include copies of all required plans, drawings, permits, and authorizations.

5.1 SITE DECONSTRUCTION AND REMOVAL METHODOLOGY

All the action alternatives considered in both this SDP and the forthcoming EA involve varying levels of removal of manmade structures and infrastructure. Some alternatives, including ALT-2 and ALT-3 involve complete facility and infrastructure removal, while ALT-4 would entail removal of all facilities with some capping of underground infrastructure. However, while acknowledging these differences, the following subsections outline the deconstruction activities required to remove the above-ground facilities and underground CSO infrastructure in sequential order and are generally applicable to all action alternatives.

The deconstruction and removal process is laid out in detail and includes numerous precautions and protocols for safe and sensitive work by the contractor.

5.1.1 Best Management Practices and Decommissioning Monitoring

All general contractors, subcontractors, and suppliers involved in deconstruction and restoration activities will be required to adhere to Best Management Practices (BMPs) and other commitments in this SDP, commitments included in the forthcoming EA, commitments in permit applications, and conditions in permit approvals. The principal purpose of these BMPs and other commitments is to identify the safety, environmental, and resource protection requirements and constraints related to these activities. The BMPs will include measures to comply with applicable aspects of the CMP and other guidance, including (*i*) worker orientation regarding historic, cultural, ecological, and natural resources; (*ii*) invasive species prevention and control program protocols; (*iii*) safety and accident prevention, including fire prevention related to use of cutting torches; (*iv*) spill prevention and response; (*v*) materials storage and waste management; (*vi*) erosion and water quality measures;[7] (*vii*) dust and debris management; (*ix*) private and company vehicle use and parking; and (*viii*) coordination with/reporting to CMS and the Maunakea Observatories (MKOs), including related to radio use and other possible impacts to maintenance and operations. The specifics of the BMPs will be developed after the EA for the proposed project is complete. To the extent possible, the BMPs will address input received and concerns raised throughout the project planning process. All BMPs will be implemented during both the deconstruction and removal phase and the site restoration phase.

A fulltime decommissioning manager, independent of the general contractor, will ensure that BMPs and other commitments are being implemented throughout the decommissioning process.

[7] Physical erosion and water quality BMPs, such as perimeter controls, will not use of any biological material or non-native rock or cinder.

The decommissioning manager will work with archaeological, cultural, and biological monitors required at varying times during deconstruction. The three types of specialist monitors are described below:

- Archaeological monitor. As recommended in the Archaeological Assessment (AA) prepared for the proposed project (ASM, 2018), an Archaeological Monitoring Plan (AMP) will be prepared in accordance with HAR Chapter 13-279 and approved by SHPD prior to deconstruction activities starting. The AMP will be included in the CDUA for the proposed project. The archaeological monitor will be present during ground-altering activity (e.g., digging trenches, removal of underground foundations and utilities, and removal of existing fill material).
- Cultural monitor. As recommended in the Cultural Impact Assessment (CIA) prepared for the proposed project (ASM, 2020), a cultural monitor will be present during ground-altering activity. A Cultural Monitoring Plan that incorporates recommendations in the CIA will be prepared and included in the CDUA for the proposed project.
- Biological monitor. As recommended in the Biological Setting Analysis (SRGII 2019), a biological monitor will conduct monthly surveys for non-native species throughout the deconstruction process in order to identify any such introductions and formulate a response if necessary. Biological monitoring will address other components of the invasive species prevention and control program, such as vehicle and material inspections, throughout the deconstruction process. A Biological Monitoring Plan that incorporates recommendations in the BSA will be prepared and included in the CDUA for the proposed project.

All third-party deconstruction monitors will participate in regularly scheduled deconstruction meetings led by the general contractor to keep abreast of the progress of decommissioning activities and to schedule monitoring efforts. The independent monitors will interface with the general contractor to confirm that deconstruction activities follow the established protocols. It is also anticipated that each of the monitors will contribute the project's worker orientation program. Among other benefits, archaeological and cultural monitoring will help to ensure that negative impacts do not occur on archaeological, historic, or cultural resources during site decommissioning. Input on the scope of the AMP and other monitoring plans will be sought through the SDP and EA process.

Regular communications through deconstruction meetings and notices will be necessary to conduct a safe and environmentally sensitive removal of the CSO while maintaining normal public access to the mountain. These lines of communications will include: (*i*) the general contractor, (*ii*) CMS's assigned internal decommissioning manager, (*iii*) the CSO's independent decommissioning manager, (*iv*) third-party monitors, (*v*) Mauna Kea Observatories Support Services, (*vi*) Maunakea Rangers, and (*vii*) representatives of the other observatories.

5.1.2 Deconstruction Preliminary Activities

5.1.2.1 Deconstruction Mobilization and Staging

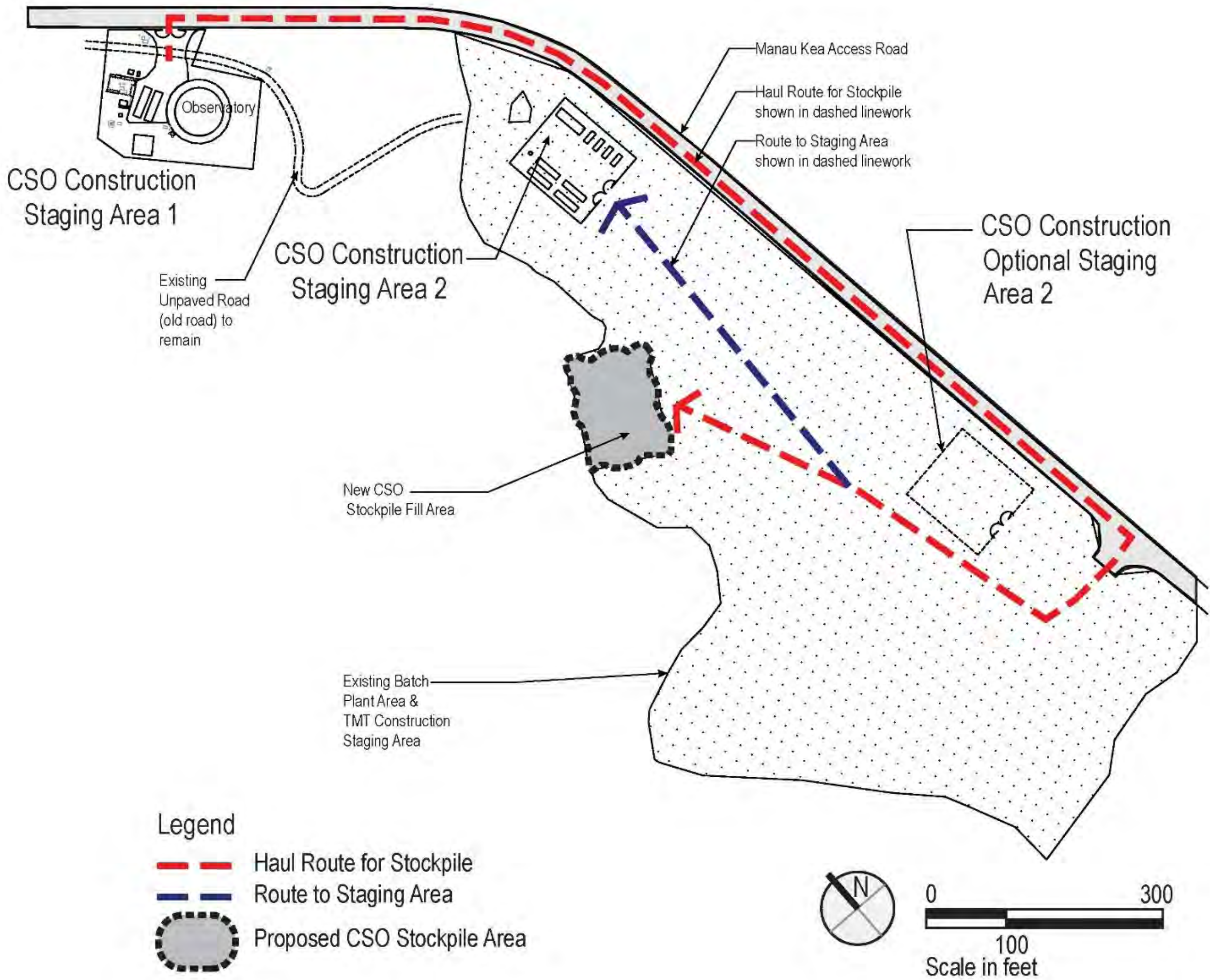
Prior to commencement of deconstruction, proper installation of support infrastructure and procedures will promote safe and efficient conduct. The initial phase of deconstruction will consist of:

- The installation of temporary construction fencing around the perimeter of the work and staging areas.
- Placement of BMPs, including dust and erosion control materials at appropriate locations established in the Storm Water Pollution Prevention Plan (SWPPP), which will be a component of the NPDES general construction permit. Dust and erosion control BMPs will be maintained and the SWPPP updated as appropriate throughout the deconstruction period.
- Installation of portable office trailers and portable toilets at Staging Area 2 within the nearby Batch Plant and a portable toilet at the CSO Site.

The temporary construction fencing is intended to visually define the spatial extent of deconstruction activity and to limit access to the CSO Site and staging areas to authorized individuals only. The perimeter fencing can also allow for the work site to be, within established limits, expanded or contracted during the course of the decommissioning process to properly segregate deconstruction activity from areas accessible by the public. This fencing will also serve dust and erosion control functions. The requirement for fencing will be included in the deconstruction specifications distributed as part of the bidding process for general contracting firms. These specifications will require that the general contractor provide calculations for securing the fencing against wind loads at the project site as determined by the applicable building code.

As originally constructed, the CSO site consists primarily of fill from other locations on Maunakea. Depending on the decommissioning alternative that Caltech ultimately implements (see Table 1-1), the fill will remain onsite or be removed and transported to an approved alternative location in the "Batch Plant" area. In either instance, appropriate BMPs related to dust and erosion control will be prioritized from the outset. Figure 5-1 depicts the planned staging and haul routes during deconstruction for all action alternatives considered in this SDP. All vehicle and foot traffic will follow that route along the Mauna Kea Access Road; the dirt road will not be utilized.

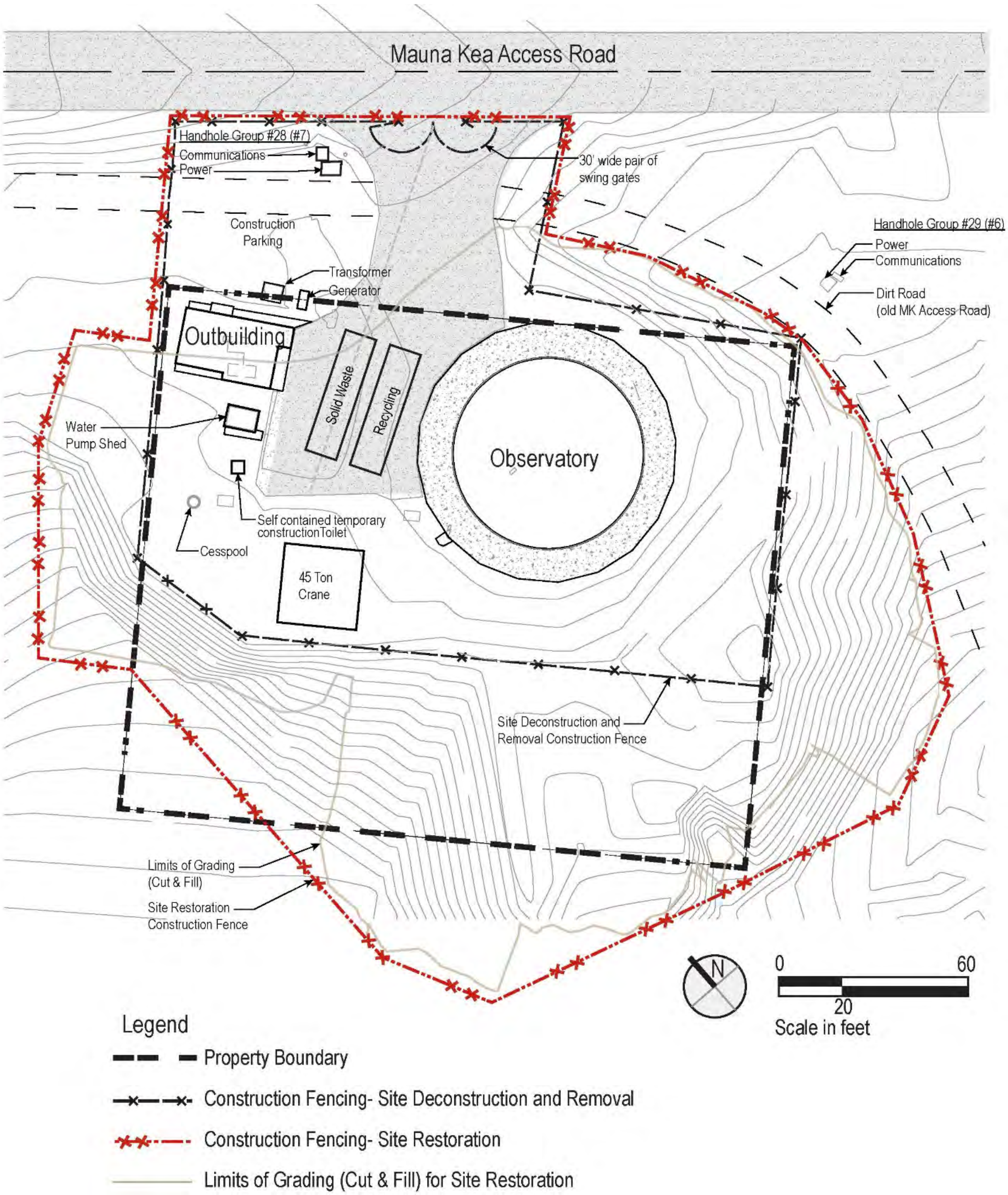
Figure 5-1: Conceptual Plan View of Overall Deconstruction Staging



Source: M3 (2020)

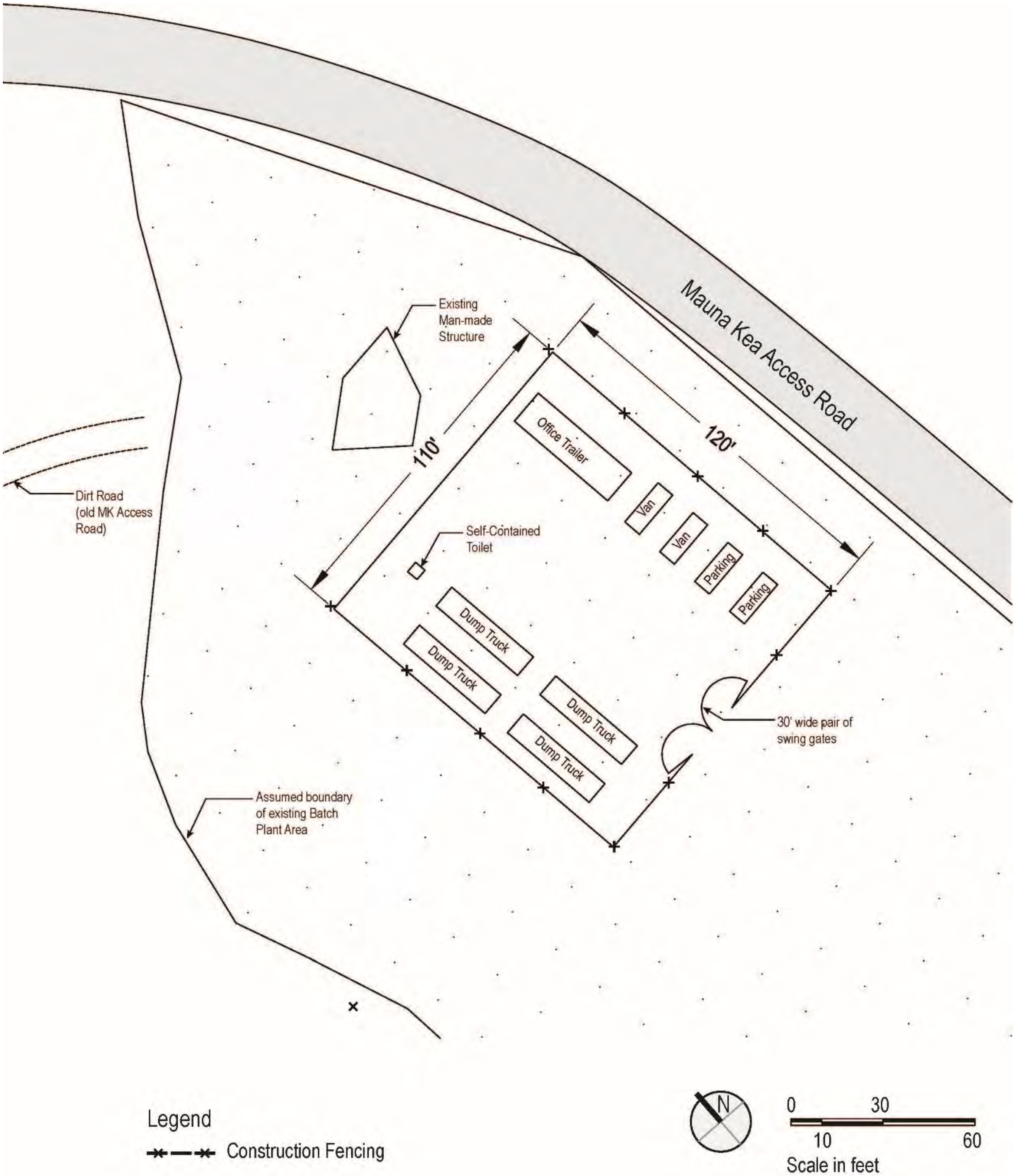
As shown in Figure 5-1, the staging will be partitioned into three areas: (*i*) Staging Area 1 on the CSO Site; (*ii*) at one of two locations within Staging Area 2 in the Batch Plant adjacent to the Mauna Kea Access road; and (*iii*) the 135′ x 100′ CSO fill stockpiling area within the Batch Plant. Figure 5-2 depicts a conceptual plan view of the Staging Area 1 on the CSO Site; Figure 5-3 provides a conceptual plan view of Staging Area 2. No grading of the Batch Plant would be required prior to establishing the staging area.

Figure 5-2: Plan View of Deconstruction Staging Area 1



Source: M3 (2020)

Figure 5-3: Conceptual Plan View of Deconstruction Staging Area 2



Source: M3 Engineering and Technology (2020)

Once fencing is emplaced, additional dust and erosion control BMPs will be placed around the perimeter of the CSO Site and staging areas.

An office trailer will be stationed at Staging Area 2 throughout the decommissioning process (see Figure 5-3). The trailer will be provided by the general contractor, with space provided for an independent decommissioning manager onsite daily. It will also afford adequate space for third-party archaeological, cultural, and biological monitors that will be present, as appropriate, during the site deconstruction and restoration phases of the project (see Section 4.1.1).

Temporary power interconnections for all deconstruction activities will also occur during mobilization and staging. Electrical power will be drawn from the closest remaining power source, likely Handhole Nos. 28 or 29 (see Figure 5-2). Water for deconstruction purposes will be provided via the existing tank and pump (see Figure 4.2) before being removed during latter stages of the deconstruction and removal process and/or a temporary above-ground water tank at Staging Area 2.

5.1.2.2 Demolition Preparation and Fire Prevention

Once the site has been secured and staged, the first deconstruction task will be to prepare the existing structures for demolition. All power and plumbing lines serving the observatory will be taken out of service by deenergizing or capping the lines, respectively, at the nearest point of remaining service. This point will likely be at Handhole Nos. 28 (see Figure 5-2). Caltech anticipates that this modest task can be carried out in a single day with a limited crew of subcontractors.

The Hawaiʻi County Fire Department (HCFD) is the primary agency responsible for fire prevention, fire control, and emergency medical services in the County of Hawaiʻi. Caltech has been in communication with the HCFD regarding the CSO decommissioning and will continue to coordinate with them during its implementation. The National Fire Prevention Association's (NFPA) *NFPA 241: Standard for Safeguarding Construction, Alteration, and Demolition Operations* (2004) notes:

> *"A.5.4.1 Failure to remove scrap and trash accumulations provides fuel for the rapid expansion of a fire that might otherwise be confined to a small area. These accumulations also provide a convenient fuel source for malicious fires."*

The HCFD has indicated that during deconstruction, Caltech and its contractors may stage trailers to sort and deposit aluminum, steel, and deconstruction waste onsite. Caltech anticipates using roll-off trailers or similar container that can be securely covered, brought to the site, and stationed there during demolition. The contractor will be responsible for sorting and depositing deconstruction waste in the appropriate onsite container. HCFD has also stated that:

- Up to four locations may be designated onsite for deconstruction material sorting and collection, and that up to three roll-off trailers may be used, as appropriate, at any time during deconstruction.
- A truck may deliver an empty roll-off container up to a designated open location and haul away the full container while still complying with the total limit of three roll-off containers noted above.
- Recyclable material and deconstruction waste will be properly separated at all times during the deconstruction process.

5.1.2.3 Lead Paint and Mold

Between January 22 and 23, 2019, Lehua Environmental Inc. (LEI) performed site reconnaissance to identify and inventory: (*i*) asbestos-containing material (ACM), (*ii*) lead-containing paint (LCP), (*iii*) lead-based paint (LBP), and (*iv*) mold-impacted areas of the CSO Site. This survey is discussed in Section 3.4 and included in Appendix D.

LEI recommended the following:

1. Manage and/or remove and dispose of hazardous and regulated materials in accordance with applicable local, state, and federal regulations, prior to renovation and/or demolition activities that may disturb these materials.
2. Remove and dispose of all loose and flaking (i.e., poor condition) LCP and LBP that may be disturbed during renovation/demolition activities in accordance with applicable local, state, and federal regulations.
3. Spot remove and dispose of LCP and LBP in areas that have the potential to become airborne or otherwise create dust (e.g., from sanding, drilling, friction, etc.) during renovation/demolition activities.
4. Any remediation and demolition contractor(s) must take appropriate measures to comply with applicable EPA, Occupational Safety and Health Administration (OSHA) and Hawaiʻi Occupational Safety and Health Division (HIOSH) regulations pertaining to the handling of lead-containing materials and worker protection.
    - Note that OSHA and HIOSH regulate activities that disturb paint which contain any detectable concentration of lead.
    - Note that detectable levels of lead in the paint were found throughout the Subject Site.
5. Have air monitoring conducted for airborne lead by qualified personnel during any lead paint disturbance and general renovation activities of areas that were determined to contain this contaminant.
6. Conduct multi-incremental sampling of soils surrounding the CSO Site prior to and after any exterior lead paint disturbance activities.
7. Previously water damaged ceiling tiles located throughout the CSO Site should be removed. These tiles may be identified by water staining and/or discoloration.

Caltech will direct appropriately trained personnel to implement all seven recommendations prior to starting demolition of the buildings.

5.1.3 Telescope Demolition

Caltech has been, and continues to, actively pursue the possibility of reusing the existing CSO telescope for further scientific research at an astronomical site other than Maunakea. If this effort is successful, the removal of the telescope will occur prior to the deconstruction activities presented in this plan. However, at the time this SDP was prepared, no candidate site for relocation had yet been funded. If no relocation is funded prior to deconstruction, demolishing and removing the telescope will occur as part of the decommissioning of the CSO Site. The steel telescope structure will be cut using cutting torches and saws into transportable pieces and recycled as scrap material. All the support equipment that remained onsite is specific to the CSO telescope and will be disposed of appropriately if the telescope is subject to demolition.

5.1.4 Mechanical, Electrical, and Plumbing (MEP) Demolition

General demolition work will begin with the removal of interior building components. The demolition of observatory mechanical, electrical, and plumbing (MEP) building systems will be first and will include removal of all power, lighting, water, waste, and communication lines integrated throughout the observatory facility and outbuildings.

Removing these “guts” of the facility will be mostly performed by means of individuals utilizing various handheld cutting equipment. All MEP material removed from the facility will be placed in the appropriate onsite container to be trucked off-site to the designated landfill or recycled.

5.1.5 Partition/Built-In Demolition

To complete the interior demolition and prepare for the removal of the outer shell itself, all interior partitions, ceilings, and built-in units will be disconnected from the structure and removed. Working within the tightly confined shell of the observatory structure will require that the majority of interior demolition work be done by means of individuals utilizing appropriate cutting equipment. All material is to be considered waste and placed in the appropriate onsite container for later removal off-site to the designated landfill.

5.1.6 Skin Removal

The enclosure skin of the outer shell of the observatory consists of individual thin triangular aluminum panels fastened to the supporting steel tube structure (see Figure 5-4). During deconstruction, the panels of the skin will be cut into manageable pieces using saws and cutting torches, and removed with the use of a crane and lift.

Figure 5-4: CSO's Aluminum Panel Skin

Source: Caltech (2020)

It is anticipated that the individual facets will be removed on a one-by-one basis rather than through simultaneous removal of multiple panels by multiple workers. All aluminum panels are considered recyclable material and will be placed in the appropriate onsite container for removal off-site to the designated recycling center.

5.1.7 Structure Demolition

With the building interiors, including MEP, and exterior skin removed, the structural skeleton of the observatory will be ready for dismantling (see Figure 5-5). The dismantling process will be performed with a manlift for cutting steel members into manageable pieces using cutting torches and saws and a crane for lifting these pieces from the structure to a flatbed truck for removal off-site. All steel deconstruction waste is planned to be recycled.

Figure 5-5: CSO's Internal Structure During Construction

Source: Caltech (1985)

5.1.8 Paving Removal

To prepare for underground demolition work, existing asphalt paving will be removed. Demolished paving will be loaded on to a dump truck for removal to a designated off-site landfill.

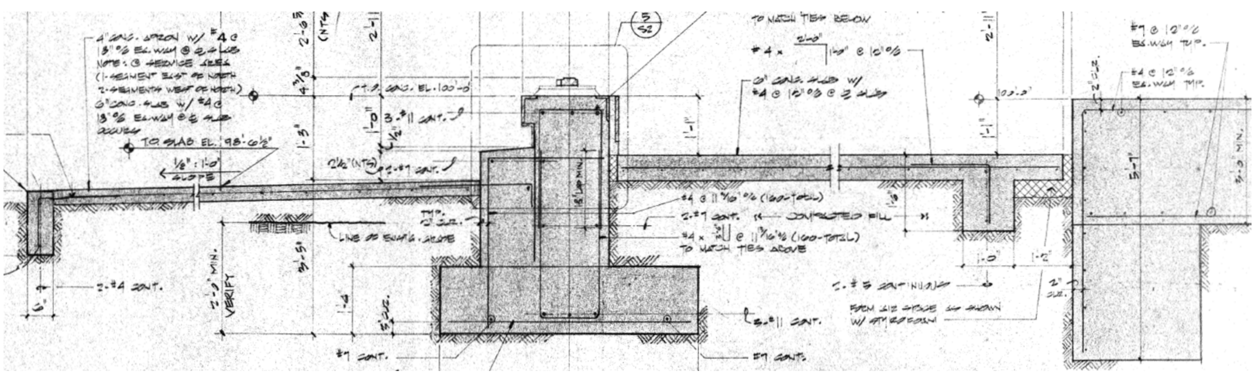
5.1.9 Foundation and Grounding Grid Removal

The CSO does not have a basement level and the structural footings underpinning the observatory consist of shallow spread footings. For this reason, total foundation removal is included in all alternatives. The CSO's foundations can be seen in Figure 5-6 and Figure 5-7, with the latter showing how the depth and thickness of the foundation varies from the center to the apron.

Figure 5-6: Photograph of CSO's Foundation During Construction

Source: Caltech (1985)

Figure 5-7: Section Drawing Illustrating a Portion of CSO's Foundation



Source: CSO Foundation Plan by H. Robert Hoggan & Associates dated 12/5/83.

The reinforced concrete foundation will be broken or cut, removed from the ground, and placed in roll-off bins. The portions of the grounding grid near the CSO's foundation will be removed during this phase; construction drawings indicate that the grounding grid is roughly one foot below grade and, therefore, all within the fill material placed on the CSO Site during construction. All material removed will be designated as deconstruction waste material and will be removed from the CSO Site and transported to an approved landfill, with the exception of recyclable material such as copper piping or grounding mats, which will be transported to a designated recycling center.

5.1.10 Cesspool

As part of the decommissioning of the CSO Site, the cesspool will be closed. Caltech, in preparation for this closure, has consulted with the DOH, Planning and Design Section, Wastewater Branch (DOH-WB), to identify alternative courses of action for closure and backfilling of the cesspool. As part of this consultation, DOH-WB provided information from *General Backfilling Scenarios for an Injection-Well Cesspool*, summarized as follows:

- Backfilling and permanently abandoning an injection-well cesspool constitutes an injection-well closure.
- Prior to any method of backfilling, each injection-well cesspool should be cleared to its original constructed depth, and all sediments, sludge, and organic materials in the cesspool should be removed and disposed of properly.
- Backfilling with a cement mixture or flowable fill may stop short of reaching the ground surface in order to accommodate topsoil, landscaping, grading, underground utilities, or foundation considerations.
- All backfilling methods should not leave behind a depression in the ground. The final ground surface should be shaped or graded to prevent tripping or falling, as well as water ponding.
- An official injection-well closure indicates that the injection-well has been cleaned out and permanently filled and sealed with an inert material having stability and physical strength.

Because backfilling the cesspool with cement would permanently leave CSO infrastructure material onsite, contrary to its stated intention to totally remove all infrastructure and fully restore the site, CSO has explored other options for closure of the cesspool that would return the area more closely to its pre-construction condition. On March 1, 2018, Caltech representatives met with Sanitarian Amy Cook of HDOH, Environmental Services (HDOH-ES) to discuss options for the closure of the CSO cesspool, including whether excavation below the cesspool was warranted or if fill from the CSO Site, rather than cement, was an acceptable fill alternative. In that meeting, HDOH-ES acknowledged Caltech's intention to remove all manmade structures from the site and stated that they were not aware of any instances of excavating below or beyond a cesspool base, except to enlarge a cesspool. In addition, HDOH-ES indicated that use of natural material from the CSO Site to fill the cavity left by removal of the cesspool was acceptable. (Amy Cook, pers. comm., March 1, 2018).

Based on its consultation with HDOH-WB and HDOH-ES, for all action alternatives Caltech now plans to: (*i*) pump out all sludge remnants in the cesspool, (*ii*) test the sludge for potential contaminants and dispose of it properly, (*iii*) trench around the outer perimeter of the concrete cesspool cylinder to its depth; (*iv*) remove the concrete cesspool structure and dispose of it properly; and then (*v*) use structural fill from the CSO Site[8] to fill the void to a depth even with the surrounding native lava flow surface and compact the fill during the backfilling process to

[8] This structural fill to be used is the fill placed on the lava flow during CSO construction and is native to Maunakea (Intera, 2019).

minimize settling in the future. CSO will continue to coordinate with the HDOH and comply with the instructions provided by it during closure of the cesspool.

5.1.11 Phase II ESA

Following removal of the underground concrete slab (see Section 5.1.9) and cesspool (Section 5.1.10), Caltech will perform sampling and analysis per the Phase II SAP (see Section 3.3, Appendix C).

5.1.12 Outbuilding and Secondary Above-Ground Infrastructure

Under all alternatives, the outbuilding and secondary above-ground infrastructure will be removed. This includes the outbuilding, a smaller nearby building housing a water pump, a generator mounted on a concrete pad, and a transformer mounted on a concrete pad.

All building materials, including concrete pads and slabs, will be deconstructed and placed in roll-off bins. All material removed will be designated as deconstruction waste material and will be removed from the CSO Site and transported to an approved landfill, with the exception of recyclable material such as copper piping, if any, which will be transported to a designated recycling center.

5.1.13 Remaining Underground Infrastructure

Underground improvements to be demolished include: (*i*) utility lines, (*ii*) water tank, and (*iii*) remaining grounding grid and other ancillary subsurface infrastructure. Under all alternatives, except ALT-4, all the utility conduits from Handhole #28, which provides service to CSO (see Figure 5-2), and throughout the CSO Site will be removed. In concert with these activities, the remaining grounding grid will be removed. It may be discovered that it is not feasible to remove a portion of these facilities, which is accounted for by ALT-4. Under ALT-4 they would be removed to the maximum extent feasible but some portion would be capped and left in place.

All building materials, including conduit and tank, will be removed from the ground and placed in roll-off bins. All material removed will be designated as deconstruction waste material and will be removed from the CSO Site and transported to an approved landfill, with the exception of recyclable material such as copper piping and wire (including the grounding grid), which will be transported to a designated recycling center.

5.1.14 Backfill and Finish Grading

Following the removal of all infrastructure, removal of remaining fill material will take place using heavy, medium, and small equipment and hand tools. The temporary construction fencing will be repositioned (Figure 5-2) to surround the site restoration work area prior to this fill removal activity. As the fill is removed, a quantity of roughly five cubic yards of fine ash material and small rocks, consistent with the size and material of the rocks scattered in the nearby undisturbed areas, will be segregated using a screen or similar method and stockpiled on site or at the staging area until needed for restoring the arthropod habitat (Section 6.5.2.1).

No fill imported from a non-Maunakea source will be brought to the CSO Site. The level of backfill will vary depending on the level of removal and the corresponding level of restoration implemented. Excess fill material will be stockpiled at the Batch Plant Staging Area and available for use by CMS in the future. The stockpile location is shown in Figure 5-1. The stockpiles will be approximately five feet in height and cover an area of approximately 100′ x 135′, tightly arrayed in overlapping piles.

Once all the excess fill material has been removed, the reserved fine ash and small rocks will be layered on top of summit-native rock to leave a visual appearance consistent with the original condition of the Site. Because the CSO Site is located on a lava flow, it will not be possible to fully reconstruct the preexisting flow in excavated areas. Rather, restoration will use rocks and fill, compacting as necessary for long-term stability, to return those areas to a natural condition consistent with the surrounding topography.

5.1.15 Demobilization

Upon completion of the backfill and the site restoration processes (Chapter 5) that can be completed with the temporary construction fence in place, the general contractor will remove the fencing, soil erosion and dust control BMPs, and the office trailer from the CSO Site for its final restoration as stipulated in the SRP (see Chapter 6).

5.2 DECONSTRUCTION DURATION, PERSONNEL, AND SITE LOGISTICS

5.2.1 Deconstruction Duration and Personnel

Table 5-1 summarizes the type and purpose of major equipment that will be used and temporarily stationed on the CSO Site or adjacent deconstruction staging/stockpiling areas (see Figure 5-1) during the decommissioning process. Table 5-2, Table 5-3, and Table 5-4 identify the deconstruction activity and sequencing for each of the action alternatives (i.e., ALT-2, ALT-3, and ALT-4) considered in the SDP (see Table 1-1). These tables include all the general deconstruction activities noted in the preceding sections of this SDRP for the deconstruction and removal of the CSO, but are distinguished from each other by the duration, type of equipment, onsite deconstruction personnel, and estimated number of total daily vehicle-trips up and down the mountain. Though the total deconstruction duration of each alternative varies, all alternatives considered in this SDP can be completed within one season if provided with continuous access throughout that period.

Table 5-1: Summary of Major Equipment Present During CSO Decommissioning

Type	***Purpose***
Office Trailer	Provides adequate workspace for deconstruction superintendent and independent, archaeological, cultural, and biological monitors.
Roll-off Waste Containers	Sorted storage for deconstruction waste and recyclable materials.
Thirty-ton Crane	Securely lifting dismantled observatory skin, structural members, and cesspool.
Lift(s)	Provide deconstruction-worker access to upper portions of the CSO structure.
Water Truck	Dust control per erosion and water contamination prevention BMP sub-plan.
Trackhoe with Hammer	Demolition and removal of concrete foundations.
Backhoe	Removal of underground utility interconnections.
Loader	Depositing demolition material into appropriate waste containers and for regrading of CSO Site.
Flatbed Trailer and/or Dump Truck(s)	Transporting equipment up and down the summit and for removal of waste material off-site to the designated landfill or recycling center and for moving excess fill material to the Batch Plant.
Soil Compacter	Compacting soil during backfill operations.
Toilets	Portable toilets and/or incorporated into the office trailer.
Source: M3 (2020)	

Table 5-2: ALT-2 Deconstruction Activity

Deconstruction Activity	Duration (working days)	Crew Size Max./Day	Equipment	Deconstruction Vehicular Trips:			
				Large Vehicle		Small Vehicle	
				Max/Day	Total	Max/Day	Total
Mobilization	4	3	Office Trailer, Water Truck	2	3	1	29
Demolition Prep	1	6	-	-	-	2	2
MEP Demolition	20	5	1 Crane, 1 Flatbed w/Tractor, 2 Dump Trucks	3	6	1	20
Partition / Built-In Demolition	10	5	2 Dump Trucks	2	2	1	10
Skin Removal (Aluminum)	15	6	1 Manlift, 1 Crane, 1 Flatbed w/Tractor	1	2	1	15
Structure Demolition (Steel)	33	11	1 Crane, 1 Manlift, 2 Flatbed w/Tractors	2	11	2	63
Paving Demolition (Asphalt)	3	2	1 Loader, 4 Dump Trucks	5	14	1	3
Underground Removal	25	7	1 Backhoe, 1 loader, 2 Dump Trucks	3	27	2	32
Backfill	13	5	1 loader, 1 Compactor	1	2	1	13
Demobilization	2	4	-	2	3	-	-
Finish Work	10	8	1 loader, 1 Compactor, 4 Dump Trucks	*	*	2	20
Habitat Restoration	5	2	-	-	-	1	5
Daily Superintendent / Site Monitors	-	4	-	-	-	4	549
Total Duration / Trips	141	-	-	-	70	-	776

Note: * there will be 25 trips a day and 242 total large vehicle trips during finish work; however, these trips will be entirely within the summit region as fill material is moved from the CSO Site to the Batch Plant (Figure 5-1).
Source: M3 (2020)

Table 5-3: ALT-3 Deconstruction Activity

Deconstruction Activity	Duration (Working Days)	Crew Size Max/Day	Equipment	Deconstruction Vehicular Trips:			
				Large Vehicle		Small Vehicle	
				Max/Day	Total	Max/Day	Total
Mobilization	4	3	Office Trailer, Water Truck	2	3	1	27
Demolition Prep	1	6	-	.	-	2	2
MEP Demolition	20	5	1 Crane, 1 Flatbed w/Tractor, 2 Dump Trucks	3	6	1	20
Partition / Built-In Demolition	10	5	2 Dump Trucks	2	2	1	10
Skin Removal (Aluminum)	15	6	1 Manlift, 1 Crane, 1 Flatbed w/Tractor	1	2	1	15
Structure Demolition (Steel)	33	11	1 Crane, 1 Manlift, 2 Flatbed w/Tractors	2	11	2	63
Paving Demolition (Asphalt)	3	2	1 loader, 4 Dump Trucks	5	14	1	3
Underground Removal	25	7	1 Backhoe, 1 Loader, 2 Dump Trucks	3	27	2	32
Backfill	13	5	1 Loader, 1 Compactor	1	2	1	13
Demobilization	2	4	-	2	3	-	-
Finish Work	3	4	1 Loader	-	-	1	3
Habitat Restoration	5	2	-	-	-	1	5
Daily Superintendent / Site Monitors	-	4	-	-	-	4	536
Total Duration / Trips	134	-	-	-	70	-	729

Source: M3 (2020)

Table 5-4: ALT-4 Deconstruction Activity

Deconstruction Activity	Duration (Working Days)	Crew Size Max/Day	Equipment	Deconstruction Vehicular Trips:			
				Large Vehicle		Small Vehicle	
				Max/Day	Total	Max/Day	Total
Mobilization	4	3	Office Trailer, Water Truck	2	3	1	25
Demolition Prep	1	6	-	-	-	2	2
MEP Demolition	20	5	1 Crane, 1 Flatbed w/Tractor, 2 Dump Trucks	3	6	1	20
Partition / Built-In Demolition	10	5	2 Dump Trucks	2	2	1	10
Skin Removal (Aluminum)	15	6	1 Manlift, 1 Crane, 1 Flatbed w/Tractor	1	2	1	15
Structure Demolition (Steel)	33	11	1 Crane, 1 Manlift, 2 Flatbed w/Tractor s	2	11	2	63
Paving Demolition (Asphalt)	2	2	1 Loader, 4 Dump Trucks	5	14	1	3
Underground Removal	21	6	-	3	20	4	29
Backfill	9	5	1 Loader, 1 Compactor	1	2	1	9
Demobilization	2	4	-	2	3	-	.
Finish Work	3	4	1 Loader	-	.	1	3
Habitat Restoration	5	2	-	-	-	1	5
Daily Superintendent / Site Monitors	.	4	.	.	-	4	480
Total Duration / Trips	125	-	-	-	63	-	684
Source: M3 (2020)							

Deconstruction activity related to the decommissioning of CSO will have a modest and temporary impact on the use of the Mauna Kea Access Road. Table 5-2, Table 5-3, and Table 5-4 indicate the estimated deconstruction duration, crew size, quantities of deconstruction waste and recycling, and deconstruction vehicular use for each decommissioning alternative identified in this SDP.

The following general notes are equally applicable to Table 5-2, Table 5-3, and Table 5-4:

1. Duration total is based on the total days for sequential activities and durations account for unusual conditions present at the high elevation CSO Site.
2. Crew total is a maximum per day, as determined by the highest number of individuals identified for any one sequential activity. Alternative total includes the highest number of individuals for any one activity plus supervision and monitoring personnel.

3. Fill material will utilize regraded site material.
4. Equipment list represents the type and number on site at any one time.
5. Maximum vehicles onsite per day/total number of trips. One (1) trip is defined as the combination of ascending and descending the mountain within a day. If a trip is split, such as delivery of the office trailer and its subsequent removal at a later date, then a trip is defined as one (1) ascending and one (1) descending for that deconstruction activity (i.e., a total of two vehicle trips). Total for maximum per day were determined by the higher number of trips/day for any one sequential activity. Permanently staffed deconstruction personnel will travel up to the site individually on a daily basis (i.e., 4 vehicles/day) with parking spaces onsite for each; subcontractor crews will carpool from Halepōhaku on a daily basis. The crane delivered to the site, starting with MEP Demolition, will remain onsite for the duration of the deconstruction process. The one (1) trip for crane delivery is accounted for under MEP Demolition.
6. Dump truck trips for stockpile of removed fill are within summit region via the path identified in Figure 5-1. No fill removal will traverse down Mauna Kea Access Road past the Batch Plant.
7. Concurrent activities are identified to reduce the overall deconstruction duration.

5.2.2 Deconstruction Logistics

Figure 5-1 depicts the likely configuration of deconstruction staging logistics, indicating the locations for each of the major pieces of equipment and vehicles used during the various stages of deconstruction; Figure 5-2 and Figure 5-3 provide additional detail. The basic configuration of the staging areas would be similar for each of the decommissioning alternatives, but the general contractor may propose a slightly different approach depending on the decommissioning alternative implemented and other activities in the summit region. A clear path for HCFD access will be maintained at all times during deconstruction activities with portable firefighting equipment maintained on site at all times.

Use of the adjacent Batch Plant site for deconstruction staging is also being proposed by the Thirty Meter Telescope (TMT). Construction for TMT may be concurrent with the deconstruction activities of the CSO. The CSO decommissioning effort will make use of the Batch Plant site for temporary deconstruction staging activities and permanent stockpiling of excess fill removed from the Site. TMT currently has a stockpiling permit for use of the Batch Plant. CSO will also be required to obtain a stockpiling permit from the County of Hawaiʻi Planning Department. The CSO decommissioning project will coordinate use of the Batch Plant with any concurrent construction projects.

The number of deconstruction personnel onsite will vary for each deconstruction activity. The total number of deconstruction workers on any given day will typically consist of the: (*i*) general contractor superintendent; (*ii*) independent deconstruction monitors and potentially other monitors (archaeological, cultural, and biological); and (*iii*) general contractor and subcontractor's crew. The anticipated numbers of personnel for each decommissioning alternative and their estimated number of vehicle trips are provided in Table 5-2, Table 5-3, and Table 5-4. One vehicle-trip is defined as the combination of one ascent to, and one descent from, the summit of Maunakea.

Vanpools are to be provided for subcontractor personnel leaving from and returning to Halepōhaku on a daily basis. Should parking be limited at Halepōhaku for subcontractor crew parking, crew members can convene in Hilo and vanpool directly up to the site, stopping only at Halepōhaku for a short duration (~30 minutes) to acclimate to the higher elevation. Deconstruction crews will not have access to Halepōhaku astronomy support common building dining and toilet facilities. Stopping at Halepōhaku on the return trip at the end of the day will not be necessary.

Deconstruction vehicles on site will be limited to current deconstruction activity only. No parking (day or overnight) will occur on the CSO Site and all BMPs related to vehicle use will be followed. Limited day parking will be available at the designated portion of the Batch Plant for CSO deconstruction. This designated portion will be for the sole use of the CSO deconstruction team and its location and access will be coordinated with other concurrent summit region construction projects, if any. This limited parking will be for the exclusive use of the general contractor, vans that transport subcontractor crews, independent deconstruction monitor and potentially other monitors (archaeological, cultural, and biological), and inspectors. Overnight parking in the summit region will be limited to large deconstruction vehicles, such as a water truck and dump trucks (up to four maximum) and located within the secure fencing at both the CSO Site and at CSO's designated staging area at the Batch Plant. Overnight parking for large deconstruction vehicles in the summit region reduces the daily overall number of deconstruction vehicle trips on the Mauna Kea Access Road.

As shown in Table 5-2, Table 5-3, and Table 5-4, it is not anticipated that the CSO deconstruction activity will see a significant number of deconstruction vehicles on a daily basis along the Mauna Kea Access Road under any of the action alternatives considered in this SDP. Planning for the deconstruction activities shows a limited number of small vehicles carrying personnel traveling between Saddle Road and Halepōhaku and even fewer (via vans) traveling on the unpaved portion of the road up to the CSO Site. Personnel trips will mainly occur at the start and end of the day and generally not interfere with observatory, maintenance, and other vehicles during the day.

Larger deconstruction vehicles, such as flatbeds for delivery of equipment and dump trucks for removal of recyclable and solid waste material, will also be limited and can be coordinated with CMS, other observatories, tour groups, and Rangers for off-peak hours, as necessary. Dump trucks for removal of existing fill on site will have a short haul route on the paved portion of the Mauna Kea Access Road between the CSO Site and the stockpile locations at the Batch Plant (Figure 5-1) and, therefore, there is limited potential for conflicts between CSO deconstruction and other vehicles. Flagpersons with radios can be provided to control general and deconstruction traffic between the CSO Site and the Batch Plant when fill material transport operations are ongoing.

With the small number of CSO deconstruction vehicle trips along the Mauna Kea Access Road daily, it is not anticipated that additional road maintenance work will be necessary beyond the current regular road maintenance efforts provided above Halepōhaku. However, should it be found that additional road maintenance is necessary due to CSO decommissioning activities, Caltech would reimburse CMS for additional road maintenance costs incurred.

Temporary Mauna Kea Access Road closures or restrictions (from Saddle Road to the summit region) will be necessary to deliver and return wide-load deconstruction equipment such as trailers and crane(s). The necessary road closures will be coordinated with HDOT, CMS, Rangers, summit observatories, tour groups, and other observatory and summit construction activities. Notifications will be sent in advance of any road closures to these parties and made public. Road closures will be scheduled to occur during off-peak times.

Caltech does not anticipate that any of the larger deconstruction vehicles for the CSO deconstruction will require towing or braking assistance from other vehicles. Most large deconstruction vehicle trips will be for moving fill material between the CSO Site and the designated stockpile locations at the adjacent Batch Plant, approximately 1,200 feet apart (Figure 5-1).

CHAPTER 6: SITE RESTORATION PLAN (SRP)

6.1 INTRODUCTION

The DP defines the purpose of the SRP as follows:

> *"The purpose of a Site Restoration Plan is to present specific targets for site restoration and to describe the methodology for restoring disturbed areas after the demolition/construction activities described in the Site Deconstruction and Removal Plan are completed. Each SRP shall be specific to the site and consider cultural, biological, and physical aspects of site restoration. Each SRP shall include a provision for effectiveness monitoring to characterize success and/or failure of restoration efforts."*

It also goes on to provide definitions for three levels—minimal, moderate, and full—of site restoration that can be considered. As outlined in Chapter 4, only moderate and full restoration are being considered in detail for the CSO decommissioning (see Table 1-1).

This SRP incorporates consideration of the cultural, physical, and biological aspects of site restoration, providing a survey of the existing condition of these resources and presenting an analysis of how the intent, process, or outcome of site restoration may impact these resources. Finally, the CBA (see Chapter 7) weighs these potential impacts in order to determine the balance between cost(s) and benefit(s) for each alternative.

Figure 6-1 depicts the condition of the CSO Site prior to the facility's construction in the 1980s.

Figure 6-1: CSO Site Prior to Construction

Note: The “CIT” label refers to the California Institute of Technology and identifies the CSO site.

Source: Caltech (1985)

6.1.1 Introduction to Topographic Site Restoration Methodology

Details regarding topographic site restoration are provided in Section 6.5.1. This introductory overview is provided context for the analysis included in this Chapter that informed Caltech’s decision-making regarding site restoration. Caltech has established that only modest excavations into the native ground were made during construction. Fill was placed over the native ground where the observatory and most other infrastructure was built. Thus, it appears that it will be feasible to fully restore the look and feel of geophysical site topography, per the recommendations of the DP. Restoration of the CSO Site's topography to pre-construction condition will principally consist of removing the excess fill placed during construction. There will be only modest quantities of backfilling required for the site restoration, primarily for the cavity left after cesspool removal, which will use the fill material (Section 5.1.10).

6.1.2 Introduction to Biological Site Restoration Methodology

Details regarding biological site restoration are provided in Section 6.5.2. This introductory overview is provided context for the biological analysis included in this Chapter (Section 6.3) that informed Caltech's decision-making regarding site restoration. Pre-construction and contemporary biological surveys indicate that it also seems feasible to fully restore the habitat and recover a population of flora and fauna, including arthropods, similar to surrounding areas (SRGII, 2019). This SRP describes the methodology for habitat restoration, which will consist of surface treatment of the restored topography to mimic the surrounding areas (i.e., active habitat restoration) followed by passive recruitment of native flora and fauna, including the arthropod community (i.e., passive habitat restoration).

Should unforeseen circumstances arise during decommissioning that render full restoration impossible (ALT-3 and ALT-4, see Sections 4.3.3 and 4.3.4, respectively), moderate restoration will include surface treatments (i.e., active habitat restoration) followed by passive recruitment of native flora and fauna (i.e., passive habitat restoration).

Per the DP, three years of biological monitoring will be conducted to characterize the effectiveness of habitat restoration and inform future decommissioning efforts on Maunakea.

6.1.3 Introduction to Archaeological-Cultural Site Decommissioning Considerations

The archaeological and cultural surveys undertaken to inform this SDP have documented Maunakea's cultural landscape and have catalogued the specific cultural resources present in the vicinity of the CSO Site (see Section 6.4). Based on those surveys, there are no known specific historic properties (archaeological sites) that will be directly affected by site restoration. Archaeological and cultural monitoring (Section 5.1.1) will help to ensure that no negative impacts on previously unidentified archaeological, historic, or cultural resources will occur during site restoration activities. Considerations related to specific historic properties are discussed in Section 6.4.2.

The related issue of how site restoration may affect the cultural landscape, which is not a specific historic site, is more complex. For those who value the more broadly defined cultural landscape, the positive or negative impact(s) of site restoration depends on the intent and outcome of the decommissioning effort. Considerations related to the cultural landscape are presented in Section 6.4.1.

6.2 PHYSICAL SITE RESTORATION

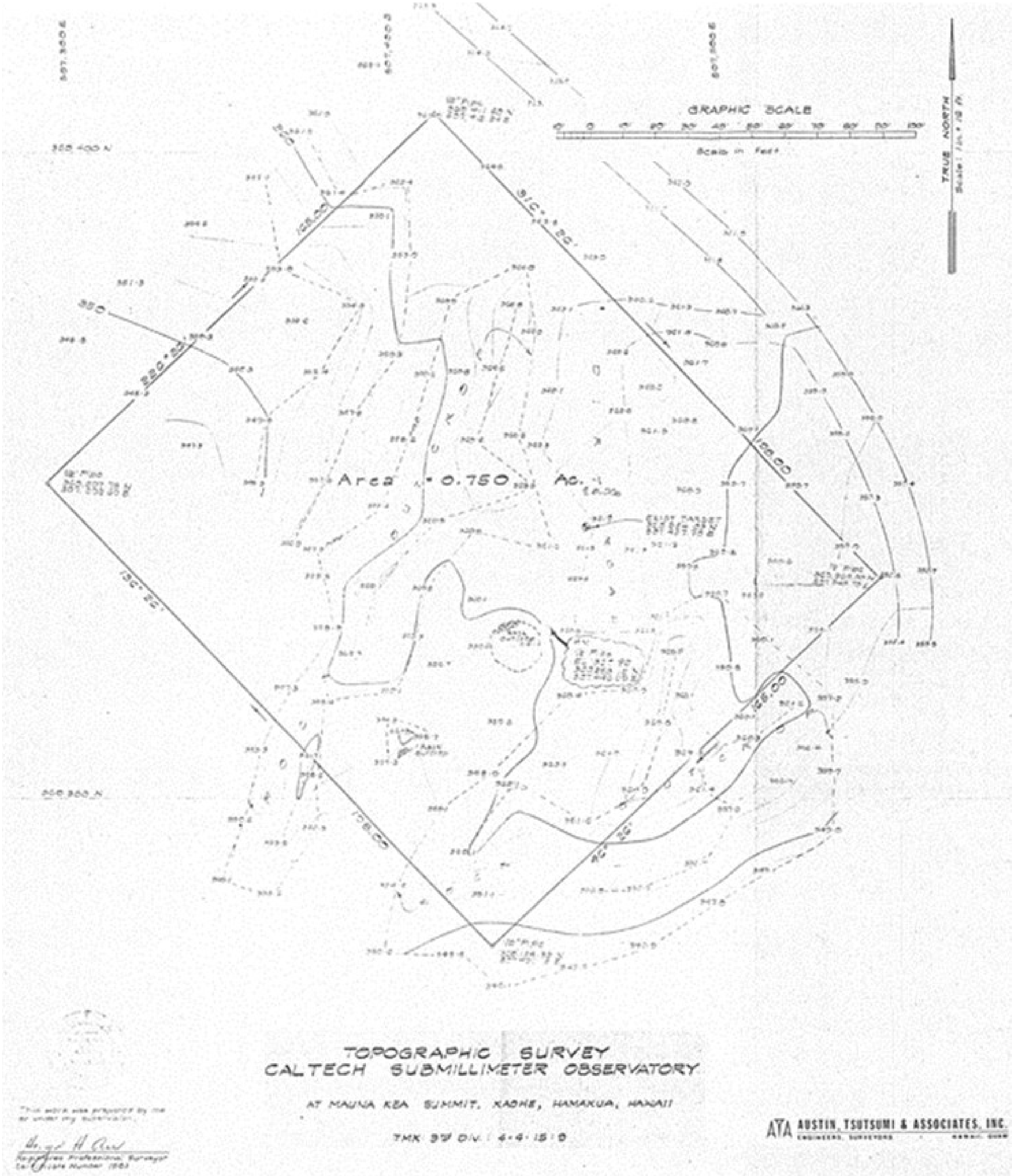
6.2.1 Pre- and Post-CSO Topography

Austin, Tsutsumi & Associates, Inc, undertook a pre-construction site topographical survey, presumably prepared in 1982-1983 and noted as received January 21, 1983; the survey is provided in Figure 6-2. M3 Engineering and Technology, Caltech's decommissioning planning contractor, digitized this prior survey and overlaid it with an updated site survey performed by dlb & Associates in 2016 (see Figure 6-3), with corrections for relative calibrations, to determine more accurately the amount of fill added and excavation done during construction. A comparison of the two surveys indicates that:

- Pre-construction grading and excavation cut approximately 495 cu. yds. of material from the site and filled with approximately 2,830 cu. yds. material, yielding a net fill of 2,335 cu. yds.;
- The maximum depth of the fill is about 10 feet, on the downhill side of the facility;
- The deepest foundation, under the telescope, is about 4 feet below grade and entirely in fill; and
- The cesspool extends approximately 13.5 feet below grade, with the upper 9 feet in fill and the lower 4.5 feet in the pre-construction topography.

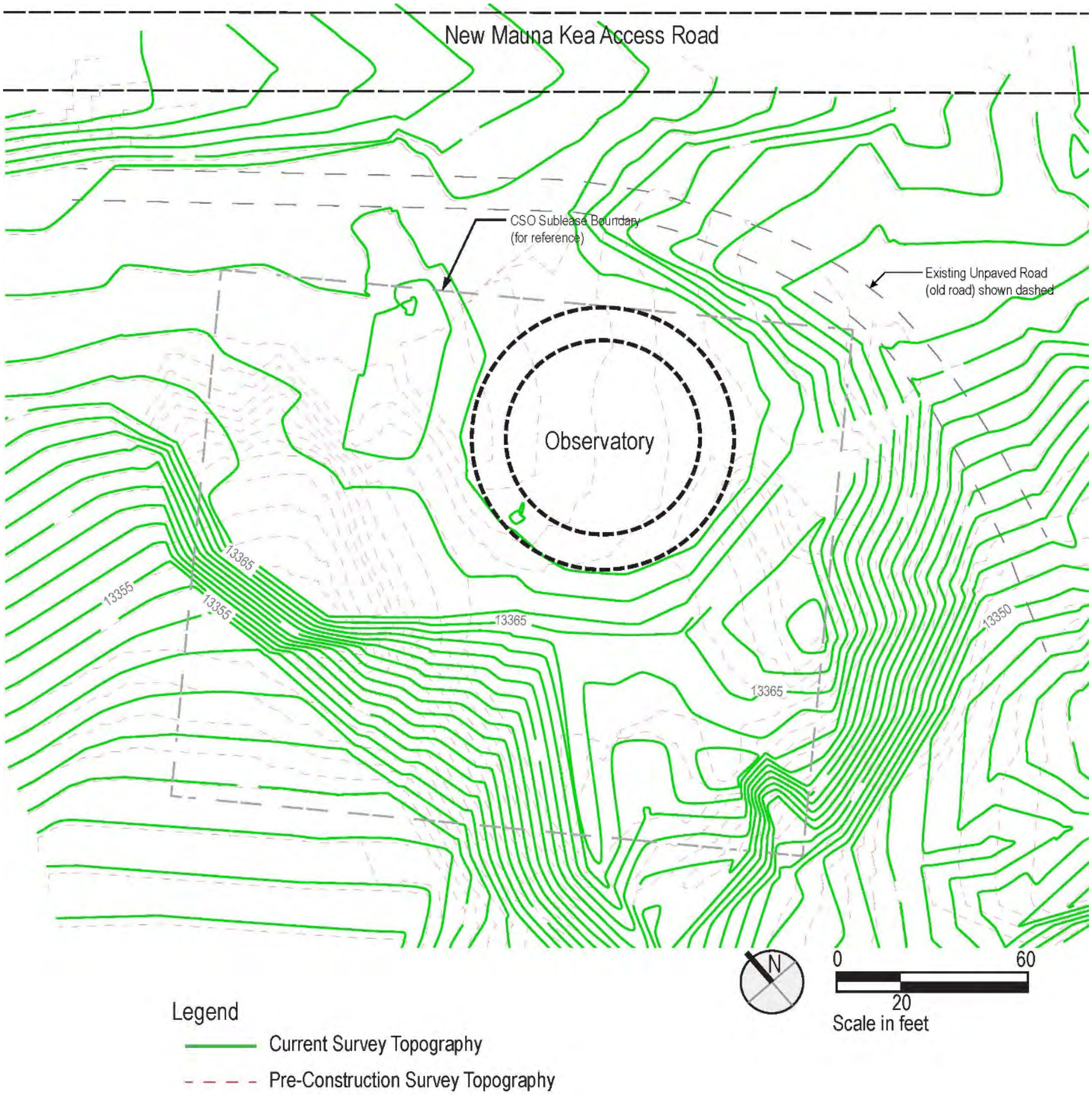
Because restoration of the pre-construction topography would primarily require removal of fill from the site, with only modest excavation and backfill for the cesspool, there appear to be no engineering obstacles to full restoration of the pre-construction topography.

Figure 6-2: Pre-Construction Topographical Survey of Site (1982)



Source: Austin, Tsutsumi & Associates, Inc (1982)

Figure 6-3: Comparison of Pre-Construction and 2016 Topographical Surveys



This figure reproduces information not legible in the 1982 pre-construction topographical conducted by Austin, Tsutsumi and Associates, Inc.
Source: dlb & Associates (2016)

6.2.2 Geological Source of Fill

Geological analysis of fill used during construction can provide information about its source, which in turn has substantial implications for the success of biological and cultural site restoration. The following subsections describe the available information related to onsite fill.

6.2.2.1 Pre-Construction Geological Analysis

During the planning and preparation for the observatory, Caltech retained Dames & Moore to conduct a pre-construction geological and hydrological study of the CSO Site. Their report, *Geologic and Hydrologic Factors*, was incorporated as Appendix B of the *A 10-Meter Telescope for Millimeter and Submillimeter Astronomy at Mauna Kea, Hamakua, Hawaii: Final Environmental Impact Statement* (Group 70, 1982). That report states:

> *The principal rock type of the summit area of Mauna Kea is hawaiite which commonly forms clinkery aa lava flows or cinder cones up to 600 feet high with ejecta fragments up to 10 feet in size. These hawaiites range from non-vesicular and dense to extremely vesicular and less dense. The surfaces of lava flows are frequently striated (which signify overriding glacier movement) and inter-stratified with glacial debris (characterized by loose rock fragments), which in turn are inter-layered with cinder, ash and other volcanic pyroclastic materials...*
>
> *Based on available photographs and interviews with University of Hawaii researchers (Woodcock; Laws; West, personal communications, 1982), the proposed site is interpreted to be an aa lava flow which vented in the vicinity of the Site (probably from one of the summit cones) and flowed primarily northwest with one lobe extending to the south. From the existing topography, the southern lobe of this flow appears to have moved about 2,000 feet downhill from the Site – about half the distance to Lake Waiau. However, the flow surface has been subject to subsequent glaciation and the original flow paths of the lava are obscured. This aa flow overlies a slightly older flow (possibly part of the same eruption period) which also moved to the south and southwest -- surrounding Lake Waiau and filling the area between Puu Waiau, Puu Poliahu and Puu Hau Kea and partially covering the north and west rim of Puu Waiau.*

With respect to anticipated specific site work in the construction of CSO, Dames & Moore noted:

> *The proposed earthwork for the site is minimal – limited to minor levelling, removal of lava fragments, and footing excavations up to 4 feet deep at the telescope site. Estimated total excavation is only about 100 cubic yards. The excavated lava rock will be utilized mostly for footing backfills.*

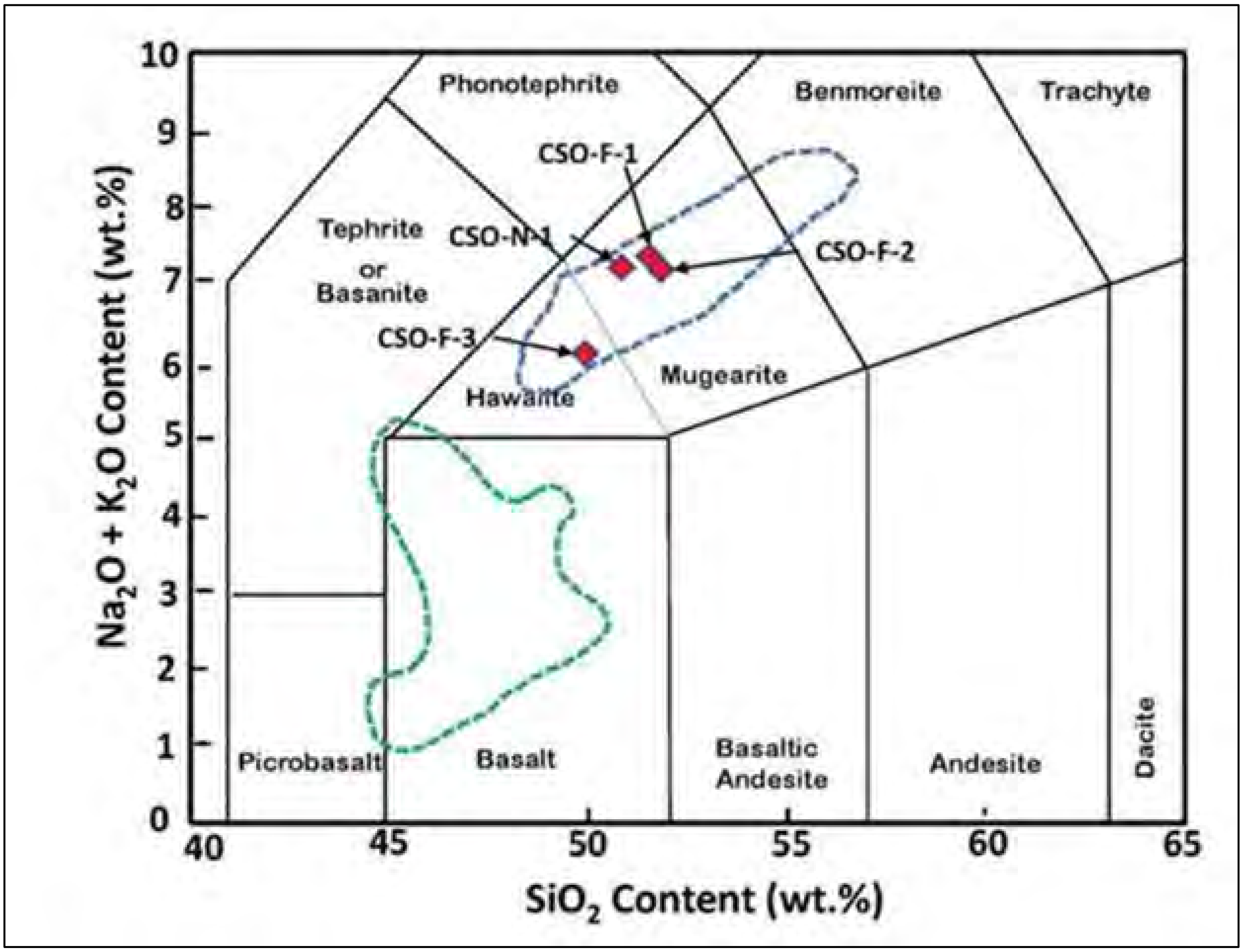
Final grading and construction plans amended the excavation plan, necessitating no excavation for the telescope footings but requiring excavation for the cesspool and a larger excavation volume overall. Review of the available documentation from the construction of the observatory do not document the origin of the fill that was used on the CSO Site.

6.2.2.2 Contemporary Geological Analysis

In the absence of clear information indicating the source of the fill used during construction on the CSO Site, Caltech retained geoengineering consultant Intera, Inc. to sample and analyze the fill. Their report, *Hydrogeological and Geological Evaluation: Decommissioning of the California Institute of Technology Submillimeter Observatory* (Intera Inc., 2019), describes their methods and findings.

Figure 6-4, reproduced from the Intera, Inc. (2019) report, provides a geochemical comparison of the CSO Site fill material (samples CSO-F-1, CSO-F-2, and CSO-F-3) to a reference sample (sample CSO-N-1) of volcanic material from an adjacent ‘a‘ā lava flow.

Figure 6-4: Geochemical Analysis of Composition and Origin of CSO Fill



Notes: 1. Diagram was used by Wolfe et al. (1997) to compositionally classify Mauna Kea lavas. The green dashed line denotes the approximately extent and range of geochemically analyzed older Hāmākua Volcanics and the blue dashed line denotes the approximately extent and range of geochemically analyzed younger Laupāhoehoe Volcanics as reported by Wolfe et al. (1997, p. 17, Figure 5). The four samples collected and analyzed for this investigation (red diamonds) all fall within the Laupāhoehoe Volcanics extent.

2. Samples CSO-F-1, CSO-F-2, and CSO-N-1 are fairly closely clustered, suggesting that they are very likely “related”, possibly even produced by the same eruptive event. Sample CSO-F-3 does not cluster with the other three (3) samples and is compositionally different enough to suggest that it is not related to the other three (3) samples. [It is] …a Hawaiite, while the other three (3) samples are mugearite. This Hawaiite sample may represent a piece of tephra from one of the adjacent cinder cones.

Source: Intera, Inc., *Hydrogeological and Geological Evaluation* (2019)

That report goes on to provide the following conclusion based on this comparison (Intera, Inc., 2019):

> *“Based on the lithologic descriptions and geochemical analyses of the three (3) fill samples and one (1) sample from an adjacent a’a lava flow, the fill material at the CSO Site is determined to be sourced from Laupāhoehoe Volcanics which underlies Maunakea summit area. Much of the CSO Site fill was likely originally sourced from an excavation in a Laupāhoehoe lava flow during widening of the main road.*

> *Other components of the fill are probably tephra from one of the nearby Laupāhoehoe cinder cones."*

Based on the analysis and results of this geological investigation it appears to be clear that the fill used on the CSO Site during construction was native to the summit area of Maunakea (i.e., "native fill") and was not transported to the site from a more distant source. Consequently, the use of this native fill for backfill during decommissioning does not present a hazard of negative cultural or biological impacts.

6.3 BIOLOGICAL SITE RESTORATION

This section discusses the biological, ecological, and environmental restoration of the CSO Site. To provide the necessary context for a discussion of biological habitat restoration, it reviews: (*i*) the biological inventory conducted prior to CSO construction; (*ii*) the contemporary biological survey of the CSO Site conducted during preparation of this SDP; and (*iii*) an assessment of the potential impacts to biology during and after site restoration.

6.3.1 Pre-Construction Biological Inventory

During the planning and preparation for the observatory, Caltech retained Dr. Francis G. Howarth of the Bishop Museum to conduct a pre-construction biological survey and assessment of the CSO Site. The resulting report, *A Provisional Assessment of the Arthropod Fauna of the Area to be Impacted by the Proposed University of Hawaii/California Institute of Technology 10-Meter Telescope Near the Summit Mauna Kea, Hawaii*, was incorporated as Appendix C of the *A 10-Meter Telescope for Millimeter and Submillimeter Astronomy at Mauna Kea, Hamakua, Hawaii: Final Environmental Impact Statement* (Group 70, 1982). The report begins with an overview of what was known about fauna at the summit at that time:

> *The major component of the fauna of the aeolian ecosystem on the summit of Mauna Kea is composed of arthropods. Currently, about 12 species appear to be maintaining populations in this ecosystem. These include 3 spiders, 4 mites, 2 springtails, 1 bark louse, and 2 true bugs. ... Some of these species could be associated with the algae, mosses, or lichens which grow near the summit.*

The report states that the two true bugs include one in the genus *Nysius*, the endemic wēkiu bug, while the other is the non-native *Geocoris pallens*. The report indicated that wēkiu bugs were not observed at the CSO Site during the survey, but that the season and weather conditions during the survey reduced the likelihood of them being found. Arthropods that were found in the field at the CSO Site included a native Hawaiian lycosid wolf spider and an anystid mite. Two springtails and four mites were found in the soil samples collected during the survey.

6.3.2 Contemporary Biological Inventory

During the planning and preparation for the decommissioning of the CSO Site, Caltech retained Sustainable Resources Group International, Inc. (SRGII) to conduct a biological survey of the site and prepare a report (*Biological Setting Analysis: Caltech Submillimeter Observatory Decommissioning*; SRGII, 2019) characterizing the existing biota and identifying biological considerations related to site restoration. The report characterizes the ecosystem at the CSO Site as alpine stone desert, with limited potential for the development of plant and animal communities. The following summarizes the survey's findings:

- Lichens, Mosses, and Vascular Plants. Eleven clumps of lichens were observed. The most abundant vascular plant in and near the survey site was the endemic grass pili uka (*Trisetum glomeratum*). Most pili uka clumps were growing on topographically disturbed areas and one individual was found growing in a crack in the pavement driveway. Several individual ‘iwa ‘iwa (*Asplenium adiantum-nigrum*) ferns were found just outside of the east-to-south boundary of the subleased lands, none were found within the subleased lands. No other plant species were recorded. The species observed were typical of the alpine stone desert ecosystem; none are listed as threatened or endangered species.

- Arthropods. The majority of species recorded during the survey were species not native to the aeolian desert on Maunakea. The exceptions were one native spider species (*Lycosa hawaiiensis*), one native moth species (*Agrotis kuamauna*), and one fly species from an unknown origin (*Bradysia sp.*). Arthropods from the *Aphis* genera were found in traps but could not be identified to the species level; all *Aphis* species in Hawai‘i are non-native and some have been previously recorded in the aeolian desert on Maunakea. One member of the survey team, who samples arthropods regularly in the UH managed areas on Maunakea, reported previously noting native spiders and caterpillars at or near the CSO site although they were not common in this recent survey. Wēkiu bugs were not found at the CSO Site during the study and the report indicates that they are not found on lava flows or areas dominated by compacted ash/silt. Studies conducted on Maunakea have indicated that environments like the CSO Site are not likely to be prime wēkiu bug habitat currently or after restoration (Kirkpatrick 2018, Kirkpatrick & Klasner 2015, UH Hilo 2010, Englund et al. 2007, Porter and Englund 2006). None of the arthropods present in the alpine stone desert on Maunakea are listed as threatened or endangered species.

- Birds and Mammals. No birds or non-human mammals were observed during the study. The report noted that what appeared to be dog feces was observed at the CSO Site and that two endangered birds, ‘ua‘u (*Pterodrama sandwichensis* or Hawaiian Petrel) and ‘akē‘akē (*Oceanodroma castro* or Band-rumped Storm Petrel), may utilize the lower elevation alpine shrublands and grasslands on Maunakea, but there have been no recorded detections of birds or burrows in the vicinity of the CSO Site. Similarly, the endangered ‘ōpe‘ape‘a (*Lasiurus cinereus semotus* or Hawaiian hoary bat) has not been detected in the vicinity of the CSO Site but may occur at high elevations.

6.3.3 Impacts of Biological Site Restoration

With the exception of ALT-1 (i.e., the No Action alternative), all of the alternatives considered in this SDP (see Table 1-1) contemplate total facility removal, partial or full infrastructure removal, and moderate or full site restoration. Removal and restoration can impact biological resources in two periods: (*i*) during removal and site restoration activities, also referred to as “process impacts;” and (*ii*) after restoration activities, also referred to as “outcome impacts.” Both phases of site restoration (i.e., during/process and after/outcome) are given further consideration in the following subsections.

6.3.3.1 *Site Decommissioning Process Impacts*

The *Biological Setting Analysis* (SRGII, 2019) provides an extensive analysis of the potential impacts related to the process of removing the observatory and restoring the CSO Site. In contrast to the action alternatives, and as a baseline for comparison with them, the *Biological Setting Analysis* concludes that (SRGII, 2019):

> *"Under a No Action Alternative, biological resources would remain unimpacted [relative to status quo], and both native and non-native species would continue to occupy the project footprint."*

Thus, there would be no decommissioning process impact relative to status quo under ALT-1 because the site would not be disturbed and the species would continue to occupy the site as they did during CSO operation and continue to do so since CSO ceased operation.

The following points summarize SRGII's assessment of the potential for impacts during the decommissioning process under the action alternatives:

- The process of site decommissioning will disturb the CSO Site and potentially adversely impact lichens, mosses, vascular plants, and arthropods, as well as the habitat that supports them, but these impacts will be temporary and not considered significant.
- No native birds or mammals frequent the CSO Site or nearby areas.
- The best management practices (BMPs) and monitoring during site deconstruction and restoration described in Section 5.1.1 will minimize impacts.
- These impacts will be limited to the CSO Site and staging and stockpiling areas, leaving broader populations on the summit unaffected.
- Recolonization of the CSO Site by native species, once site restoration is complete, is almost certain to occur.
- The process of restoration, because it involves a range of equipment coming onto the CSO Site from elsewhere, can present a threat of introduction of non-native vascular plans and arthropods. However, utilization of the BMPs described in Section 5.1.1 will minimize this potential, and the extreme summit conditions render the survival and establishment of non-native species unlikely.
- Significant adverse impacts due to the introduction or establishment of non-native species are not anticipated.
- The site restoration process presents the risk of exposing flora and fauna to potentially hazardous biological material from the cesspool and chemicals, such as the documented hydraulic fluid spill and hydrocarbons from motorized equipment, as those substances are being removed. However, observing the BMPs discussed in Section 5.1.1 will minimize this risk and no significant adverse impacts relating to exposure are anticipated as a result.

6.3.3.2 Restoration Outcome Impacts

The *Biological Site Assessment* indicates that the planned scope of topographical site restoration is adequate for the restoration of the biological community (SRGII, 2019):

> *"Geological analysis has confirmed that [fill material from the site to be used for backfilling] is consistent with other material at the summit. The only non-native species present in the fill would be those that are already part of the existing environment. Estimates of the volume of earthen material needed to backfill and finish the site indicate more material is available than needed. This phase of the restoration process aims to create the topographic conditions that provide sufficient conditions for passive restoration of the biological community."*

As the discussion of methodology will indicate, the anticipated outcome of full restoration of the CSO Site, per ALT-2 (Section 4.3.2) is that all prior habitat will be recovered, allowing native flora and fauna to reestablish themselves over time. Thus, the after restoration (outcome) impact of full site restoration would be entirely positive. Other action alternatives that incorporate moderate site restoration (i.e., ALT-3 and ALT-4) will yield more modest benefits because, although they would enhance the physical habitat structure to benefit the native arthropod community, they would not restore the topography, which is likely necessary for the establishment of native flora.

Under ALT-1 (No Action) there would be no restoration of the CSO Site. Thus, the benefits of the action alternatives outlined above would not occur, there would be no negative or positive biological impacts relative to status quo, and negative biological impacts relative to the pre-construction conditions (e.g., the presence of structures and hardscape displacing habitat) would endure.

6.4 ARCHAEOLOGICAL-CULTURAL CONSIDERATIONS AND IMPLICATIONS

During CSO Site decommissioning planning, Caltech retained ASM Affiliates to conduct an Archaeological Assessment (AA) and a Cultural Impact Assessment (CIA) to identify archaeological and cultural resources present in the area and to assess the potential for impacts during decommissioning activities, also referred to as "process impacts," and after decommissioning is complete, also referred to as "outcome impacts." The resulting reports, *An Archaeological Assessment for the Caltech Submillimeter Observatory Decommissioning Project on Maunakea* (ASM Affiliates, 2018) and the *Cultural Impact Assessment for the Caltech Submillimeter Observatory Decommissioning Project on Maunakea* (ASM Affiliates, 2020) are, collectively, the primary sources of the information and analysis contained in the following subsections of this SDP. Together, they offer two complementary approaches to cultural considerations: (*i*) specific archaeological, historical, or cultural resources; and (*ii*) Maunakea's summit region cultural landscape.

The AA is based on a pedestrian survey of the study area, which is defined as the areas, "where ground disturbance may be anticipated to occur during the decommissioning process" (ASM Affiliates, 2018). This survey sought to identify archaeological or historic sites which were not previously identified in prior surveys, confirm previously identified properties nearby, and take photographs from "a visual effects study area that includes the viewshed of the CSO facility" (ASM Affiliates, 2018). As such, the AA is most directly relevant to the consideration of specific archaeological, historical, or cultural resources.

The CIA: (*i*) summarizes the literature on the cultural significance of Maunakea, (*ii*) reviews prior studies of similar type, and (*iii*) reports on prior and contemporary consultations with Native Hawaiian practitioners and community members. It is primarily relevant to cultural landscape, though it references some of the specific cultural resources that the AA identifies.

The AA and CIA assess the potential for impacts both during site decommissioning (process) and after it is complete (outcome). For reference, Figure 6-5 provides a depiction of the AA's direct effect and visual study areas overlaid; the visual study area is the area within the summit region from which the CSO Site can been seen. Figure 6-6 zooms in on the direct effect study area; the direct effect study area is the area that could be disturbed by CSO decommissioning activities. The AA involved a pedestrian study of the direct effect study area and visiting nearby historic properties within the visual effects study area in May 2018. The CIA effort included:

- Reviewing previous Maunakea cultural studies.
- Contacting the Office of Hawaiian Affairs (OHA) main office on O‘ahu and their West Hawai‘i branch office.
- Sending consultation requests to 38 individuals or groups.
- Receiving responses from eight of those sent requests.[9]
- Having four of those responding consent to participate in the CIA (Harry Fergerstrom, Kohala Hawaiian Civic Club, La‘i‘ōpua 2020 Association, and Jimmy Medeiros, Sr.).
- Reviewing information from an informal meeting regarding the proposed decommissioning between Peter Young of Ho‘okuleana LLC and three kūpuna that have knowledge concerning Maunakea cultural practices and have demonstrated interest in Maunakea land uses.
- Attending two meetings of Kahu Kū Mauna.

The AA and CIA indicated:

- The CSO Site, direct effect study area, and visual effect study area are within the Mauna Kea Summit Region Historic District (SIHP Site 50-10-23-26869), which encompasses the area from the summit down to a relatively pronounced change in slope that creates the impression of a summit plateau. All known archaeological sites and historic properties within the district area are considered to contribute to the district.
- No archaeological sites that contribute to the historic district are within the CSO Site or direct effect study area.
- Eleven historic properties that contribute to the historic district are within the visual effects study area. SIHP Site 50-10-23-16164, a shrine, is 188 meters to the south-

[9] One of the eight who responded and consented is not listed in CIA Tables 4 or 5 because they were responding to an earlier invitation to consult on the project.

southwest of the CSO Site. A photograph from that site to the CSO Site is provided in Figure 6-7.

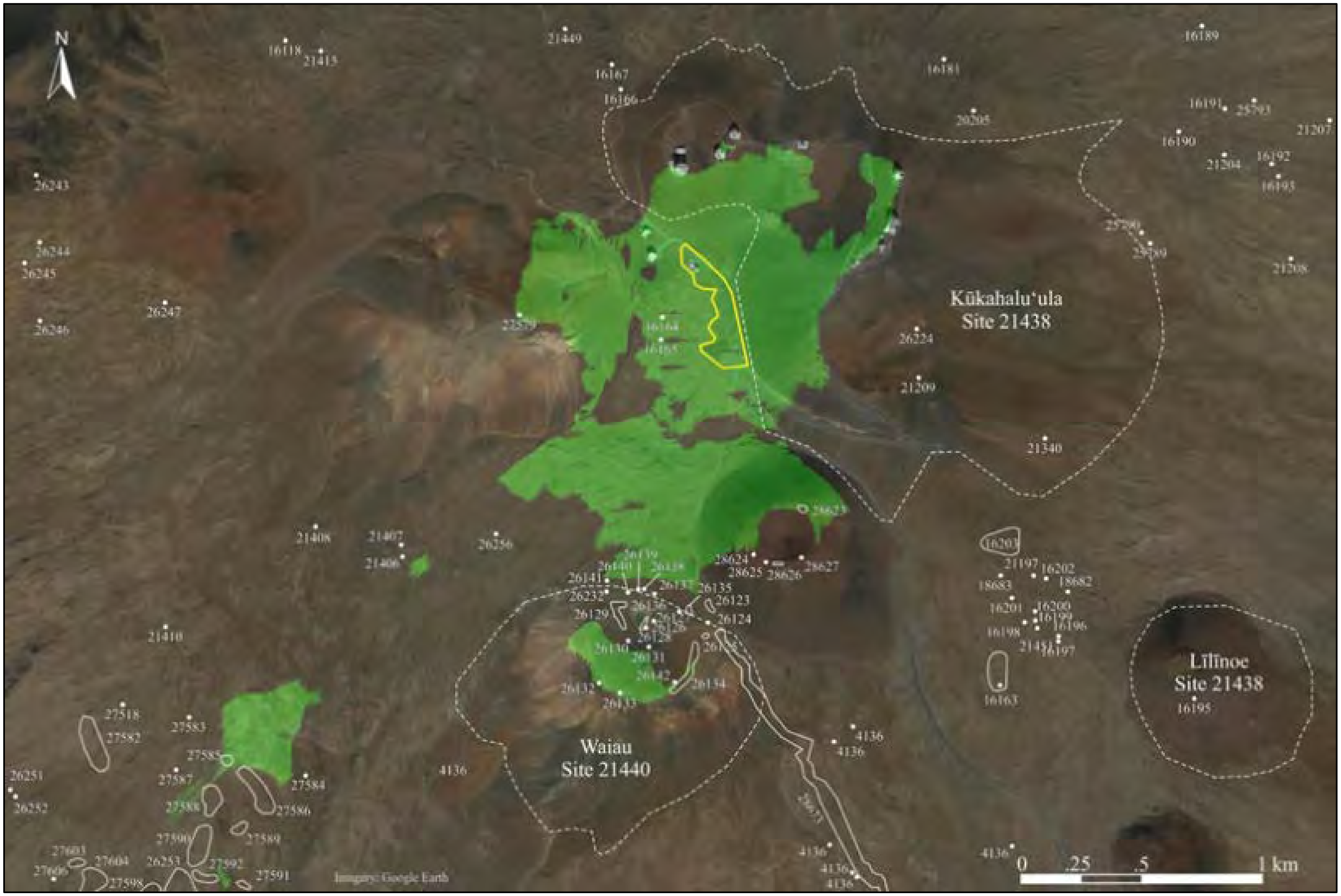
- The decommissioning of CSO will "result in an enhancement of the integrity of setting, feeling, and association" of the historic properties and district. Thus, in accordance with applicable rules and regulations, the determination of effect for the proposed decommissioning would be "no historic properties affected."
- Native Hawaiians are not monolithic in their views, and there may be a multitude of opinions regarding the sanctity of Maunakea. This was illustrated by members of Kahu Kū Mauna stressing that based on their experience it is important to acknowledge that "there is a diversity of perspectives regarding the sacredness of Maunakea and some Native Hawaiians do not view Maunakea as sacred."
- Maunakea's upper slopes continue to be sacred – i.e., provide a cultural landscape – to contemporary cultural practitioners, whether their practices are "traditional and customary" or contemporary. Cultural practitioners place value on this cultural landscape, and their practices reinforce that value for them.
- The CIA, and the quotes from it included in the sections below, focus on those that participated in the CIA and hold the region to be sacred. That cohort of Native Hawaiians believes that it would be improper and culturally offensive if the CSO decommissioning effort does not *intend* to remove all facilities and infrastructure and fully restore the CSO Site.

The reports did not identify:

- Any specific ongoing traditional, customary, or contemporary cultural practices occurring within or associated with the CSO Site or direct effect study area.
- Any specific cultural practices that would be directly affected (adversely or beneficially) by the decommissioning of CSO.
- Any resources used for traditional and customary cultural practices that are present on the CSO Site.
- That the CSO Site or direct effect study area is used to access locations where traditional and customary cultural practices are conducted or cultural resources are gathered.

Consequently, Caltech has concluded that there will be no direct effect on any specific archaeological, historical, or cultural resources as a result of the CSO Decommissioning Project and that any resulting indirect effects will be entirely positive. Nevertheless, Caltech will implement the mitigation measure suggested by those that participated in the CIA: having a cultural monitor present during decommissioning as mentioned in Section 5.1.1.

Figure 6-5: Direct Effect and Visual Study Areas for the Archaeological Assessment



Google Earth™ satellite image showing the visual effects study area (green) and the direct effects study area (outlined in yellow). Historic sites in the vicinity are indicated.
Source: ASM Affiliates, Archaeological Assessment for the Caltech Submillimeter Observatory Decommissioning Project on Maunakea (2018)

Figure 6-6: Direct Effect Study Area for the Archaeological Assessment

Google Earth™ satellite image showing the direct effects study area (outlined in yellow). It includes the CSO Site, the Batch Plant, the area in between, and land to the northwest of the CSO Site.
Source: ASM Affiliates, *Archaeological Assessment for the Caltech Submillimeter Observatory Decommissioning Project on Maunakea* (2018).

Figure 6-7: CSO Site from SIHP Site 50-10-23-16164

Note: CSO is in center left midground, site 50-10-23-16164 is in the foreground, view to the northeast.
Source: ASM Affiliates, *Cultural Impact Assessment for the Caltech Submillimeter Observation Decommissioning Project on Mauna Kea* (2020).

6.4.1 Site Restoration Impacts to the Cultural Landscape

6.4.1.1 The Cultural Landscape

The CIA provides a substantial body of literature identifying Maunakea as a *wahi pana*, or storied place, and describes its cultural significance from a variety of perspectives. In its review of the literature regarding the cultural significance of Maunakea, it states (ASM Affiliates, 2020):

> *"An extensive body of literature describing the significance of Mauna Kea and the summit region has been developed over the past three decades (Kanahele and Kanahele 1997; Lang and Byrne 2013; Langlas 1999; Langlas et al. 1999, Maly 1998, 1999; Maly and Maly 2005, 2006; McCoy et al. 2009; McEldowney 1982; PHRI 1999; Simonson and Hammatt 2010). Through archival research and a compilation of native traditions, historical accounts, and oral-historical interviews, a detailed culture-history of Mauna Kea has been presented that documents a wide range of cultural knowledge and practice associated with the mountain, and more specifically with the summit region and [its] association with Hawaiian deities.*

> *These studies have also recognized Mauna Kea as a landscape that continues to be sacred to contemporary cultural practitioners."*

Its concluding analysis states:

> *"The culture-historical background information that has been generated for Mauna Kea as a result of the numerous detailed studies clearly demonstrates the sanctity of Mauna Kea and its summit region. The compiled oral-historical information provides further specific details about the cultural importance of the summit's viewplanes, the traditional significance of individual pu'u, and the importance of proper cultural protocol. It is also clear from the oral-historical information that current-day Hawaiian cultural activities on Mauna Kea are perceived by the practitioners of those activities to be an exercise in, and extension of traditional and customary practices."*

While some of this text references specific cultural resources, these references augment its overarching position about the sanctity and significance of Maunakea's upper slopes to current-day cultural practitioners. This SDP terms this sanctity and significance as the "cultural landscape." The cultural landscape is not merely a sum of specific, identifiable resources, it represents the combined works of nature and cultural practitioners and the values attributed to the landscape by Native Hawaiians.

6.4.1.2 <u>Impacts of CSO Decommissioning on the Cultural Landscape</u>

The CIA begins its analysis of impacts of site decommissioning as follows (ASM Affiliates, 2020):

> *"…there is no disputing that the decommissioning of an observatory facility within the Astronomy Precinct on Mauna Kea would have a positive cultural impact. What is up for review and discussion in this analysis is the identification of those aspects of the decommissioning that could diminish or reverse the positive impact, and the measures that can be taken to avoid or mitigate any potential negative effects."*

The following subsection identifies the measures that will be incorporated into cultural, archaeological, and biological resources monitoring plans (see Section 5.1.1) and observed during the process of site restoration to avoid diminishing the positive cultural impacts of the decommissioning on the cultural landscape. The second subsection outlines the potential positive and negative impacts on the cultural landscape as a result of site decommissioning and site restoration.

6.4.1.2.1 Site Restoration Process Impacts

The CIA offers guidance on measures to take during the process of site restoration to prevent the lessening of the positive impact on the cultural landscape (ASM Affiliates, 2020):

> *"Also, consistent with recommendations contained in the NASA (2005) study, it is recommended that a cultural monitor be present when ground-altering activities are being conducted for the CSO decommissioning. The role of the onsite cultural monitor will be to provide an appropriate cultural orientation to individuals conducting onsite work, and to provide guidance on following cultural protocols during the decommissioning process. In that vein, and as specified in the CMP*

> *(Ho'akea 2009:7-7) and its decommissioning sub-plan (Sustainable Resources Group Int'l, Inc. 2010:ii) as "Management Action CR-1," it is also recommended that a set of cultural protocols be developed in consultation with Kahu Kū Mauna, families with lineal and historical connections to Mauna Kea, as well as cultural practitioners to address all aspects of the demolition and restoration work to be completed as part of the decommissioning process."*

As described in Section 5.1.1, the cultural monitor will be present and provide services consistent with the recommendations in the CIA. The procedures and protocols, directed by a cultural monitor, should help to avoid and minimize the potential for adverse impacts throughout the decommissioning effort.

6.4.1.2.2 Impacts Associated with Removal Option and Restoration Level

The CIA analyzes the impact of CSO decommissioning associated with its goals and intents on the cultural landscape as follows (ASM Affiliates, 2020):

> *"What has been expressed by several cultural practitioners in prior and current interviews is that the goal of decommissioning from their perspective would be to ultimately clear the summit of Mauna Kea of "Western" intrusions and return the landscape as best as possible to its pre-development condition. While this ideal is not necessarily achievable given the existing roadways and associated infrastructure, it is the assessment of the current study that any decommissioning proposal that leaves behind physical remnants of a facility, whether above or below the current ground surface, would result in a negative cultural impact with respect to the proposed action [with the proposed action being removal and restoration to the fullest extent possible]."*

From this point of view, the presence of the current CSO facilities, including any invisible underground infrastructure, has a negative impact on the cultural landscape, and the greater the degree of removal and restoration, the proportionately greater the potential positive impact on that resource would be. However, while the above discussion suggests simply that greater levels of removal and restoration have greater benefit, the CIA (ASM Affiliates, 2020) follows immediately with a statement regarding targets and desires created by the DP (2010) and how the restoration outcome may or may not align with them:

> *"As stated in the Decommissioning Sub-Plan, "Ideally, the target for all sites is restoration to the site's historical condition prior to construction of the facility." (Sustainable Resources Group Int'l, Inc. 2010:23). If this is DLNR and the University's position, adopted through approval of the CMP (and its sub-plans), then as stated in the CMP, the "[d]esired outcome to the extent possible, [is to] reduce the area disturbed by physical structures ... by upgrading and reusing buildings and equipment at existing locations, <u>removing obsolete facilities, and restoring impacted sites to pre-disturbed condition</u>" (Ho'akea 2009:7-53; emphasis [added]). Both the CMP and the Decommissioning Sub-Plan indicate that the decommissioning starting point is for the observatories to do their utmost to completely remove all structures and fully restore the site, and based on what was said during consultation, doing less than that could be perceived as improper and culturally offensive."*

Thus, a negative impact to the cultural landscape may arise if the removal option and restoration level employed at the CSO Site is less extensive than the DP's "starting point" (e.g., complete removal and full restoration) when the greater extent was technically feasible. The CIA provides the following statements and recommendations related to decommissioning:

> *With the understanding that some negative impacts may result from decommissioning, these impacts would not completely erase the overall positive impact. However, a perception exists that anything short of an attempt at complete facility removal and full environmental restoration would result in a disingenuous decommissioning effort, as well as be an affront to cultural sensibilities. Therefore, it is recommended that the complete facility (above and below ground) be removed and the affected environment be restored to the fullest extent possible. Following this, and the other above-offered recommendations, will help to ensure that the proposed decommissioning will not result in impacts to any traditionally valued cultural or historical resources nor any traditional cultural practices or beliefs.*

These two passages indicate, in the view of the authors of the CIA and based upon the sentiments expressed during the consultation process, that removal and restoration of the CSO Site to the greatest extent possible would result in a qualitatively better outcome for the cultural landscape than other options. By extension, these two quotes also suggest that anything less than an attempt at total removal and full site restoration could have a negative impact, compounding the ongoing adverse impact caused by the presence of the CSO.

Consequently, remaining committed to Caltech's intent, first outlined in the NOI (Chapter 2, Appendix A), to completely remove the CSO infrastructure and fully restore the site will maximize the beneficial effects, and prevent negative impacts, of decommissioning on the cultural landscape. This benefit is based on repeated statements, both in the DP (2010) and by Caltech, regarding total removal and full restoration being the starting point and the desired goal of the decommissioning process (see Section 4.1 and Chapter 5). ALT-2, ALT-3, and ALT-4 all reflect Caltech's intent, but under ALT-3 and ALT-4 that intent would not be fully realized, despite being attempted, due to unanticipated factors beyond Caltech's control. Thus, ALT-2 would provide the largest beneficial effect and ALT-3 and ALT-4 would provide a quantitatively lesser, but qualitatively comparable, benefit if complete removal and full restoration could not be achieved.

6.4.2 Site Restoration Impacts to Specific Cultural Resources

6.4.2.1 Specific Cultural Resources

The AA summarizes the absence of previously known archaeological or historic resources in the direct effects study areas and lists the known resources in the visual effects study area in its Executive Summary (ASM Affiliates, 2018):

> *"The direct effects study area was included in three prior archaeological surveys (McCoy 1982a; McCoy and Nees 2010; McCoy et al. 2010). The visual effects study area was included in these three studies, and also two other archaeological inventory surveys (McCoy and Nees 2009, 2013). No archaeological sites were previously reported within the direct effects study area. The two closest previously recorded sites are two shrines (Sites 50-10-23-16164 and 16165) located 188 meters and 250 meters, respectively, to the south-southwest of the CSO project*

> *area. The Mauna Kea Summit Region Historic District (SIHP Site 50-10-23-26869), which encompasses the extent of the glacial moraines and crest of the relatively pronounced change in slope that create the impression of a summit plateau (Log No.: 23155; Doc No.:9903PM07), includes the CSO facility site, although no contributing elements of the district are located within the direct effects study area. Eleven of the historic properties that contribute to the historic district lie within the visual effects study area."*

It goes on to report the results of the direct effect study areas pedestrian survey (ASM Affiliates, 2018):

> *"As a result of the fieldwork, no archaeological resources of any kind were identified within the direct effects study area."*

Based on prior studies and the results of the AA and CIA (ASM Affiliates, 2018; 2020), Caltech is unaware of any traditional or customary native Hawaiian practices, such as spiritual practices, religious practices, or subsistence gathering occurring on the CSO Site, nor is there access to any traditional trails via the CSO Site. However, while no archaeological or historical properties have been identified, either during previous archaeological surveys or detected during the AA's pedestrian survey of the direct effect study area, there are archaeological-historic sites within the CSO viewshed. Section 6.4.2.2 discusses the implications of site restoration on the archaeological and historic resources in the visual effects study area.

6.4.2.2 Impacts of Site Restoration on Specific Cultural Resources

Based on the preceding discussion and the findings of the AA and CIA, Caltech has concluded that, provided site decommissioning operations include the presence of appropriate archaeological and cultural monitoring, the process of site restoration will have no negative impacts on any specific cultural resources. With regard to the outcome of decommissioning and site restoration, Caltech has also concluded that the greater the extent of removal and restoration of the CSO Site, the greater the positive impact will be on the two relevant specific cultural resources: (*i*) cultural viewplanes, and (*ii*) sense of place. The following subsections provide additional detail related to the potential for impacts both during and after site restoration operations.

6.4.2.2.1 Site Restoration Process Impacts

The AA concluded that site restoration will have no impact on archaeological and historical resources because there are none present on the CSO Site (ASM Affiliates, 2018):

> *"Given the negative findings of the current study with respect to archaeological resources, it is concluded that the Caltech Submillimeter Observatory Decommissioning Project on Maunakea will have no direct effect on any historic property within the project area."*

The above is relevant to both the process and the outcome of restoration. Nevertheless, with respect to process, it makes the following recommendation (ASM Affiliates, 2018):

> *"Archaeological monitoring is recommended as a precautionary measure to ensure protection of Site 21438 (Kūkahau'ula), which is adjacent to the Mauna Kea Summit Access Road and the lower portion of the CSO project area, and as a contingency for the discovery of unanticipated archaeological resources. An*

> *archaeological monitoring plan in accordance with HAR 13 §13-279 will be prepared for acceptance by DLNR-SHPD prior to project implementation."*

Since the SDRP already calls for the presence of an onsite archaeological and cultural monitors during deconstruction and removal activities (see Section 4.2.2), their continued presence during the site restoration activities described in this SRP would satisfy this recommendation.

6.4.2.2.2 Restoration Outcome Impacts

In addition to the AA's conclusion that site restoration will have no direct effect on any historic property within the decommissioning project area, it also gives due consideration to cultural viewplanes and sense of place. To do so, it used the following methodology (ASM Affiliates, 2018):

> *"…an assessment of the potential visual impacts of the removal of the CSO dome and facilities was made by photographing the CSO facility site from the nearest historic property within the visual effects study area…. Removal of the CSO facility was simulated by digitally erasing the telescope superstructure from the photographs…."*

Using this methodology, the AA concluded that with regard to cultural viewplanes and sense of place, as well as the entire Mauna Kea Summit Region Historic District (ASM Affiliates, 2018):

> *…will experience overall beneficial effects from the removal of the CSO facilities. For those sites, the removal of the above-ground facilities will partially restore the appearance of the summit as it was prior to the construction of the CSO. This will result in an enhancement of the integrity of setting, feeling, and association of the six sites as well as the historic district.*

Based on the findings in the AA and CIA (ASM Affiliates, 2018; 2020), Caltech has concluded that all alternatives will have positive impacts on the specific cultural resources (i.e., cultural viewplanes and sense of place). While neither the AA nor the CIA specifically address the partial infrastructure removal and/or less than full restoration considered in ALT-3 and ALT-4, it is reasonable to conclude that the positive impacts would be tempered to a degree commensurate with the extent of removal and restoration.

6.5 SITE RESTORATION METHODOLOGY

As noted in Section 6.1, site restoration consists of two elements: (*i*) topographic restoration; and (*ii*) biological habitat restoration. All site restoration operations will adopt the recommendations regarding geophysical and habitat restoration contained in the BSA (see Section 6.3.3). Caltech will also require all decommissioning operations to observe the provisions of the BMPs, including site monitoring (see Section 5.1.1), augmented with informal input from local experts. The following subsections summarize the consistency of the topographic restoration methodology discussed in Section 6.2 vis-à-vis the BSA and BMPs. It will also evaluate how moderate restoration (e.g., ALT-3 and ALT-4) would necessarily modify that methodology.

6.5.1 Topography Restoration Methodology

Guidance on topography restoration from the BSA is as follows (SRGII, 2019):

> *"[Topography] restoration includes removal of all manmade features, backfilling holes and trenches, and placing and removing fill to restore the topography and surficial material of the site. Under full restoration, restored topography and surface materials would mimic site conditions just prior to the CSO construction to the extent possible. A topographic map dated January 21, 1983 represents the site prior to construction. A second topographic map dated November 24, 2015 depicts existing site conditions. The 2015 map, along with other documents, indicates that some earthen material moved during construction activities at the summit in this area (i.e. CSO, James Clerk Maxwell Telescope and potentially road work) was pushed into elongated piles. [The previous sentence refers to earthmoving at the time of CSO and JCMT construction in the 1980s.] All fill material used for backfilling and finishing would come from the piles around parts of the site's perimeter. Geological analysis has confirmed that this fill is consistent with other material at the summit. The only non-native species present in the fill would be those that are already part of the existing environment. Estimates of the volume of earthen material needed to backfill and finish the site indicate more material is available than needed. This phase of the restoration process aims to create the topographic conditions that provide sufficient conditions for passive restoration of the biological community."*

Consistent with this guidance, and to the extent practicable depending on the alternative being implemented, the grade at the CSO Site will be completed as outlined in Section 5.1.14 so that it matches the pre-construction topography to the maximum extent possible. As stated in that section, because the CSO Site is located on a lava flow, it will not be possible to fully reconstruct the preexisting flow in excavated areas. Rather, restoration will use rocks and fill, compacting as necessary for long-term stability, to return those areas to a natural condition visually consistent with the surrounding topography.

Section 5.1.1 presented BMPs for minimizing habitat disturbance, avoiding the introduction of non-native species and monitoring for them, and for onsite storage and disposal of materials. Because of the intensity of topography restoration activities, it will be critical to apply these BMPs throughout the restoration process. In addition, Sections 6.3.3.1, 6.4.1.2.1, and 6.4.2.2.1 document that doing so will result in no significant adverse physical, biological, or cultural impacts as a result of site restoration operations.

6.5.2 Habitat Restoration Methodology

6.5.2.1 Full Restoration

The BSA indicates that habitat restoration will occur passively once restoration of the physical environment is complete (SRGII, 2019):

> *"Passive [habitat] restoration through natural recruitment of lichens, mosses, and vascular plants as well as the arthropod community is expected once the site has been topographically restored. No out-planting of native species is recommended as few plants were present prior to construction of the CSO, and sparse plant populations are typical of lava flow habitat in the alpine stone desert. No transfer of arthropods, other than those already present in fill, is recommended."*

Caltech has augmented the BSA's guidance with input from a local expert, Jessica Kirkpatrick, CMS' Natural Resource Specialist staff:

> *As far as habitat…, observations suggest that the Hawaiian wolf spiders prefer rocky habitats while endemic Agrotis caterpillars are usually found in spaces between rocks, in an ash layer that holds moisture. Various rock sizes with interstitial spaces provide habitat for lichens, mosses, spiders, caterpillars and other taxa on the CSO site.* (Jessica Kirkpatrick, personal communication, November 6, 2020)

Based on her advice, prior to long-term, passive restoration, active habitat restoration will be performed. It will consist of scattering fine ash material and small rocks stockpiled during fill removal using medium to small equipment (e.g., a mini loader) and hand tools. It is Caltech's intent that this effort will provide the variety of niche habitats Ms. Kirkpatrick mentions. Section 5.1.1 presented BMPs for minimizing habitat disturbance, avoiding the introduction of non-native species and monitoring for them, and for onsite storage and disposal of materials. Because of the intensity of topography restoration activities, it will be critical to apply these BMPs throughout the restoration process. Sections 6.3.3.1, 6.4.1.2.1, and 6.4.2.2.1 document that doing so will result in no significant adverse physical, biological, or cultural impacts as a result of site restoration operations. Further, the biological monitoring called for throughout the site deconstruction and removal process will continue during the site restoration phase of the effort.

6.5.2.2 Moderate Restoration

Moderate restoration differs from full restoration in that it does not include full topographical restoration; moderate restoration is similar to full restoration in that it includes active habitat restoration where the ground surface is disturbed and no longer provides good habitat. ALT-3 and ALT-4 would result in at least a portion of the CSO Site being moderately restored due to circumstances discovered during decommissioning. Where subsurface infrastructure could not be removed or other obstacles prevented full restoration, the ground would be graded to leave a safe condition (i.e., no cavities or large depressions) followed by restoration of surficial material to provide suitable habitat. Over portions of the site where there was no such work, the existing surface may already be suitable. This restoration (or retention) of surficial material corresponds to the last steps of topography restoration (see Section 6.5.1) and the entirety of active habitat restoration (see Section 6.5.2.1). Successful execution of these active components of site restoration will promote passive habitat restoration even in the moderate restoration scenario called for under ALT-3 and ALT-4 (see Table 1-1).

6.5.3 Restoration Monitoring

Finally, to assess the success of habitat restoration there will be monitoring after completion of restoration activities. The specific protocol will be that suggested in the BSA (SRGII, 2019):

> *"It is recommended that two points within the sub-lease footprint be selected for monitoring during the OMKM [now CMS] annual native/non-natives species monitoring program to evaluate if restoration goals are being achieved."*

Three years of monitoring will take place, satisfying the guidance from the DP (2010). Assessment will consist of comparison of native and non-native species diversity and abundance to pre-decommissioning survey efforts and surrounding areas.

6.6 FUTURE LAND USE

Upon completion of the decommissioning process outlined in this SDP, except for the restoration monitoring, Caltech intends to terminate its sublease for the CSO Site. Caltech has no plans for any future land use at the CSO Site. Future land use on the site will be guided by the applicable Master Plan and CMP and is beyond the scope of Caltech's planning and decommissioning process.

CHAPTER 7: COST-BENEFIT ANALYSIS

7.1 CONTEXT

7.1.1 Cost-Benefit Analysis Guidance

In addition to the requirement for the NOI, EDD, SDRP, and SRP addressed in prior chapters of this SDP, the CMP (2009) and its DP (2010) both stipulate that observatories present a Cost-Benefit Analysis (CBA). The CBA must address, for each alternative identified in the SDP, the potential costs and benefits associated with implementation of all activities described in the SDRP and SRP. The CMP states (UH, 2009)

> *"Each observatory will need to identify what course of action they will pursue when the life expectancy of their technology is reached and it becomes obsolete, or when the lease expires. While OMKM shall be responsible for overseeing compliance of these activities with the CMP, the process needs to be a collaborative effort between OMKM, DLNR, the University, and the observatories.*
>
> *…Appropriate strategies shall be developed to address restoring the land to its original condition, as required by the lease. In particular, any plan to restore habitat needs to be analyzed at the landscape level, rather than as only the footprint of a single observatory. A cost-benefit analysis will need to be conducted by the observatories to determine what level of restoration is appropriate for their site."*

The CMP reiterates this requirement in Table 7-13, SR-2 (CMP, 2009):

> *"Require observatories to develop a restoration plan in association with decommissioning, to include an environmental cost-benefit analysis and a cultural assessment."*

With these statements, the CMP makes clear that the CBA is intended to consider and contrast the costs and benefits of varying levels of observatory removal and site restoration called for under the various alternatives considered in the SDRP and SRP and is an adjunct to those documents. The purpose of the CBA is further developed in the DP:

> *"Ideally, the target for all sites is restoration to the site's historical condition prior to construction of the facility. However, the SRP must also consider cultural sensitivities, the extent of infrastructure removal and deconstruction, the size of the site restoration effort, the use of backfill cinder with respect to its source and size. The level of restoration attempted and the potential benefits and impacts of the restoration activities on natural and cultural resources during and post-activity must be carefully evaluated. A cost-benefit analysis shall also be conducted."*

The purpose of this CBA is to fulfill the CMP and DP requirement by providing an analysis of the potential costs and benefits of the varying levels of observatory removal and site restoration called for in each of the alternatives described in Table 1-1 and developed in further detail in Chapter 4. Caltech interprets the CMP and DP as requiring a financial CBA, which is provided in this chapter; Caltech's decision making is informed by other factors as well, as discussed in Section 7.4.

7.1.2 Consideration of Impacts

Caltech acknowledges that decommissioning decision-making must consider factors beyond the "costs" considered in the CBA. Consequently, the potential natural and cultural impacts associated with the various alternatives, which cannot be assessed quantitatively in the CBA, are addressed first, in the SRP (see Section 6.2, 6.3, and 6.4) and remain critically important when evaluating the alternatives and selecting the best course of action.

7.1.3 Content of the CBA

In general, a CBA is a systematic method for estimating the strengths and weaknesses of alternative courses of action. A CBA can be a useful method for identifying which of a range of options provides the most benefit while preserving the greatest degree of savings. Because a CBA is a comparative exercise, it requires that costs and benefits be expressed with the same unit so that the positive(s) and negative(s) associated with a potential alternative can be effectively and consistently weighed in the balance. Here, Caltech is the one conducting the CBA, therefore, the costs and benefits are considered from their perspective. The alternative courses of action being considered are the project alternatives in Table 1.1. The common unit of comparison is estimated costs (dollars) and estimated decommissioning process duration (days). These two "costs" are used in this CBA; however, Caltech believes that any measure of "cost" could be examined and arrive at the same outcome. In terms of process, this CBA will:

- Define the CSO deconstruction and restoration steps that need to be taken under each alternative;
- Assign estimated costs associated with each of those steps;
- Assign estimated value for the benefits associated with taking each of those steps; and
- Compare the relative costs and benefits of each alternative to determine which offers the most benefit while providing the most savings.

As noted above, the range of alternatives being evaluated are the alternatives identified for detailed consideration in this SDP (see Table 1-1 and Chapter 4). Collectively, these alternatives include varying combinations of the two site deconstruction and removal options and the three levels of site restoration, and are representative of the full range of reasonable alternatives. Table 7-1 below summarizes the alternatives for quick reference.

Table 7-1: Removal Option and Level of Site Restoration by Alternative

Alternative	*Deconstruction and Removal Option*	*Level of Restoration*
ALT-1	n/a	n/a
ALT-2	Complete facility and infrastructure removal	Full restoration
ALT-3	Complete facility and infrastructure removal	Moderate restoration
ALT-4	Complete facility removal and infrastructure capping	Moderate restoration
Source: Compiled by Planning Solutions, Inc. (2020)		

Each possibility—both the extent of site deconstruction and removal and level of site restoration—comes with an attached cost in dollars, defined as the sum total of an alternative's cost factors. By contrasting the comparative costs and benefits of each alternative against the others, Caltech will be able to illustrate how, and to what extent, cost factors bear on the decision-making process.

As a final note, it is important to acknowledge that not all the alternatives considered in the SDP, and by extension this CBA, would fulfill all of Caltech's obligations regarding disposition of the CSO Site. The *Sublease Agreement Among the California Institute of Technology, the University of Hawaii, and the State of Hawaii, Department of Land and Natural Resources, Sublease H09176* (henceforth, "the sublease") offers four options for termination or extirpation of its sublease: (*i*) sale to UH; (*ii*) surrender with concurrence of UH; (*iii*) sale to a third party acceptable to UH; and (*iv*) removal of the property and restoration of the site to even grade at the expense of Caltech. At minimum, ALT-1 (the No Action alternative), does not comport with this requirement. However, it remains a valuable alternative for reasons described in Section 1.3.2, including as a baseline for comparison with the action alternatives.

7.2 ASSESSING COST

For the purposes of this CBA, cost factors are those project elements (e.g., materials, labor, services, time, etc.) that will incur cost per unit during the decommissioning process. This section considers the costs that will be incurred during the deconstruction and restoration of the CSO Site, and how they differ between the various action alternatives, based on their unique scopes of work.

The general deconstruction activities which are applicable to all the action alternatives considered in this SDP are provided in Table 7-2, which divides the activities into two groups for cost estimating purposes. Group 1 deconstruction activities can be considered equal in all quantifiable measures, including duration and cost, across all decommissioning action alternatives; Group 2 activities may have decommissioning costs that vary by action alternative. The No Action alternative (i.e., ALT-1) has no associated deconstruction activities or costs and is therefore excluded from the discussion below.

Table 7-2: General Deconstruction, Removal, and Site Restoration Activities

Description	***Activity***
Group 1 – Decommissioning activities with equal costs in all action alternatives	*Mobilization* – Preparing the Site for deconstruction activity including securing the Site and establishing staging areas (Sections 5.1.1 and 5.1.2).
	Demolition Preparation – Isolating the observatory from shared summit utility systems (Section 5.1.2) and removing the telescope, if it remains (Section 5.1.3).
	MEP Demolition – Removing internal mechanical, electrical, and plumbing systems that operate the observatory (Section 5.1.4).
	Partition Demolition – Removing interior walls and ceilings to complete the interior gutting of the observatory leaving only the building shell (Section 5.1.5).
	Skin Removal – Removing the exterior aluminum panels from the main structure (Section 5.1.6).
	Structure Demolition – Dismantling of the observatory structural steel frame (Section 5.1.7).
	Surface Paving Demolition – Removing asphaltic surface treatments (Section 5.1.8).
	Cesspool Removal – Removing the full extent of the underground cesspool (Section 5.1.10).
	Outbuilding and Secondary Above-Ground Instructure Removal – Removing the outbuilding, generator, pump house, transformer, and other above ground improvements that remain (Section 5.1.12)
	Demobilization – Removing all fencing, staging facilities, and equipment from the Site (Section 5.1.15).
Group 2 – Decommissioning activities with costs that may vary by action alternative	*Foundation and Grounding Grid Removal* – Removing the telescope and dome foundation plus the ground grid nearby and under the foundation (Section 5.1.9)
	Remaining Underground Removal – Removing remaining concrete slabs, tanks, grounding grid, and underground utility lines (Section 5.1.13).
	Backfill and Finish Grading – Filling in of trenches created during the activities above and grading the Site to the level of site restoration identified in each decommissioning alternative (Section 5.1.14).
	Habitat Restoration – Restoring habitat for the native arthropod community (Chapter 6).

Source: Compiled by Planning Solutions, Inc. (2020)

Unlike Group 1, Group 2 deconstruction and removal activities will vary in duration and cost by alternative. The following discussion describes the applicable differences between the alternatives for the Group 2 activities:

- *Foundation and Ground Grid Removal*. A small scope and cost difference exists between the action alternatives, specifically, ALT-2 and ALT-3 in comparison to ALT-4. ALT-2 and ALT-3 both involve the complete removal of the underground infrastructure, including foundations and ground grid. ALT-4 involves not removing at least a portion of the underground infrastructure due to unanticipated circumstances that only become evident after removal begins; thus, the extent of infrastructure that would be capped and not removed under ALT-4 is unknown. For the purpose of this analysis, the extreme-case scenario is assumed where the entire grounding grid is left in place (Figure 4-6). Although it is assumed that the foundations can be removed under all action alternatives, ALT-4 as illustrated in Figure 4-6 may not result in the removal of the grounding grid near and under the foundation. Because efforts will be made to remove all the infrastructure under ALT-4, limited cost or schedule savings would be realized. Any cost savings would primarily be related to not removing the fill material covering the infrastructure left in place.

- *Remaining Underground Removal*. A small scope and cost difference exists between the action alternatives, specifically, ALT-2 and ALT-3 in comparison to ALT-4. ALT-2 and ALT-3 both involve the complete removal of the underground infrastructure. ALT-4 involves not removing at least a small portion of the remaining underground infrastructure due to unanticipated circumstances that only become evident after removal begins; thus, the extent of infrastructure that would be capped and not removed under ALT-4 is unknown. For the purpose of this analysis, the extreme-case scenario is assumed where all underground utilities are capped and left in place (Figure 4-5 and Figure 4-6). Because efforts will be made to remove all the infrastructure under ALT-4, limited cost or schedule savings would be realized. The cost savings would primarily be related to not removing the fill material covering the infrastructure left in place.

- *Backfill and Finish Grading* and *Habitat Restoration*. In the case of the CSO Site, these activities involve removal of remaining fill brought to the site during construction in 1980s. True backfilling is only necessary where excavation into the lava flow occurred during CSO construction (e.g., the cesspool and some utility trenches). Relative to ALT-2, ALT-3 and ALT-4 have limited differences, the extent of which would not be known until after deconstruction commences. The quantity of fill removed from the CSO Site and the number of vehicle trips necessary to move it to the Batch Plant has a direct relationship to the duration and cost associated with it.[10]

Total deconstruction duration and the number of vehicle trips associated with disposing of removed infrastructure off-site and moving the fill material to the Batch Plant is summarized in Table 7-3. The table also includes the estimated deconstruction cost for each alternative, illustrating the relationship of duration and trips to the cost. There is no more than a 10 percent difference in duration and not more than a 5 percent different in cost between the three action alternatives.

Table 7-3: Summary of Deconstruction Activity Duration, Vehicle Trips, and Total Deconstruction Costs for each Alternative

Alternative	*Duration (days)*	*Total Number of Large Vehicle Trips*	*Total Number of Small Vehicle Trips*	*Estimated Deconstruction Cost*
ALT-1	0	0	0	$0
ALT-2	141	70	776	$4,034,040
ALT-3	129	70	729	$3,947,430
ALT-4	125	63	684	$3,834,120
Note: Deconstruction costs are in Q4 2019 US dollars. Source: M3				

[10] Although attempts will be made to remove all of the infrastructure under ALT-4 and attempts will be made to conduct full restoration over the entire CSO Site under ALT-3 and ALT-4, the cost estimates, durations, and vehicle trips presented in the tables (e.g., Table 5-3, Table 5-4, Table 7-3, Table 7-6, and Table 7-7) assume the extreme case that would result in the least work in the shortest possible time. The extreme case being that none of the ground grid and utility infrastructure can be removed (ALT-4, Figure 4-5) and none of the site can be fully restored (ALT-3 and ALT-4; Figure 4-4 and Figure 4-6, respectively). This assumption results in the maximum difference in cost, duration, and trip numbers between the alternatives.

The estimated deconstruction costs in Table 7-3 are derived from detailed estimates provided in Table 5-2, Table 5-3, and Table 5-4 and dollar cost estimates below. Table 7-4 provides a summary spreadsheet breaking down deconstruction activity cost factors. It identifies a cost per unit and any applicable contingency factor for it, demonstrating how costs were computed for each action alternative. This cost estimate is based on a conceptual understanding of the project conditions, plus or minus 30 percent. Based on the calculation in Table 7-4, detailed cost projections for ALT-2, ALT-3, and ALT-4 are provided in Table 7-5, Table 7-6, and Table 7-7, respectively. All costs in these tables are shown in Q4 2019 dollars.

Table 7-5, Table 7-6, and Table 7-7 also include rows for (*i*) site habitat restoration and three years of monitoring, and (*ii*) decommissioning of shared infrastructure, the cost for which is based on estimates prepared by UH. As discussed in Section 1.3.2 and Section 4.3, the action alternative cost estimates include costs for the future removal of shared infrastructure; Caltech has committed to provide those funds to UH so that the shared infrastructure can be removed at a later date.

Table 7-4: Summary of Deconstruction, Removal, and Site Restoration Cost Factors

MASTERSPEC				QUANTITY					MATERIAL						
DES	DES	DES	DES	DES	DES	DES / PM	PM		CE	CE		DES / CE	PM		
Section	Division	Origin	Design % Complete	Base Quantity	Unit	Quantity Multiplier	* Quantity Contingency (Risk) Factor	TOTAL QUANTITY	Base Unit Cost	Unit Cost Multiplier	TOTAL UNIT COST	SHIPPING	* Material Contingency (Risk) Factor	Material Contingency (Risk) Cost	TOTAL MATERIAL COST
DIVISION 02 - EXISTING CONDITIONS															
	Paving & ABC Demolition (asphalt)			540	sy	1.00	1.00	540	$ -	1.10	$ -	$ -	1.00	$ -	$ -
	Loading & Hauling			1	ea	1.00	1.00	1	$ -	1.10	$ -	$ -	1.00	$ -	$ -
	Subtotal														$ -
DIVISION 03 - CONCRETE															
	Concrete Demolition			250	cy	1.00	1.00	250	$ -	1.00	$ -	$ -	1.00	$ -	$ -
	Loading & Hauling			1	ea	1.00	1.00	1	$ -	1.00	$ -	$ -	1.00	$ -	$ -
	Subtotal														$ -
DIVISION 04 - MASONRY															
					sf	1.00	1.00	0	$ -	1.00	$ -	$ -	1.00	$ -	$ -
	Subtotal														$ -
DIVISION 05 - METALS															
	Skin Removal for Recycling (Alum)			11000	sf	1.00	1.00	11,000	$ -	1.00	$ -	$ -	1.00	$ -	$ -
	Loading & Hauling			1	ea	1.00	1.00	1	$ -	1.00	$ -	$ -	1.00	$ -	$ -
	Structure Demolition (Steel)			155	ton	1.00	1.00	155	$ -	1.00	$ -	$ -	1.00	$ -	$ -
	Loading & Hauling			1	ea	1.00	1.00	1	$ -	1.00	$ -	$ -	1.00	$ -	$ -
	Subtotal														$ -
DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES															
						1.00	1.00	0		1.00	$ -	$ -	1.00	$ -	$ -
						1.00	1.00	0		1.00	$ -	$ -	1.00	$ -	$ -
	Subtotal														$ -
DIVISION 07 - THERMAL AND MOISTURE PROTECTION															
	Subtotal														$ -
DIVISION 08 - OPENINGS															
	Subtotal														$ -
DIVISION 09 - FINISHES															
	Partition Wall Demolition			150	sf	1.00	1.00	150	$ -	1.00	$ -	$ -	1.00	$ -	$ -
	Loading & Hauling			1	ea	1.00	1.00	1	$ -	1.00	$ -	$ -	1.00	$ -	$ -
	Subtotal														$ -
DIVISION 10 - SPECIALTIES															
						1.00	1.00	0		1.00	$ -	$ -	1.00	$ -	$ -
	Subtotal														$ -
DIVISION 11 - EQUIPMENT															
						1.00	1.00	0		1.00	$ -	$ -	1.00	$ -	$ -
	Subtotal														$ -
DIVISION 12 - FURNISHINGS															
						1.00	1.00	0		1.00	$ -	$ -	1.00	$ -	$ -
	Subtotal														$ -
DIVISION 13 - SPECIAL CONSTRUCTION															
						1.10	1.00	0		1.10	$ -	$ -	1.00	$ -	$ -
						1.10	1.00	0		1.10	$ -	$ -	1.00	$ -	$ -
	Subtotal														$ -
DIVISION 14 - CONVEYING EQUIPMENT															
						1.00	1.00	0		1.00	$ -	$ -	1.00	$ -	$ -
						1.00	1.00	0		1.00	$ -	$ -	1.00	$ -	$ -
	Subtotal														$ -
DIVISION 21 - FIRE SUPRESSION															
	Subtotal														$ -
DIVISION 22 - PLUMBING															
						1.00	1.00	0		1.00	$ -	$ -	1.00	$ -	$ -
						1.00	1.00	0		1.00	$ -	$ -	1.00	$ -	$ -
	Subtotal														$ -
DIVISION 23 - HEATING VENTILATION AND AIR COND. (HVAC)															
						1.00	1.00	0		1.00	$ -	$ -	1.00	$ -	$ -
						1.00	1.00	0		1.00	$ -	$ -	1.00	$ -	$ -
	Subtotal														$ -
DIVISION 26 - ELECTRICAL															
						1.00	1.00	0		1.00	$ -	$ -	1.00	$ -	$ -
						1.00	1.00	0		1.00	$ -	$ -	1.00	$ -	$ -
						1.00	1.00	0		1.00	$ -	$ -	1.00	$ -	$ -
	Subtotal														$ -
DIVISION 27 - COMMUNICATIONS															

	INSTALLATION								
	CE	CE / PM		CE		CE	PM		
	Labor: Base Unit Manhours	Labor: * Site Difficulty Factor	Labor: Total Base Manhours	Labor: * Average Rate	Labor: Total Labor Costs	Other Direct Costs	* Installation Contingency (Risk) Factor	Installation Contingency (Risk) Cost	TOTAL INSTALL COST
DIVISION 02 - EXISTING CONDITIONS									
Paving & ABC Demolition (asphalt)	0.12	1.00	0.12	$ 78.57	$ 5,091	$ 3,996	1.00	$ -	$ 9,087
Loading & Hauling	60.0	1.00	60	$ 75.00	$ 4,500	$ 3,500	1.00	$ -	$ 8,000
Subtotal					$ 9,591	$ 7,496			$ 17,087
DIVISION 03 - CONCRETE									
Concrete Demolition	2.20	1.00	2.20	$ 100.85	$ 55,469	$ 43,750	1.00	$ -	$ 99,219
Loading & Hauling	200	1.00	200.00	$ 75.00	$ 15,000	$ 12,500	1.00	$ -	$ 27,500
Subtotal					$ 70,469	$ 56,250			$ 126,719
DIVISION 04 - MASONRY									
	0.00	1.00	0.00	$ 92.94	$ -	$ -	1.00	$ -	$ -
Subtotal					$ -	$ -			$ -
DIVISION 05 - METALS									
Skin Removal for Recycling (Alum)	0.11	1.00	0.11	$ 103.29	$ 124,984	$ 93,500	1.00	$ -	$ 218,484
Loading & Hauling	600	1.00	600.00	$ 75.00	$ 45,000	$ 40,000	1.00	$ -	$ 85,000
Structure Demolition (Steel)	32.20	1.00	32.20	$ 103.29	$ 515,531	$ 209,250	1.00	$ -	$ 724,781
Loading & Hauling	3050	1.00	3050.00	$ 75.00	$ 228,750	$ 125,000	1.00	$ -	$ 353,750
Subtotal					$ 914,265	$ 467,750			$ 1,382,015
DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES									
		1.00	0.00	$ 103.39	$ -	$ -	1.00	$ -	$ -
		1.00	0.00	$ 75.00	$ -	$ -	1.00	$ -	$ -
Subtotal					$ -	$ -			$ -
DIVISION 07 - THERMAL AND MOISTURE PROTECTION									
Subtotal					$ -	$ -			$ -
DIVISION 08 - OPENINGS									
Subtotal					$ -	$ -			$ -
DIVISION 09 - FINISHES									
Partition Wall Demolition	0.62	1.00	0.62	$ 99.56	$ 9,259	$ 7,860	1.00	$ -	$ 17,120
Loading & Hauling	30	1.00	30.00	$ 75.00	$ 2,250	$ 1,500	1.00	$ -	$ 3,750
Subtotal					$ 11,509	$ 9,360			$ 20,870
DIVISION 10 - SPECIALTIES									
		1.00	0.00	$ 103.39	$ -	$ -	1.00	$ -	$ -
Subtotal					$ -	$ -			$ -
DIVISION 11 - EQUIPMENT									
		1.00	0.00	$ 103.79	$ -	$ -	1.00	$ -	$ -
Subtotal					$ -	$ -			$ -
DIVISION 12 - FURNISHINGS									
		1.00	0.00	$ 99.56	$ -	$ -	1.00	$ -	$ -
Subtotal					$ -	$ -			$ -
DIVISION 13 - SPECIAL CONSTRUCTION									
		1.00	0		$ -		1.00	$ -	$ -
		1.00	0		$ -		1.00	$ -	$ -
Subtotal									$ -
DIVISION 14 - CONVEYING EQUIPMENT									
		1.00	0.00	$ 103.79	$ -	$ -	1.00	$ -	$ -
		1.00	0.00	$ 103.79	$ -	$ -	1.00	$ -	$ -
Subtotal					$ -	$ -			$ -
DIVISION 21 - FIRE SUPRESSION									
Subtotal					#REF!	#REF!			$ -
DIVISION 22 - PLUMBING									
		1.00	0.00	$ 103.80	$ -	$ -	1.00	$ -	$ -
		1.00	0.00	$ 103.80	$ -	$ -	1.00	$ -	$ -
Subtotal					$ -	$ -			$ -
DIVISION 23 - HEATING VENTILATION AND AIR COND. (HVAC)									
		1.00	0.00	$ 103.80	$ -	$ -	1.00	$ -	$ -
		1.00	0.00	$ 103.80	$ -	$ -	1.00	$ -	$ -
Subtotal					$ -	$ -			$ -
DIVISION 26 - ELECTRICAL									
		1.00	0.00	$ 113.34	$ -	$ -	1.00	$ -	$ -
		1.00	0.00	$ 113.34	$ -	$ -	1.00	$ -	$ -
		1.00	0.00	$ 113.34	$ -	$ -	1.00	$ -	$ -
Subtotal					$ -	$ -			$ -
DIVISION 27 - COMMUNICATIONS									

	TOTAL MATERIAL & INSTALL COST	CONTRACTOR COSTS							LINE SUBTOTAL	Total Design Contingency	* Construction Contingency Percentage (%)	Construction Contingency Cost ($)	TOTAL
		CE / PM	CE / PM	CE / PM	CE / PM	PM		CE / PM			PM		
		* Division 1 (General Conditions)	* Overhead	* Profit	* Bond	* Contractor Cost Contingency	CONTRACTOR GENERAL COND/OH&P	* Room & Board					
DIVISION 02 - EXISTING CONDITIONS													
Paving & ABC Demolition (asphalt)	$ 9,087	$ 1,363.10	$ 1,567.56	$ 1,202	$ 396.59	$ 226.45	$ 4,756	$ -	$ 13,843	$ -	30.0%	$ 4,153	$ 17,996
Loading & Hauling	$ 8,000	$ 1,200.00	$ 1,380.00	$ 1,058	$ 349.14	$ 199.36	$ 4,186	$ -	$ 12,186	$ -	30.0%	$ 3,656	$ 15,842
Subtotal	$ 17,087						$ 8,942	$ -	$ 26,029			$ 7,809	$ 33,838
DIVISION 03 - CONCRETE													
Concrete Demolition	$ 99,219	$ 14,883	$ 17,115	$ 13,122	$ 4,330	$ 2,472.49	$ 51,922	$ -	$ 151,141	$ -	30.0%	$ 45,342	$ 196,483
Loading & Hauling	$ 27,500	$ 4,125	$ 4,744	$ 3,637	$ 1,200	$ 685.29	$ 14,391	$ -	$ 41,891	$ -	30.0%	$ 12,567	$ 54,458
Subtotal	$ 126,719						$ 66,313	$ -	$ 193,032			$ 57,910	$ 250,941
DIVISION 04 - MASONRY													
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
Subtotal	$ -						$ -	$ -	$ -			$ -	$ -
DIVISION 05 - METALS													
Skin Removal for Recycling (Alum)	$ 218,484	$ 32,773	$ 37,688	$ 28,894	$ 9,535	$ 5,444.53	$ 114,335	$ -	$ 332,819	$ -	30.0%	$ 99,846	$ 432,664
Loading & Hauling	$ 85,000	$ 12,750	$ 14,663	$ 11,241	$ 3,710	$ 2,118.17	$ 44,482	$ -	$ 129,482	$ -	30.0%	$ 38,844	$ 168,326
Structure Demolition (Steel)	$ 724,781	$ 108,717	$ 125,025	$ 95,852	$ 31,631	$ 18,061.28	$ 379,287	$ -	$ 1,104,068	$ -	30.0%	$ 331,220	$ 1,435,289
Loading & Hauling	$ 353,750	$ 53,063	$ 61,022	$ 46,783	$ 15,439	$ 8,815.32	$ 185,122	$ -	$ 538,872	$ -	30.0%	$ 161,661	$ 700,533
Subtotal	$ 1,382,015						$ 723,225	$ -	$ 2,105,240			$ 631,572	$ 2,736,812
DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES													
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
Subtotal	$ -						$ -	$ -	$ -			$ -	$ -
DIVISION 07 - THERMAL AND MOISTURE PROTECTION													
Subtotal	$ -						$ -	$ -	$ -			$ -	$ -
DIVISION 08 - OPENINGS													
Subtotal	$ -						$ -	$ -	$ -			$ -	$ -
DIVISION 09 - FINISHES													
Partition Wall Demolition	$ 17,120	$ 2,568	$ 2,953	$ 2,264	$ 747	$ 426.62	$ 8,959	$ -	$ 26,079	$ -	30.0%	$ 7,824	$ 33,903
Loading & Hauling	$ 3,750	$ 563	$ 647	$ 496	$ 164	$ 93.45	$ 1,962	$ -	$ 5,712	$ -	30.0%	$ 1,714	$ 7,426
Subtotal	$ 20,870						$ 10,922	$ -	$ 31,792			$ 9,537	$ 41,329
DIVISION 10 - SPECIALTIES													
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
Subtotal	$ -						$ -	$ -	$ -			$ -	$ -
DIVISION 11 - EQUIPMENT													
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
Subtotal	$ -						$ -	$ -	$ -			$ -	$ -
DIVISION 12 - FURNISHINGS													
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
Subtotal	$ -						$ -	$ -	$ -			$ -	$ -
DIVISION 13 - SPECIAL CONSTRUCTION													
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
Subtotal	$ -						$ -	$ -	$ -			$ -	$ -
DIVISION 14 - CONVEYING EQUIPMENT													
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
Subtotal	$ -						$ -	$ -	$ -			$ -	$ -
DIVISION 21 - FIRE SUPRESSION													
Subtotal	$ -						$ -	$ -	$ -			$ -	$ -
DIVISION 22 - PLUMBING													
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
Subtotal	$ -						$ -	$ -	$ -			$ -	$ -
DIVISION 23 - HEATING VENTILATION AND AIR COND. (HVAC)													
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
Subtotal	$ -						$ -	$ -	$ -			$ -	$ -
DIVISION 26 - ELECTRICAL													
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
Subtotal	$ -						$ -	$ -	$ -			$ -	$ -
DIVISION 27 - COMMUNICATIONS													

MASTERSPEC Section	MASTERSPEC Division	Origin	Design % Complete	QUANTITY: Base Quantity	Unit	Quantity Multiplier	* Quantity Contingency (Risk) Factor	TOTAL QUANTITY	MATERIAL: Base Unit Cost	Unit Cost Multiplier	TOTAL UNIT COST	SHIPPING	* Material Contingency (Risk) Factor	Material Contingency (Risk) Cost	TOTAL MATERIAL COST
						1.10	1.00	0		1.10	$ -	$ -	1.00	$ -	$ -
						1.10	1.00	0		1.10	$ -	$ -	1.00	$ -	$ -
						1.10	1.00	0		1.10	$ -	$ -	1.00	$ -	$ -
	Subtotal														$ -
DIVISION 28 - ELECTRICAL SAFETY AND SECURITY															
						1.10	1.00	0		1.10	$ -	$ -	1.00	$ -	$ -
						1.10	1.00	0		1.10	$ -	$ -	1.00	$ -	$ -
						1.10	1.00	0		1.10	$ -	$ -	1.00	$ -	$ -
	Subtotal														$ -
DIVISION 31 - EARTHWORK															
312000	Site Excavation			2800	cy	1.00	1.00	2,800	$ -	1.00	$ -	$ -	1.00	$ -	$ -
312000	Site Backfill			765	cy	1.00	1.00	765	$ -	1.00	$ -	$ -	1.00	$ -	$ -
312000	Area for final grading			25000	sf	1.00	1.00	25,000	$ -	1.00	$ -	$ -	1.00	$ -	$ -
	Loading & Hauling			1	ea	1.00	1.00	1	$ -	1.00	$ -	$ -	1.00	$ -	$ -
	Subtotal														$ -
DIVISION 32 - EXTERIOR IMPROVEMENTS															
						1.00	1.00	0		1.00	$ -	$ -	1.00	$ -	$ -
						1.00	1.00	0		1.00	$ -	$ -	1.00	$ -	$ -
						1.00	1.00	0		1.00	$ -	$ -	1.00	$ -	$ -
	Subtotal														$ -
DIVISION 33 - UTILITIES															
	MIIEP Demolition			60	cy	1.00	1.00	60		1.00	$ -	$ -	1.00	$ -	$ -
	Loading & Hauling			1	ea	1.00	1.00	1	$ -	1.00	$ -	$ -	1.00	$ -	$ -
						1.00	1.00	0		1.00	$ -	$ -	1.00	$ -	$ -
	Subtotal														$ -
	TOTAL														$ -

MASTERSPEC Section	MASTERSPEC Division	INSTALLATION – Labor: Base Unit Manhours	* Site Difficulty Factor	Total Base Manhours	* Average Rate	Total Labor Costs	Other Direct Costs	* Installation Contingency (Risk) Factor	Installation Contingency (Risk) Cost	TOTAL INSTALL COST	TOTAL MATERIAL & INSTALL COST
			1.00	0		$ -		1.00	$ -	$ -	$ -
			1.00	0		$ -		1.00	$ -	$ -	$ -
			1.00	0		$ -		1.00	$ -	$ -	$ -
	Subtotal									$ -	$ -
DIVISION 28 - ELECTRICAL SAFETY AND SECURITY											
			1.00	0		$ -		1.00	$ -	$ -	$ -
			1.00	0		$ -		1.00	$ -	$ -	$ -
			1.00	0		$ -		1.00	$ -	$ -	$ -
	Subtotal									$ -	$ -
DIVISION 31 - EARTHWORK											
312000	Site Excavation	0.09	1.00	0.09	$ 78.57	$ 20,625	$ 18,200	1.00	$ -	$ 38,825	$ 38,825
312000	Site Backfill	0.08	1.00	0.08	$ 78.57	$ 4,808	$ 3,017	1.00	$ -	$ 7,825	$ 7,825
312000	Area for final grading	0.001	1.00	0.00	$ 78.57	$ 1,964	$ 1,875	1.00	$ -	$ 3,839	$ 3,839
	Loading & Hauling	75	1.00	75.00	$ 75.00	$ 5,625	$ 3,500	1.00	$ -	$ 9,125	$ 9,125
	Subtotal					$ 27,397	$ 30,292			$ 66,814	$ 66,814
DIVISION 32 - EXTERIOR IMPROVEMENTS											
			1.00	0.00	$ 78.57	$ -	$ -	1.00	$ -	$ -	$ -
			1.00	0.00	$ 78.57	$ -	$ -	1.00	$ -	$ -	$ -
			1.00	0.00	$ 78.57	$ -	$ -	1.00	$ -	$ -	$ -
	Subtotal					$ -	$ -			$ -	$ -
DIVISION 33 - UTILITIES											
	MIIEP Demolition	18.60	1.00	18.60	$ 78.57	$ 87,684	$ 41,100	1.00	$ -	$ 128,784	$ 128,784
	Loading & Hauling	180	1.00	180.00	$ 75.00	$ 13,500	$ 10,500	1.00	$ -	$ 24,000	$ 24,000
			1.00	0.00	$ 78.57	$ -	$ -	1.00	$ -	$ -	$ -
	Subtotal					$ 101,184	$ 51,600			$ 152,784	$ 152,784
	TOTAL									$ 1,766,289	$ 1,766,289

MASTERSPEC Section	MASTERSPEC Division	CONTRACTOR COSTS: * Division 1 (General Conditions)	* Overhead	* Profit	* Bond	* Contractor Cost Contingency	CONTRACTOR GENERAL COND/OH&P	* Room & Board	LINE SUBTOTAL	Total Design Contingency	* Construction Contingency Percentage (%)	Construction Contingency Cost ($)	TOTAL
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
	Subtotal						$ -	$ -	$ -			$ -	$ -
DIVISION 28 - ELECTRICAL SAFETY AND SECURITY													
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
	Subtotal						$ -	$ -	$ -			$ -	$ -
DIVISION 31 - EARTHWORK													
312000	Site Excavation	$ 5,824	$ 6,697	$ 5,135	$ 1,694	$ 967.49	$ 20,317	$ -	$ 59,142	$ -	30.0%	$ 17,743	$ 76,884
312000	Site Backfill	$ 1,174	$ 1,350	$ 1,035	$ 342	$ 195.01	$ 4,095	$ -	$ 11,920	$ -	30.0%	$ 3,576	$ 15,497
312000	Area for final grading	$ 576	$ 662	$ 508	$ 168	$ 95.67	$ 2,009	$ -	$ 5,848	$ -	30.0%	$ 1,755	$ 7,603
	Loading & Hauling	$ 1,369	$ 1,574	$ 1,207	$ 398	$ 227.39	$ 4,775	$ -	$ 13,900	$ -	30.0%	$ 4,170	$ 18,070
	Subtotal						$ 34,965	$ -	$ 101,779			$ 30,534	$ 132,312
DIVISION 32 - EXTERIOR IMPROVEMENTS													
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
	Subtotal						$ -	$ -	$ -			$ -	$ -
DIVISION 33 - UTILITIES													
	MIIEP Demolition	$ 19,318	$ 22,215	$ 17,032	$ 5,620	$ 3,209.24	$ 67,394	$ -	$ 196,178	$ -	30.0%	$ 58,853	$ 255,031
	Loading & Hauling	$ 3,600	$ 4,140	$ 3,174	$ 1,047	$ 598.07	$ 12,559	$ -	$ 36,559	$ -	30.0%	$ 10,968	$ 47,527
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	30.0%	$ -	$ -
	Subtotal						$ 79,954	$ -	$ 232,737			$ 69,821	$ 302,559
	TOTAL						$ 924,320	$ -	$ 2,690,609			$ 807,183	$ 3,497,792

Note: Table is for construction costs only and does not include habitat restoration and costs related to shared infrastructure. Values in this table are representative of ALT-2, the preferred alternative.
Source: M3 Engineering and Technology (2020)

Table 7-5: ALT-2 Cost Estimate

Summit Facilities Decommissioning		*Total Labor*	*Other Directs*	*Contractor Costs*	*Contin-gency*	*Line Total*
Division 02	Existing cond.	$9,600	$7,500	$8,940	$7,810	$33,850
Division 03	Concrete	$70,470	$56,250	$66,310	$57,910	$250,940
Division 05	Metals	$914,260	$467,750	$723,230	$631,570	$2,736,810
Division 09	Finishes	$11,510	$9,360	$10,920	$9,540	$41,330
Division 31	Earthwork	$27,400	$30,290	$34,960	$30,530	$123,180
Division 33	Utilities	$101,180	$51,600	$79,950	$69,820	$302,550
Habitat restoration & monitoring		-	-	-	-	$20,000
Off-site shared infrastructure		-	-	-	-	$525,380
Totals		**$1,134,420**	**$622,750**	**$924,310**	**$807,180**	**$4,034,040**

Note Contractor general condition costs (Division 01 in Table 7-4) are included in each of the construction building components. Only those divisions shown in in Table 7-4 that have costs associated with them are included in this table.
Source: M3.

Table 7-6: ALT-3 Cost Estimate

Summit Facilities Decommissioning		*Total Labor*	*Other Directs*	*Contractor Costs*	*Contin-gency*	*Line Total*
Division 02	Existing cond.	$9,600	$7,500	$8,940	$7,810	$33,850
Division 03	Concrete	$70,470	$56,250	$66,310	$57,910	$250,940
Division 05	Metals	$914,260	$467,750	$723,230	$631,570	$2,736,810
Division 09	Finishes	$11,510	$9,360	$10,920	$9,540	$41,330
Division 31	Earthwork	$16,200	$7,830	$4,100	$8,450	$36,570
Division 33	Utilities	$101,180	$51,600	$79,950	$69,820	$302,550
Habitat restoration & monitoring		-	-	-	-	$20,000
Off-site shared infrastructure		-	-	-	-	$525,380
Totals		**$1,123,220**	**$600,290**	**$893,450**	**$784,600**	**$3,947,430**

Note Contractor general condition costs (Division 01 in Table 7-4) are included in each of the construction building components. Only those divisions shown in in Table 7-4 that have costs associated with them are included in this table.
Source: M3.

Table 7-7: ALT-4 Cost Estimate

Summit Facilities Decommissioning		*Total Labor*	*Other Directs*	*Contractor Costs*	*Contin-gency*	*Line Total*
Division 02	Existing cond.	$9,600	$7,500	$8,940	$7,810	$33,850
Division 03	Concrete	$70,470	$56,250	$66,310	$57,910	$250,940
Division 05	Metals	$914,260	$467,750	$723,230	$631,570	$2,736,810
Division 09	Finishes	$11,510	$9,360	$10,920	$9,540	$41,330
Division 31	Earthwork	$9,800	$5,220	$2,750	$5,330	$23,100
Division 33	Utilities	$67,790	$34,570	$53,570	$46,780	$202,710
Habitat restoration & monitoring		-	-	-	-	$20,000
Off-site shared infrastructure		-	-	-	-	$525,380
Totals		**$1,083,430**	**$580,650**	**$865,720**	**$758,940**	**$3,884,120**

Note Contractor general condition costs (Division 01 in Table 7-4) are included in each of the construction building components. Only those divisions shown in in Table 7-4 that have costs associated with them are included in this table.
Source: M3.

7.3 ASSESSING BENEFIT

As evidenced in the discussion of natural, biological, historic, and cultural impacts in the SRP (see Chapter 6), total removal of all structures and infrastructure, together with full restoration to pre-construction condition, would provide the maximum achievable environmental benefit. It also offers other significant advantages, including fulfilling the terms of Caltech's sublease and eliminating liability posed by remnant facilities.

As shown in Table 7-3, the cost of total removal and full site restoration called for under the preferred alternative (i.e., ALT-2) is approximately 141 days and $4.0 million. It follows then that, in alternatives that involve less than complete removal and restoration, that maximum financial/duration benefit relative to ALT-2 is 141 days and $4.0 million. The consideration of benefits derived from other alternatives must be in contrast and comparison to this amount.

However, a challenge arises in attaching a specific value to the variation in benefits realized by the different degrees of removal and restoration under ALT-3 and ALT-4. These alternatives diverge from the maximum achievable benefit of total removal and full site restoration in some way, and the difficulty lies in assessing the value of that difference. As noted in Section 7.1, the typical approach to a CBA estimates total equivalent values for the costs and benefits of a set of alternatives, so that they can be weighed comparatively, and the best course of action identified. Here, however, some of the factors deserving of analysis—visual, biological, and cultural impacts—are impossible to place cost values on and doing so effectively devalues them.

Ultimately, if it is accepted that the best possible outcome of total removal and full restoration (i.e., ALT-2) has a value of 141 construction days and $4.0 million, it is not critically necessary to precisely quantify or rank the more modest benefits that would be accrued under the other action alternatives. To illustrate this, consider ALT-4, where some subsurface infrastructure would remain, and a portion of the site would not be fully restored. To the extent that a portion of the infrastructure is not removed or that a portion of the site is not fully restored, the net benefit is diminished because the existing impact to the landform caused by the past CSO development would persist. The cost difference between ALT-2 and ALT-4 is roughly $200,000; and while it is not possible to assign a value to the diminished benefit, Caltech believes that if its intent was to proceed with ALT-4 as its preferred alternative the diminishment in benefit value would exceed the reduced cost value based on the input it has received.

The CIA prepared by ASM Affiliates (2020) states:

> *"Both the CMP and the Decommissioning Sub-Plan indicate that the decommissioning starting point is for the observatories to do their utmost to completely remove all structures and fully restore the site, and based on what was said during consultation, doing less than that could be perceived as improper and culturally offensive. …"*
>
> *"…a perception exists that anything short of an attempt at complete facility removal and full environmental restoration would result in a disingenuous decommissioning effort, as well as be an affront to cultural sensibilities. Therefore, it is recommended that the complete facility (above and below ground) be removed and the affected environment be restored to the fullest extent possible. Following this, and the other above-offered recommendations, will help to ensure that the*

> *proposed decommissioning will not result in impacts to any traditionally valued cultural or historical resources nor any traditional cultural practices or beliefs."*

From the above quote it may be reasonably concluded that:

- If Caltech's intent varied between the alternatives and included something less than an attempt at complete removal and full restoration, the benefit would vary substantially for those with strong cultural ties to Maunakea.
- If Caltech's intent is always complete removal and full restoration (ALT-2), the benefit resulting for different outcomes dictated by unanticipated findings would be nearly identical.

As outlined in this document, all the alternatives start with the intent to completely remove the facility and infrastructure and fully restore the site. With that intent as a foundation, ALT-3 and ALT-4 would only come to pass if conditions are encountered during decommissioning that the work needed to achieve complete removal and/or full restoration would create a new, unanticipated, adverse cultural or physical effect sufficiently great to outweigh the physical and cultural benefit of complete removal and full restoration.[11] Thus, although ALT-3 and ALT-4 would not achieve complete removal and full site restoration despite the intent, it is logical to conclude that they would result in a benefit greater than ALT-2 would achieve in a situation where such an unanticipated condition is encountered.

ALT-1, which does not achieve either facility removal or site restoration, provides less benefit than any of the action alternatives. While these varying degrees of benefit are not quantifiable, in terms of cost values, for reasons noted above they represent the most precise appraisal of comparative benefit possible under the circumstances.

7.4 CONCLUSIONS

In Section 7.2, Table 7-3 provide the projected schedule and dollar cost values of each of the action alternatives considered in this SDP. It is believed that other potential "cost" variables would have similar distributions/differences between the alternatives. As can be seen from a side-by-side comparison of these action alternatives, the difference in cost values is inconsequential. Thus, from the point of view of cost, all action alternatives are functionally the same; the No Action alternative (i.e., ALT-1) is the only alternative that would provide a meaningful cost savings.

Section 7.3, the assessment of relative benefit of the various action alternatives, establishes that the value of the greatest financial and duration benefit is equal to the cost values of ALT-2. That section also demonstrates that the other action alternatives do not provide the same level of benefit as ALT-2, even though they incur similar costs. While acknowledging that it may not be possible to attach a value to the ALT-2 vs. ALT-3 or ALT-4 benefit differential, there is ample support for attributing value to the protection of natural and cultural resources in State of Hawaiʻi law. With respect to the natural resources, Article XI, Section 1 of the *Constitution of the State of Hawaiʻi* states that:

[11] Should an unanticipated situation arise that increases the cost of achieving ALT-2 but does not create a new adverse cultural effect, Caltech would provide the funds to cover the additional ALT-2 costs.

> *"For the benefit of present and future generations, the State and its political subdivisions shall conserve and protect Hawaiʻi's natural beauty and all natural resources, including land, water, air, minerals and energy sources, and shall promote the development and utilization of these resources in a manner consistent with their conservation and in furtherance of the self-sufficiency of the State."*

And, in text added as part of the 1978 Constitutional Convention, the *Constitution of the State of Hawaiʻi* (Article XI, Section 1) establishes that:

> *"All public natural resources are held in trust by the State for the benefit of the people."*

Thus, it is both logical and reasonable to conclude that while none of the action alternatives offers consequential savings in terms of cost, ALT-2 provides significant additional benefit related to the positive environmental, biological, and cultural impacts of total removal and full site restoration. While these benefits and impacts may not be assessed in terms of cost values, there is strong support in Hawaiʻi State Law for protection of these as valuable public trust resources. In the absence of a clear cost difference differences in the action alternatives assessed in this SDP, these benefits and impacts are the most relevant factors identifying ALT-2 as the alternative possessing the best balance of cost and benefit.

CHAPTER 8: DECOMMISSIONING FUNDING PLAN

When Caltech and UH representatives signed the sublease dated December 20, 1983, they agreed that, upon termination or expiration of the sublease, Caltech would follow one of four options (Section 4.1). All the action alternatives involve the fourth option: removal of the property at the expense of the Caltech. Thus, funding for all the decommissioning activities described in this SDP must be provided by Caltech.

8.1 FINANCIAL COST OF DECOMMISSIONING

As detailed in Section 7.2, the estimated cost to decommission CSO is approximately $4,000,000.

8.2 FINANCIAL ASSURANCE AND MEANS OF FUNDING

Per the DP, there are several potential financial assurance "methods." The method of financial assurance that Caltech is employing is the "surety, insurance, or guarantee" where the sublessee self-guarantees the funding of decommissioning activities.

In the Notice of Intent to Decommission (NOI), Caltech stated that "Caltech intends to remove the CSO from Mauna Kea and to restore the Site in accordance with provision V.4 of its sublease" and "Caltech intends no further use of the Site. Upon completion of the decommissioning process, Caltech will surrender its sublease." That statement was made by Edward Stolper; Provost, William E. Leonhard Professor of Geology, and Carl and Shirley Larson Provostial Chair at Caltech. In addition, in a letter dated August 21, 2008, to UH's Institute for Astronomy (IfA) Caltech stated, "We confirm that we are aware of the technical and financial implications of the removal/restoration option in the event of termination or expiration of the sublease. Consistent with Caltech's legal obligations set forth in the sublease and the operating agreement, if the removal/restoration option becomes necessary, we are able to guarantee its implementation. Caltech will be the source of funding for the removal of the facilities and restoration of the property." Caltech, and its general funds, are backed by its endowment, which the National Center for Education Statistics estimates as the 35th biggest in the country, worth roughly $2.879 billion in 2019. Thus, Caltech has adequate financial strength to self-guarantee CSO's decommissioning and has done so via the NOI, 2008 letter, and this SDP.

CHAPTER 9: REFERENCES

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University of Hawaiʻi at Hilo, Center for Maunakea Management, Jessica Kirkpatrick personal communication with Jim Hayes, November 6, 2020.

Appendix A. Notice of Intent

CALIFORNIA INSTITUTE OF TECHNOLOGY
Pasadena, California 91125 USA

Parsons-Gates
Mail Code 206-31

ems@caltech.edu

Tel: (626) 395-6336
Fax: (626) 795-1898

November 18, 2015

Office of Mauna Kea Management
Attn: Stephanie Nagata, Director
640 N. A'ohōkū Place, Room 203
Hilo, Hawai'i 96720

Re: Notice of Intent to Decommission
Caltech Submillimeter Observatory

Dear Ms. Nagata:

The California Institute of Technology hereby submits the enclosed Notice of Intent to Decommission its Caltech Submillimeter Observatory located on Maunakea.

In accordance with the process outlined in the *Decommissioning Plan for the Mauna Kea Observatories*, a sub-plan of the *Mauna Kea Comprehensive Management Plan*, Caltech will proceed to conduct an environmental due diligence review and to prepare the Site Deconstruction and Removal Plan and the Site Restoration Plan. As stipulated by the *Decommissioning Plan,* these documents will be submitted to OMKM.

Sincerely,

Edward Stolper

Edward Stolper
Provost
William E. Leonhard Professor of Geology
Carl and Shirley Larson Provostial Chair

CALIFORNIA INSTITUTE OF TECHNOLOGY

CSO Decommissioning
Notice of Intent

2015 November 18

Introduction

Since 1986, the California Institute of Technology has operated the Caltech Submillimeter Observatory (CSO) on Maunakea. The CSO site is subleased to Caltech by the University of Hawaii (UH) and the State of Hawaii, Department of Land and Natural Resources (DLNR) (Sublease H09176; Attachment A). Operation of the CSO is subject both to a Conservation District Use Permit issued by the DLNR (Attachment C) and to an Operating Agreement between Caltech and the UH (Attachment B).

In 2009 and again in 2015, Caltech publicly announced the closure of the CSO on Maunakea. This document is Caltech's formal Notice of Intent (NoI) for decommissioning the CSO.

Intent to Remove

Caltech intends to remove the CSO from Maunakea and to restore the site in accordance with provision V.4 of its sublease (H09176; Attachment A). Caltech intends no further use of the site. Upon completion of the decommissioning process, Caltech will surrender its sublease.

Caltech intends to follow the process outlined in the *Decommissioning Plan for the Mauna Kea Observatories*, a sub-plan of the *Mauna Kea Comprehensive Management Plan*. Submittal of this NoI is the first step in that process. Caltech intends to carry out the activities stipulated in the *Decommissioning Plan*, including, but not limited to, preparation and submittal for review of:

- An Environmental Due Diligence Review,
- A Site Deconstruction and Removal Plan (SDRP), and
- A Site Restoration Plan (SRP).

Caltech intends that deconstruction and removal will entail:

- Removal of the telescope and dome (enclosure);
- Removal of all other above ground structures, furnishings, and other improvements, including but not limited to the outbuilding, transformer, generator, and pump shed;
- Removal of all concrete slabs, aprons, and walkways that are 6 in or less thick;
- Removal of the asphalt parking lot;
- Removal of all underground plumbing connected to the cesspool and water tank;
- Removal of all underground electrical and communications conduits back to their branch connection point at the summit service lines;
- Removal of the underground water tank and backfilling of the cavity with native material; and

- Condemnation of the cesspool, removal of the manhole, and backfilling of the cavity with native material.

Caltech intends that site restoration will entail:
- Backfilling with native material of all cavities remaining after structures and furnishings are removed; and
- Grading the site to the approximate pre-construction topography to leave a visual appearance consistent with the original condition.

The *Decommissioning Plan* stipulates, "the level of restoration attempted and the potential benefits and impacts of the restoration activities on natural and cultural resources during and post-activity must be carefully evaluated. A cost-benefit analysis shall also be conducted." For the telescope and dome foundations and for other deep underground structures, therefore, Caltech intends to carry out a benefit study. This study will compare the environmental, cultural, and cost benefits and impacts of two options:
1. Removal of the top of the underground structures and burial of the reminder.
2. Complete removal of the underground structures.

The study will assess, for example, the impact of any additional excavation necessary to completely remove the underground structures and the impact of relocating or importing material to backfill any cavities. This benefit study will be incorporated into the Site Restoration Plan (SRP).

Caltech fully intends to complete all phases of the decommissioning process, including deconstruction and site restoration, as expeditiously as practical. Caltech recognizes, however, the uncertainty concerning the appropriate level of site restoration. Caltech anticipates the additional studies and evaluation necessary to resolve this uncertainty may delay the completion of the SRP. Caltech intends, therefore, to proceed initially with removal of the telescope, the dome, and other above ground structures. Removal of below ground structures and site restoration will follow once the SRP is approved.

Site Description

The CSO is located on a 0.75 acre site at 13,350 ft altitude near the summit of Maunakea. The site is located within the Astronomy Precinct of the Mauna Kea Science Reserve (TMK: (3) 4-4-15:09) managed by the University of Hawaii. Caltech subleases the CSO site from the University of Hawaii. Placement of the CSO on Maunakea is governed by:
- Sublease H09176 among Caltech, the UH, and the state of Hawaii, DLNR (Attachment A);
- General Lease S4191 between the State of Hawaii and the University of Hawaii (Attachment A, Exhibit A);
- Operating and Site Development Agreement between the California Institute of Technology and the University of Hawaii Concerning the Construction and Operation of the Caltech Submillimeter Telescope Facility on Mauna Kea (Attachment B);
- Conservation District Use Permit HA-1492 issued by the state of Hawaii, DLNR (Attachment C).

The CSO (Figure 1) was constructed in 1983–6 and consists of the following structures and improvements:

1. The telescope itself, enclosed in a corotating dome.
   1.1. The 10.4 m (34 ft) diameter radio telescope has a reflector constructed of aluminum panels supported by a tubular steel truss. The weight of the reflector is about 10,500 lb. The reflector is attached to a two axis steel mount structure that allows pointing to any location on the sky. The approximate total weight of the telescope is 86,000 lb.
   1.2. The corotating dome is a steel structure clad with aluminum sheets. It is approximately hemispherical, about 60 ft in diameter and 52 ft high. It has a two part shutter door that opens to allow the telescope to observe the sky. To follow the telescope motion, the entire dome structure rotates on a rail. Inside the dome, there are several labs and other rooms on three levels with various furnishings and equipment. The approximate weight of the dome is 300,000 lb.
   1.3. The telescope and dome rest on concrete foundations surrounded by a sidewalk with an overall diameter of about 80 ft diameter (Figure 7).
2. A utility outbuilding. This is a single story building with metal framing on a concrete slab with an adjoining concrete sidewalk.
   2.1. The original outbuilding houses the main electrical switchgear for the CSO. It was also used as an occasional workshop and for storage.
   2.2. The outbuilding was extended in 1990. At present, the OMKM rangers store emergency equipment in the extension.
3. An electrical transformer on a concrete pad.
4. A backup electrical generator on a concrete pad, installed in 1990. This is fueled with propane from portable tanks stored in the outbuilding. Fuel lines are underground.
5. An underground water tank. Atop the tank, a pump is housed in a shed on a concrete pad.
6. An underground cesspool (Figure 8). There is a manhole for access.
7. A small concrete pad adjacent to the dome has plumbing fixtures for the water tank and cesspool.
   7.1. An underground ¾ in copper line connects to the water tank.
   7.2. An underground 4 in sewer line connects to the cesspool.
8. Underground electrical lines between the Helco service point, the transformer, the outbuilding, the generator, and the dome.
9. Underground conduits for communications cables between connection boxes near the access road, the outbuilding, and the dome.
10. Underground copper grid for electrical grounding.
11. The parking area between the dome and outbuilding is paved with asphalt. The parking area connects to a branch of the Maunakea access road.
12. Four ½ in diameter survey markers at the four corners of the CSO site and a fifth Bench Mark near the center of the site.

Site Plan

The locations of the CSO structures and improvements are shown on the attached site plan:

- Figure 2: Site Layout and Grading Plan, dated 1983-02-07, approved by the Chief Engineer, County of Hawaii on 1983-03-22, and field checked as graded on 1983-10-07.

Because this original drawing predates construction of the CSO structures, Caltech has contracted a surveyor to prepare an up to date, as built site plan. This updated site plan will be submitted as an addendum to this NoI.

Pre-Construction Condition

Prior to the construction of the CSO, which began in 1983, there was no development at the site, which was a flat region covered with native material typical of the summit. The following documents illustrate the pre-construction site condition:

- Figure 3. Pre-construction Topographic Survey, dated 1983-01-21.
- Figure 4: Photo of pre-construction site from nearby ridge.
- Figure 5: Photos of site before and after grading/construction of foundation.
- Figure 6: Photo of Prof. Robert Leighton installing a survey marker.

Historical Usage

Since 1983, the site has been used exclusively for the construction and scientific operation of the CSO. Other than the extension of the outbuilding in 1990, all the structures and improvements have been in place since the initial construction.

Attachments

A. Sublease agreement among the California Institute of Technology, the University of Hawaii, and the State of Hawaii, Department of Land and Natural Resources, H09176, 1983-12-20. Includes Exhibits:
   A. General lease by and between the State of Hawaii and the University of Hawaii, S-4191, 1968-06-20.
   B. Caltech Telescope Site
   C. Description of the Construction of the Caltech Telescope.
B. Operating and Site Development Agreement between the California Institute of Technology and the University of Hawaii Concerning the Construction and Operation of the Caltech Submillimeter Telescope Facility on Mauna Kea, Hawaii, 1983-12-20.
C. Conservation District Use Permit, HA-1492, approved 1982-12-17.

Figure 1. The Caltech Submillimeter Observatory (CSO) near the summit of Maunakea, Hawaii.

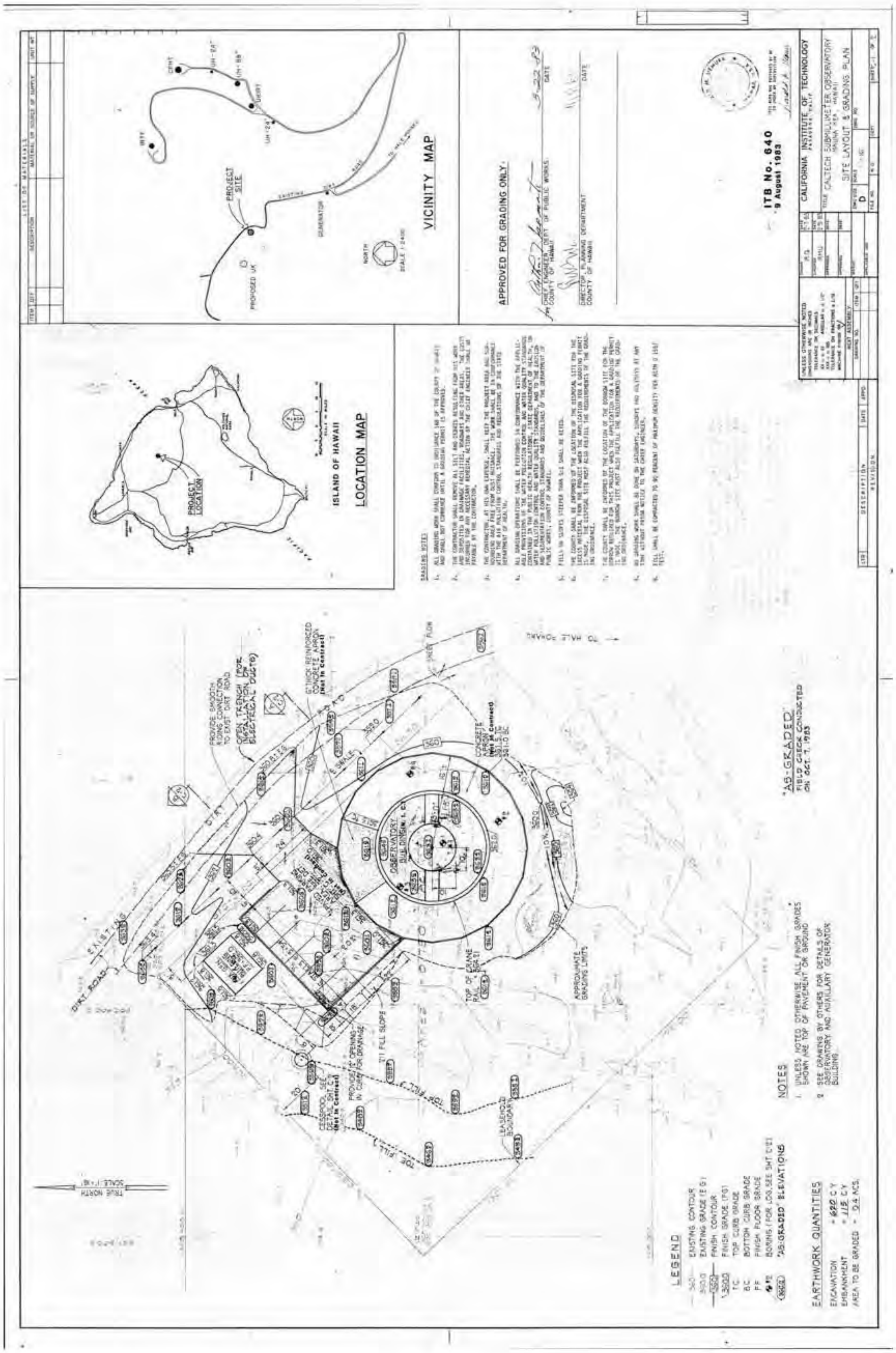


Figure 2: Site Layout and Grading Plan, 1983-02-07.

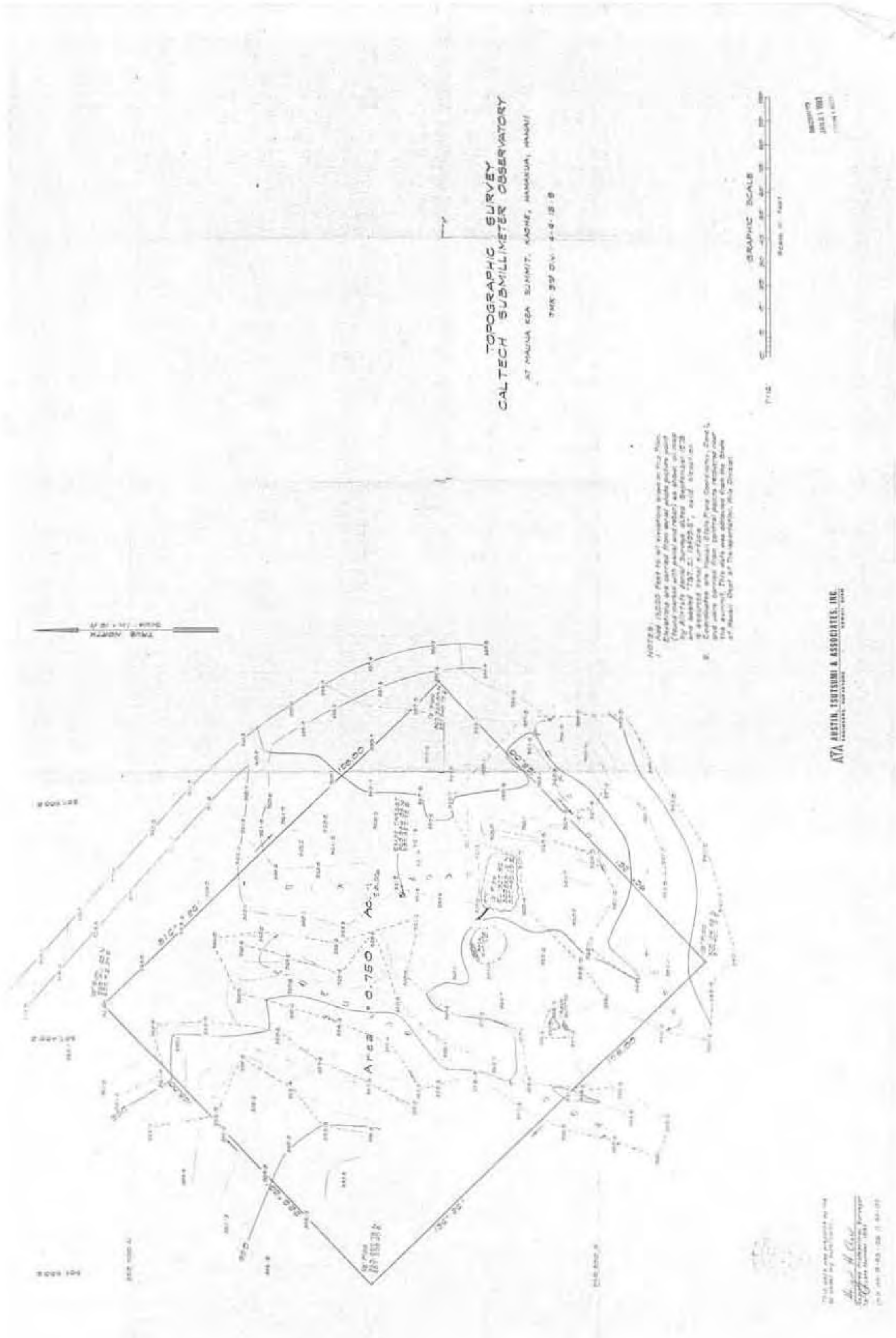


Figure 3: Pre-construction Topographic Survey, 1983-01-21.

Figure 4: Pre-construction photograph of CSO site.

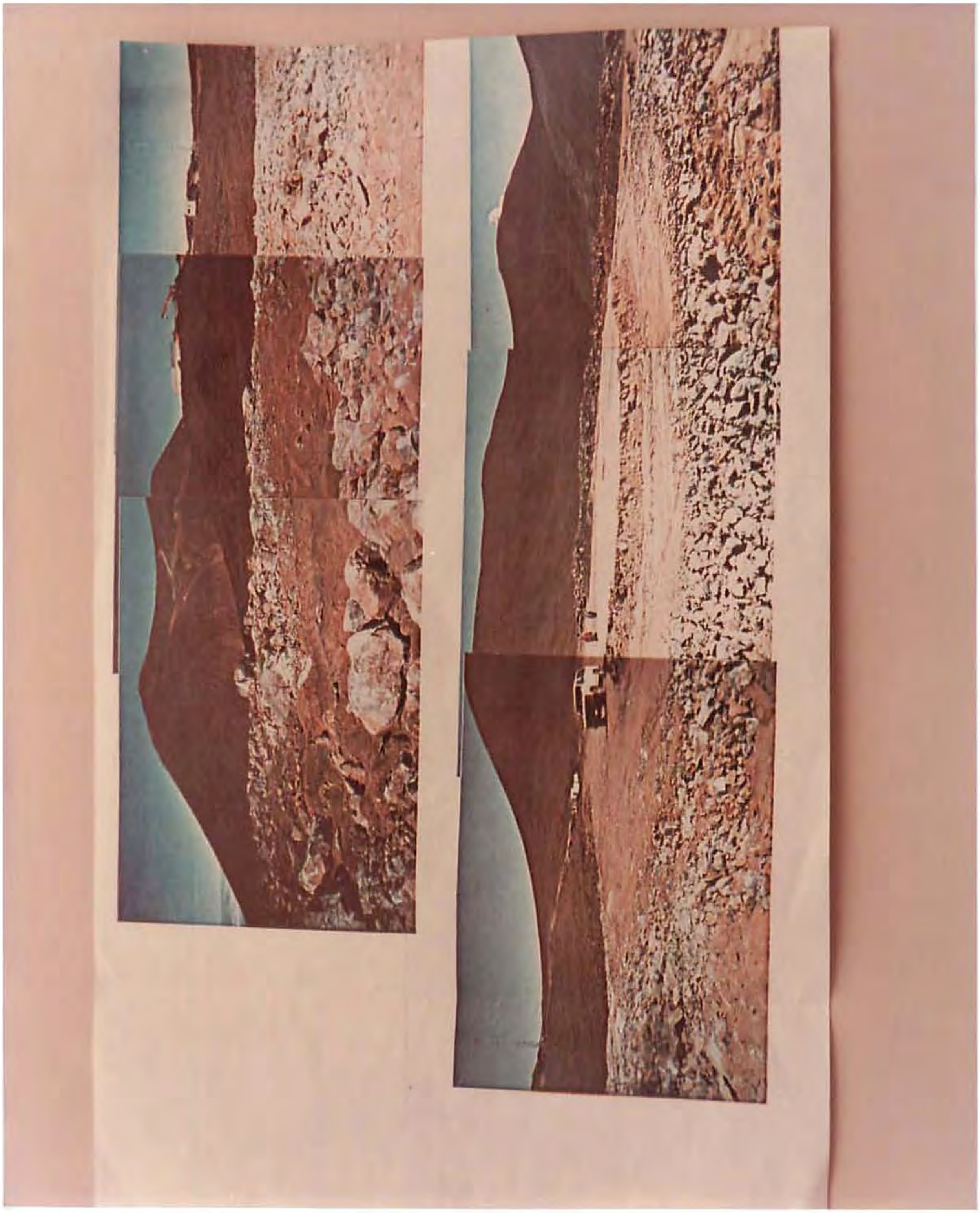


Figure 5: Panoramic photographs of CSO site before (left) and after (right) grading and construction of foundations for the dome and telescope.


Figure 6: Prof. Robert Leighton hammering in the Bench Mark noted in Figure 3.

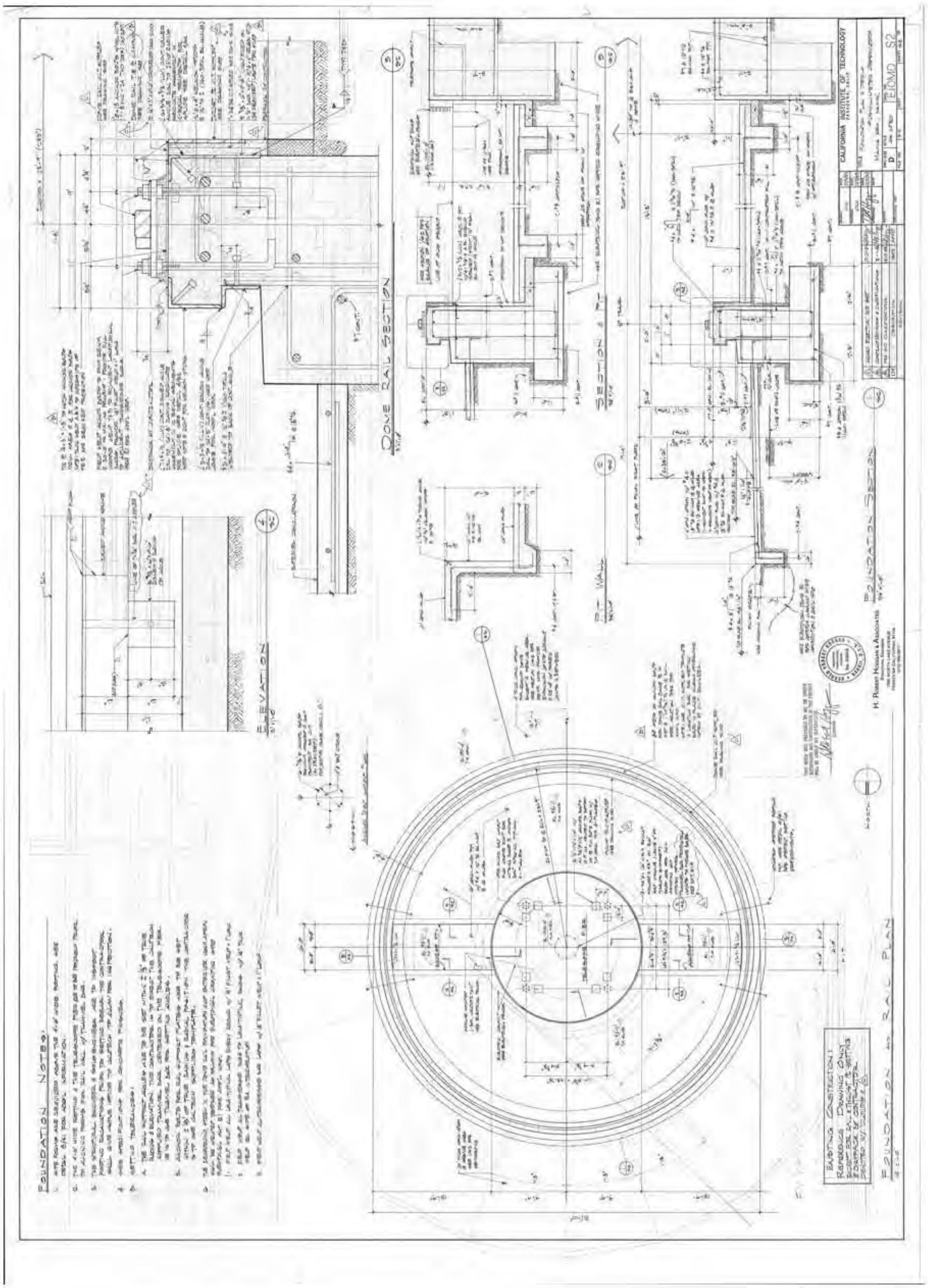


Figure 7. Foundation Plan, 1984-12-20.

REPORT ON INDIVIDUAL WASTEWATER SYSTEM Page 2 of 2

PROPERTY OWNER: California Institute of Technology
Address: Mauna Kea, Hawaii
Lot Size: 198.00' X 165.00'
CONTRACTOR: Constructors Hawaii Inc.
OWNER'S AGENT: Robert E. Arneson, P.E.
Mailing Address: 1116 Donna Beth Avenue
West Covina, CA 91791
Telephone: (818) 9193304
(213) 8252853

ROBERT E. ARNESON
REGISTERED PROFESSIONAL ENGINEER
No. 5592
MECHANICAL
HAWAII, U.S.A.

Robert Arneson
3/2/87

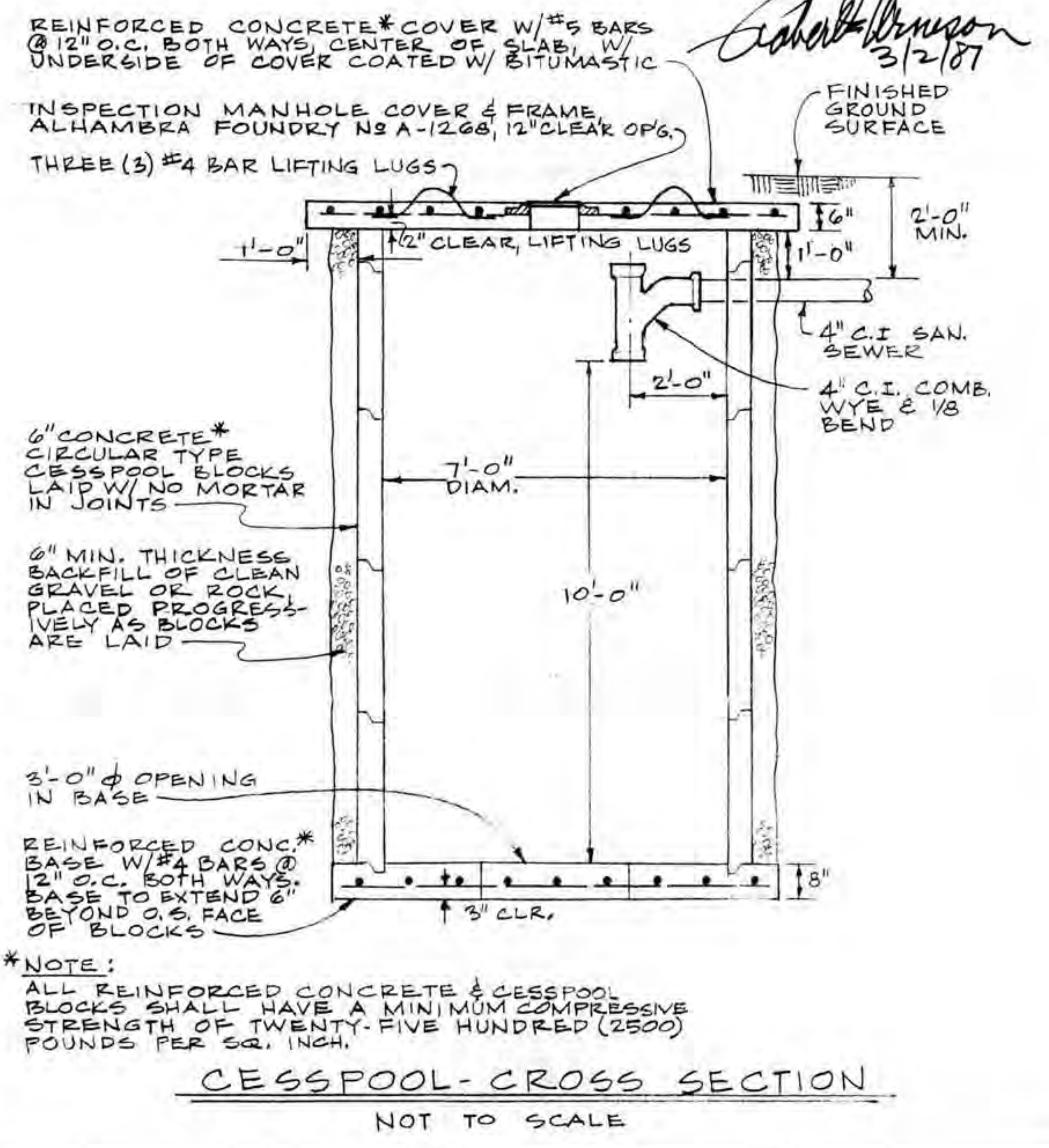


Figure 8: Cesspool report, 1987-03-02.

CALIFORNIA INSTITUTE OF TECHNOLOGY

Attachment A

Sublease agreement among the

California Institute of Technology

the University of Hawaii

and the

State of Hawaii, Department of Land and Natural Resources

H09176

1983-12-20

ATTACHMENT A

SUBLEASE AGREEMENT AMONG THE

CALIFORNIA INSTITUTE OF TECHNOLOGY

THE UNIVERSITY OF HAWAII

AND THE

STATE OF HAWAII, DEPARTMENT OF LAND AND NATURAL RESOURCES

RECORDATION REQUESTED BY:

AFTER RECORDATION, RETURN TO:

When completed: Mail ( )
Pick up ( ) Phone:

H09176

SUBLEASE AGREEMENT

THIS SUBLEASE is made this 20 day of DECEMBER, 1983, by and between the University of Hawaii, hereinafter called "SUBLESSOR," and the California Institute of Technology, Pasadena, California 91125, hereinafter called "SUBLESSEE." This Sublease is approved pursuant to General Lease S-4191, dated June 21, 1968, between Sublessor and the State of Hawaii, Board of Land and Natural Resources, hereinafter called "LESSOR." A copy of General Lease S-4191 is attached hereto as Exhibit A and incorporated herein by reference.

W I T N E S S E T H T H A T

Sublessor, in consideration of the rent hereinafter reserved and upon the conditions, covenants and agreements hereinafter express, does hereby demise and let to Sublessee the parcels of land described in Exhibit B, hereto attached and by reference made a part hereof, and Sublessee does hereby Sublease from Sublessor for the purposes of erecting a tele-

I. GENERAL

A. Location/Area

The location/area comprises a portion of that certain land area described in General Lease S-4191, Exhibit A, and more specifically identified in Exhibit B, hereto attached and by reference made a part hereof, together with the right reserved to Sublessor to establish an access road, and power and communication lines to the above portion of land, and the right reserved to Sublessee of access to said premises over and across the common entrances and rights of way, together with others entitled thereto under such rules and regulations as may be established by and amended from time to time by Sublessor.

B. Term of Sublease

To have and to hold the demised premises unto Sublessee in strict compliance with the terms, conditions, and restraints contained in General Lease S-4191, until the 31st day of December 2033, or such earlier date as provided for in Article IV.I.

C. Rental Charge

Sublessee hereby covenants and agrees to pay rental for the demised premises at ONE DOLLAR ($1.00) per year in legal tender of the United States of America for the duration of the Sublease. Said fee shall be paid to the Business Office, Bachman Hall, University of Hawaii, 2444 Dole Street, Honolulu, Hawaii 96822.

D. Fire or Destruction of Facilities

If all three of the following events occur: (1) the facilities are destroyed by fire or other causes rendering the same unsuitable for purposes of millimeter-and submillimeter-wave astronomy, (2) Sublessee elects not to restore the faci

If the facilities or a portion thereof are restored, such restoration shall be subject to approval by the Sublessor, and in keeping with Article III.I. below.

E. Controlling Lease

In the event that any term or condition contained herein is inconsistent with or contrary to General Lease S-4191, the General Lease shall be controlling.

F. Operation of Facilities

Neither Sublessee nor its successor or assigns shall operate or permit to be operated the aforementioned Telescope for purposes of research without a signed Operating and Site Development Agreement between Sublessor and Sublessee. The Telescope may be operated in the absence of an Operating and Site Development Agreement by Sublessee when necessary to ensure the safety of personnel or of the facilities.

G. Indemnity

Sublessee will indemnify, defend and hold harmless the Lessor and Sublessor, their officers, agents, employees or any person acting on their behalf from and against any claim or demand for loss, liability or damages (including, but not limited to, claims for property damage, personal injury or death, based upon any accident, fire, or other incident on the demised premises and roadways adjacent thereto) which arises from any act or omission of Sublessee, its officers, agents, employees, or invitees, or occasioned by any failure on the part of Sublessee to maintain the premises in a safe condition or to observe or perform any of the terms and conditions herein or any regulations, ordinances and laws of the Federal, State, Municipal or County Governments.

Additionally, Sublessee shall, during the period of this Sublease, at its own cost and expense, maintain liability

II. SUBLESSOR HEREBY COVENANTS WITH SUBLESSEE AS FOLLOWS:

A. Peaceful Enjoyment

Upon provision by Sublessee of the use rights in lieu of rent in the aforesaid Operating and Site Development Agreement and upon observance and performance of all the terms, covenants and conditions herein contained and on the part of Sublessee to be observed and performed, Sublessee shall peaceably hold and enjoy the demised premises during the term hereof without hindrance or interruption.

B. Covenant Against Contingent Fees

Sublessee warrants that no person or selling agency has been employed or retained to solicit or secure this Sublease upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by Sublessee for the purpose of securing business. For breach or violation of this warranty, Sublessor shall have the right to annul this Sublease without liability or in its discretion to deduct from the Sublease price or consideration, or otherwise recover, the full amount of such commission, percentage, brokerage, or contingent fee.

C. Renewal

At lease SIX (6) months prior to the expiration of General Lease S-4191 on the 31st day of December 2033, Sublessor shall seek to negotiate a renewal of the General Lease with the Board of Land and Natural Resources or its successor and, in the event of renewal, Sublessor shall renew or extend this Sublease, or shall negotiate in good faith a new Sublease with Sublessee, if so desired by Sublessee, and under such terms and conditions as may then be mutually acceptable.

III. SUBLESSEE HEREBY COVENANTS WITH SUBLESSOR AS FOLLOWS:

C. Repairs and Maintenance

At all times during the term of this Sublease, Sublessee shall, at Sublesse's own cost and expense, keep and maintain the demised premises and the buildings and improvements erected upon the demised premises, in good order and repair and in a clean condition. This obligation shall include, but not be limited to, the obligation of painting the improvements and any part thereof, when necessary, and making any modification, improvement, or alteration approved by Sublessor and made by Sublessee.

D. Utilities and Other Charges

Except as may be agreed in the Operating and Site Development Agreement, Sublessee shall pay or shall cause to be paid when due all charges associated with the Telescope and, all charges, duties and rates of every description, including electricity, water, communications, sewer, gas, refuse collection or any other similar charges, as to which said demised premises, or any part thereof, or any improvements thereon, or to which Sublessor or Sublessee in respect thereof, are now or may be assessed or become liable by authority of law during the term of this Sublease.

E. Taxes and Assessments

Sublessee shall pay or cause to be paid when due, the amount of all taxes, rates, assessments, and other outgoings of every description as to which said premises or any part thereof, or any improvements thereon, or Sublessor or Sublessee in respect thereof, are now or may be assessed or become liable by authority of law during the term of this Sublease.

F. Assignment and Subleasing

Neither Sublessee nor its successor or assigns shall, without the prior written consent of Sublessor, assign or mortgage this Sublease or any interest therein, or sublet the "reasonable wear and tear" shall include without limitation such grading, excavation and filling of the land demised as may be reasonably required for the construction, modification or removal of the improvements contemplated by this Sublease, and such grading, excavation and filling shall not be deemed to constitute strip or waste. Sublessee shall make every reasonable effort to minimize grading, excavation and filling.

H. Liability

All goods, wares, merchandise, equipment or other property of Sublessee shall be kept on the demised premises at the sole risk of Sublessee.

I. Improvements and Alterations

Prior to the commencement of any construction, alteration, or repair of any building or other improvement which expands or changes the external structure or appearance of facilities located on the demised premises, the final location map, plans, and specifications shall be submitted to Sublessor and to the Chairman, Department of Land and Natural Resources, or to their authorized representatives, for approval, which approval shall not be arbitrarily or capriciously withheld or delayed. Sublessor and Lessor shall process any application for such alterations and additions as expeditiously as possible and subject to regulations of the Department of Land and Natural Resources.

All construction shall be in full compliance with all laws, rules, regulations of the Federal, State and County Governments applicable thereto, and also in accordance with plans and specifications submitted by Sublessee to and approved by Sublessor prior to commencement of construction.

IV. AND THE PARTIES MUTUALLY COVENANT AS FOLLOWS:

A. Service of Process

B. Governing Law; Severability

The validity, construction and performances of this Sublease, and the legal relations among the parties to this Sublease shall be governed by and construed in accordance with the laws of the State of Hawaii, excluding that body of law applicable to choice of law. In the event any provision of this Sublease shall be held by a court of competent jurisdiction to be contrary to law, the remaining provisions of this Sublease shall remain in full force and effect.

C. Binding on Successors

This Sublease shall be binding on and inure to the benefit of the successors of the parties hereto.

D. Partial Invalidity

Should any provision of this Sublease be held by a court of competent jurisdiction to be either invalid, void, or unenforceable, the remaining provisions of this Sublease shall remain in full force and effect.

E. Final Agreement

This instrument constitutes the final agreement between Sublessor and Sublessee regarding the Sublease of the demised premises to Sublessee for purposes of Sublessee's construction of the telescope herein described. All prior discussions and/or agreements between the parties concerning the subject matter addressed in this Sublease shall have no force and effect.

F. Notices

All notices required or permitted to be given hereunder by Sublessor to Sublessee or Sublessee to Sublessor shall be in writing and sent to the following people or offices at the following addresses:

Sublessor and Sublessee may change the address of the recipient of notices by sending a written notice of each such change to the last designated address of the addressee.

G. Termination

This Sublease may be terminated by the Sublessor upon the occurrence of any of the following events:

1. If a substantial part of the planned construction as described in Exhibit C does not exist on the site by the 31st day of December 1986, unless otherwise agreed in writing between Sublessor and Sublessee.

2. Termination of the "Operating and Site Development Agreement Between the California Institute of Technology and the University of Hawaii Concerning the design, Construction and Operation of the 10.4-m Millimeter-Wave Telescope of the California Institute of Technology on Mauna Kea, Hawaii."

3. The expiration of General Lease S-4191 on December 31, 2033. If said General Lease is renewed, extended or renegotiated, this Sublease may be renewed, extended, or renegotiated at that time.

4. If Sublessee fails to observe or comply with any of the terms and conditions herein within THIRTY (30) days after being notified in writing by Sublessor of such failure. In the event that more than THIRTY (30) days are reasonably required to observe or perform, Sublessee shall in good faith, and within said THIRTY (30) days, initiate action and provide a plan for observance or performance, and shall diligently prosecute the same to completion.

5. Destruction of the improvements by fire or other causes rendering the same unsuitable for purposes of millimeter and submillimeter astronomy, unless Sublessee notifies Sublessor within SIX (6) months of the date of casualty of its

V. TITLE TO FACILITIES, ALTERATIONS, ADDITIONS, IMPROVEMENTS, AND EQUIPMENT, AND DISPOSITION IN EVENT OF TERMINATION

Title to all facilities, additions, improvements, alterations, and equipment (collectively referred to herein as "property") on, affixed or installed in, or placed on the premises by Sublessee shall, at all times, remain in the name of the California Institute of Technology.

However, upon the termination or expiration of this Sublease for any cause, Sublessee must select one of the following options:

1. Negotiate with Sublessor for sale of the property to Sublessor.

2. With concurrence of Sublessor, peaceably surrender the demised premises and all or part of the property in place and good repair, order, and clean condition, reasonable wear and tear excepted. In the event that part of the property is removed, Sublessee shall restore the demised premises, or any portion affected thereby, to even grade to the extent that improvements are removed, and shall repair any damage done to the improvements in the event that equipment is removed.

3. Sell the assets to a third party acceptable to Sublessor, which acceptance shall not be arbitrarily or capriciously withheld. Such sale shall be contingent upon the execution of a new Sublease and Operating and Site Development Agreement between the third party and Sublessor.

4. Remove the property at the expense of Sublessee provided such removal is completed within EIGHTEEN (18) months after termination or expiration of Sublease, unless otherwise agreed to in writing between Sublessor and Sublessee. In the event of such removal, Sublessee shall restore the property, or any portion affected thereby, to even grade to the extent

IN WITNESS WHEREOF, the parties hereto have executed these presents on the day and year first above written.

FOR THE UNIVERSITY OF HAWAII

By Fujio Matsuda — OCT 24 1983
Fujio Matsuda — Date
President

By — OCT 24 1983
Date

APPROVED AS TO FORM:

By — 8/5/83
Its Deputy Attorney — Date
General

FOR THE CALIFORNIA INSTITUTE OF TECHNOLOGY

BY — Date
Marvin L. Goldberger
President

FOR THE DEPARTMENT OF LAND AND NATURAL RESOURCES

By ______________ / 12.20.83
Susumu Ono / Date
Chairman

By ______________ / 12/16/83
Member / Date

APPROVED AS TO FORM:

By ______________ / September 27, 1983
Its Deputy / Date
Attorney General

APPROVED BY THE BOARD OF
LAND AND NATURAL RESOURCES
AT ITS MEETING HELD ON

AUGUST 26, 1983

STATE OF CALIFORNIA)
) S.S.
CITY AND COUNTY OF LOS ANGELES)

On this 15th day of November, 1983, before me appeared Marvin L. Goldberger, to me personally known who, being by me duly sworn, did say that he is President of the CALIFORNIA INSTITUTE OF TECHNOLOGY, a California corporation; that the seal affixed to the foregoing instrument is the corporate seal of said corporation; that said instrument was signed and sealed in behalf of said corporation by the authority of its Board of Trustees; and said Marvin L. Goldberger acknowledged the instrument to be the free act and deed of said corporation.

OFFICIAL SEAL
SUSAN RUTH MARTIN
NOTARY PUBLIC - CALIFORNIA
LOS ANGELES COUNTY
My comm. expires SEP 22, 1986

Susan Ruth Martin
Notary Public, State of California
My commission expires: 9/22/86

STATE OF CALIFORNIA)
) S.S.
CITY AND COUNTY OF LOS ANGELES)

On this 15th day of November, 1983, before me appeared David W. Morrisroe, to me personally known who, being by me duly sworn, did say that he is Vice-President for Business & Finance of the CALIFORNIA INSTITUTE OF TECHNOLOGY, a California corporation; that the seal affixed to the foregoing instrument is the corporate seal of said corporation; that said instrument was signed and sealed in behalf of said corporation by the authority of its Board of Trustees; and said David W. Morrisroe acknowledged the instrument to be the free act and deed of said corporation.

OFFICIAL SEAL
SUSAN RUTH MARTIN
NOTARY PUBLIC - CALIFORNIA
LOS ANGELES COUNTY
My comm. expires SEP 22, 1986

Susan Ruth Martin
Notary Public, State of California
My commission expires: 9/22/86

STATE OF HAWAII)
) ss.
CITY AND COUNTY OF HONOLULU)

On this 24th day of October, 1983, before me appeared Fujio Matsuda and Harold S. Masumoto, to me personally known, who, being by me duly sworn, did say that they are President and Vice President for Administration respectively, of the University of Hawaii, a Hawaii corporation; that the seal affixed to the foregoing instrument is the corporate seal of said corporation; that said instrument was signed and sealed in behalf of said corporation by the authority of its Board of Regents; and said Fujio Matsuda and Harold S. Masumoto acknowledged the instrument to be the free act and deed of said corporation.

Ruth M. Chang
Notary Public, First Circuit

Attachment A, Exhibit A

General lease S-4191

by and between

the State of Hawaii and the University of Hawaii

1968-06-20

EXHIBIT A

GENERAL LEASE S-4191

1

GENERAL LEASE NO. S-4191

THIS INDENTURE OF LEASE, made this 21st day of June, 1968, by and between the STATE OF HAWAII, by its Board of Land and Natural Resources, pursuant to the provisions of Section 103A-90(b), Revised Laws of Hawaii 1955, as amended, hereinafter referred to as the "LESSOR", and the UNIVERSITY OF HAWAII, a body corporate, whose post office address is 2444 Dole Street, Honolulu, City and County of Honolulu, State of Hawaii, hereinafter referred to as the "LESSEE",

WITNESSETH THAT:

FOR and in consideration of the mutual promises and agreements contained herein, the Lessor does hereby demise and lease unto the said Lessee and the said Lessee does hereby rent and lease from the Lessor, all of that certain parcel of land situate at Kaohe, Hamakua, County and Island of Hawaii, State of Hawaii, and more particularly described in Exhibit "A", hereto attached and made a part hereof.

TO HAVE AND TO HOLD, all and singular the said premises, herein mentioned and described, unto the said Lessee, for and during the term of sixty-five (65) years, to commence from the 1st day of January, 1968, and to terminate on the 31st day of December, 2033.

RESERVING UNTO THE LESSOR THE FOLLOWING:

1. Water Rights. All surface and ground waters appurtenant to the demised premises, together with the right to enter and to capture, divert or impound water; provided, that the Lessor shall exercise such rights in such manner as not to interfere unreasonably with the Lessee's use of the demised premises; provided, further, that the Lessee shall have the right to use the waters of Lake Waiau for any purpose necessary or incidental to the use permitted by this lease on the following conditions:

a. No drilling or disturbance of Lake Waiau's bottom, banks or areas adjacent thereto shall be permitted;

b. No activity shall be permitted which will result in the pollution of the waters of Lake Waiau;

c. Lessee shall not take or divert any of the waters arising from springs which furnish the water supply for Pohakuloa, and no alterations to said springs shall be made by Lessee.

2. Access. All rights to cross the demised premises for inspection or for any government purposes.

3. Hunting and Recreation Rights. All hunting and recreation rights on the demised lands, to be implemented pursuant to rules and regulations issued by said Board in dis-

4. <u>Right to use Demised Lands</u>. The right for itsel and its successors, lessees, grantees and permittees, to use a portion of the lands demised and the right to grant to others rights and privileges affecting said land; provided, however, that, except as otherwise provided herein, no such use shall be permitted or rights and privileges granted affecting said lands, except upon mutual determination by the parties hereto that such use or grant will not unreasonably interfere with th Lessee's use of the demised premises; provided, further, that such agreement shall not be arbitrarily or capriciously withheld.

THE LESSEE, IN CONSIDERATION OF THE PREMISES, COVENANTS WITH THE LESSOR AS FOLLOWS:

1. <u>Surrender</u>. The Lessee shall, at the expiration or sooner termination of this lease, peaceably and quietly sur render and deliver possession of the demised premises to the Lessor in good order and condition, reasonable wear and tear excepted.

2. <u>Maintenance of the Premises</u>. The Lessee shall keep the demised premises and improvements in a clean, sanitar and orderly condition.

3. <u>Waste</u>. The Lessee shall not make, permit or suf fer, any waste, strip, spoil, nuisance or unlawful, improper c

Rev'd ~~during hours of darkness~~ and certain types of electric or electronic installation on the demised lands, but shall not necessarily be limited to the foregoing.

5. Assignments. The Lessee shall not sublease, subrent, assign or transfer this lease or any rights thereunder without the prior written approval of the Board of Land and Natural Resources.

6. Improvements. The Lessee shall have the right during the existence of this lease to construct and erect buildings, structures and other improvements upon the demised premises; provided, that plans for construction and plot plans of improvements shall be submitted to the Chairman of the Board of Land and Natural Resources for review and approval prior to commencement of construction. The improvements shall be and remain the property of the Lessee, and shall be removed or disposed of by the Lessee at the expiration or sooner termination of this lease; provided, that with the approval of the Chairman such improvements may be abandoned in place. The Lessee shall, during the term of this lease, properly maintain, repair and keep all improvements in good condition.

7. Termination by the Lessee. The Lessee may terminate this lease at any time by giving thirty (30) days' notice in writing to the Lessor.

8. Termination by the Lessor. In the event that (1) the Lessee fails to comply with any of the terms and conditions of this lease, or (2) the lessee abandons or fails to use the demised lands for the use specified under paragraph 4 of these covenants for a period of two years, the Lessor may terminate this lease by giving six months' notice in writing to the Lesse

9. Non-Discrimination. The Lessee covenants that th use and enjoyment of the premises shall not be in support of ar

policy which discriminates against anyone based upon race, creed, color or national origin.

10. General Liability. The Lessee shall at all time with respect to the demised premises, use due care for safety, and the Lessee shall be liable for any loss, liability, claim or demand for property damage, personal injury or death arisin out of any injury, death or damage on the demised premises caused by or resulting from any negligent activities, operati or omissions of the Lessee on or in connection with the demise premises, subject to the laws of the State of Hawaii governinc such liability.

11. Laws, Rules and Regulations, etc. The Lessee shall observe and comply with Regulation 4 of the Department of Land and Natural Resources and with all other laws, ordinances, rules and regulations of the federal, state, municipal or county governments affecting the demised lands or improvements.

12. Objects of Antiquity. The Lessee shall not appropriate, damage, remove, excavate, disfigure, deface or destroy any object of antiquity, prehistoric ruin or monument of historical value.

13. Undesirable Plants. In order to prevent the introduction of undesirable plant species in the area, the Lessee shall not plant any trees, shrubs, flowers or other

day of ______________, 1968, and the UNIVERSITY OF HAWAII, by its ______________ and ______________, has caused these presents to be duly executed this ________ day of ______________, 1968, effective as of the day and year first above written.

STATE OF HAWAII

By: ______________________
Acting Chairman and Member
Board of Land and
Natural Resources

And By: ______________________
Member
Board of Land and
Natural Resources

UNIVERSITY OF HAWAII

By: ______________________
Its Acting President

And By: ______________________
Its

APPROVED AS TO FORM:

____
Deputy Attorney General
Dated: ______________

mm
Proofed by:

EXHIBIT "A"

MAUNA KEA SCIENCE RESERVE

Kaohe, Hamakua, Island of Hawaii, Hawaii

Being a portion of the Government Land of Kaohe

Beginning at a point on the south boundary of this parcel of land, the coordinates of said point of beginning referred to Government Survey Triangulation Station "SUMMIT 1955" being 12,325.95 feet South and 471.84 feet West, as shown on Government Survey Registered Map 2789, thence running by azimuths measured clockwise from True South:-

1. Along Mauna Kea Forest Reserve, Governor's Proclamation dated June 5, 1909, on a curve to the right with a radius of 13,200.00 feet, the chord azimuth and dist being: 135° 00' 18,667. feet;

2. Thence along Mauna Kea Forest Reserve, Governor's Proclama dated June 5, 1909, still a curve to the right with radius of 13,200.00 feet, chord azimuth and distance being: 225° 00' 18,667. feet;

3. Thence along Mauna Kea Forest Reserve, Governor's Proclama dated June 5, 1909, still a curve to the right with radius of 13,200.00 feet, chord azimuth and distance

6. 27° 49' 06.5" 841.63 feet along Mauna Kea Forest Reserve, Governor's Proclamation dated June 5, 1909;

7. Thence along Mauna Kea Forest Reserve, Governor's Proclamation dated June 5, 1909, on a curve to the right with a radius of 13,200.00 feet, the chord azimuth and distance being: 306° 59' 47.4" 1824.16 feet;

8. 227° 29' 00.9" 2805.06 feet along Mauna Kea Forest Reserve, Governor's Proclamation dated June 5, 1909;

9. Thence along Mauna Kea Forest Reserve, Governor's Proclamation dated June 5, 1909, on a curve to the right with a radius of 1500.00 feet, the chord azimuth and distance being: 317° 29' 00.9" 3000.00 feet;

10. 47° 29' 00.9" 2805.06 feet along Mauna Kea Forest Reserve, Governor's Proclamation dated June 5, 1909;

11. Thence along Mauna Kea Forest Reserve, Governor's Proclamation dated June 5, 1909, on a curve to the right with a radius of 13200.00 feet, the chord azimuth and distance being: 325° 3[illegible] 55.2" 701.87 feet;

12. 245° 46' 12.7" 2760.45 feet along Mauna Kea Forest Reserve, Governor's Proclamation dated June 5, 1909;

13. Thence along Mauna Kea Forest Reserve, Governor's Proclamation dated June 5, 1909, on a curve to the right with a radius of 2000.00 feet, the chord azimuth and distance being: 335° 46' 12.7" 4000.00 feet;

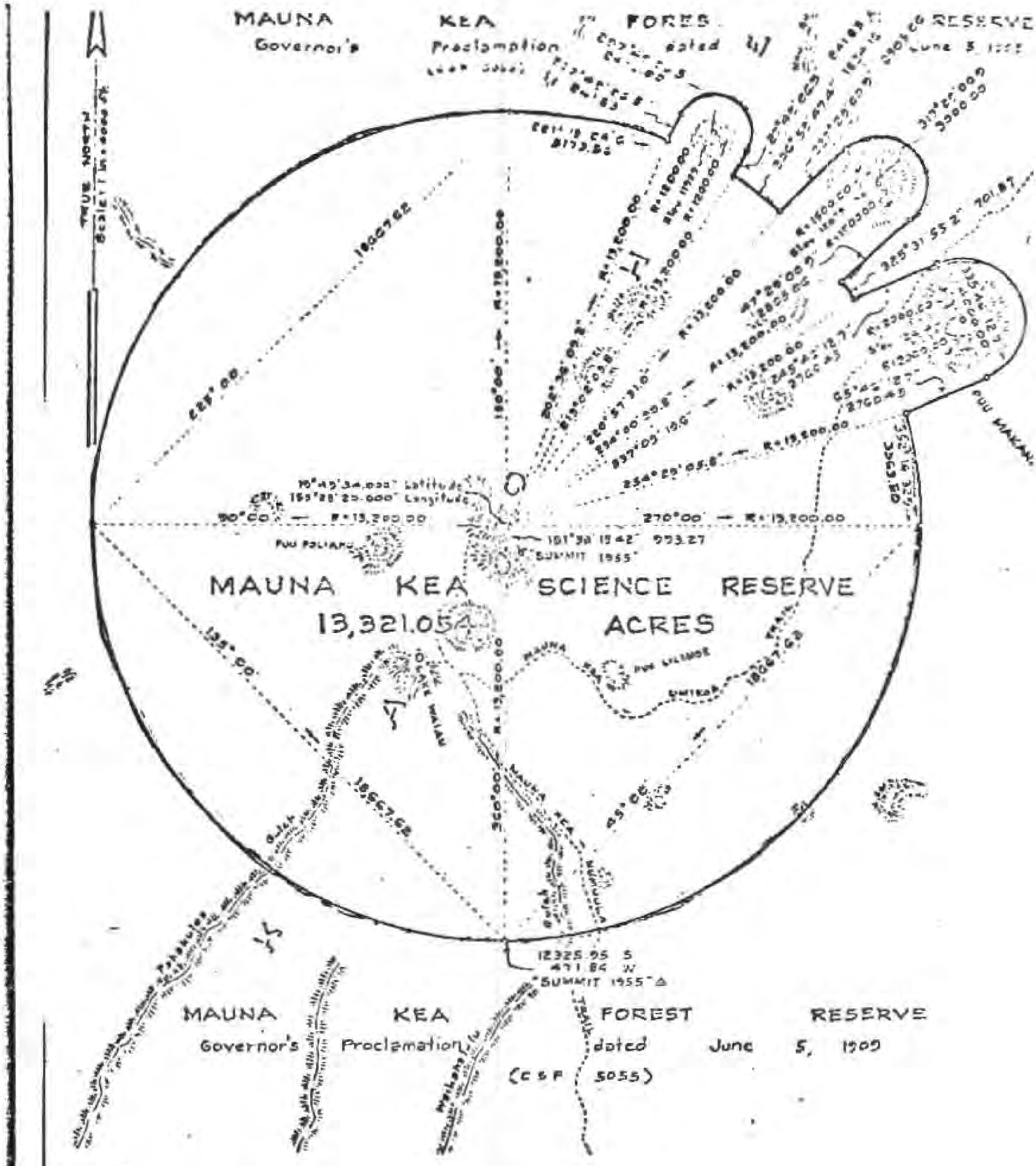
14. 65° 46' 12.7" 2760.45 feet along Mauna Kea Forest Reserve, Governor's Proclamation dated June 5, 1909;

15. Thence along Mauna Kea Forest Reserve, Governor's Proclamation dated June 5, 1909, on a curve to the right with a radius of 13,200.00 feet, the chord azimuth and distance being: 352° 14' 33.9" 3563.50 feet;

16. Thence along Mauna Kea Forest Reserve, Governor's Proclamation dated June 5, 1909, still on a curve to the right with a radius of 13,200.00 feet, the chord azimuth and distance being: 45° 00' 18,667.62 feet to the point of beginning and containing an AREA OF 13,321.054 ACRES.

EXCEPTING and RESERVING to the State of Hawaii and to all others entitled thereto, the Mauna Kea-Humuula and Mauna Kea-Umikoa Trails, and all other existing trails within the above-described parcel of land, together with rights of access over and across said trails.

ALSO, EXCEPTING and RESERVING to the State of Hawaii, its successors and assigns, the waters and all riparian and other rights in and to all the streams within the above-described parcel of land.



MAUNA KEA SCIENCE RESERVE

Kaohe, Hamakua, Island of Hawaii, Hawaii

Scale: 1 inch = 4000 feet

JOB 4-3878

C. BK. (Hwi. Hawaii Folder)

TAX MAP 4-4-15

SURVEY DIVISION
DEPARTMENT OF ACCOUNTING AND GENERAL SERVICES
STATE OF HAWAII

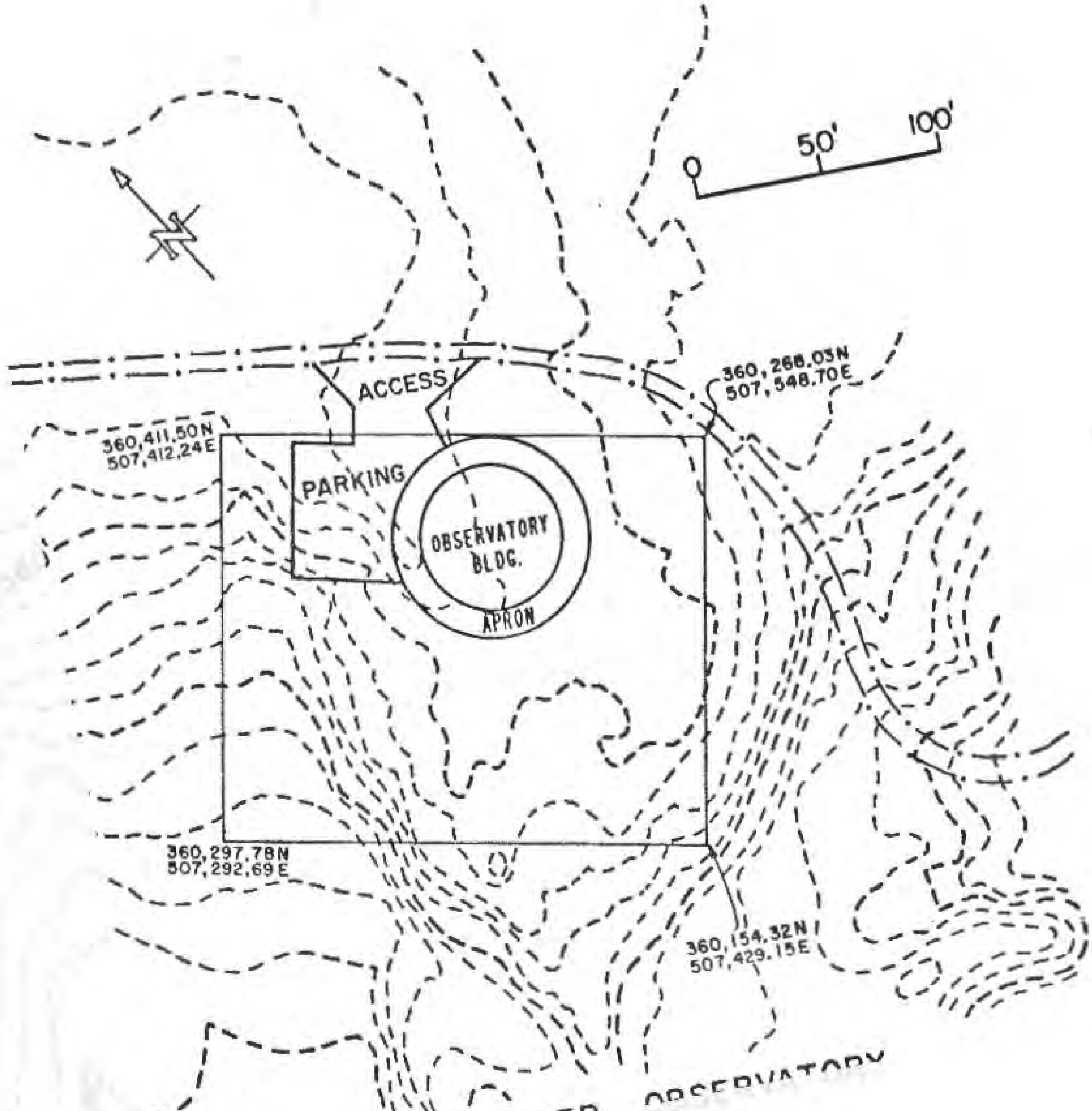
CALIFORNIA INSTITUTE OF TECHNOLOGY

Attachment A, Exhibit B

Caltech Telescope Site

EXHIBIT B

CALTECH TELESCOPE SITE



L TECH SUBMILLIMETER OBSERVATORY

CALIFORNIA INSTITUTE OF TECHNOLOGY

Attachment A, Exhibit C

Description of the Construction

of the Caltech Telescope

EXHIBIT C

DESCRIPTION OF THE CONSTRUCTION

OF THE CALTECH TELESCOPE

EXHIBIT C

Description of the Caltech Submillimeter Telescope Facility

BACKGROUND

The California Institute of Technology plans to construct a submillimeter wave telescope for astronomical research, on a site at about 13,360 feet altitude in the Science Reserve on Mauna Kea. The telescope will be used by astronomers from Caltech and the University of Hawaii in accordance with the provisions of an operating and site development agreement.

The major components of the construction are a 10.4-meter diameter parabolic dish, supported by an azimuth-elevation mount on a concrete foundation. The telescope is protected by a 60-foot-diameter astronomical dome with shutter doors which open for observations. The dome, which rotates to follow the azimuth of the telescope, is supported by a concrete foundation.

SITE WORK

In the vicinity of the telescope and dome the site will be leveled at an alti-

TELESCOPE

The primary reflector is made from hexagonal sections of aluminum honeycomb material, surfaced with aluminum sheeting which is accurately polished. It is backed by a tubular steel structure which maintains it in a parabolic shape. The mount for the reflector is a steel structure with azimuth and elevation bearings which permit all sky coverage. A secondary reflector, supported by four feed legs, directs the submillimeter radiation from the primary to the detection system at the secondary focus.

DOME

The dome is a steel structure, of approximately hemispherical shape, 60 feet across and 52 feet high. It is surfaced with aluminum sheet. The aperture through which the telescope observes the sky is a slit in the top and front of the dome about 11 meters in width, covered by two rolling shutter doors. The whole dome structure rotates in azimuth on a rail, so that the slit can follow the pointing of the telescope. Internally the dome consists of an internal space, which is occupied by the telescope, and a personnel work space on the first and second floors in which the telescope control, data collection, instrument preparation, maintenance and personnel needs are accomodated.

Attachment B

Operating and Site Development Agreement

between the California Institute of Technology

and the

University of Hawaii

Concerning the

Construction and Operation

of the

Caltech Submillimeter Telescope Facility

on

Mauna Kea, Hawaii

1983-12-20

Final version – signed

T.G.P.

OPERATING AND SITE DEVELOPMENT AGREEMENT

BETWEEN THE

CALIFORNIA INSTITUTE OF TECHNOLOGY

AND THE

UNIVERSITY OF HAWAII

CONCERNING THE

CONSTRUCTION AND OPERATION

OF THE

CALTECH SUBMILLIMETER TELESCOPE FACILITY

ON

MAUNA KEA, HAWAII

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THIS AGREEMENT, made this 20 day of December, 1983, by and between the California Institute of Technology, hereinafter Caltech, and the University of Hawaii, hereinafter UH;

WITNESSETH:

WHEREAS, the far-infrared and millimeter regions of the electromagnetic spectrum have shown great scientific potential for contributing to our understanding of the astronomical universe;

WHEREAS, the summit area of Mauna Kea is exceptionally well-endowed as a site for observations in these wavelengths;

WHEREAS, Caltech has correspondingly initiated a program to construct a 10.4-meter-aperture telescope dedicated to observations at these wavelengths and is desirous of locating the Telescope on Mauna Kea;

WHEREAS, Caltech and UH believe that the best interests of both parties are to be served through a program of close scientific cooperation centered around the Telescope; and

WHEREAS the academic program of UH will benefit significantly from the establishment in Hawaii of a major facility dedicated to far-infrared and millimeter-wave astronomy;

WHEREAS, Caltech and UH have executed a Memorandum of Understanding on October 29, 1981 to proceed with the arrangements necessary for Caltech to construct and operate the Telescope on land leased by UH on Mauna Kea;

NOW, THEREFORE, in consideration of the mutual accommodations and agreements herein contained, the parties hereto agree as follows:

I DEFINITIONS:

"Associated Installations" include all other facilities associated with the Telescope on the subleased property, such as electrical and telephone conductors, cableways and tunnels, driveways and parking lots, and access roads from the border of the subleased property.

"Mauna Kea Science Reserve" (Science Reserve) is that area on the summit of Mauna Kea consisting generally of the area higher than 12,000 feet above sea level and specifically of that area leased by UH from the State of Hawaii, Board of Land and Natural Resources, under General Lease S-4191.

II. LOCATION OF FACILITIES:

Sublease No. H09176, attached hereto as Attachment A and specifically incorporated herein by reference, specifies the proposed location on Mauna Kea of the Telescope.

III. PARTIES TO THE AGREEMENT:

A. Principal Parties:

1. California Institute of Technology

The California Institute of Technology (Caltech), incorporated in 1891 under the laws of the State of California, is a privately endowed nonprofit educational institution of university rank devoted to undergraduate and graduate instruction and research in science, engineering and the humanities and social sciences. The governing body of Caltech is a Board of Trustees, which has the ultimate responsibility for the conduct of Caltech's affairs.

2. University of Hawaii

The University of Hawaii (UH) is the public university of the State of Hawaii. The University system comprises the Manoa, for representing the interests of UH on UH-owned or UH-leased land on Haleakala and Mauna Kea.

2. Division of Physics, Math and Astronomy

The Division of Physics, Math and Astronomy (PMA) is the research organization within Caltech which has responsibility for the conduct of astronomy research programs.

C. Interaction Between Parties:

While this Agreement is between Caltech and UH, the functional interaction between these parties will usually be carried out for UH by the IFA and for Caltech by the PMA.

IV. RESPONSIBILITIES:

A. Caltech:

1. Design and Construction of Facilities

Caltech shall be solely responsible for the design, fabrication and installation of the Facilities on Mauna Kea. Caltech shall obtain such funds for design and construction and associated work connected with the Facilities as shall be needed. Caltech shall conform to uniform regulations established by UH, by the State of Hawaii, and by the United States of America for the preservation of the environmental quality and the scientific integrity of the summit area.

2. Operation and Maintenance of the Facilities

Funds for operating and maintaining the Facilities shall be obtained by Caltech.

3. Permanent Mid-Level Facilities

If Caltech elects to participate in the expansion of the permanent Mid-Level Facilities at Hale Pohaku, this participation will be governed by the terms of a separate Agreement to be negotiated between Caltech and UH. In order to facilitate the planning effort if Caltech makes such election, Caltech agrees to negotiate this separate agreement in conjunction with at least one other major astronomy-related future project on Mauna Kea at the first opportunity presented for such expansion (see also IV.B.3.).

4. Base Support Facilities

If Caltech elects to participate in construction of base support facilities in Hilo on the Big Island (Island of Hawaii), it will give first consideration to doing so on land provided by UH in Hilo, and in cooperation with users of other telescope facilities on Mauna Kea. If Caltech elects to rent base support accommodation in Hilo, it will give first consideration to any accommodation available on the UH Hilo campus (see also VI.C.2.).

5. Installation of Individually Metered Electrical Service Connection and Telephone Lines

Caltech will be responsible for the installation and maintenance of power and telephone lines from central terminals to the subleased property. Caltech may coordinate and fund this effort in conjunction with other users of those same lines.

6. Research Environment

Recognizing that Caltech is part of a community of research organizations using the Science Reserve, Caltech shall ensure that its activities are compatible with activities of other telescope facilities located there.

B. UH:

1. Sublease

Subject to the approval of the Board of Land and Natural Resources, UH shall execute a Sublease with Caltech to cover the land and necessary easements for the construction and operation of the Telescope.

2. Access

UH shall ensure right-of-access to Caltech to the

3. Permanent Mid-Level Facilities

Until such time as an opportunity to participate in the construction or permanent use of additional space at the permanent Mid-Level Facilities at Hale Pohaku is presented, UH will rent to Caltech space in the form of four bedrooms from its share of the Mid-Level Facilities. This provision will apply for no more than five (5) years from the execution of this Agreement, unless both parties elect to extend or renegotiate this provision. If Caltech elects to participate in the permanent Mid-Level Facilities, UH shall negotiate a separate Agreement with Caltech detailing the conditions of that participation.

4. Management

UH shall provide a forum to allow Caltech and other astronomy-related organizations using the Science Reserve to discuss, on an equal footing, aspects of the management of the Science Reserve. However, since UH is the primary lessee with the State of Hawaii, it is recognized that the final responsibility for management of the Science Reserve resides with UH.

5. Mauna Kea Support Services

a. UH shall provide services on a basis of no profit, no loss, to all the astronomical facilities in the Science Reserve through Mauna Kea Support Services (MKSS). Such services shall include, but shall not be limited to, food and lodging, transportation and library services, road maintenance, snow removal, utilities, access control and public information services, and general administration. Caltech shall reimburse UH for such services provided for its benefit; reimbursement is referred to here as a User's fee and shall be made on the basis of invoices distributed periodically by MKSS.

b. Annually UH shall provide Caltech with a statement setting forth UH's cost of the services described in the immedithe denominator of which is the number of subleases, including the Caltech Sublease, which have been executed for land within the Science Reserve for separately identified telescope facilities. If the number of such subleases in the Science Reserve changed during the year for which the statement is rendered, the allocation of costs shall be prorated appropriately. In the event that services are provided for the benefit of a subgroup of all such facilities, the terms of reimbursement will be negotiated prior to the initiation of this service.

c. Caltech shall be represented on the MKSS Oversight Committee which reviews existing activities and recommends changes to the activities of the MKSS.

6. Research Environment

Recognizing that Caltech is part of a community of research organizations using the Science Reserve, UH shall ensure that activities in the Science Reserve are compatible with the research or potential research related to the Telescope. UH shall determine which activities are compatible with such research in consultation with all astronomy-related organizations using the Science Reserve.

7. Electrical Power and Roads

UH plans to construct an electric power line in the Mauna Kea summit area and to grant to the Telescope access to this power to a peak capacity of 150 kW. The location of the handhole where connection may be made will be within approximately 2000 feet of the subleased property.

Pending the installation of permanent power, Caltech will be entitled to connect to an existing 850-kW generator and to draw a peak load of 60 kW, conditional on payment to UH of the sum of $19,907.12, this being its share of the capital cost of the generator. The costs of connection from the Telescope to the terminal, and of electric power, are to be paid by Caltech.

the summit to Hale Pohaku, but, in any case, including the spur road from the Telescope to the main access road. Both of these improvements (hereinafter Infrastructure Improvements) are subject to State and County permits and approvals, and to appropriate amendment of the 1977 DLNR Mauna Kea Plan, and to the UH's obtaining the agreements of the existing and future users to paying a negotiated share of the costs. The power line shall provide Caltech with at least 150 kW of electrical power at a handhole described in IV.B.7. Funds available to UH for Infrastructure Improvements shall be used in order of priority as follows: First, for the construction of said power line; and second, for the improving and paving, in whole or in part, of said road (including safety devices), including the spur road from the Telescope to the main access road, beginning at the boundary of the subleased properties of all facilities existing, under construction, or which are the subject of a completed Operating and Site Development Agreement.

C. Responsibilities Shared by Caltech and UH

1. Operating and Maintenance Costs:

a. Caltech shall be responsible for payment of an annual User's fee as prescribed in IV.B.5.

b. Caltech shall be responsible for operation and maintenance costs of the permanent power line from the handhole described in IV.B.7. to the Caltech Telescope, together with any other parties who may share the line.

2. Infrastructure Improvements:

a. In recognition of benefits to Caltech accruing from the Infrastructure Improvements referenced in IV.B.8, Caltech agrees to pay additions to its annual User's fee. Any such additions to the User's fee are to commence at the time that the contract for the improvement construction is let. The basis for determining the additions to the User's fee are set out below.

b. It is the intention of UH to spend a total of $7 million on Infrastructure Improvements. Approximately $5 million will be set aside for the power line, and any funds remaining will be given to improving the safety features of the road and to paving, beginning at the boundary of the subleased properties of all facilities existing, under construction, or which are the subject of a completed Operating and Site Development Agreement SIX (6) months before the contract for road improvement and paving is let. UH intends to fund the infrastructure improvements on behalf of existing and future non-UH Users with revenue bonds.

c. UH has developed a scheme for assessing the additional User fees which each telescope sponsor at Mauna Kea should pay for the availability and use of a permanent power line and an improved road. Consistent with this, Caltech will undertake to pay over a period of FIVE (5) years, an additional annual User's fee for use of the permanent power line and the road improvements. The added User's fee will be set at a sum sufficient to compensate UH for providing a fraction (0.06840) of the total cost that UH has assumed on behalf of Caltech. If the rate on the loan taken out by UH to finance the power line and road improvements exceeds 12% per annum, this User's fee will be subject to approval by Caltech. In return for payment of the additional annual User's fee discussed above, Caltech will be entitled to the use of the power line and road throughout the tenure of the Sublease.

d. If the capital amounts spent by UH on either the road or power line are less than stated in IV.C.1.b. above, the additional User's fees charged to Caltech shall be proportionately reduced. If it appears that UH will be unable to complete the Infrastructure Improvements for $7 million, UH shall so notify Caltech. Caltech shall thereupon consider in good faith its ability to pay additional User's fees to help defray the additional cost.

e. If UH receives funds from future users buying into the infrastructure, or from the power company for repayment of the construction advance, these amounts will be used to (1) retire the Revenue bond portion of the University's investment in the infrastructure which will have been made for the benefit of future users, and (2) defray the common costs of supporting astronomy-related activities on the mountaintop.

f. If for any reason this Agreement is terminated after Caltech has obtained the funds necessary to construct and install the Facilities, and before the additional User's fees have been paid for the number of years indicated in IV.C.1.c. above, then Caltech shall be obligated to continue to pay the addition-operation of the facilities in the Science Reserve, they shall negotiate in good faith to determine Caltech's fair share of the cost of such improvements.

VI. SCIENTIFIC COOPERATION:

In recognition of the potential for scientific interaction between Caltech and UH which the Telescope offers, and of the contribution of UH in making the site available to Caltech, Caltech and UH agree on the following matters with regard to the operational phase of the Telescope.

A. UH Access to the Telescope

Scientists sponsored by UH will compete on an equal footing with Caltech colleagues for observing time on the Telescope up to a maximum allocation of 10 percent of the total time scheduled for observing. UH anticipates that the growth in its new program in the area will result in observing proposals of sufficient merit to match this allocation. UH shall receive technical support whilst at the Telescope and access to the Telescope and its instrumentation on the same basis as Caltech scientists.

B. Participation in Caltech Committee Structure

In order to encourage productive interaction between UH and Caltech, UH shall be represented by one voting member on the Caltech Submillimeter Observatory Advisory Committee (CSOAC).

In order to facilitate UH/Caltech interaction during the design and construction phases at both the engineering and scientific levels, the UH member shall be represented on the CSOAC as soon as possible after the signing of this Agreement. The UH member shall be appointed by the Director of the IFA upon consultation with the Chairman of the CSOAC.

A Time Allocation Committee (TAC) shall be formed by the CSOAC and shall include a voting member of UH.

C. Interaction with UH Academic Program

It is the expressed policy of UH, and consistent with past practice, that new astronomical facilities in the Science Reserve should provide some specific benefit to the academic program of UH. UH wishes to implement this policy in such a manner as to bring a parallel benefit to the sponsoring institutions. To this end, UH is seeking specific interaction with Caltech staff, both at its UH Manoa headquarters and at its Hilo campus. Details of this interaction are set out below.

1. Joint Scientific Programs

Caltech and UH intend to encourage interaction among their staff members and graduate students, in submillimeter astronomy. This would be expected to include some joint scientific investigations, development of some communal instrumentation and visits of UH staff to Pasadena and vice versa. To further such collaboration and to insure the full advantage to UH of the presence of the Telescope in Hawaii, UH expects to appoint a faculty member in the field of submillimeter-wave astronomy. That person would be eligible for a Caltech visiting appointment, subject to the usual Caltech regulations.

Collaborative proposals between Caltech and UH faculty would be encouraged. Such proposals from Caltech to funding agencies could contain requests for salary funds for the UH faculty member.

2. UH Hilo

Caltech expects to place its base support facility in Hilo, on UH property (see IV.A.4.) and under conditions which will be negotiated at the time that Caltech wishes to proceed. It is specifically envisaged that Caltech staff members based in Hilo, or visiting for an extended period, will interact academically and professionally with UH Hilo staff and students.

VII. GENERAL LIABILITY

Caltech will indemnify, defend and hold harmless UH, its officers, agents, employees or any person acting on its behalf from and against any claim or demand for loss, liability or damages (including, but not limited to, claims for property damage, personal injury or death, based upon any accident, fire, or other incident on the demised premises and roadways adjacent thereto) which arises from any act or omission of Caltech, its officers, agents, employees, or invitees, or occasioned by any failure on the part of Caltech to maintain the [illegible]

VIII. TERMINATION

This Agreement shall be dissolved upon any of the following events:

1. Termination of Sublease No. H09176 between Caltech and UH. One or both of the parties may wish to extend, renew, or renegotiate the Sublease prior to its termination and, if so, the parties will give consideration to a simultaneous extension, renewal, or renegotiation of this Agreement.

2. Failure of Caltech to obtain, by December 31, 1985, the funds necessary to construct and install the Facilities.

3. Failure of Caltech to observe or comply with any of the terms and conditions herein within THIRTY (30) days after being notified in writing by UH of such failure. In the event that more than THIRTY (30) days are reasonably required to observe or perform, Caltech shall in good faith, and within said THIRTY (30) days, initiate action and provide a plan for observance or performance, and shall diligently prosecute the same to completion.

4. Expiration of General Lease No. S-4191 on 31 December 2033, unless said Lease is renewed, extended, or renegotiated.

5. Mutual agreement in writing between Caltech and UH.

Disposition of property and improvements shall be conducted under the provisions of Sublease No. H09176 referenced above.

IN WITNESS WHEREOF, the parties hereto have executed these presents on the day and year first above written.

FOR THE UNIVERSITY OF HAWAII:

by ____________________ OCT 24 1983
Fujio Matsuda — Date
President

by ____________________ OCT 24 1983
Its — Date

APPROVED AS TO FORM:

____________________ 8/8/83
Its Deputy Attorney General — Date

FOR THE CALIFORNIA INSTITUTE OF TECHNOLOGY:

by Marvin L. Goldberger 11/15/83
Marvin L. Goldberger — Date
President

by ____________________ 11/15/83
[illegible] — Date
Vice-President for
Business and Finance

CALIFORNIA INSTITUTE OF TECHNOLOGY

Attachment C

Conservation District Use Permit

HA-1492

approved 1982-12-17

Caltech CSO Permit
1524

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

RECEIVED
JAN 12
Vice Pre
Admin

RECEIVED
JAN 13 1983
DIRECTOR
INSTITUTE FOR ASTRONOMY

SUSUMU ONO, CHAIRMAN
BOARD OF LAND & NATURAL RESOURCES

EDGAR A. HAMASU
DEPUTY TO THE CHAIRMAN

DIVISIONS:
AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

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

JAN 11 1983

REF. NO.: CPO-1096
FILE NO.: HA-7/22/82-1492
180-DAY EXP. DATE: 1/20/83

Mr. Harold S. Masumoto
Vice-President for Administration
University of Hawaii
2444 Dole Street, Room 202
Honolulu, Hawaii 96822

1/12/83 - Xcs to J. Jefferies/G. Pilcher
Mae Nishioka

Dear Mr. Masumoto:

We are pleased to inform you that your Conservation District Use Application for construction of the California Institute of Technology 10-meter telescope for millimeter and submillimeter astronomy at Mauna Kea, with right-of-entry, at Hamakua, Hawaii, was approved on December 17, 1982. Subject to the following recommendations and conditions:

A. Approval of the application subject to the following conditions:

1. That the applicant comply with all applicable statutes, ordinances, rules and regulations of the Federal, State and City and County governments, and applicable parts of Section 13-2-21 of Title 13, Chapter 2, Administrative Rules, as amended;

2. Other terms and conditions as prescribed by the Chairman;

3. In that this approval is for use of conservation lands only, the applicant shall obtain appropriate authorization through the Division of Land Management, State Department of Land and Natural Resources for the occupancy of State lands;

4. In the event any unanticipated sites or remains such as shell, bone or charcoal deposits, human burials, rock or coral alignments, pavings, or walls are encountered during construction, the applicant shall stop work and contact the Historic Preservation Office at 548-7460 or 548-6408;

5. That the applicant comply with all applicable Public Health Regulations;

6. A fire contingency plan, acceptable to the Division of Forestry and Wildlife shall be implemented during and after the construction of the structure.

B. That this approval is not to be considered as precedence for any future action the Board may desire to exercise through their discretionary conditional land use action.

C. That no further commitment of land use involving major improvements within the Mauna Kea Science Reserve be considered until such time as the University's Mauna Kea Science Reserve Development Plan is completed.

Should you have any questions on any of these conditions, please feel free to contact Mr. Roger C. Evans of our Planning Office at 548-7837.

Very truly yours,

Susumu Ono

SUSUMU ONO, Chairman
Board of Land and Natural Resources

cc: Hawaii Board Member
Hawaii Land Agent
Hawaii Planning Dept.
DOH/OEQC/EQC/OHA/DPED

Jefferies / Plasch

UNIVERSITY OF HAWAII

Vice-President for Administration

June 10, 1982

RECEIVED
JUN 16 1982
DIRECTOR
INSTITUTE FOR ASTRONOMY

Mr. Susumu Ono, Chairman
Board of Land and Natural Resources
Department of Land and Natural Resources
State of Hawaii
State Office Building
Honolulu, Hawaii 96813

Dear Mr. Ono:

SUBJECT: CDUA for the Subdivision and Construction of California Institute of Technology 10-Meter Telescope for Millimeter and Submillimeter Astronomy at Mauna Kea
Hamakua District, County of Hawaii
Tax Map Key: 4-4-15:9 (Por.)

The University of Hawaii as lessee of the Mauna Kea Science Reserve, requests the approval by the Board of Land and Natural Resources of the attached Conservation District Use Application for a .75 acre site and construction and operation of a 10.4 meter telescope for millimeter and submillimeter astronomy by the California Institute of Technology. A right-of-entry permit is also requested for the inspection and survey of the site for the preparation of the metes and bounds description and map.

The enclosed CDUA submittal requires your signature, as representative of the landowner, for its completion. The California Institute of Technology would like to begin site preparation work by May 1983.

The draft EIS for this facility was filed on May 23, 1982. A copy of this document is attached to the CDUA.

A filing fee of fifty ($50.00) is enclosed. Copies of the construction plans will be submitted to your office for review and approval at a later date.

Mr. Susumu Ono
Page Two
June 10, 1982

Please feel free to communicate with me if there are any questions. For more specific information on the project, please contact Mr. Walter Muraoka of the Facilities Planning Office at 948-8216.

Sincerely yours,

Harold S. Masumoto

Harold S. Masumoto
Vice President for Administration

Enclosures
cc Group 70
Dr. T. G. Phillips, CIT
Dr. John Jefferies/G. Plasch
Mrs. Mae Nishioka/W. Muraoka

LNR-PU
EV. 1981

FOR DLNR USE ONLY

Reviewed by ______
Date ______
Accepted by ______
Date ______
File No. ______
EIS Required ______
PH Required ______

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

CONSERVATION DISTRICT USE APPLICATION

(Print or Type)

I. LANDOWNER (If State land, to be filled in by Gov't. Agency in control of property).

Name Dept. of Land and Natural Resources

Address P.O. Box 621
Honolulu, Hi 96809

Telephone No. 548-6550

SIGNATURE ______

II. APPLICANT (Omit if applicant is landowner).

Name University of Hawaii

Address 2444 Dole Street
Honolulu, Hi 96822

Telephone No. 948-7069

Interest in Property G.L.No. S-4191
(Indicate interest in property; submit written evidence of this interest).

SIGNATURE Harold S. Masumoto

III. USE REQUESTED -- DESCRIPTION OF AREA

District Hamakua

Island Hawaii

County Hawaii

Tax Map Key 4-4-15:09(Por.)

Area of Parcel .75 acre
(Indicate in acres or sq. ft.).

Area of Proposed Use 8,850 sq. ft.
(Indicate in acres or sq. ft.).

Name & Distance of Nearest Town or Landmark Hilo 42 miles

Boundary Interpretation (If the area is within 40 feet of the boundary of the Conservation District, include map showing interpretation of the boundary by the the State Land Use Commission).

Conservation District District Subzone Resource

County General Plan Designation Conservation

IV. TYPE OF USE REQUESTED (Mark where appropriate).

1. Permitted Use (exception occasional use): DLNR Chapter 2, Section 13-2 ; Subzone 13 .
2. Accessory Use (accessory to a permitted use): DLNR Chapter 2, Section ____; Subzone ____.
3. Occasional Use: Subzone ____.
4. Temporary Variance: Subzone ____.
5. Conditional Use: Subzone ____.

V. FILING FEE

1. Enclose $50.00. All fees shall be in the form of cash, certified or cashiers check, and payable to the State of Hawaii.
2. If use is commercial, as defined, submit additional public hearing fee of $50.00.

NOTE: Use additional sheets, as necessary, to provide the requied information listed on pages 2 and 3.

INFORMATION REQUIRED FOR ALL USES

I. Description of Parcel

A. Existing structures/Use. (Attach description or map).

B. Existing utilities. (If available, indicate size and location on map. Include electricity, water, telephone, drainage, and sewerage).

C. Existing access. (Provide map showing roadways, trails, if any. Give street name. Indicate width, type of paving and ownership).

D. Vegetation. (Describe or provide map showi g location and types of vegetation. Indicate if rare native plants are present).

E. Topography; if ocean area, give depths. (Submit contour maps for ocean areas and areas where slopes are 40% or more. Contour maps will also be required for uses involving tall structures, gravity flow and other special cases).

F. If shoreline area, describe shoreline. (Indicate if shoreline is sandy, muddy, rocky, etc. Indicate cliffs, reefs, or other features such as access to shoreline).

G. Existing covenants, easements, restrictions. (If State lands, indicate present encumbrances).

H. Historic sites affected. (If applicable, attach map and descriptions).

II. Description: Describe the activity proposed, its purpose and all operations to be conducted.

I. Commencement Date: May 1983

Completion Date: May 19X6

V. Environmental Requirements

Pursuant to Chapter 343, Hawaii Revised Statutes, and in accordance with Section 1:30b of the EIS Regulations for applicant actions, an Environmental Assessment of the proposed use must be attached. The Environmental Assessment shall include, but not be limited to the following:

A. Identification of application;

B. Description of proposed use and statement of objectives;

C. Description of affected environment, including appropriate maps and plans to show location, topography, site improvements, existing utilities and vegetation and archaeological/historical sites, if any. (See Page 3, Section I).

D. General description of the technical, economic, social and environmental characteristics of the proposed use.

: The Environmental Assessment may be submitted in lieu of the information required above.

INFORMATION REQUIRED FOR CONDITIONAL USE ONLY

I. Plans: (All plans should include north arrow and graphic scale).

A. Area Plan: Area plan should include but not be limited to relationship of proposed uses to existing and future uses in abutting parcels; identification of major existing facilities; names and addresses of adjacent property owners.

B. Site Plan: Site plan (maps) should include, but not be limited to, dimensions and shape of lot; metes and bounds, including easements and their use; existing features, including vegetation, water area, roads, and utilities.

C. Construction Plan: Construction plans should include, but not be limited to, existing and proposed changes in contours; all buildings and structures with indicated use and critical dimensions (including floor plans); open space and recreation areas; landscaping, including buffers; roadways, including widths; offstreet parking area; existing and proposed drainage; proposed utilities and other improvements; revegetation plans; drainage plans including erosion sedimentation controls; and grading, trenching, filling, dredging or soil disposal plans.

D. Maintenance Plans: For all uses involving power transmission, fuel lines, drainage systems, unmanned communication facilities and roadways not maintained by a public agency, plans for maintenance shall be included.

E. Management Plans: For any appropriative use of animal, plant, or mineral resources, management plans are required.

F. Historic or Archaeological Site Plan: Where there exists historic or archaeological sites on the State or Federal Register, a plan must be submitted including a survey of the site(s); significant features; protection, salvage, or restoration plans.

II. Subzone Objective: Demonstrate that the intended use is consistent with the objective of the subject Conservation District subzone (as stated in Chapter 2).

I. Description of Parcel

A. Existing Structures/Use

Figure 1 illustrates the location of the proposed site at approximately the 13,360 foot elevation within the Mauna Kea Science Reserve. The .75 acre site, which is at the foot of Puu Poliahu, is empty and undeveloped.

The site is located in the Resource subzone. The objective of this subzone is to develop, with proper management, areas to ensure sustained use of the natural resources of those areas. The Mauna Kea Science Reserve, within which the proposed use will be located, was established as a "scientific complex, including without limitation thereof an observatory" in recognition of its outstanding astronomical attributes.

The proposed Caltech telescope will, in adding to the research capabilities of the Mauna Kea Observatory, fulfill the goals of the Resource subzone by utilizing the excellent astronomical resources that Mauna Kea possesses. These resources and their importance to submillimeter research are discussed on pages 18 through 21 and pages 28 and 29 in the attached draft EIS.

B. Existing Utilities

No utilities directly serve the site. The generator used for power needs at the summit is approximately 1300 ft. south of Caltech's proposed site. Two 12 KV underground power lines run from the generator to the summit cinder cone. The power is distributed through underground conduits to the existing facilities. The microwave antenna which provides telephone communication to the summit is located on the UH 88-inch telescope facility. Water must be trucked to the summit from Hilo. Each telescope has its own water storage tank. Each of the four large existing telescopes has its own septic tank. Solid waste is carried down to Hale Pohaku by telescope personnel. A more detailed description of the existing utilities can be found on page 51 of the attached draft EIS.

C. Existing Access

Access to the summit of Mauna Kea is from Saddle Road, Route 20, which connects Hilo to Mamalahoa Highway, Route 19. From Saddle Road at Puu Huluhulu, a paved road extends approximately six miles to Hale Pohaku. From there, an 8.5 mile unpaved one-lane road extends to the summit. Figure 1 shows the roads within the Science Reserve. Caltech's proposed site is adjacent to an unpaved road.

D. Vegetation

There are no officially designated endangered plant species on the summit. Photographs of the proposed site indicate that the area is a likely site for lichens and bryophytes, the principal components of flora at the summit. The project site is not suitable for higher plant life such as ferns or seed bearing plants. The attached draft EIS describes some potential impacts of locating a telescope on the site and prposes some measures to mitigate them.

E. Topography

The topography of the site is relatively flat. Figure 2.

F. If shoreline area - N/A

G. Existing covenants, easements, restriction

See attached Lease S-4191.

H. Historic sites affected

Dr. Patrick McCoy, Bishop Museum anthropologist, has been retained by Caltech to conduct a reconnaissance survey of the site.

Because of the snow pack, which to date still covers the site, he has been unable to complete his field research. A survey will be completed prior to approval of the CDUA. Dr. McCoy is fairly certain that there are no archaeological sites at Caltech's site. (Appendix E, attached draft EIS)

II. Description

Operations to be conducted:

Construction: Although the .75 acre site selected for this telescope is essentially level, some grading and excavating will be necessary to prepare the area for construction. A minimal foundation will be required, since the telescope and dome are relatively light (total building and telescope weight will be less than 250 tons).

Approximately 100 cubic yards will have to be excavated for concrete footing, foundations, an 850 gallon septic tank, housing for the 25 KW standby generator and 1,000 gallon fuel tank, and a 1,000 - 1,500 gallon water tank. Most of the excavated material will be used as fill or for balancing the site. Additional excavation will be done for installation of the telephone and power lines. The existing utility trench and 1,300 linear feet of a new trench from the generator to the Caltech site will have to be excavated for telephone and power lines.

One hundred fifty yards of concrete will be used in the construction of the facility. No concrete batch plant will be required. Dry mix concrete will be trucked to the summit in mixing trucks and water will be added at the site. Approximately thirty truck loads will be required.

Construction equipment, vehicles, and materials, a temporary construction field office and an auxiliary generator will be stored on-site during construction and will be removed upon completion of the construction phase. Outdoor sanitary facilities will be used during the construction phase. Power will be provided by the on-site auxiliary generator.

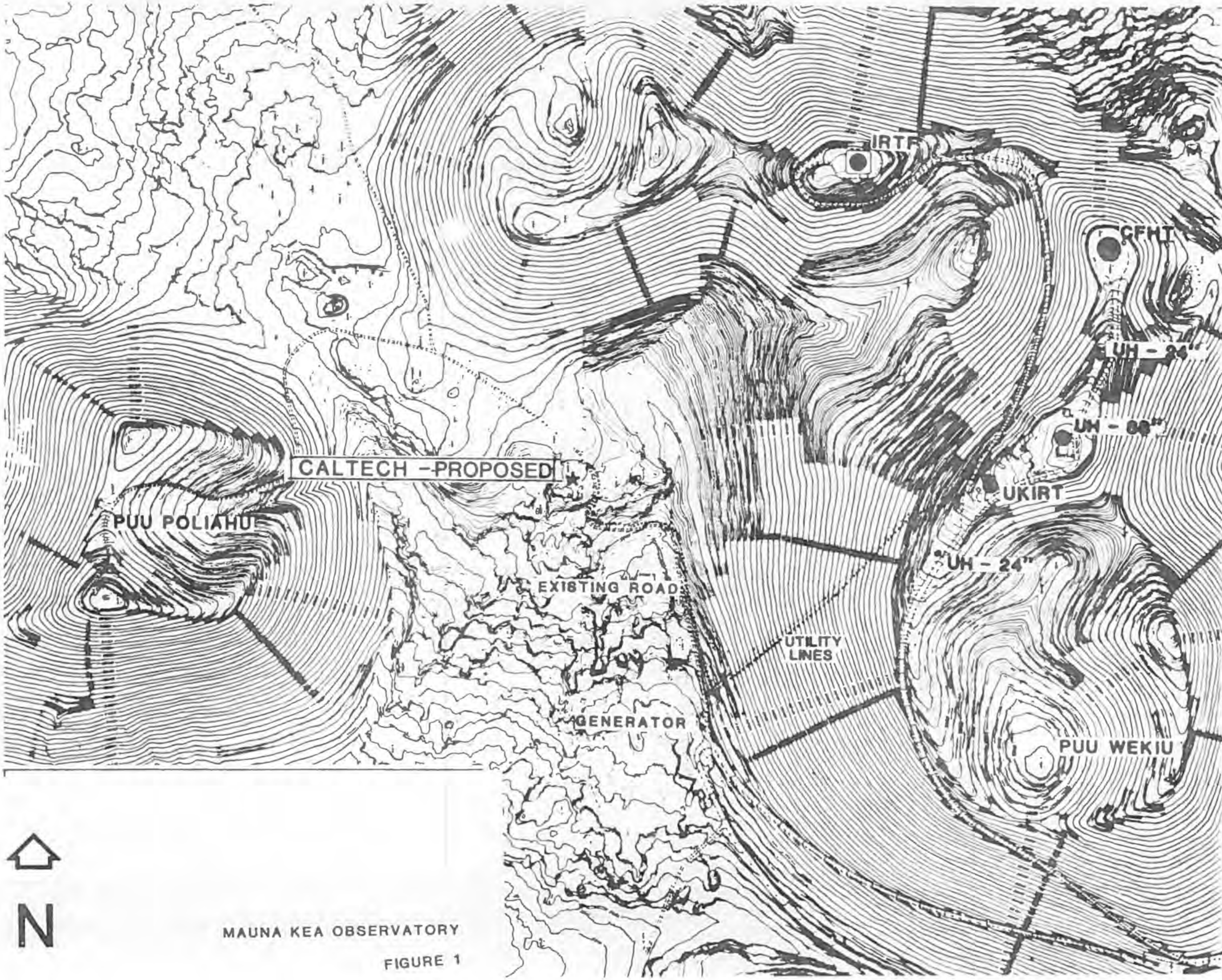
Operations: It is estimated that when the telescope becomes operational an average of five to seven persons will be present on the mountain at one time, operating in two shifts per day at the telescope site. The additional personnel are expected to generate an additional 1,100 - 1,500 gallons per month of liquid sewage, the consumption of 1,500 - 2,000 gallons per month of water for heating, cooling and domestic consumption, and the additional consumption of less than four gallons per hour of diesel fuel by the 850 KW generator.

The proposed telescope will be able to investigate the submillimeter portion of the electromagnetic spectrum. The development of an instrument capable of studying the submillimeter band has opened a whole new field of inquiry for astronomers. The telescope provides a new way to investigate the astronomical environment in regions inaccessible to optical methods. The attached draft EIS describes the scientific capabilities of the proposed telescope more fully.

III. Commencement Date: May 1983
Completion Date: May 1986

IV. Environmental Requirements

EIS attached



MAUNA KEA OBSERVATORY

FIGURE 1

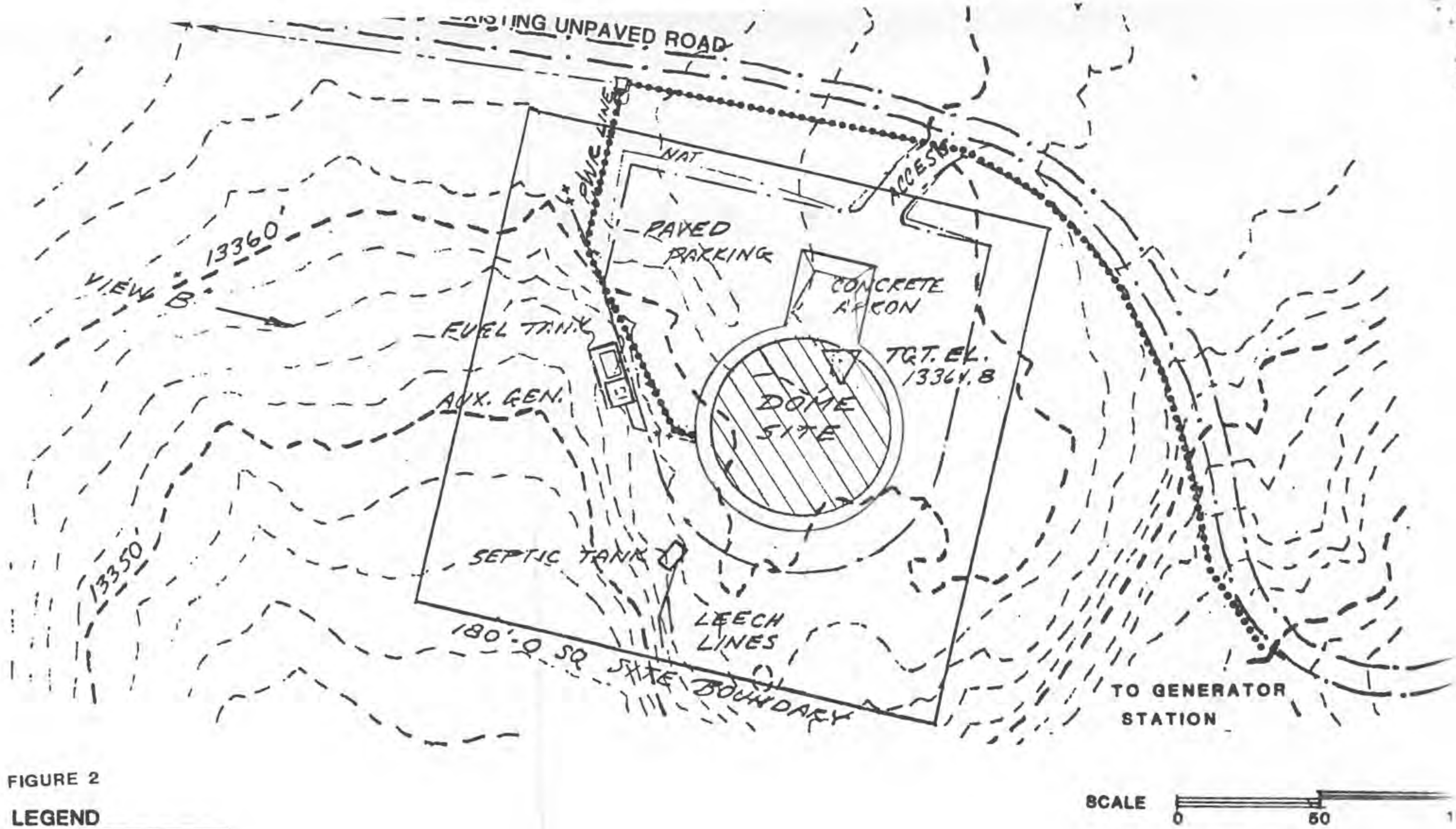


FIGURE 2

LEGEND

.... UTILITY LINES

Source: Survey Office & Tax Maps Bureau
By D.K. c F.P. May 1955

CALIFORNIA INSTITUTE OF TECHNOLOGY
DIVISION OF PHYSICS, MATHEMATICS, AND ASTRONOMY
MAIL CODE 367-17, 1200 E. CALIFORNIA BOULEVARD, PASADENA, CA 91125
EMAIL: GOLWALA@CALTECH.EDU; VOICE: 626-395-8003; FAX: 626-395-2366

March 22, 2016

Office of Mauna Kea Management
Attn: Stephanie Nagata, Director
640 N. Aʻohōkū Place, Room 203

Re: Notice of Intent to Decommission
Caltech Submillimeter Observatory
Site Survey

Dear Ms. Nagata,

On November 18, 2015, the Provost of the California Institute of Technology submitted to your office a Notice of Intent to Decommission the Caltech Submillimeter Observatory located on Maunakea, in accordance with the *Decommissioning Plan for the Mauna Kea Observatories*, a sub-plan of the *Mauna Kea Comprehensive Management Plan*.

We hereby submit, as an addendum to the above Notice of Intent, an updated site plan, as required by the *Decommissioning Plan*. The development of the site plan was undertaken on behalf of Caltech by dlb & Associates, Keaʻau, HI 96749, in cooperation with our staff. In addition to the survey data acquired by this firm, the site plan incorporates historical data provided by CSO. The updated site plan is included as an attachment to this letter. An electronic version (include a .DWG file of the site plan) will be transmitted electronically to your office.

Sincerely,

Sunil Golwala
Professor of Physics
California Institute of Technology
Director, Caltech Submillimeter Observatory

dlb & Associates
LAND SURVEYING • MAPPING • CONSULTING

Daniel L. Berg, PLS11245
Ph: 808-966-4206 Email: info@dlbandassoc.com
Fax: 808-982-6830 Web: www.dlbandassoc.com
P.O. Box 49-2281, Kea'au, HI 96749

Report

March 1, 2016

To: California Institute of Technology
Purchasing Services, Attn. Sheri Stoll
1200 E. California Blvd.
Mail Code 103-6
Pasadena, CA. 91125

Caltech Subm. Observatory
Attn.: Simon Radford
111 Nowelo St.
Hilo, HI., 96720

Re: **Caltech Submillimeter Observatory**
TMK (3) 4-4-015:009 (portion)
Mauna Kea Science Reserve,
Kaohe, Hamakua, Island & Co. of Hawaii, Hawaii

This report summarizes methods of topographic survey completed November 24 2015 at Caltech Submillimeter Observatory at Mauna Kea summit.

Methods

Office preparation consisted of delivery of historical construction plans (dated Feb., 1983) and a lease area diagram. The original lease boundary appears to be referenced to NAD27, Hawaii State Plane coordinates, which was superseded by NAD83 projection.

The current topographic survey used static GPS observations at a control point near the site (station 101) to establish coordinates. Observations to CORS stations yields coordinate value on NAD 83, Hawaii State Plane Zone 1 (PA11) 2010.00 Epoch. This is the reference frame. GPS vectors were processed using NGS OPUS service. CORS stations used are:

1. Mauna Kea CORS ARP (PID: DE6589)
2. Mauna Loa Observ CORS (PID: DG9765)
3. Honolulu WAAS1 CORS ARP (PID: DF8972)

Geographic coordinates and residuals ( ) at control station 101 are:
Lat. N 19°49'22.27469" (0.010 m); Lon. W 155°28'31.20801" (0.027 m); Elev. 4075.299m (0.064 M)

Finally, Lat./Lon. were converted to North/East grid plane coordinates in US Survey Feet units.

Topographic survey data was acquired using GPS RTK methods in an assumed Hawaii state plan projection. The data was translated to the CORS derived coordinates at Sta. 101 and expanded from grid (raw meas.) to ground. Therefore the only true state plane coord value is at Sta. 101.

Diligent search of lease boundary evidence yielded only 1 found monument. The lease area was inserted at this location, oriented to grid azimuth. Contouring/drafting was completed in CAD software. Electronic files delivered to Simon Radford at the Hilo office of CSO

Daniel L. Berg, PLS11245
Ph: 808-966-4206 Email: info@dlbandassoc.com
Fax: 808-982-6830 Web: www.dlbandassoc.com
P.O. Box 49-2281, Kea'au, HI 96749

Archived Plans

As above, historical construction plans (dated Feb., 1983) were provided to this office. At request of CalTech, certain underground utilities were included as a revision February 2016.

Image files were inserted into cad, aligned to observatory footprint or lease boundary, and digitally traced. Following features were included:

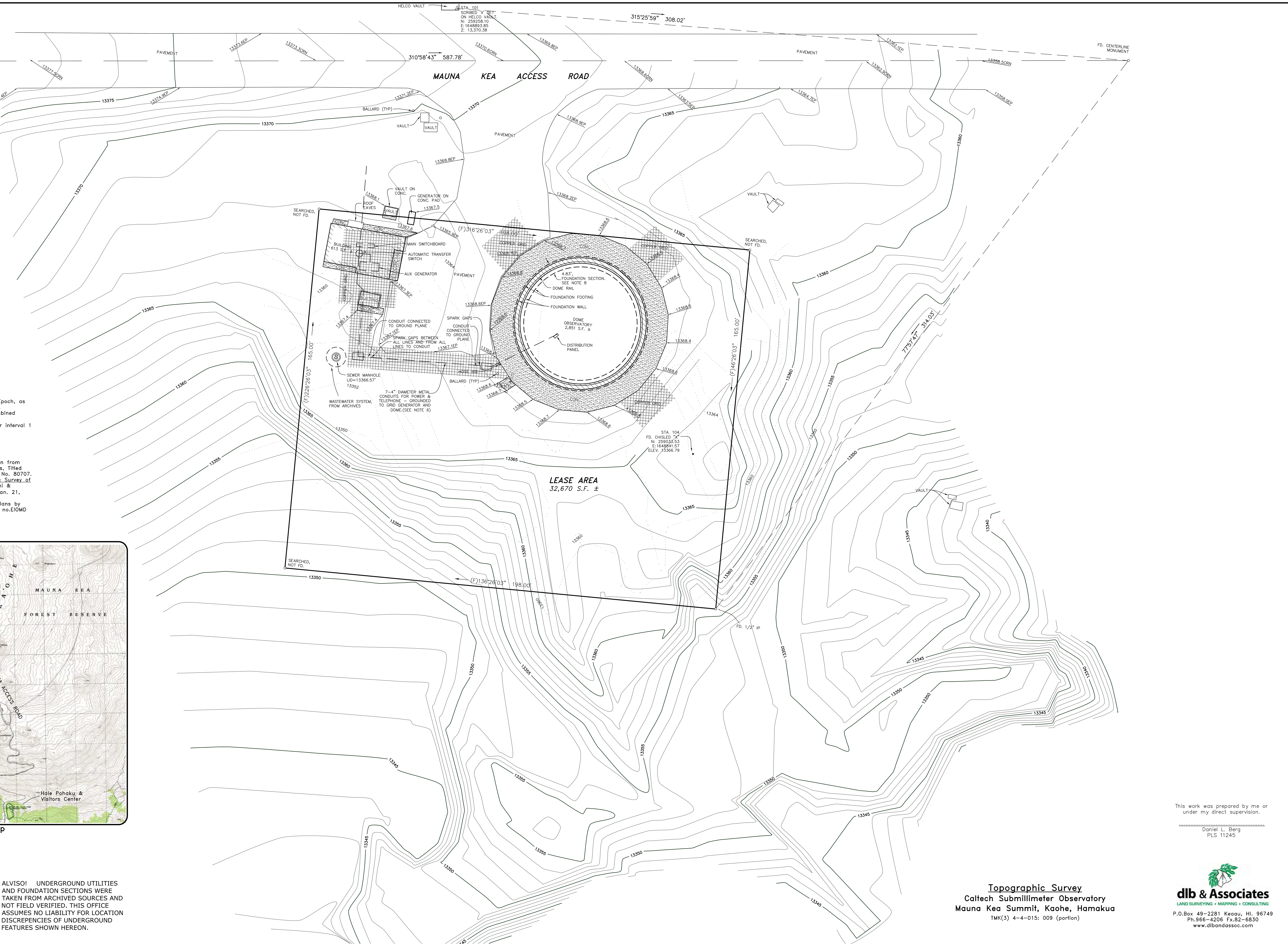
- Underground electrical conduit, power distribution panel, underground copper ground grid were taken from plans entitled Grounding and Power Distribution Diagram. Code id 80707 Being a diagram, exact location may not follow the alignment shown on the plans. No dimensions are specified for these features. (Note 6 on topo survey.)
- Preconstruction contors were taken from a topographic survey by Austin, Tsutsumi & Associates, dated Jan. 21, 1983 (Job No. 0-83-125-0-83-153.) The rastor pdf is of poor quality, but contours were traced as best possible. Contour interval varies. The Austin Tsutsumi plan includes breaklines and spot elevations. The correct method to produce the original surface is to digitize breaklines and spot elevations and create a 1983 era TIN model. Such a task is beyond the scope of this survey. (Note 7 on topo survey.)
- The observatory structural foundation and rail was taken from Foundation Plans and Detail, Submillimeter Observatory, drawing no. EIOMD S2 dated 12/5/83. The foundation wall was measured at exterior. Detail 1/S2 and 3/S2 per plans indicate a foundation thickness up to 4.83 ft. (4'10") and 5 ft. below grade. These values were not field verified. (Note 8 on topo survey.)

Underground features were taken from archived sources provided by others. Field verification by potholing or probing was not a part of the scope of work and not conducted. dlb and associates assumes no liability for variance of location, depth or material of underground features shown on the revised topographic survey dated February 29, 2016.

This report was prepared by
me or under my direction.

____

Daniel L. Berg
PLS 11245 (HI)



0' 20' 40'

SCALE IN FEET

LEGEND

PROPERTY MOMNUMENT AS DESCRIBED.

BUILDING FOOTPRINT

ROOF EAVES

CONCRETE SURFACE

AC PAVEMENT

UNDERGROUND COPPER GRID. (SEE NOTE 6.)

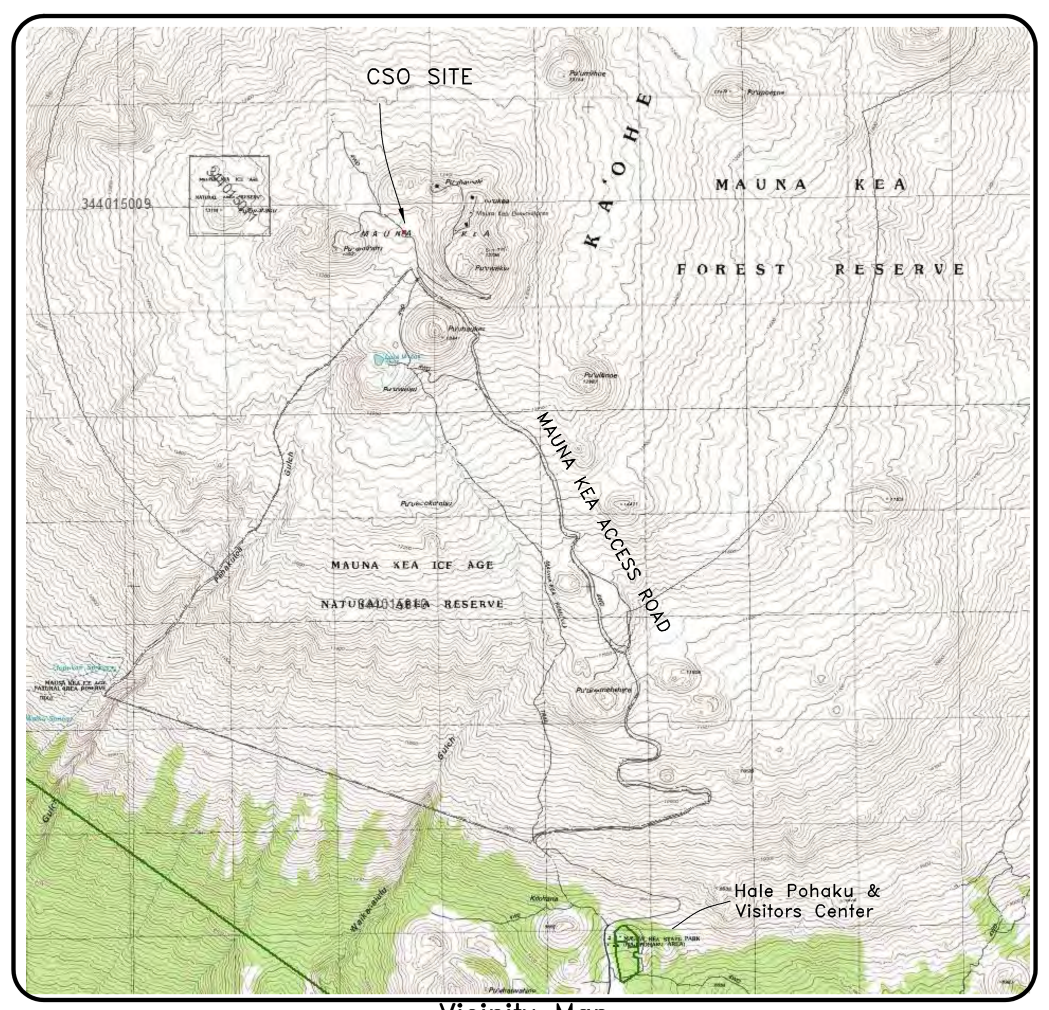
13345 EXISTING CONTOURS. (SEE NOTE 4.)

13360 PRE-CONSTRUCTION CONTOURS, DIGITIZED FROM ARCHIVED PLANS. (SEE NOTE 7.)

CRN CROWN OF ROAD
EP EDGE OF PAVEMENT
TYP TYPICAL

NOTES:

1. Field survey completed November 24, 2015.
2. Coordinates referenced to NAD83 (PA11) 2010.000 Epoch, as derived from static GPS observations at station 101.
3. Distances are ground. To reduce to grid use a combined factor (CF) of 0.99932244 (Grid=Grnd x CF)
4. Elevations referenced to Hawaii Tidal Datum. Contour interval 1 ft.
5. CORS control stations used:
   MKEA Mauna Kea Cors ARP (PID: DE6589)
   MLO1 Mauna Loa Observ Cors (PID: DG9765)
   ZHN1 Honolulu WAAS1 Cors ARP (PID: DF8972)
6. Underground conduit and electrical copper grid taken from design plans by CalTech Central Engineering Services, Titled Grounding and Power Distribution Diagram, Code ID No. 80707.
7. Preconstruction countours digitized from Topographic Survey of CalTech Submillimeter Observatory by Austin Tsutsumi & Associates,(Job No. 0-83-125-0-83-153) dated Jan. 21, 1983.
8. Observatory Foundation section taken from design plans by CalTech Foundation Plans and Detail, SMO drawing no.EIOMD S2, dated 12/5/83.



Vicinity Map
(No Scale)

REVISION NOTES

2/29/16	ADD PRE-CONST. CONTOUR MAPPING
2/29/16	ADD ELEC. GRND.& POWER FROM PLANS
2/29/16	ADD FOUNDATION SECTION PER PLANS

Date: December 01, 2015
Project: J2015-208

ALVISO! UNDERGROUND UTILITIES AND FOUNDATION SECTIONS WERE TAKEN FROM ARCHIVED SOURCES AND NOT FIELD VERIFIED. THIS OFFICE ASSUMES NO LIABILITY FOR LOCATION DISCREPENCIES OF UNDERGROUND FEATURES SHOWN HEREON.

Topographic Survey

Caltech Submillimeter Observatory
Mauna Kea Summit, Kaohe, Hamakua

TMK(3) 4-4-015: 009 (portion)

This work was prepared by me or under my direct supervision.

Daniel L. Berg
PLS 11245

dlb & Associates
LAND SURVEYING • MAPPING • CONSULTING
P.O.Box 49-2281 Keaau, HI. 96749
Ph.966-4206 Fx.82-6830
www.dlbandassoc.com

24X36L

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

KEKOA KALUHIWA
FIRST DEPUTY

JEFFREY T. PEARSON
ACTING DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

REF: OCCL: MC

Correspondence HA-16-118
FEB 19 2016

Stephanie Nagata
Director, Office of Mauna Kea Management
640 N. Aohoku Place
Hilo, HI 96720

SUBJECT: **NOTICE OF INTENT TO DECOMMISSION**
Caltech Submillimeter Observatory
University of Hawai‘i at Hilo Hoku Kea Telescope
Mauna Kea Science Reserve, Ka`ohe Mauka, Hāmakua District, Hawai`i
TMK (3) 4-4-015:009

The Department of Land and Natural Resources (DLNR) Office of Conservation and Coastal Lands (OCCL) has reviewed the Notices of Intent to Decommission the Caltech Submillimeter Observatory and the University of Hawai‘i at Hilo Hoku Kea Telescope, both in the Mauna Kea Science Reserve.

Pursuant to the Decommissioning Plan, a subplan of the Mauna Kea Comprehensive Management Plan, the decommissioning of an astronomy facility in the Science Reserve is a multi-step process involving 1) a Notice of Intent, 2) an environmental due diligence review, 3) a Site Deconstruction and Removal Plan, 4) a Site Restoration Plan, and, if necessary, 5) a Remedial Action Plan.

Both Notices of Intent appear to be in compliance with the requirements of the Decommissioning Plan. The next steps will be the preparation of an environmental assessment and a Conservation District Use Application (CDUA) for each of the proposals. The environmental assessment should discuss the preferred alternatives for the deconstruction and removal of the facilities, and the restoration plan for the sites.

The environmental assessment and the CDUA can be processed simultaneously by our office. At the end of the 180-day review process, dated from acceptance of the CDUA and draft EA for processing, our office will present our analysis and recommendations to the Board of Land and Natural Resources. The Board will have the final authority to approve, modify, or deny the permit.

If you have any questions please contact Michael Cain at (808) 587-0048.

Sincerely,

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

copy: Chair; Hawai‘i Board member; Hawai‘i Land Division; Hawai‘i County Planning Department

University of Hawai‘i at Hilo
640 N. A‘ohoku Place, Room 203, Hilo, Hawai‘i 96720
Telephone: (808) 933-0734 Fax: (808) 933-3208
Mailing Address: 200 W. Kawili Street, Hilo, Hawai‘i 96720

Minutes
Regular Meeting

Mauna Kea Management Board
Wednesday, May 11 2016

Kukahau‘ula, Room 131
640 N. A'ohoku Place
Hilo, Hawaii 96720

Attending

MKMB: Chair Gregory Mooers, 1st Vice Chair Hannah Kihalani Springer, 2nd Vice Chair/Secretary Gregory Chun, Roger Imoto, Herring Kalua and Douglas Simons

BOR: Wayne Higaki and Barry Mizuno

Kahu Kū Mauna: Shane Palacat-Nelsen

OMKM: Wally Ishibashi, Fritz Klasner, Stephanie Nagata, Scotty Paiva, Dawn Pamarang, Lukela Ruddle, Amber Stillman, Sage Van Kralingen, Darcy Yogi and Joy Yoshina

Others: Mark Chun, John Coney, Kathy Cooksey, Jesse Eiben, Sunil Golwala, N. Gonsalves, Saeko Hayashi, Clyde Higashi, Stewart Hunter, Patrick Kahawaiola‘a, Paula Kekahuna, David Lonborg, Wendy Light, R. Pierre Martin, Warren Matsumoto, John McBride, Shirley Pedro, John Roberts, Marianne Takamiya, Barry Taniguchi, Nicolette Thomas, Dwight Vicente, Keahi Warfield, Ross Wilson Jr., and Dwayne Yoshina

I. CALL TO ORDER

Chair Mooers called the meeting of the Mauna Kea Management Board (MKMB) to order at 10:00 a.m.

II. APPROVAL OF MINUTES

Upon motion by Kihalani Springer and seconded by Greg Chun the minutes of the March 9, 2016, meeting of the MKMB were unanimously approved.

III. DIRECTOR’S REPORT

A. Thirty-Meter Telescope (TMT) Contested Case

On May 6th the Board of Land and Natural Resources (BLNR) denied the petitioners’ request to have Judge Riki May Amano disqualified as the hearing officer for the TMT contested case because of her family membership in the ‘Imiloa Astronomy Center. The BLNR found that “under applicable legal standards, a reasonable person knowing all the facts would not doubt the impartiality of Judge Amano.” Based on case law, a hearing officer is entitled to a “presumption of honesty and integrity,” and in the case of Judge Amano, that presumption remains in tack. The BLNR also denied the petitioner’s objections to the selection process which they believed was improper. The BLNR provided a full discussion that the process they followed was legally sound.

A pre-hearing conference has been set for Monday, May 16 on Oahu. The purpose of this conference is to discuss: 1) the record; 2) the parties; 3) anticipated prehearing motions; 4) motions hearing(s) schedule; and 5) other procedural and logistical matters.

- Review and provide feedback on Site Deconstruction and Removal Plan and Site Restoration Plan
- Suggested Participants:
  - Decommissioning Facility
  - Landscape Architect
  - Engineer
  - Planner
  - Environmental Consultant
  - Kahu Kū Mauna
  - Environment Committee
  - Maunakea Management Board
  - Institute for Astronomy
  - OMKM

F. Caltech Submillimeter Observatory (CSO) Notice of Intent to Decommission

The Caltech Submillimeter Observatory is requesting approval of their Notice of Intent (NOI) to decommission their telescope. Pursuant to the 2009 Comprehensive Management Plan (CMP) and the 2010 Decommissioning Plan (DP), CSO submitted their NOI to decommission in November 2015. CSO began operating in 1986 and ceased operations in 2015. They first announced their intent to decommission back in 2009.

Purpose

The purpose of the NOI is to notify UH of an observatory's intention to: 1) propose whether their site will be removed; 2) continue use of the observatory by a third party, or 3) retrofit the facility for a different use. The NOI should contain the following:

1. Intentions for site restoration.
2. Site description summarizing of the overall condition and land use, including a description of all structures, equipment and other appurtenances.
3. Site plan(s) drawn to scale showing all existing structures, above and below grade.
4. Available historical information on the development, operation, and use of the site.
5. A description of the pre-construction condition of the site based on available information.
6. Site restoration will be based on pre-construction, topographic condition prior to construction of the observatory.

Proposed Activities

CSO's intent is to remove the observatory and restore the site (as opposed to transferring the site to a 3rd party or retrofit the facility for a different use). CSO intends to:

1. Remove all above ground structures, all surface infrastructure, all conduits and sewer lines, and the top six inches of concrete and asphalt.
2. Backfill the cesspool with native material.
3. Restore the ground by grading the site to approximate pre-construction topography and leave a visual appearance consistent with the original condition.

CSO's NOI contained a site description including a list of the structures and improvements, historical documents, a scaled site layout and grading plan and foundation drawing, and photographs depicting the site prior to construction. CSO recognizes their proposed actions may likely undergo modification to address concerns raised by Kahu Kū Mauna and others during the decommissioning review process.

The CSO started their environmental due diligence process and have all but completed Phase 1. They had a hydraulic oil spill that was identified in early 2000 which constitutes a potential recognized condition and they will need to go to Phase 2.

Kahu Kū Mauna

Kahu Kū Mauna Council was consulted on April 12, 2016. The Council requested that OMKM and CSO proceed with preparation of the Site Deconstruction Plan assuming a starting point of complete infrastructure removal and full restoration, reaffirming the stated DP expectation. OMKM and CSO concur and subsequent documents will be prepared accordingly while complying with the DP and Environmental Assessment requirements to identify alternatives that include infrastructure capping and minimal or moderate restoration levels. Decisions regarding removal and restoration options will be made after consultation with the Council and submittal to the Board.

The Council questioned when doing the cost benefit analysis if economics or money would trump culture. Kahu Kū Mauna also expressed their appreciation to CSO for providing a detailed proposal.

Maunakea Environment Committee

The Environment Committee chose to submit comments on an individual basis, rather than reviewing the NOI as a committee. The Committee requested that the NOI be made publicly available. The Committee remains interested in consulting on details regarding environmental due diligence along with alternatives and choices associated with infrastructure removal and site restoration.

Dr. Jesse Eiben summarized his written testimony urging the Board to consider the total impacts of ecological effects of construction (including decommissioning) and not just single projects. Also make sure it is clear that the two telescope sites are not likely to be ideal restoration sites for endemic arthropods, especially the wēkiu bug. Lastly, to his knowledge, there has not been public justification to the Board, or from the Board, or from the Governor's Office concerning why or how accelerating three telescope decommissioning processes and potentially changing management of 10,000 acres from OMKM to the DLNR Department of Forestry and Wildlife (DOFAW) is to be handled to ensure continued high quality and accountable environmental stewardship of alpine stone desert of Maunakea.

Department of Land and Natural Resources

The Department of Land and Natural Resources, Office of Conservation and Coastal Lands (OCCL) indicated that an Environmental Assessment (EA) should be prepared along with completion of the Site Decommissioning Plan and that a CDUP will be required.

Comprehensive Management Plan Compliance

The decommissioning process is detailed in the 2010 Decommissioning Plan for the Maunakea Observatories, a sub-plan to the 2009 Maunakea Comprehensive Management Plan. The OMKM and Caltech are committed to implementing the decommissioning process in accordance with these plans. Should the Board approve the NOI, OMKM will work with Caltech to establish a “Decommissioning Advisory Committee” to help guide preparation of the Site Deconstruction and Removal Plan, Site Restoration Plan, and Environmental Assessment. This committee would include subject matter experts in fields such as construction management (i.e. civil engineering) and landscape architecture, planning, environmental consulting as well as representation from the Kahu Kū Mauna Council, the Environment Committee, and the Maunakea Management Board.

Recommendation

Approval of CSO’s NOI is recommended. CSO has fulfilled the content requirements of the NOI, including existing historical documents. Should the Board approve the NOI, OMKM will work with Caltech to conduct the Environmental Due Diligence review for submittal to the Board for approval and establish the Decommissioning Advisory Committee to advise on preparing a Site Decommissioning Plan and Environmental Assessment.

Discussion

Chair Mooers stated the critical decision here is to see if CSO reviewed their three options and if this is the appropriate action to take. He believes CSO has evaluated all their options and that this is the appropriate course of action for them.

Ms. Springer commented since CSO indicated their intent as far back as 2009, it seems as though they have been moving progressively and deliberately towards this NOI.

Dr. Simons stated they have seen this coming for years and the need to decommission it is mostly driven by the lack of finances. CSO has been a state-of-the-art telescope. There simply is not enough money to keep it afloat and now is the time, as they have hinted for years, to remove the facility. From his perspective within the observatory community, CSO has met the requirements of the NOI and people should understand that when you lack the resources to run these facilities it is a natural consequence to take it down.

Dr. Chun stated relative to this particular matter, he does not see any public submission questioning its decommissioning, or removal, or any desire to take over. He assumes that at some level that conversation has been thought through by different people. He did want to go back to Dr. Eiben's testimony because somewhere in this process, and it may not be during the NOI step, we have to be thinking about the collective impact of decommissioning. He is not sure where in the process this would fit.

Chair Mooers commented that during Chapter 343, the portion that talks about cumulative impacts when doing the environmental analysis would be the opportunity to review cumulative impacts in conjunction with Chapter 343.

Sunil Golwala, CSO director, stated the issue of total impact is one of the things that will be considered and discussed in future plans for submittal. We need to consider not just the impact of the removal of the observatory and the infrastructure, but impacts elsewhere on the mountain such as fill in holes in the foundation. There will be an analysis of different options to see what these total impacts are.

Ms. Springer asked about outreach to the community concerning the letters received. She felt a letter acknowledging receipt would be the standard operating procedure.

Action
It was moved by Doug Simons and seconded by Greg Chun to approve Caltech Submillimeter Observatory's Notice of Intent to decommission its telescope. The motion was carried unanimously.

G. Hoku Keʻa Telescope Notice of Intent to Decommission

The University of Hawaii at Hilo (UHH) is requesting approval of their Notice of Intent (NOI) to decommission its telescope. Pursuant to the 2009 Comprehensive Management Plan and the 2010 Decommissioning Plan, the UHH submitted its NOI to decommission in September 2015. Hoku Keʻa telescope is located in an observatory structure originally constructed in 1968, and renovated under a permit issues in 2007, for teaching and educational purposes.

Proposed Activities
UHH indicated in its NOI it intends to remove the observatory and restore the site (as opposed to transferring the site to a 3rd party or retrofit the facility for a different use). UHH intends to deconstruct and remove the telescope and observatory structure and restore the site according to a Site Deconstruction and Removal Plan and Site Restoration Plan, both of which will be developed and implemented in accordance with the DP. For documentation and site-specific detail, UHH references the 2006 Environmental Assessment and 2007 Conservation District Use Permit Application.

Kahu Kū Mauna
Kahu Kū Mauna Council was consulted on April 12, 2016. The Council noted that Hoku Keʻa's decommissioning NOI had very limited detail, especially compared to CSO's NOI, and thus the Council had no comments other than to reiterate their position that any decommissioning proceed with preparation of the Site Deconstruction Plan assuming a starting point of complete infrastructure removal and full restoration, reaffirming the stated DP expectation.

At the Council’s meeting, three letters were submitted and given in-person. These were testimonies by members of the Native Hawaiian community stating their position against the decommissioning of the Hoku Kea and UKIRT telescopes. The Keaukaha Community Association and Panaʻewa Hawaiian Home Lands Community Association each submitted a letter expressing concern over the potential loss of on-mountain, site-specific education and training opportunities while expressing an interest to “adopt” Hoku Keʻa and UKIRT and continue to have the UHH operate the telescopes should UHH decide not to change their position on the decommissioning of both telescopes.

Keaukaha and Panaʻewa communities together are effectively acting as a third party by ʻadoptingʻ Hoku Keʻa as a demonstration of their support and commitment to the educational and work force opportunities provided by Maunakea astronomy. The third letter was from an individual also expressing similar concerns over the loss of on-mountain, site-specific education and training for local, especially Native Hawaiian, students.

Maunakea Environment Committee
Dr. Eiben's written testimony and comments also apply to Hoku Keʻa's decommissioning. Written testimony was also received by Ms. Heather Kaluna. In summary she urges to not remove the telescope and references the governor's press release from May 2015 and the political implications with TMT. Her vision for Hoku Keʻa is that it can help serve as a bridge within the community and help broaden the base for support for as long as astronomy remains on the mountain.

Department of Land and Natural Resources
The Department of Land and Natural Resources, Office of Conservation and Coastal Lands (OCCL) indicated that an Environmental Assessment should be prepared along with completion of the Site Decommissioning Plan and that a Board of Land and Natural Resources issued CDUP will be required.

Comprehensive Management Plan Compliance
The decommissioning process is detailed in the 2010 Decommissioning Plan for the Maunakea Observatories, a sub-plan to the 2009 Maunakea Comprehensive Management Plan.

OMKM
Office of Mauna Kea Management

University of Hawai'i at Hilo
640 N. A'ohoku Place, Room 203, Hilo, Hawai'i 96720
Telephone (808) 933-0734 Facsimile (808) 933-3208
Mailing Address: 200 W. Kawili Street, Hilo, Hawai'i 96720

MEMORANDUM

December 20, 2019

TO: David Lassner
President

VIA: Bonnie Irwin
Chancellor, UH Hilo

FROM: Stephanie Nagata
Director

SUBJECT: Review and Approval of Caltech Submillimeter Observatory's (CSO): *Notice of Intent to Decommission*, *Phase I Environmental Site Assessment*, and *Asbestos, Lead Paint and Mold Survey Report*

I. Request

Your review and consideration for approval is requested of Caltech's Notice of Intent (NOI) to decommission, *Phase I Environmental Site Assessment* (ESA I) and *Asbestos, Lead Paint and Mold Survey Report* (Hazmat). Links to these documents are provided below.

II. Background

Pursuant to the Board of Land and Natural Resources approved 2010 Decommissioning Plan for the Mauna Kea Observatories (DP), various documents in an observatory decommissioning process shall be approved by the Maunakea Management Board (MKMB) followed by approval by the University of Hawai'i President. Among the documents requiring the President's approval are the NOI, and environmental due diligence reports, including ESA I and Hazmat.

The CSO's NOI was approved by the MKMB on May 11, 2016, following consultation with Kahu Kū Mauna on April 12, 2016.

The ESA I and Hazmat reports were approved by the MKMB on September 27, 2019. Kahu Kū Mauna was consulted on the ESA I and Hazmat on August 29, 2018 and May 16, 2019, respectively. Both of these documents are part of CSO's environmental due diligence. As described in the Phase I assessment, additional steps in the environmental due diligence process will include a Phase II Environmental Site Assessment which will be completed during the site deconstruction process. This is a State of Hawai'i, Department of Health requirement based on a hydraulic oil spill that occurred in 2009. Hazardous material abatement of lead paint and mold, will also be required during the facility deconstruction process.

Observatory decommissioning refers to a process that results in the *partial or total* removal of all structures associated with an observatory facility, and the restoration of the site, to the *greatest extent possible*, to its preconstruction condition. The DP defines *facility* as the physical structures existing on site at each observatory and *infrastructure* as non-facility structures, including all supporting structures beyond a facility footprint such as utility lines and roads, if common or shared.

The decommissioning process includes preparation of: 1) a Notice of Intent to decommission (NOI), 2) an environmental due diligence review, 3) an Environmental Assessment, and 4) a Conservation District Use Application including a Site Deconstruction and Removal Plan, a Site Restoration Plan, a funding plan, and if necessary a remedial action plan, with each of these steps approved by the MKMB and University of Hawai'i President. The Board of Land and Natural Resources will then be asked to approve a Conservation District Use Permit authorizing the implementation of an approved decommissioning plan.

The CMP and DP emphasize *community* involvement. To this end, various reviewers of decommissioning related materials shall include the Office of Maunakea Management, Kahu Kū Mauna, and the MKMB. In addition other community groups, including the MKMB Environment Committee, Decommissioning Review Committee, and a Decommissioning Working Group (comprised of university staff) also participate in the review process prior to submission of the documents to the Maunakea Management Board for its review and approval. OMKM is responsible for overall coordination of the decommissioning process as well as overseeing the deconstruction and site restoration process. OMKM also serves as the liaison with the Department of Land and Natural Resources' Office of Conservation and Coastal Lands.

The current focus in the CSO decommissioning process is the preparation of an Environmental Assessment in compliance with: Hawai'i Revised Statutes Chapter 343.

APPROVE / DISAPPROVE
Bonnie Irwin, Chancellor, UH Hilo

APPROVE / DISAPPROVE
David Lassner
David Lassner, President

Links

1. Notice of Intent:
   https://www.dropbox.com/s/fu6wtq037vtthqi/NOIwithDLNRapproval_2019-12-20.pdf?dl=0
2. Notice of Intent addendum:
   https://www.dropbox.com/s/28jso6m9d8l70bn/NOIaddendum_2019-12-20.pdf?dl=0
3. Due Diligence - Phase I Environmental Site Assessment:
   https://www.dropbox.com/s/4mwioesqk3tex7z/CSO-DueDiligence_Phase1_2019-12-20.pdf?dl=0
4. Due Diligence - Asbestos, Lead Paint and Mold Survey Report (aka HazMat):
   https://www.dropbox.com/s/cdhahbmekat0nlb/CSO-DueDiligence_HazMat_2019-12-20.pdf?dl=0

c: Sunil Golwala, Caltech
c: Greg Chun, Executive Director of Maunakea Stewardship

Appendix B. Phase I Environmental Site Assessment

CALIFORNIA INSTITUTE OF TECHNOLOGY
DIVISION OF PHYSICS, MATHEMATICS, AND ASTRONOMY
MAIL CODE 367-17, 1200 E. CALIFORNIA BOULEVARD, PASADENA, CA 91125
EMAIL: GOLWALA@CALTECH.EDU; VOICE: 626-395-8003; FAX: 626-395-2366

June 14, 2018

Office of Mauna Kea Management
Attn: Stephanie Nagata, Director
640 N. Aʻohōkū Place, Room 203

Re: Caltech Submillimeter Observatory Decommissioning
Phase I Environmental Site Assessment

Dear Ms. Nagata,

On November 18, 2015, the Provost of the California Institute of Technology submitted to your office a Notice of Intent to Decommission the Caltech Submillimeter Observatory located on Maunakea, in accordance with the *Decommissioning Plan for the Mauna Kea Observatories*, a sub-plan of the *Mauna Kea Comprehensive Management Plan*. I submitted on March 22, 2016, an addendum to this Notice of Intent, consisting of an updated site plan.

With this letter, we hereby undertake the next step in the decommissioning process by submitting, in compliance with the *Decommissioning Plan for the Mauna Kea Observatories*, a sub-plan of the *Mauna Kea Comprehensive Management Plan*, a Phase I Environmental Site Assessment. The assessment was undertaken by ENPRO Environmental, Kailau, HI 96734. The first page of the attachment includes a letter of clarification provided by ENPRO regarding Section 4.1.3 Geology/Hydrogeology and should be considered an integral piece of the report.

As you will note upon reading the report, the only significant issue identified in the Phase I Environmental Site Assessment is the possibility of remaining contamination due to the 2009 hydraulic oil spill and, possibly, a prior spill at an unknown prior date (perhaps during construction of the CSO). The report recommends a Phase II Environmental Site Assessment in connection to this spill, to be undertaken at a later point during decommissioning when the spill area is made fully accessible. The Phase II ESA may result in a recommendation for remediation.

Sincerely,

Sunil Golwala
Professor of Physics
California Institute of Technology
Director, Caltech Submillimeter Observatory

June 14, 2018

Sunil Golwala
California Institute of Technology
1200 East California Boulevard
Pasadena, California 91125

RE: Letter of Clarification
Phase I Environmental Site Assessment
Caltech Submillimeter Observatory
Mauna Kea Summit
Hawaii Island, Hawaii
ENPRO Project Number: 1512-00532-PHI

Dear Sunil Golwala,

This letter is to clarify ENPRO's March 21, 2016 Phase I Environmental Site Assessment report for the Caltech Submillimeter Observatory (CSO) at the Mauna Kea Summit on Hawaii Island, Hawaii, identified by TMK (3) 4-4-015: 009 (the "project site").

At the time the report was prepared, ENPRO Environmental (ENPRO) documented the general hydrology of the Waimea Aquifer System of the West Mauna Kea Aquifer Sector as described in Mink and Lau's 1993 *Aquifer Identification and Classification for the Island of Hawaii: Groundwater Protection Strategy for Hawaii*. While the West Mauna Kea Aquifer extends from the coastline to the summit of Mauna Kea, the Mink and Lau reference primarily describes groundwater production near the shore. The shallow, unconfined aquifer occurs approximately 10,000 feet below the summit of Mauna Kea.

At the request of California Institute of Technology, ENPRO has reviewed the following documents:

1. Leopold, M. et al. (2016), Subsurface Architecture of Two Tropical Alpine Desert Cinder Cones that Hold Water. *Journal of Geophysical Research.*
2. NASA (2005), Final Environmental Impact Statement for the Outrigger Telescopes Project, Volume I.
3. Schorghofer, N. et al (2017), State of High-Altitude Permafrost on Tropical Maunakea Volcano, Hawaii. *Permafrost and Periglac. Process.*

According to the documents reviewed, the nearest groundwater wells are in Waikii (State Well Numbers 5239-01 and 02), approximately 13 miles west of the project site. At the Mauna Kea summit, low-permeability dikes constitute a significant percentage of the entire rock mass, resulting in a significant reduction of overall effective permeability. Any groundwater compartments formed by intersecting dikes are very small and wells generally cannot be successfully developed in them.

None of the above documents alter the recommendations made by ENPRO in the Phase 1 Environmental Site Assessment dated March 21, 2016. However, the documents indicate that there is no shallow groundwater present at the CSO site.

Sincerely,

Kim Rottas
Environmental Professional

Prepared for:

California Institute of Technology
1200 East California Boulevard
Pasadena, California 91125

Phase I Environmental Site Assessment

Caltech Submillimeter Observatory

Mauna Kea Summit
Hawaii Island, Hawaii

Prepared by:

ENPRO Environmental
151 Hekili Street, Suite 210
Kailua, Hawaii 96734

808.262.0909
808.262.4449 (fax)
www.enproenvironmental.com

ENPRO Environmental Contact:

Heather Schauer
Environmental Technician
808.748.2108
hschauer@enproenvironmental.com

ENPRO Project Number: 1512-00532-PH1
Date of Report: March 24, 2016
On-Site Investigation: January 6, 2016

PROJECT AT A GLANCE™

Assessment Component	Not Requested	Acceptable (†)	Routine Solution	Phase II ESA	Estimated Cost (‡)	Report Reference Section	
						Project Site	Adjoining Property
Historical Review		X					
Regulatory Review				**(1)***	**$15,000-$20,000**		
Operations		**X**					
Hazardous Materials			X				
Underground Storage Tanks		X					
Aboveground Storage Tanks		X					
Solid Waste		X					
Surface Areas							
Wells		(N/A)					
PCBs		X					
Asbestos	X						
Lead Based Paint	X						
Lead in Drinking Water	X						
Radon	X						
Mold	X						
Data Gaps						**9.2**	

***BOLD** = Identified issues. **Numbers [(1)] reference Action Items listed on the following page.**

(†) = Based on this preliminary study, it appears that further investigation in this area is not a priority concern for this site at the present time.

(‡) = Costs depicted are for investigation/program development activities. Remediation costs, if required, will be identified as a result of investigation/program development activities

Conditions noted in the Project at a Glance™ table represent the overall conditions of the property. More specific details on assessment components may be included in the text of this report; therefore the Project at a Glance™ should not be used as a stand-alone document.

ACTION ITEMS

Based on our investigation, ENPRO has concluded that there is sufficient risk to warrant additional action AND investigation. ENPRO has identified the following action items and makes the following recommendations:

(1) Hydraulic oil release in May 2009 resulted in the excavation of contaminated soil beneath the slab of the observatory. Incidentally, additional contaminated backfill was discovered just below the slab. This contaminated backfill is believed to be the result of a previous incident occurring possibly during the construction of the observatory. Cleanup of the May 2009 hydraulic oil release has been completed to the satisfaction of the Department of Health. However, a *No Further Action* designation is pending additional investigation and cleanup to be undertaken when the observatory decommissions.

ENPRO recommends multi-increment sampling of the soil at the project site and analysis for contaminants of potential concern associated with the hydraulic fluid release.

Further details regarding ENPRO's conclusions and recommendations may be found in Section 1.1 and section 9.0 of this report.

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1.0 Executive Summary

California Institute of Technology retained ENPRO Environmental (ENPRO) to conduct a Phase I Environmental Site Assessment of the Caltech Submillimeter Observatory located at the summit of Mauna Kea (the "project site"). The objective of this assessment was to provide an independent, professional opinion regarding *recognized environmental conditions* (RECs), as defined by the American Society for Testing and Materials (ASTM), associated with the project site.

This assessment was performed under the conditions of, and in accordance with ENPRO's Proposal Number 15K-0639-ITO dated November 30, 2015, the *ASTM E 1527-13, Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process,* and *All Appropriate Inquiries* (AAI) which includes 40 CFR Part 312, §312.21 and §312.31. Any exceptions, additions to, or deletions from the ASTM or AAI practice, details of the work performed, sources of information, and findings are presented in the report. Limitations of the assessment are described in Sections 2.5 and 2.6.

The project site, currently owned by Department of Land and Natural Resources, is 0.75 acres.

The historical research presented in this report indicates that the project site was undeveloped land until 1985, when the property was developed into an observatory.

1.1 Findings and Conclusions

ASTM E-1527-13 defines three categories of *recognized environmental conditions (RECs)* which may impact the project site.

- A REC is defined as the presence or likely presence of any hazardous substance or petroleum product in, on, or at the property: 1) due to any release to the environment, 2) under conditions indicative of a release to the environment, or 3) under conditions that pose a material threat of a future release to the environment

- Historical RECs (H-RECs) are defined as a past release of any hazardous substance or petroleum product that has occurred in connection with the property and has been addressed to the satisfaction of the applicable regulatory authorities or meeting *unrestricted* use criteria established by a regulatory authority, without subjecting the property to any required controls

- Controlled RECs (C-RECs) are defined as a REC resulting from a past release that has been addressed to the satisfaction of the applicable regulatory authority, with hazardous substances or petroleum products allowed to remain in place, subject to the implementation of required controls, such as property use restrictions, activity and use limitations (AULs), institutional controls, or engineering controls

Additionally, ASTM E-1527-13 allows for the identification of *de minimis conditions*. A *de minimis condition* is defined as a condition that generally does not represent a threat to human health or the environment and that generally would not be the subject of an enforcement action if brought to the attention of appropriate government agencies.

We have performed a *Phase I Environmental Site Assessment* in conformance with the scope and limitations of ASTM Practice E 1527-13 of the Caltech Submillimeter Observatory near the summit of Mauna Kea, the *property*. Any exceptions to, or deletions from, this practice are described in Section 2.6 of this *report*.

This assessment has revealed no evidence of *recognized environmental conditions (RECs)* in connection with the *property* except for the following:

- REC 1 Hydraulic Fluid Release. This finding is considered a *recognized environmental condition* because, despite the release being cleaned up to the satisfaction of the Department of Health there is a *No Further Action* status pending further soil testing under the slab after the decommissioning of the observatory.

Recommendations for additional actions or investigations regarding the above findings are listed in Section 9.0.

The following *de minimis conditions* were identified at the project site:

- Minor oil leak within the dome of the observatory.

- Small drums containing contaminated glycol stored within the dome without secondary containment.

- Oil staining on the concrete slab at the base of the observatory.

- Used hydraulic oil drums without secondary containment

Recommendations for additional actions regarding the above *de minimis conditions* are listed in Section 10.0.

1.2 SIGNIFICANT DATA GAPS

A data gap is defined as a lack of, or inability to obtain, information required by the ASTM E 1527-13 despite good faith efforts by the environmental professional to gather such information. A data gap by itself is not inherently significant. The significance is determined by other information and professional experience as to whether the data gap raises reasonable concerns about activities that may present a *recognized environmental condition*. According to *ASTM E 1527-13, Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process,* and *All Appropriate Inquiries* (AAI) which includes 40 CFR Part 312, §312.21 and §312.31, the Phase I Environmental Site Assessment report shall identify and comment on significant data gaps that affect the ability of the environmental professional to identify *recognized environmental conditions* and identify the sources of information that were consulted to address the data gap

The following significant data gap was encountered by ENPRO when conducting this Phase I ESA:

- Department of Health (DOH), Hazard Evaluation and Emergency Response (HEER) Office does not have any records regarding releases at the Caltech Submillimeter Observatory other than the hydraulic oil release of May 2009. It is believed that a release occurred during the construction of the observatory resulting in soil contamination. Without these records the type of contaminant, amount of contaminant released and extent of contamination cannot be determined.

1.3 CONTINUED VIABILITY STATEMENT

An Environmental Site Assessment meeting or exceeding the requirements of ASTM E 1527-13 and completed less than 180 days prior to the date of acquisition of the property, or (for transactions not involving an acquisition) the date of the intended transaction, is presumed to be valid. The period of validity may be extended to one year from the date of the investigation, provided that the following components of the inquiries are conducted or updated within 180 days of the date of purchase or the date of the intended transaction:

(i) *Interviews* with *owners*, *operators*, and *occupants*;

(ii) Searches for recorded environmental cleanup liens;

(iii) Reviews of federal, tribal, state, and local government records;

(iv) Visual inspections of the *property* and of *adjoining properties*; and

(v) The declaration by the *environmental professional* responsible for the assessment or update

2.0 Introduction

California Institute of Technology (the Client) retained ENPRO to conduct a Phase I Environmental Site Assessment of the Caltech Submillimeter Observatory near the summit of Mauna Kea, (the "project site").

2.1 LOCATION AND LEGAL DESCRIPTION

The project site, located near the summit of Mauna Kea, is in a conservation setting (Figures 1 and 2). The longitude and latitude for the project site address are in Table 1.

The project site is further described by the County of Hawaii Real Property Tax Office as Tax Map Key (3) 4-4-015: 009; a 0.75 acre portion. It is located in an area zoned "Conservation".

Table 1

Location and Legal Description of Project Site

Location Description	Project Site
Address	Mauna Kea Summit
TMK	(3) 4-4-015:009 ; a 0.75 acre portion
Latitude (North)	19.822500 - 19° 49' 21''
Longitude (West)	-155.475800 - 155° 28' 33''
Elevation	13,350 feet above sea level
Distance and Direction to Surface Waters	Pacific Ocean, 18.5 miles to northeast, Lake Waiau, approximately 1 mile to the south

2.2 SITE AND VICINITY GENERAL CHARACTERISTICS

The project site is located near the north central part of the island of Hawaii. The project site included one rectangular-shaped parcel totaling approximately 0.75 acres. On-site structures were constructed over approximately fifty percent of the project site. Primary access to the site was from Mauna Kea Access Road, north of the project site.

2.3 PURPOSE

The objective of this environmental site assessment is to provide an independent, professional opinion regarding recognized environmental conditions, as defined by the American Society for Testing and Materials (*ASTM, Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process, Designation: E 1527-13*), associated with the project site. The term *recognized environmental condition* is defined as the presence or likely presence of any hazardous substances or petroleum products in, on, or at a property; 1) due to any release to the environment, 2) under conditions indicative of a release to the environment, or 3) under conditions that pose a material threat of a future release. The term includes hazardous substances or petroleum products even under conditions in compliance with laws. The term is not intended to include *de minimis* conditions that generally do not present a material risk of harm to public health or the environment and that generally would not be the subject of an enforcement action if brought to the attention of appropriate governmental agencies. A condition determined to be *de minimis* is not a *recognized environmental condition*.

Recognized environmental conditions (RECs) which have been subject to previous investigation to delineate the extent of contamination and/or have been subject to remediation may be further classified as *historical RECs (H-RECs)* or *controlled RECs (C-RECs)*, in accordance with *ASTM, Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process, Designation: E 1527-13*, if they meet the following requirements:

- *H-RECs* are defined as a past release of any hazardous substance or petroleum product that has occurred in connection with the property and has been addressed to the satisfaction of the applicable regulatory authorities or meeting *unrestricted* use criteria established by a regulatory authority, without subjecting the property to any required controls

- *C-RECs* are defined as a *REC* resulting from a past release that has been addressed to the satisfaction of the applicable regulatory authority, with hazardous substances or petroleum products allowed to remain in place, subject to the implementation of required controls, such as property use restrictions, activity and use limitations (AULs), institutional controls, or engineering controls

2.4 DETAILED SCOPE OF SERVICES

This assessment was performed under the conditions of, and in accordance with ENPRO's Proposal Number 15K-0639-ITO dated November 30, 2015, and in accordance with the *ASTM E 1527-13, Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process,* and *All Appropriate Inquiries* (AAI) which includes 40 CFR Part 312, §312.21 and §312.31. The scope of services in conducting this assessment included:

Records Review

- A review of environmental records, including regulatory agency reports, permits, registrations, and consultant's reports for evidence of *recognized environmental conditions* available from the property owner or site contact.
- An investigation of historical use of the project site by examining locally available aerial photographs, fire insurance maps, property tax files, recorded land title records, USGS topographical maps, building department records, zoning/land use records and/or other readily available historical information for evidence of prior land use that could have led to *recognized environmental conditions*.
- A review of an environmental database search report of federal and state regulatory agency records pertinent to the project site and offsite facilities located within ASTM-specified search distances from the project site.
- A review of regulatory agency files and records if the property, or any of the adjoining properties, is identified on one or more of the standard environmental record sources in the database search, to determine if a *REC, H-REC, C-REC,* or *de minimis* condition exists at the property in connection with the listing.
- A review of readily available information describing the general geology and topography of the project site, local groundwater characteristics, sources of water, power and sewer, and proximity to ecologically sensitive receptors that may be impacted by *recognized environmental conditions.*
- A review of title and judicial records for environmental liens and activity and use limitations (AULs) on behalf of the user, to meet the requirements of 40 CFR 312.20 and 312.25.

Site Reconnaissance

- A site walkthrough inspection of the property for visible evidence of *recognized environmental conditions* including existing or potential soil and groundwater contamination, as evidenced by staining or discoloration; stressed vegetation; indications of waste dumping or burial; pits, ponds or lagoons; containers of hazardous substances or petroleum products; electrical and hydraulic equipment that may contain polychlorinated biphenyls (PCBs), such as transformers or lifts; and underground and aboveground storage tanks.

- A site property line visual assessment of adjacent properties for evidence of potential offsite *recognized environmental conditions* that may affect the project site.

Interviews

- Interviews with available key site personnel regarding current and previous site activities on the property, especially those involving the use of hazardous substances and petroleum products. Required interviews shall include the following persons:
  - The User, defined as the party seeking to use Practice E 1527-13 to complete an environmental assessment of the property. A User has specific obligations for completing a successful application of this practice.
  - The property owner
  - A key site manager, who shall be identified by the owner, *prior to the site visit,* as a person with good knowledge of the uses and physical characteristics of the property (for example, a property manager, chief physical plant supervisor, or head maintenance person).
  - Occupants
  - Past users, when available
  - Neighbors, where the property is abandoned and the *environmental professional* determines there is evidence of potential unauthorized uses of the property.

Interviews are summarized in Section 8 of this report. Completed property questionnaires are presented in the Appendix.

2.5 SIGNIFICANT ASSUMPTIONS

ENPRO, in part, has relied on information supplied by the Client or the Client's agent(s), listed in Section 3.0, and assumes such information to be factual.

The commercial regulatory database search report, summarizing federal and state regulatory agency records, is provided by a contracted data research firm. The information provided is assumed to be correct unless otherwise noted.

Unless otherwise discovered during review, all other sources of information, whether verbal or written, are assumed to be factual.

2.6 LIMITATIONS AND EXCEPTIONS

Access was provided to all known areas of the project site.

As a matter of necessity, ENPRO relies largely on readily available sources of information such as the Client, public records, interviews, and contracted research firms for recognizing potential environmental liabilities at a project site/facility. Requests for information resources are made to collect relevant data on current and past practices conducted at the project site/facility. ENPRO may not receive all information requested or be able to confirm received information during the course of the environmental site assessment. Therefore, ENPRO shall not be held responsible for errors, omissions, or misrepresentations resulting from missing documentation or from inaccurate information provided by such sources.

2.7 SPECIAL TERMS AND CONDITIONS

The client has requested the draft report even if owners have not submitted questionnaires, with the understanding that information may change once the questionnaires are received.

3.0 User Provided Information

Per ASTM, the "User" is the party seeking to use Practice ASTM E 1527-13 to perform an environmental site assessment of the property. A user may include a purchaser, a potential tenant, an owner, a lender or a property manager, all associated with the property. According to ASTM, "the user has specific obligations for completing a successful application of this practice." A Property Questionnaire was completed by Mr. Simon Radford, operations manager, on behalf of the User (California Institute of Technology). A copy of the completed Property Questionnaire is included in the appendix section of this report. Additional User provided information is detailed in Section 8.1.

3.1 Environmental Cleanup Liens and Activity and Use Limitations (AUL) Review

On behalf of the User, ENPRO reviewed a search report for environmental liens and AULs prepared by AFX Research, LLC. The report did not identify any environmental liens or AULs associated with the project site. A copy of the AUL and environmental lien search report is included in the appendix section.

3.2 Specialized Knowledge

Mr. Radford reported the following specialized knowledge of *recognized environmental conditions* in connection with the property:

- Hydraulic fluid release in May 2009

3.3 Commonly Known or Reasonably Ascertainable Information

No commonly known areas of environmental concern were noted in the vicinity of the project site.

3.4 Valuation Reduction for Environmental Impairment

Mr. Radford did not provide information on any reduction of valuation due to environmental impairment.

3.5 OBVIOUS INDICATORS OF PRESENCE OR LIKELY PRESENCE OF CONTAMINATION AT THE PROPERTY

The client identified the following indicators that point to the presence or likely presence of contamination at the property:

- Release of hydraulic fluid occurred approximately six years ago. A *No Further Action* designation from DOH is pending further testing beneath the slab following decommissioning.

3.6 REASONS FOR PERFORMING PHASE I ENVIRONMENTAL SITE ASSESSMENT

The client, Mr. Radford, stated that the purpose for conducting the Phase I Environmental Site Assessment was for the decommissioning of the telescope in accordance with the *Decommissioning Plan for the Mauna Kea Observatories*.

4.0 Records Review

This section presents a review of physical setting sources, standard and additional environmental records sources, and historical use information on the property and surrounding area.

4.1 Physical Setting Sources

4.1.1 TOPOGRAPHY

Review of the topographic map published by the U.S. Geological Survey (2013) indicated the following:

The project site was located near the summit of Mauna Kea in the north-central part of the Big Island of Hawaii. The project site elevation was approximately 13,350 feet above mean sea level.

No individual structures were depicted on the project site.

The project site region was steeply (moderately) sloping in all directions. The nearest body of water was Lake Waiau located one mile to the south. The project site is not within 150 meters of a surface water body.

4.1.2 SOILS

A review of the soil type of the area was performed. The soil survey of the island of Hawaii is published by the USDA Natural Resources Conservation Service in cooperation with the United States Department of Agriculture (USDA) Soil Conservation Service and University of Hawaii Agricultural Experiment Station. USDA soil survey data is available at http://websoilsurvey.nrcs.usda.gov/app/ and was accessed on January 7, 2015. The following information is pertinent to the project site:

The project site was situated on soil classified as Cinder Land (rCL).

Cinder Land consists of bedded cinders, pumice and ash. The soils formed in alluvium derived from basic igneous rock in humid uplands.

Permeability for Cinder Land is described as high (over 20 inches per hour). The soil is described as having a low corrosivity for uncoated steel and concrete.

Cinder Land commonly supports some grass, but is not good pastureland because of its loose consistency. This land is a source of material for surfacing roads.

4.1.3 GEOLOGY/HYDROGEOLOGY

Groundwater beneath the project site occurs in two distinct aquifers within the Waimea Aquifer System of the West Mauna Kea Aquifer Sector. The shallow aquifer is classified as a high level, unconfined, perched aquifer, occurring on an impermeable formation. The groundwater status is reported as currently used, for drinking water. The salinity of the groundwater within this aquifer is described as fresh (<250 milligrams per liter Cl^-). The groundwater is further described as irreplaceable, with a high vulnerability to contamination (Mink and Lau, 1993).

The deeper aquifer is classified as a high level, unconfined, dike aquifer, occurring in dike compartments. The groundwater status is reported as being potentially used for drinking water purposes. The salinity of the groundwater within this aquifer is described as fresh (<250 milligrams per liter Cl^-). The groundwater is further described as irreplaceable, with a moderate vulnerability to contamination (Mink and Lau, 1993).

The hydrogeologic gradient in the vicinity of the project site is not known.

5.0 HISTORICAL RECORDS REVIEW

According to *ASTM E 1527-13, Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process,* the historical search of the property must cover a period of time back to the property's first developed use, or back to 1940, whichever is earlier.

As part of this assessment, ENPRO reviewed several historical sources of information, including aerial photographs, fire insurance maps, USGS topographic maps, building department records, chain of title documents, property tax records and zoning/land use records. The earliest available historical information was the Tax Map Key map dated 1938, when the project site was not yet developed. The first developed use of the site occurred in 1985, when the Caltech Submillimeter Observatory was constructed.

5.1 TITLE RECORDS

Readily available records at the County of Hawaii Tax Assessor's Office were reviewed to assess past ownership of the project site. Significant ownership transactions are summarized below:

Table 2

Summary of Title Information

Tax Map Key	Date	Property Transaction
(3) 4-4-015: 009	1960s	Owned by State of Hawaii
(3) 4-4-015: 009	08/19/68	Leased to the University of Hawaii
(3) 4-4-015: 009	2/10/1984	Sub-leased to the University of Hawaii Science and Engineering Research Council

No readily apparent evidence of *recognized environmental conditions* that are expected to impact the project site was noted in the ownership records reviewed

Copies of the title records reviewed for this project are provided in the appendix.

5.2 HISTORICAL USE INFORMATION ON THE PROPERTY

5.2.1 HISTORICAL SANBORN MAPS

A copy of the correspondence from EDR/Sanborn, indicating no coverage was available for the project site, is included in the appendix section of this report.

5.2.2 HISTORICAL TOPOGRAPHIC MAPS

The following topographic maps were reviewed as part of this assessment:

- A 1956 Topographic map. The scale of this map was one inch equals one-quarter mile. No structures were depicted at the project site.
- A 1982 Topographic map. The scale of this map was one inch equals one-quarter. No structures were depicted at the project site.
- A 1993 Topographic map. The scale of this map was one inch equals one-quarter mile. No structures were depicted at the project site.

- A 2013 Topographic map. The scale of the map was one inch equals one-quarter mile. No structures were depicted at the project site.

Copies of the historic topographic maps reviewed for this project are provided in the appendix section of this report.

5.2.3 HISTORICAL AERIAL PHOTOGRAPHS

The following aerial photographs were reviewed as part of this assessment:

- EDR, dated 1954. The scale of this photograph was approximately one inch equals 750 feet. The project site appeared to be undeveloped,
- EDR, dated 1977. The scale of this photograph was approximately one inch equals 750 feet. The project site appeared to be undeveloped.
- REDI, dated 1992. The scale of this photograph was approximately one inch equals 1,000 feet. The project site appeared to be developed similar to what was observed at the time of our site reconnaissance.
- EDR, dated 1995. The scale of this photograph was approximately one inch equals 1,000 feet. The project site appeared to be developed similar to what was observed at the time of our site reconnaissance.
- EDR, dated 2001. The scale of the photograph was approximately one inch equals 500 feet. The project site appeared to be developed similar to what was observed at the time of our site reconnaissance.

Copies of the historic aerial photographs reviewed for this project are provided in the appendix section of this report.

5.3 HISTORICAL USE INFORMATION ON ADJOINING PROPERTIES

5.3.1 HISTORICAL SANBORN MAPS

A copy of the correspondence from EDR/Sanborn, indicating no coverage was available for the project site, is included in the appendix section of this report.

5.3.2 HISTORICAL TOPOGRAPHIC MAPS

The following topographic maps were reviewed as part of this assessment:

- A 1956 Topographic map. The scale of this map was one inch equals one-quarter mile. No structures were depicted adjoining the project site.
- A 1982 Topographic map. The scale of this map was one inch equals one-quarter mile. Several structures were depicted adjoining the project site.
- A 1993 Topographic map. The scale of this map was one inch equals one-quarter mile. Several structures were depicted adjoining the project site.
- A 2013 Topographic map. The scale of this map was one inch equals one-quarter mile. No structures were depicted adjoining the project site.

Copies of the historic topographic maps reviewed for this project are provided in the appendix section of this report.

5.3.3 HISTORICAL AERIAL PHOTOGRAPHS

The following aerial photographs were reviewed as part of this assessment:

- EDR, dated 1954. The scale of this photograph was approximately one inch equals 750 feet. The properties adjoining the project site appeared to be undeveloped.
- EDR, dated 1977. The scale of this photograph was approximately one inch equals 750 feet. The adjoining properties appear to be developed with several structures.
- REDI, dated 1992. The scale of this photograph was approximately one inch equals 1,000 feet. The adjoining properties appear to be developed with several structures
- EDR, dated 1995. The scale of this photograph was approximately one inch equals 1,000 feet. The adjoining properties appeared to be developed similar to what was observed at the time of our site reconnaissance.
- EDR, dated 2001. The scale of the photograph was approximately one inch equals 500 feet. The adjoining properties appeared to be developed similar to what was observed at the time of our site reconnaissance.

Copies of the historic aerial photographs reviewed for this project are provided in the appendix section of this report.

5.4 PREVIOUS ENVIRONMENTAL REPORTS

No previous environmental reports were available for review.

6.0 Regulatory Database Review

6.1 STANDARD ENVIRONMENTAL RECORD RESOURCES: FEDERAL, STATE AND LOCAL DATABASE SEARCH

The regulatory database search report prepared by Environmental Data Resources, Inc. (EDR) was reviewed to evaluate the project site and listed properties within ASTM-recommended search distances. Federal, state and local databases reviewed are included in the Appendix section of this report.

Project site

The project site was not listed in the EDR regulatory database search report.

Adjacent and Nearby Properties

No adjacent or nearby properties were listed in the EDR regulatory database search report, within the ASTM minimum search distances.

6.2 ADDITIONAL ENVIRONMENTAL RECORD RESOURCES: STATE AND LOCAL AGENCY ENVIRONMENTAL RECORD SOURCES

Based on ENPRO's review of the EDR regulatory database search report, regulatory files from the State of Hawaii Department of Health (DOH) were requested and reviewed. Our review considers both proximity to the project site and local hydrogeologic conditions to identify which sites and which environmental violations may be interpreted to have a potential impact to the project site's environmental conditions.

ENPRO additionally requested information on the project site from the County of Hawaii Fire Department and reviewed documents from the Hawaii Department of Planning and Permitting.

6.2.1 DEPARTMENT OF HEALTH, SOLID AND HAZARDOUS WASTE BRANCH

Based on our review of the EDR regulatory database search report, we requested the following regulatory files from the State of Hawaii Department of Health (DOH), Solid and Hazardous Waste Branch (SHWB):

- TMK (3) 4-4-015: 009

The State of Hawaii Department of Health (DOH), Solid and Hazardous Waste Branch indicated that no regulatory files existed for TMK (3) 4-4-015: 009.

6.2.2 DEPARTMENT OF HEALTH, HAZARD EVALUATION AND EMERGENCY RESPONSE (HEER) OFFICE

Based on our review of the EDR regulatory database search report, we requested the following regulatory files from the State of Hawaii Department of Health (DOH), Hazard Evaluation and Emergency Response (HEER) Office:

- TMK (3) 4-4-015:009

The HEER Office provided the following:

1) **Caltech Submillimeter Observatory**

- Release Notification dated January 15, 2016 discussing the May 27, 2009 release of 22.7 gallons of hydraulic oil. Excavation and removal of contaminated soil was completed. There is remaining impacted soil under the slab believed to be from previous releases. A *No Further Action* designation is pending further testing of the soil under the slab to be conducted after the decommissioning of the observatory.

It is ENPRO's opinion that this is a *recognized environmental condition.* The release of hydraulic fluid is considered a REC because it has not been cleaned up to the satisfaction of the Department of Health and further testing is required.

6.2.3 BUILDING, PLANNING, AND/OR ZONING DEPARTMENTS

The County of Hawaii Department of Planning and Permitting database was reviewed on January 8, 2016 to obtain historical use information for the project site. Based on our review of the planning and permitting database, evidence of *recognized environmental conditions* associated with the project site was not discovered.

6.2.4 FIRE DEPARTMENT

The County of Hawaii Fire Communication Center was contacted on December 30, 2015 to obtain information regarding any fires, complaints, permits, violations involving hazardous materials use, USTs or ASTs on record for the project site and/or adjoining properties. ENPRO has not received a response from the County Fire Communication

Center as of the date of this report. Should our review of these files at a later date impact our findings, conclusions or recommendations, ENPRO shall forward an addendum letter to such effect.

6.3 VAPOR ENCROACHMENT SCREENING IN PROPERTY INVOLVED IN REAL ESTATE TRANSACTIONS

ENPRO reviewed the regulatory database search provided by EDR and other regulatory records for recorded releases within the recommended radii for vapor encroachment. The EDR provides an initial search of all ASTM E 2600-10 standard government record databases and EDR proprietary historical records related to former dry cleaners, gas stations and manufactured gas plants the 1/3 mile and 1/10 mile approximate minimum distances defined in ASTM E 2600-10 for chemicals of concern (COC)-contaminated sites. This measurement is based upon the distance from the known or suspect contaminated property to the target property boundary polygon. ENPRO's review of EDR's vapor encroachment screening (VES) takes into account the following factors:

- The land use of the *target property* (TP)
- Type of COC
- Location of known or suspect contaminated property is in the area of concern (AOC) having COC
- Characteristics of the soil
- Depth to groundwater
- Vapor conduits that may result in significant preferential pathways
- Cleanup status of contaminated property

Potential vapor encroachment conditions (VECs) evaluated included all *recognized environmental conditions*, including H-RECs and C-RECs with identified releases of petroleum products or other potentially volatile contaminants of concern.

ENPRO's VES did not identify any potential VECs within the recommended radii provided in ASTM E 2600-10 with the potential to impact the project site, except for the release of hydraulic oil six years ago at the project site. The release has been addressed to the satisfaction of the applicable regulatory authority. During excavation and removal of contaminated soil, additional contaminated soil was discovered. It is believed this contamination occurred during construction of the observatory. Assuming the contaminated soil is addressed during decommissioning, ENPRO has not identified any VECs associated with this property.

7.0 Site Reconnaissance

Site reconnaissance was performed by Ms. Heather Schauer on January 6, 2016. The site reconnaissance was conducted on foot. All areas of the property were available for inspection.

7.1 CURRENT USE OF THE PROPERTY

The project site is an observatory with a 10.4 meter telescope, a pump shed, a transformer, a generator and an outbuilding used for storage.

7.2 DESCRIPTIONS OF STRUCTURES, ROADS & OTHER IMPROVEMENTS

Three buildings were observed at the project site as described below:

- Telescope, approximately three stories, approximate construction date 1985.
- Pump shed, single story, approximate construction date 1985.
- Outbuilding, single story, approximate construction date 1985.

Mr. Simon Radford, Operations Manager for the Caltech Submillimeter Observatory, reported that the following companies/agencies provide project site utilities and service:

Electricity:	HELCO (Hawaii Electric Light Company)
Gas or other fuel:	Propane provided by Airgas
Water:	Trucked in by Island Topsoil from County Water Station
Sewer:	Cesspool
Refuse:	Off-site
Other Utilities:	Hydraulic systems are maintained by in-house technicians

7.3 CURRENT USES OF ADJACENT AND NEARBY PROPERTIES

The area surrounding the project site consisted of observatories and vacant land. Adjoining properties were observed from the project site and from public access lands for signs of *recognized environmental conditions* and their potential to pose an environmental concern to the project site. These properties are listed in the following table:

Table 3

Summary of Adjacent and Nearby Property Use

Direction	Name	Use
West	James Clerk Maxwell Telescope	Observatory
North	Conservation District	Vacant
East	Conservation District	Vacant
South	Conservation District	Vacant

Table 4 summarizes the site inspection and findings. All features that were observed during the site reconnaissance, or that were discovered to have been historically present at the project site, are noted in the table. Also indicated in the table are items that may present concerns to the project site. Additional information about items noted in the table can be found in the referenced section of this report.

Table 4

Site Inspection Findings

Onsite Environmental Features	Currently / Historically Present	Possible Environmental Concern	Report Section
Hazardous substances or Petroleum Products	Yes	Yes	7.4
Underground Storage Tank, UST	No	No	
Aboveground Storage Tank, AST	Yes	No	7.5.2
Odors	No	No	
Air Emissions *(stacks, hoods, other point sources)*	No	No	

Table 4 **(continued)**

Site Inspection Findings

Onsite Environmental Features	Currently / Historically Present	Possible Environmental Concern	Report Section
Pools of Liquid	Yes	No	7.9
Drums	Yes	No	7.9
Unidentified Substance Containers	Yes	No	7.9
Electrical Equipment/Possible PCBs	Yes	No	7.7.1
Hydraulic Equipment/Possible PCBs	Yes	No	7.7.2
Stains or Corrosion	Yes	No	7.9
Drains	Yes	No	7.9
Sumps	No	No	
Pits, Ponds, or Lagoons	No	No	
Stained Soil or Pavement	Yes	No	7.9
Stressed Vegetation	No	No	
Evidence of Spills or Releases	Yes	Yes	7.9
Artificially Filled Areas *(Solid Waste Disposal)*	No	No	
Waste Water	No	No	
Wells	No	No	
Septic Systems *(cisterns, cess pools, dry wells)*	Yes	No	7.9
Dry Cleaning Operations	No	No	
Agricultural Use *(pesticides/herbicides/fungicides)*	No	No	
Oil/Gas Production or Exploration	No	No	
Remedial Activities	No	No	
Other			

7.4 HAZARDOUS SUBSTANCES AND PETROLEUM PRODUCTS

Project Site

Visual observation for the use and/or storage of hazardous substances and petroleum products was performed.

Hazardous substances and/or petroleum products were observed generated, stored, accumulated, transported, or disposed on site. Glycol was located in drums in various locations within the dome of the observatory. There were also numerous hoses labeled "Glycol".

Hydraulic oil drums and buckets labeled "Used Hydraulic Oil" were observed within the dome and within the flammables storage locker outside.

None of the hazardous substances and/or petroleum products observed on the project site during the site reconnaissance appeared to be causing or contributing to any site contamination.

Adjoining or Nearby Sites

No activities were observed on adjoining or nearby properties that would indicate that hazardous substances and/or petroleum products are likely to be used, generated, stored, accumulated, transported, or disposed.

7.5 STORAGE TANKS

7.5.1 UNDERGROUND STORAGE TANKS

Project Site

Visual observations for manways, vent pipes, fill connections, concrete pressure dispersion pads, and dispenser pumps were conducted throughout the project site. Evidence indicating historical or current existence of USTs was not observed.

Adjoining or Nearby Sites

Visual observations for manways, vent pipes, fill connections, concrete pressure dispersion pads, and dispenser pumps were conducted throughout the accessible areas of adjacent properties. No evidence of the presence of USTs was noted.

7.5.2 ABOVEGROUND STORAGE TANKS

Project Site

Visual observations for vent pipes, secondary containment walls, or other evidence of above ground storage tanks were conducted throughout the project site. An above ground water storage tank was observed within the dome of the observatory.

Adjoining or Nearby Sites

Visual observations for vent pipes, secondary containment walls, or other evidence of above ground storage tanks were conducted throughout the accessible areas of adjacent properties. No evidence of the presence of ASTs was noted.

7.6 SOLID WASTE

Project Site

At the time of our investigation, non-hazardous solid waste was not generated onsite.

Adjoining or Nearby Sites

At the time of our investigation, non-hazardous solid waste was observed to be generated on adjoining or nearby site. Waste was in the form of general refuse and was disposed of off-site.

7.7 POLYCHLORINATED BIPHENYLS (PCBS)

Visual observation for electrical equipment or electrical components that use dielectric fluid, hydraulic lift equipment and fluorescent light ballasts that potentially include PCB-containing fluids was conducted. PCBs (polychlorinated biphenyl) are heavily regulated under the Toxic Substances Control Act (TSCA), which obligates a property owner to clean up any spills occurring on their property.

7.7.1 ELECTRICAL TRANSFORMERS/CAPACITORS

One vaulted transformer belonging to Hawaiian Electric Light Company (HELCO) was observed on the site. No evidence of leakage or corrosion on the outside of the vaulted transformer was noted during the project site reconnaissance.

An inquiry was sent to HELCO regarding the PCB content of the vaulted transformer. HELCO responded to the inquiry and indicated the transformers were “non-PCB” or “PCB-free.

Since the transformers are owned and operated by HELCO, HELCO is responsible for remediating any environmental impacts they might cause. Details regarding correspondence with HECO can be found in the appendix section of this report.

No privately-owned transformer equipment was observed within the facility.

7.7.2 HYDRAULIC EQUIPMENT

Visual observation for hydraulic equipment or components containing hydraulic fluid that potentially contains PCBs was conducted.

The ENPRO investigator observed evidence of hydraulic equipment throughout the project site. Hydraulic equipment included a hydraulic rotating mechanism and hydraulic pistons.

7.7.3 FLUORESCENT LIGHT BALLASTS

Fluorescent light fixtures are present at the project site. Many fluorescent light fixtures manufactured prior to 1980 may have contained ballasts with PCBs. Since the project site was constructed after 1980, PCB-containing light ballast should not be a concern.

7.8 WELLS

Evidence of wells (supply, monitoring or dry wells) was not observed during the assessment.

7.9 OTHER OBSERVATIONS

The following describes additional observations of the project site:

Odors:	Not observed
Pools of liquid:	Not observed
Drums:	Observed
Drains and Sumps:	Not observed*
Pits, ponds, lagoons:	Not observed
Stained soil or pavement:	Observed
Stressed vegetation:	Not observed
Waste water features:	Not observed

Septic systems: Observed

* Mr. Radford indicated there had been a drain at the base of the telescope which was sealed after the hydraulic oil release in May 2009.

A minor hydraulic fluid leak was observed at the base of the observatory which resulted in a small puddle.

Several drums were observed at the project site. A large drum labeled “Residue of Used Chevron Aw42 Hydraulic Oil” was under the boards at the base of the observatory. The drum was determined to be empty. An unmarked drum containing used oily rags and miscellaneous refuse was observed on the second level. Two small drums labeled “contaminated” and containing used glycol were noted on the third level.

Minor staining was observed on the asphalt in the parking area. Staining was also observed on the concrete at the base of the observatory.

A man-hole cover, associated with the cesspool, was observed to the south of the potable-water shed.

8.0 INTERVIEWS

Interviews with individuals having past or present knowledge of the project site, such as owners, key site managers, occupants, and neighbors are routinely conducted to obtain information indicating *recognized environmental conditions* in connection with the property. The following individuals were available to interview:

Table 5

Key Site Interviews

Interviewee Name	Relationship to Property	Length of Time Familiar with Property	Date of Interview
Mr. Simon Radford	Operations Manager	5.5yrs	1/06/2016
Ms. Stephanie Nagata	Master Lease Holder	15.5yrs	1/28/2016
Mr. Russell Tsuji	Owner	1 yr	3/7/2016

The ASTM Standard states that the following persons should be interviewed regarding the historical use(s) of the property:

- The User
- The property owner
- A key site manager, who shall be identified by the owner, *prior to the site visit,* as a person with good knowledge of the uses and physical characteristics of the property (for example, a property manager, chief physical plant supervisor, or head maintenance person).
- Occupants
- Past users, when available
- Neighbors, where the property is abandoned and the *environmental professional* determines there is evidence of potential unauthorized uses of the property.

8.1 KEY SITE MANAGER

Mr. Simon Radford, Operations Manager, was interviewed in person at the time of the site visit on January 6, 2016.

Project Site

Mr. Simon Radford has been familiar with the project site for 5.5 years and reported the following significant environmental issues regarding the project site:

A hydraulic fluid release in May 2009 resulted in 22.7 gallons of fluid being released onto the floor of the observatory. Most fluid was recovered but approximately five gallons was believed to have escaped down a floor drain. Myounghee Noh and Associates, LLC, hand excavated the drain hole for lab analysis. Based on the laboratory results, backfill was removed from under the concrete slab to a depth of 55-57 inches and width and length of 4 feet. Mr. Radford noted the drain has since been plugged.

Adjoining and Adjacent Properties

Mr. Simon Radford has been familiar with the project site for 5.5 years and reported no information regarding past or present contamination and/or activities on adjacent properties that may have resulted in contamination of the project site.

8.2 MASTER LEASE HOLDER

Ms. Stephanie Nagata, Director OMKM, completed a Property Questionnaire supplied by ENPRO Environmental regarding the project site. A copy of the completed Property Questionnaire is included in the appendix section of this report.

Project Site

Ms. Stephanie Nagata has been familiar with the project site for 15.5 years and reported the following significant environmental issues regarding the project site:

A hydraulic fluid release in May 2009 resulted in 22.7 gallons of fluid being released onto the floor of the observatory. Most fluid was recovered but approximately five gallons was believed to have escaped down a floor drain.

Adjoining and Adjacent Properties

Ms. Stephanie Nagata has been familiar with the project site for 15.5 years and reported no information regarding past or present contamination and/or activities on adjacent properties that may have resulted in contamination of the project site.

8.3 OWNER

Mr. Russell Tsuji, Department of Land and Natural Resources, Land Division, completed a Property Questionnaire supplied by ENPRO Environmental regarding the project site. A copy of the completed Property Questionnaire is included in the appendix section of this report.

Project Site

Mr. Russell Tsuji has been familiar with the project site approximately one year and reported no information regarding past or present contamination and/or activities on the property that may have resulted in contamination of the project site.

Adjoining and Adjacent Properties

Mr. Russell Tsuji has been familiar with the project site approximately one year and reported no information regarding past or present contamination and/or activities on adjacent properties that may have resulted in contamination of the project site.

9.0 EVALUATION

This section documents the findings, opinions, and conclusions of the Phase I Environmental Site Assessment. ASTM E 1527-13 does not require the *environmental professional* to provide recommendations regarding identified environmental conditions at the project site. As a service to its clients, ENPRO provides recommendations to further evaluate and/or address environmental concerns in Section 10.0 of this report.

9.1 FINDINGS AND CONCLUSIONS

We have performed a *Phase I Environmental Site Assessment* in conformance with the scope and limitations of ASTM Practice E 1527-13 of the Caltech Submillimeter Observatory, the *property*. Any exceptions to, or deletions from, this practice are described in Section 2.6 of this *report*. This assessment has revealed no evidence of *recognized environmental conditions (RECs)* in connection with the *property* **except for the following:**

- REC 1 Hydraulic Fluid Release. This finding is considered a *recognized environmental condition* because, despite the release being cleaned up to the satisfaction of the Department of Health there is a *No Further Action* status pending further soil testing under the slab after the decommissioning of the observatory.

REGULATORY RECORDS REVIEW SUMMARY (SECTION 6.0)

DOH HEER records indicated a release of 22.7 gallons of hydraulic oil occurred in May 2009. 3,500 pounds of backfill was removed and disposed of at the West Hawaii Landfill. The lateral extent of contamination was not determined. A *No Further Action* designation is pending additional investigation and cleanup to be undertaken when the observatory is decommissioned. Therefore, ENPRO recommends multi-increment sampling of the soil at the project site and analysis for contaminants of potential concern associated with the hydraulic fluid release following dismantling of the Caltech Submillimeter Observatory.

9.2 DATA GAPS

Data gaps are not uncommon in environmental site assessments. A data gap by itself is not inherently significant. The significance is determined by other information and professional experience as to whether the data gap raises reasonable concerns about activities that may present a *recognized environmental condition*. According to *ASTM E 1527-13, Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process,* and *All Appropriate Inquiries* (AAI) which includes 40 CFR Part 312, §312.21 and §312.31, the Phase I Environmental Site Assessment report shall identify and comment on significant data gaps that affect the ability of the environmental professional to identify *recognized environmental conditions* and identify the sources of information that were consulted to address the data gap.

The following significant data gap was encountered by ENPRO when conduction this Phase 1 ESA:

- DOH HEER Office does not have any records regarding releases at the Caltech Submillimeter Observatory other than the hydraulic oil release of May 2009. It is believed that a release occurred during the construction of the observatory resulting in soil contamination. Without these records the type of contaminant, amount of contaminant released and extent of contamination cannot be determined.

ENPRO attempted to contact the individual(s) listed in the table below to obtain information regarding the project site, however, no response has been received as of the date of this report. This represents a data gap for the project site that may or may not impact our conclusions and recommendations for this property.

Table 6

Unavailable Project Contacts

Interviewee Name	Relationship to Property	Date Contact Attempted	Purpose of Contact
Mr. Sam Lemmo	Owner, DLNR Office of Conservation and Coastal Lands	1/15/216	Property Questionnaire

Should a response from any of the above individuals be received at a later date and impact our findings, conclusions or recommendations, ENPRO shall forward an addendum letter to such effect.

9.3 CERTIFICATIONS

ENPRO has completed a Phase I Environmental Site Assessment (ESA) in conformance with the scope and limitations of ASTM Practice E 1527-13 of Caltech Submillimeter Observatory at the summit of Mauna Kea on the Island of Hawaii, Hawaii (the "project site"). This assessment was performed at the request of California Institute of Technology (the "Client") using the methods and procedures consistent with good commercial and customary practices designed to conform to acceptable industry standards.

The information and opinions rendered in this report are intended for the Client for the purposes stated herein (see Sections 1.2 and 2.3). This report is not for the use or benefit of, nor may it be relied upon by any other person or entity, for any purpose except as described below without the advance written consent of ENPRO. ENPRO shall not distribute nor publish this report without the consent of the Client except as required by law or court order. The information and opinions expressed in this report are given in response to a limited assignment and should be considered and implemented in light of that assignment.

The Client may rely upon this report in evaluating a request for one or more extensions of credit to be secured directly or indirectly by the subject property (including mortgage and mezzanine loans) and the acquisition of the direct or indirect interest in the subject property as applicable.

In expressing the opinions stated in this report, ENPRO has exercised a degree of skill and care ordinarily exercised by a reasonable prudent environmental professional in the same community and in the same time frame given the same or similar facts and circumstances. Documentation and data provided by the Client, designated representatives of the Client or other interested third parties, or from the public domain, and referred to in the preparation of this assessment, have been used and referenced with the understanding that ENPRO assumes no responsibility or liability for their accuracy.

The independent conclusions represent our professional judgment based on information and data available to us during the course of this assignment. Factual information regarding operations, conditions, and test data provided by the Client or their representatives has been assumed to be correct and complete. The conclusions presented are based on the data provided, observations, and conditions that existed on the date of the site visit.

If you have any questions regarding this report, please contact the ENPRO contact listed on the cover of this report at (808) 748-2108.

Researched by: Heather Schauer, Environmental Technician

Surveyed by: Heather Schauer, Environmental Technician

Written by: Heather Schauer, Environmental Technician

Supervised by: Kenton Beal, Executive Vice President

I declare that to the best of my professional knowledge and belief, I meet the definition of Environmental Professional as defined in §312.10 of 40 CFR Part 312.

I have the specific qualifications based on education, training, and experience to assess a property of the nature, history, and setting of the subject *property* (project site). I have developed and performed the all appropriate inquiries in conformance with the standards and practices set forth in 40 CFR Part 312.

Reviewed by:

Kenton Beal
Technical Director, ENPRO Environmental

10.0 Non-Scope Services

ASTM E 1527-13 does not require recommendations. A User should consider whether recommendations for additional inquiries or other services are desired. Recommendations are an additional service that may be useful in the User's analysis of the property. Unless otherwise directed by the Client, it is ENPRO's standard practice to include recommendations for addressing all identified *RECs* at the subject property.

ENPRO may also make recommendations regarding conditions identified at the project site which are not considered *RECs*, such as the proper storage of hazardous materials, the potential presence of asbestos containing materials, and the presence of ecological or cultural resources. Except where otherwise specified, there are no legal or regulatory requirements for the Client or the property owner to follow the recommendations presented in this report.

10.1 Recommendations

Based on the *RECs* identified in this investigation, ENPRO recommends the following additional actions and/or investigations:

(1) REC 1 Hydraulic Oil Release. Conduct Phase II multi-increment sampling of the soil at the project site and analysis for contaminants of potential concern associated with the hydraulic fluid release following dismantling if the Caltech Submillimeter Observatory.

Associated cost estimate for Phase II ESA……………$15,000-$20,000*

* - Assuming observatory has been dismantled and removed.

10.2 Additional Environmental Concerns, Non-ASTM

The following environmental conditions were evaluated for the potential to impact the property though they are not considered *recognized environmental conditions* as defined by ASTM.

Asbestos-Containing Materials

In July 1989, under the Toxic Substances Control Act (TSCA), the United States Environmental Protection Agency (USEPA) promulgated an Asbestos Ban Phaseout Rule. Beginning in 1990 and taking effect in three stages, the rule prohibits the importation, manufacture, and processing of ninety-four percent of all remaining asbestos products in the United States over a period of seven years. Presently, asbestos has not been prohibited from all construction building materials.

No sampling for asbestos containing materials was conducted as part of this investigation.

Suspect asbestos containing materials should be sampled and analyzed for possible asbestos content prior to activities (e.g., renovation, demolition,) that may damage or disturb the material. If the materials are asbestos-containing, the building owner must comply with applicable USEPA National Emissions Standards for Hazardous Air Pollutants (NESHAPS), OSHA, state and local regulations.

Radon

Radon is a naturally occurring radioactive gas formed by the decay of uranium in bedrock and soil. The potential adverse health effects associated with radon gas depend on several factors including concentration of the gas and duration of exposure. The concentration of radon gas in a building depends on subsurface soil conditions, the integrity of the building's foundation, and the building's ventilation system.

Due to the geologic composition of basalt bedrock and the soils that derive from them, as well as the composition of marine-related sediments found in Hawaii, the State of Hawaii has been determined to have a low radon potential (G.M. Reimer, U.S. Geological Survey). Therefore, investigation of radon is not recommended for this property.

Lead-Based Paint

There is no commercial property definition of what is a lead-based paint. Regulations specifically addressing lead-based paint include Housing and Urban Development (HUD) (1995) guidelines and the Consumer Product Safety Act (1977). These regulations are for housing and consumer products.

OSHA regulations apply to worker protection during renovation and demolition activities.

Sensitive Ecological Areas

According to the EDR report, no areas were depicted as sensitive ecological areas or federal wetlands.

Decommissioning and Disposal

At the time of decommissioning all hazardous materials and petroleum products must be properly managed and disposed.

11.0 REFERENCES

Publications:

Names of Publication:	Aquifer Identification and Classification for the Island of Hawaii : Groundwater Protection Strategy For Hawaii
Author of Publication:	Mink, J.F. and L.S. Lau
Published by:	Water Resources Research Center, University of Hawaii at Manoa, Honolulu, Hawaii
Date of Publication:	1993
Information Obtained:	Groundwater data

Names of Publication:	Ownership records and Tax Map Key maps
Author of Publication:	County of Hawaii
Information Obtained:	Ownership records

Names of Publication:	Aerial Photographs
Author of Publication:	EDR
Published by:	EDR
Date of Publication:	1954, 1977, 1992, 1995, 2001
Information Obtained:	Historical use

Names of Publication:	Code of Federal Regulations, Title 40, Part 761, Rules for Controlling PCBs under the Toxic Substance Control Act,
Author of Publication:	U.S. Environmental Protection Agency
Date of Publication:	December 14, 1990
Information Obtained:	PCB regulations

Names of Publication:	Soil Survey for the Island of Hawaii, State of Hawaii
Author of Publication:	Foote, Donald E. et al.
Published by:	U.S. Department of Agriculture, Soil Conservation Service, in cooperation with the University of Hawaii Agricultural Experiment Station. Also available at http://websoilsurvey.nrcs.usda.gov/app/ accessed on January 7, 2016.

Date of Publication:	1973
Information Obtained:	Soil classification

Names of Publication:	The EDR Radius Map Report
Author of Publication:	Environmental Data Resources, Inc.
Date of Publication:	December 30, 2015
Information Obtained:	Regulatory database records

Names of Publication:	Topographic Maps, Mauna Kea Quadrangle, Hawaii
Author of Publication:	United States Geological Survey (USGS)
Date of Publication:	1956, 1982, 1993, 2013
Information Obtained:	Historical use

Contacts:

Agency or Business:	California Institute of Technology
Name/Title of Representative:	Mr. Simon Radford
Location of Agency or Business:	Pasadena, California
Telephone Number:	808-333-4871
Date Information was Received:	January 6, 2016
Information Obtained:	Historical and current property use

Agency or Business:	Solid and Hazardous Waste Branch (SHWB)
Location of Agency or Business:	919 Ala Moana Boulevard
Telephone Number:	808-586-4226
Date Information was Received:	January 11, 2016
Information Obtained:	Regulatory records

Agency or Business:	Hazard Evaluation and Emergency Response (HEER)
Location of Agency or Business:	919 Ala Moana Boulevard
Telephone Number:	808-586-4249
Date Information was Received:	January 19, 2016
Information Obtained:	Regulatory records

APPENDICES

Site Figures
Site Photographs
Historical Research
Regulatory Records Documentation
Records of Communication/Interview
Qualifications of Environmental Professionals

SITE FIGURES

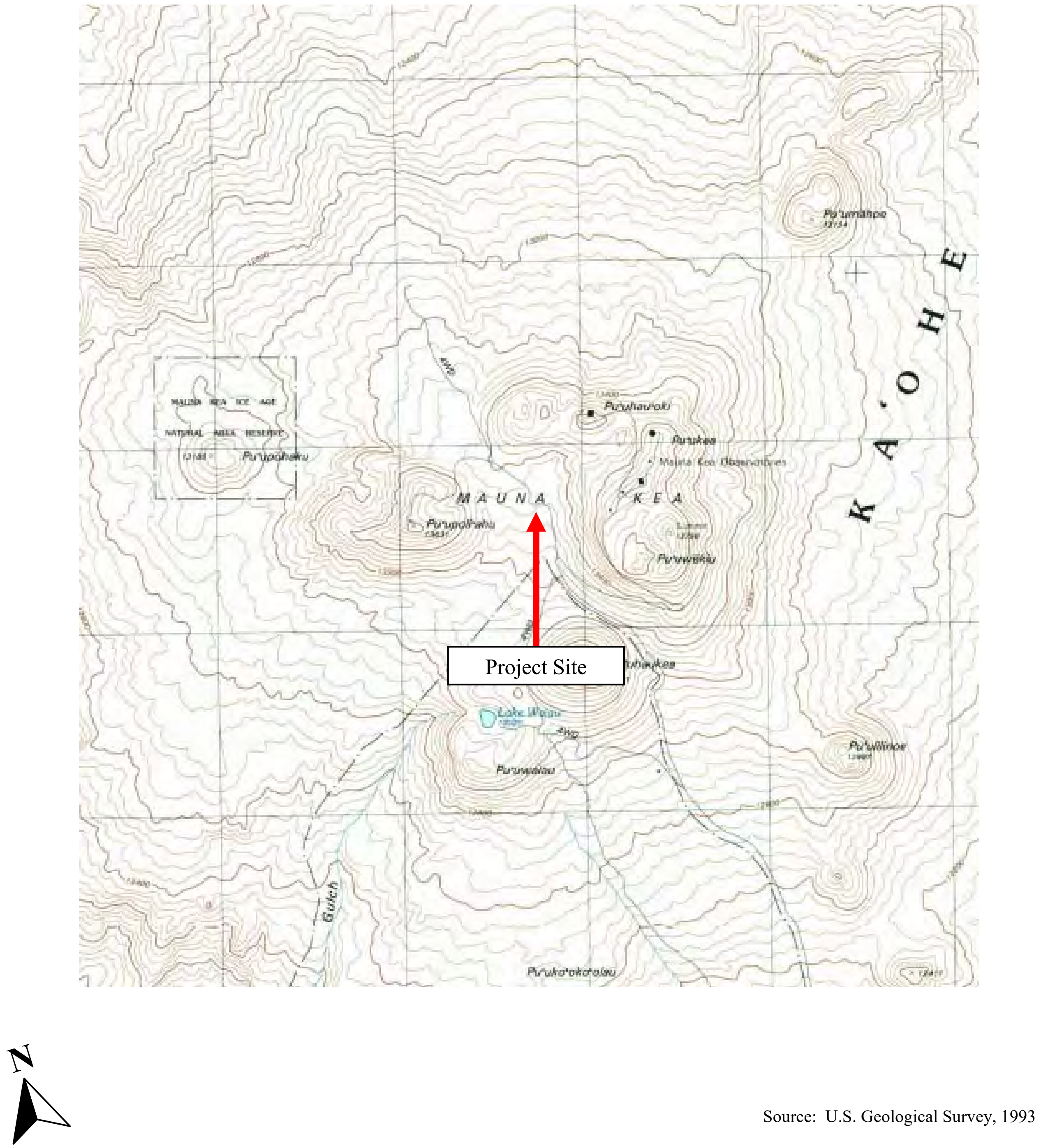
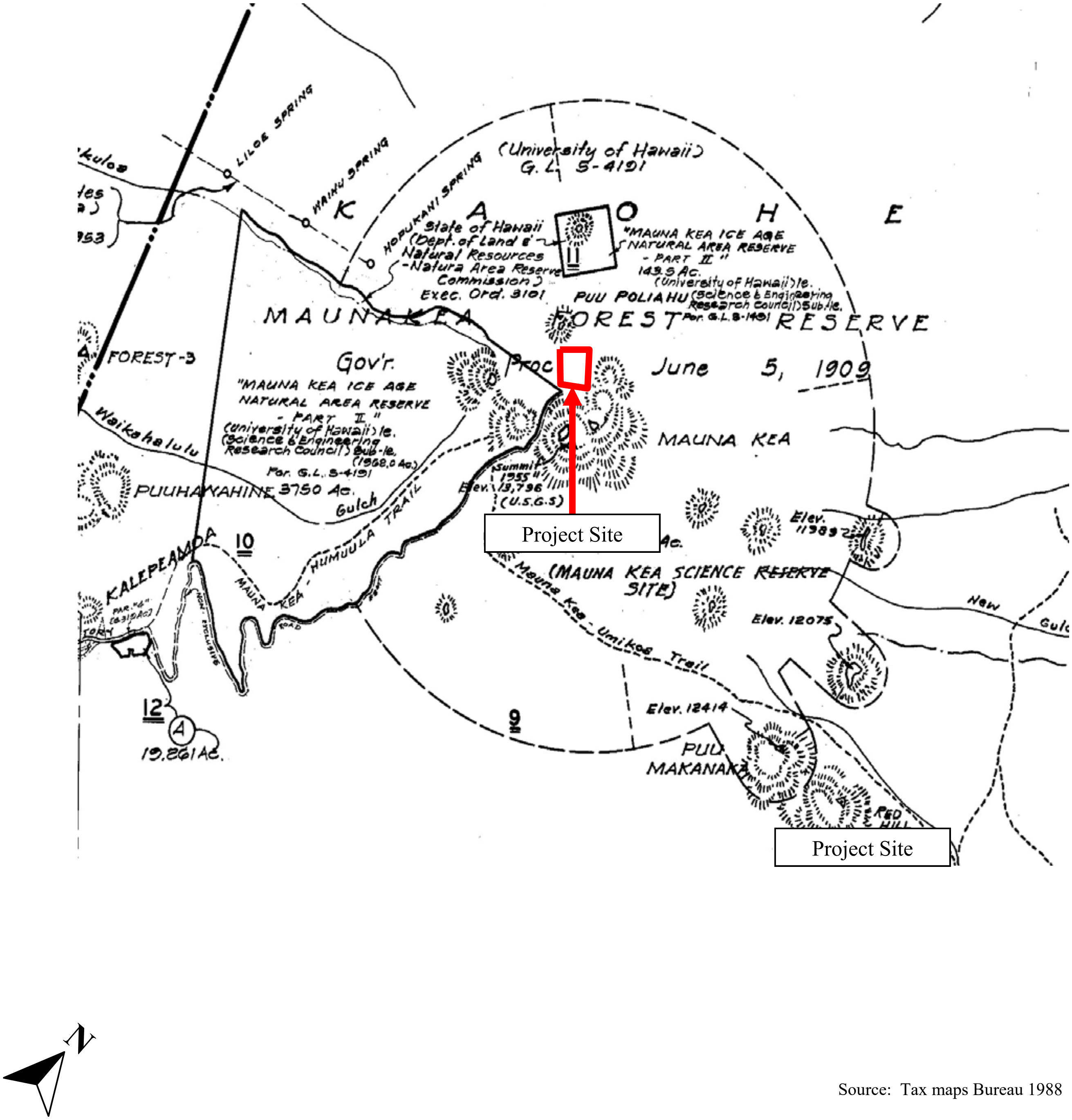


Figure 1
TOPOGRAPHIC MAP

Scale: 1 inch = 1, 320 feet

Project Number 1512-00532-PH1
Mauna Kea Summit

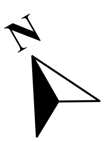


Source: Tax maps Bureau 1988

Figure 2
TAX MAP KEY (3) 4-4-015: 009

Scale: 1 inch = Approximately 1,500 feet

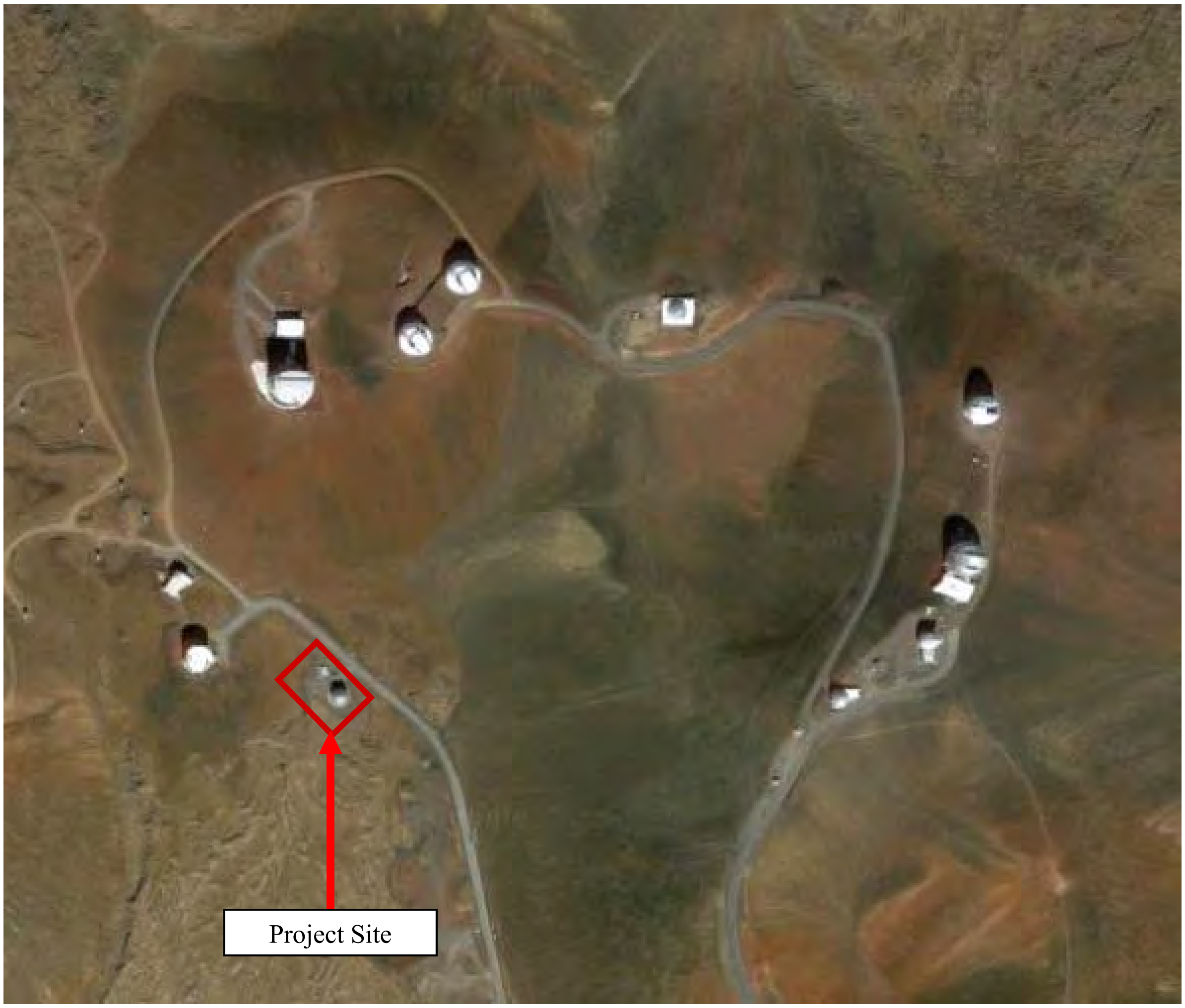
Project Number 1512-00532-PH1
Mauna Kea Summit



Source: EDR 2001

Figure 5
AERIAL PHOTOGRAPH

Scale: 1 inch = Approximately 750 feet



N

Source: Google Earth 2016

Figure 6
Aerial Photograph

Scale: 1 inch = Approximately 750 feet

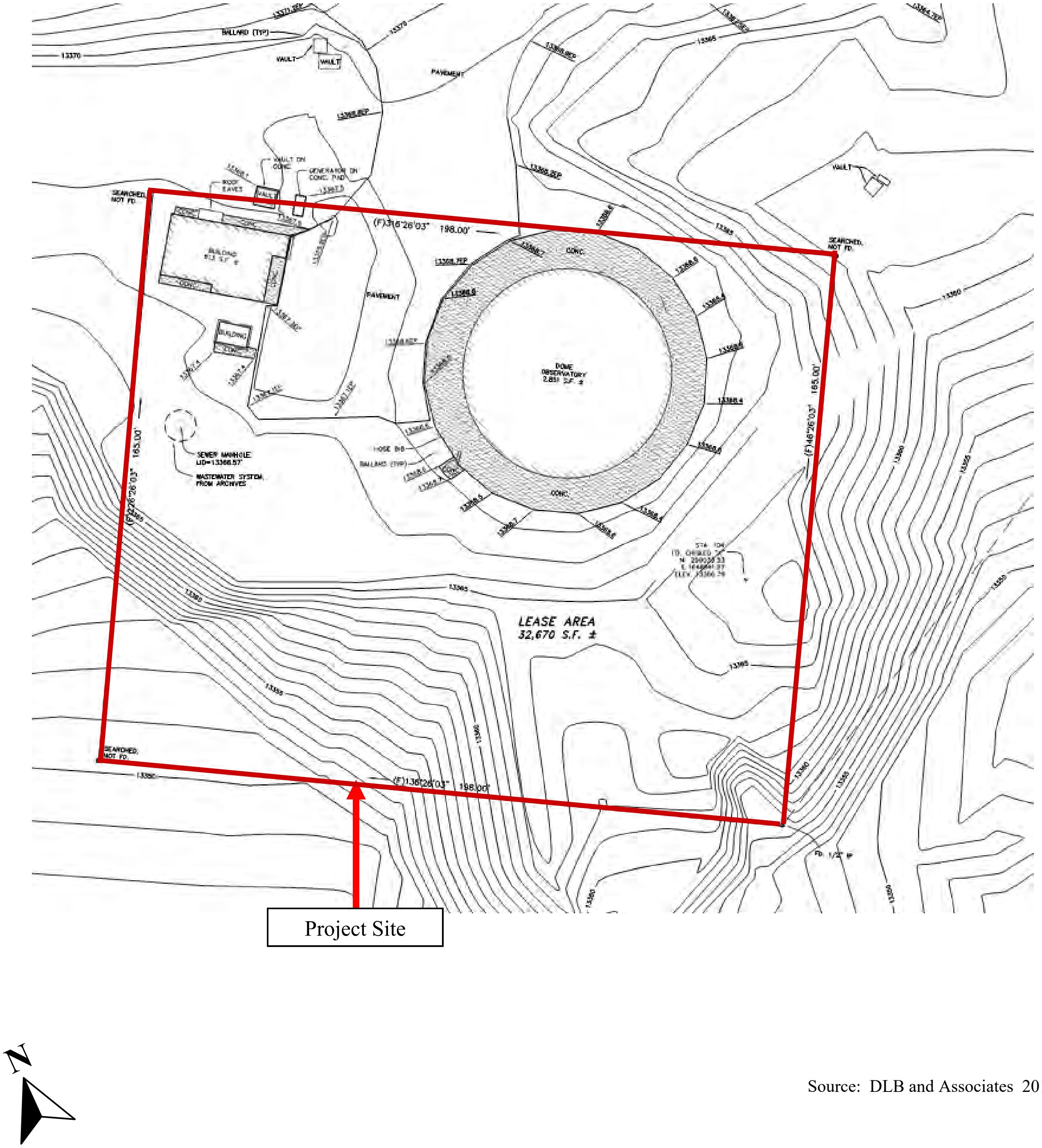


Figure 5
TOPOGRAPHIC MAP

Scale: 1 inch = 60 feet

SITE PHOTOGRAPHS

Photo 1

Caltech Submillimeter Observatory, Facing North

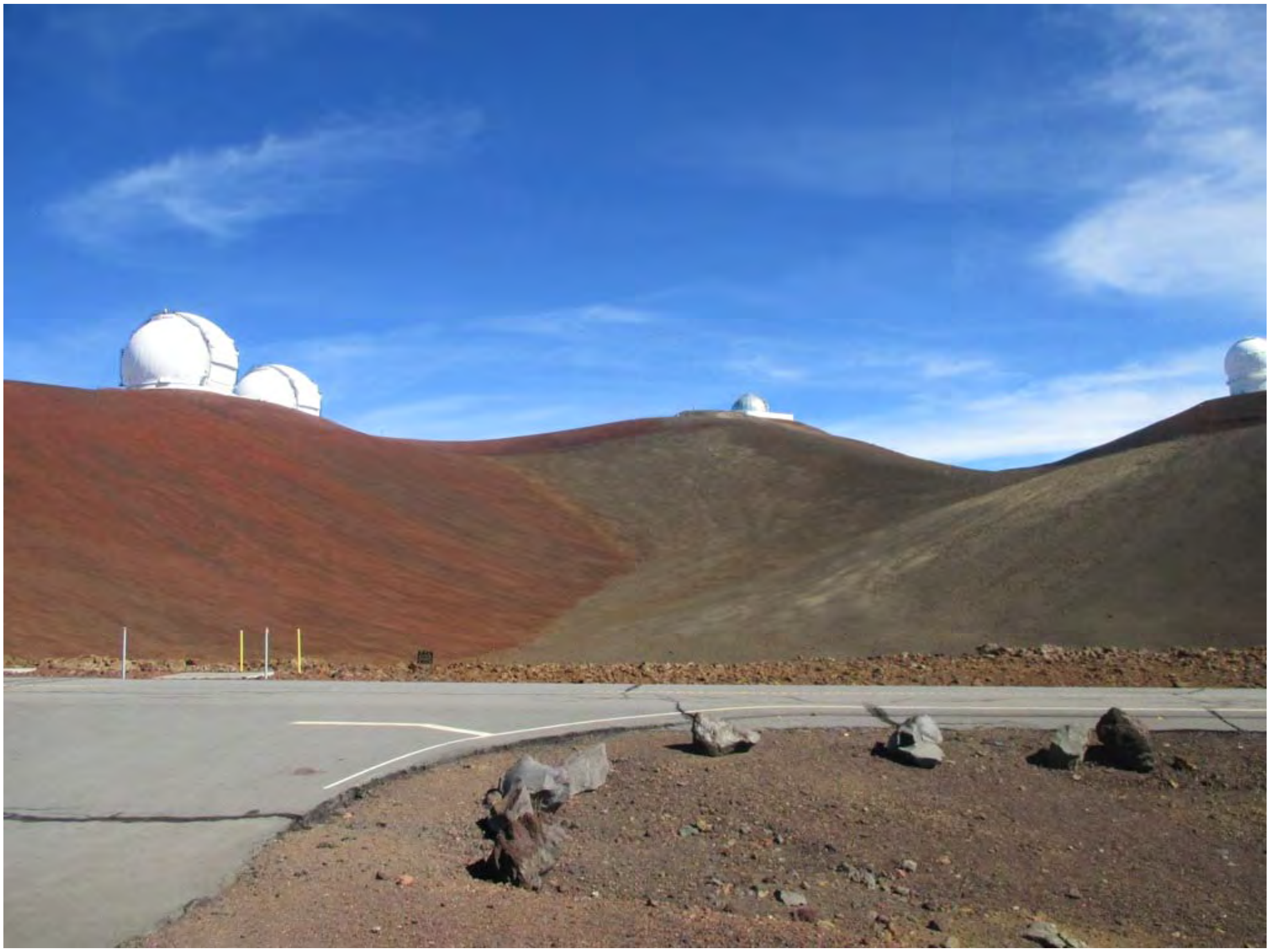


Photo 2

Adjacent Property to the North, Mauna Kea Summit, Astronomy Precinct

Photo 3

Adjancent Property to the North, Mauna Kea Summit, Astronomy Precinct

Photo 4

Cesspool Man-Hole Cover

Photo 5

Drums Containing Used Glycol

Photo 6

Empty Drum under the Wooden Planks at the Base of the Telescope

Photo 7

Glycol Pipes Running Throughout the Observatory

Photo 8

HELCO Transformer Box on the Property, Non-PCB Containing

Photo 9

Hydraulic Chain Hoist

Photo 10

Hydraulic Lift

Photo 11

Hydraulic Mechanisms, Rotate the Dome

Photo 12

Hydraulic Piston

Photo 13

Inside the Flammables Storage, Outside the Observatory, Propane Tanks and Miscellaneous

Photo 14

5 Gallon Buckets of Used Hydraulic Oil, Flammables Storage

Photo 15

Minor Fluid Leak Under the First Level Platform

Photo 16

Potable Water Pump

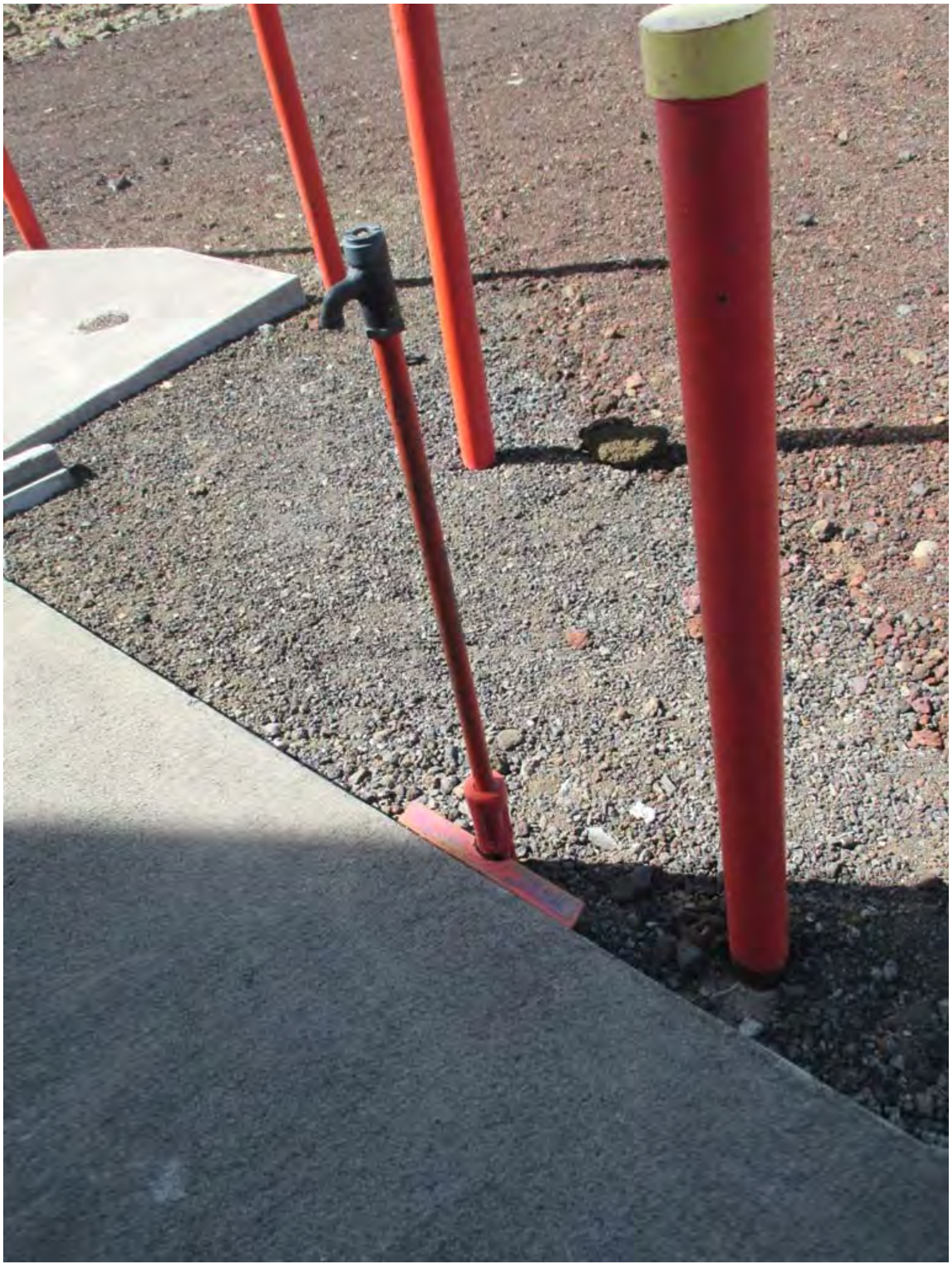


Photo 17

Potable Water Spigot

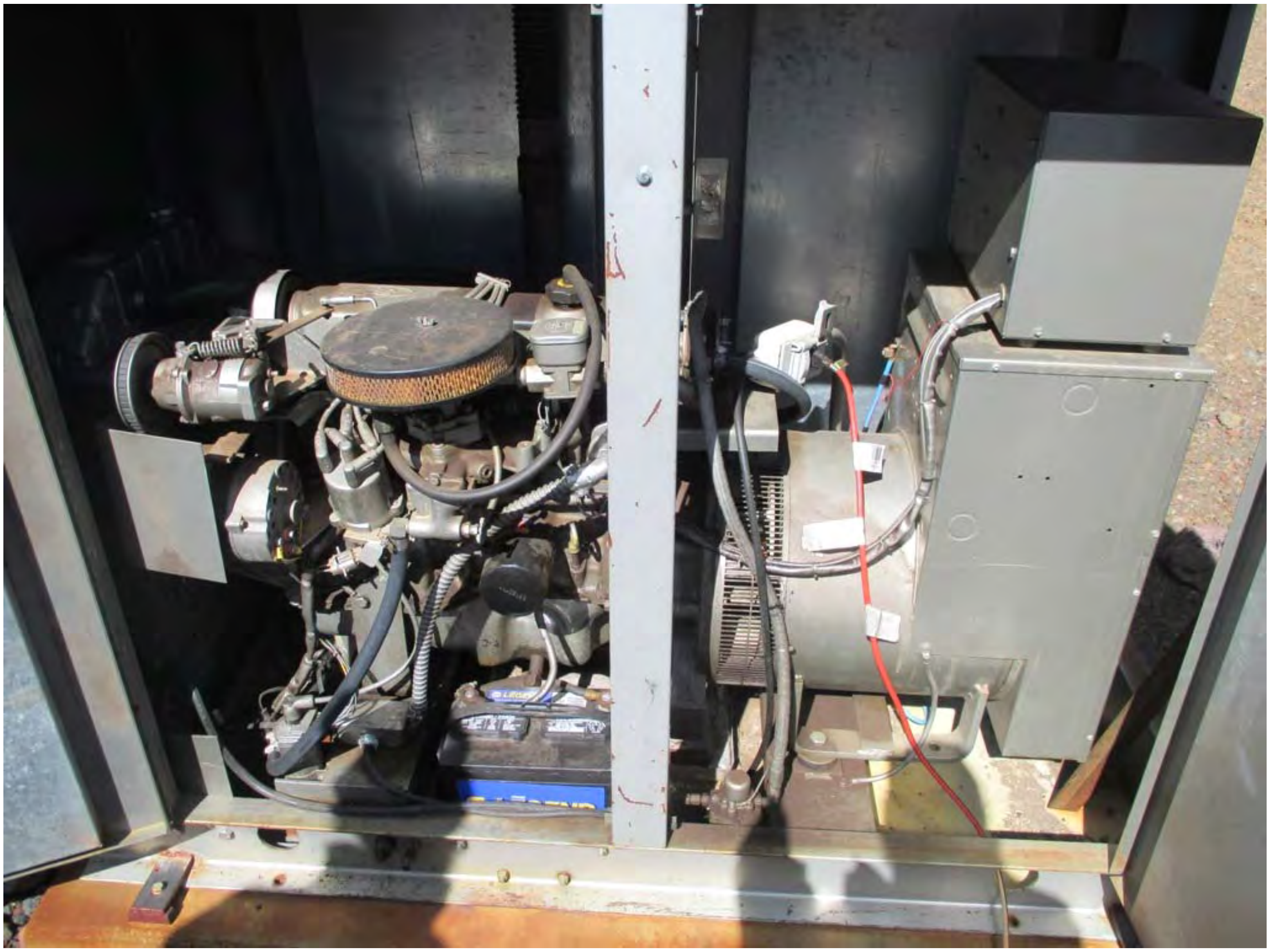


Photo 18

Propane Generator, Outside on the Property

Photo 19

Sewage Connection

Photo 20

Stained Concrete at the Base of the Observatory

Photo 21

Staining on Asphalt of Parking Area

Photo 22

Unlabeled Drum on the Second Level

HISTORICAL RESEARCH

Caltech Submillimeter Observatory
Mauna Kea Access Road
Paauilo, HI 96776

Inquiry Number: 4502574.2s
December 30, 2015

The EDR Radius Map™ Report with GeoCheck®

EDR® Environmental Data Resources Inc

6 Armstrong Road, 4th floor
Shelton, CT 06484
Toll Free: 800.352.0050
www.edrnet.com

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Thank you for your business.
Please contact EDR at 1-800-352-0050
with any questions or comments.

EXECUTIVE SUMMARY

A search of available environmental records was conducted by Environmental Data Resources, Inc (EDR). The report was designed to assist parties seeking to meet the search requirements of EPA's Standards and Practices for All Appropriate Inquiries (40 CFR Part 312), the ASTM Standard Practice for Environmental Site Assessments (E 1527-13) or custom requirements developed for the evaluation of environmental risk associated with a parcel of real estate.

TARGET PROPERTY INFORMATION

ADDRESS

MAUNA KEA ACCESS ROAD
PAAUILO, HI 96776

COORDINATES

Latitude (North):	19.8225000 - 19˚ 49' 21.00''
Longitude (West):	155.4754000 - 155˚ 28' 31.44''
Universal Tranverse Mercator:	Zone 5
UTM X (Meters):	240704.7
UTM Y (Meters):	2193609.0
Elevation:	13343 ft. above sea level

USGS TOPOGRAPHIC MAP ASSOCIATED WITH TARGET PROPERTY

Target Property Map:	5949268 MAUNA KEA, HI
Version Date:	2013

MAPPED SITES SUMMARY

Target Property Address:
MAUNA KEA ACCESS ROAD
PAAUILO, HI 96776

Click on Map ID to see full detail.

MAP ID	SITE NAME	ADDRESS	DATABASE ACRONYMS	RELATIVE ELEVATION	DIST (ft. & mi.) DIRECTION
1	UNIVERSITY OF HAWAII	MAUNA KEA SUMMIT	LUST, UST	Higher	1780, 0.337, East

EXECUTIVE SUMMARY

TARGET PROPERTY SEARCH RESULTS

The target property was not listed in any of the databases searched by EDR.

DATABASES WITH NO MAPPED SITES

No mapped sites were found in EDR's search of available ("reasonably ascertainable ") government records either on the target property or within the search radius around the target property for the following databases:

STANDARD ENVIRONMENTAL RECORDS

Federal NPL site list

NPL - National Priority List
Proposed NPL - Proposed National Priority List Sites
NPL LIENS - Federal Superfund Liens

Federal Delisted NPL site list

Delisted NPL - National Priority List Deletions

Federal CERCLIS list

FEDERAL FACILITY - Federal Facility Site Information listing
CERCLIS - Comprehensive Environmental Response, Compensation, and Liability Information System

Federal CERCLIS NFRAP site List

CERCLIS-NFRAP - CERCLIS No Further Remedial Action Planned

Federal RCRA CORRACTS facilities list

CORRACTS - Corrective Action Report

Federal RCRA non-CORRACTS TSD facilities list

RCRA-TSDF - RCRA - Treatment, Storage and Disposal

Federal RCRA generators list

RCRA-LQG - RCRA - Large Quantity Generators
RCRA-SQG - RCRA - Small Quantity Generators
RCRA-CESQG - RCRA - Conditionally Exempt Small Quantity Generator

Federal institutional controls / engineering controls registries

LUCIS - Land Use Control Information System
US ENG CONTROLS - Engineering Controls Sites List

US INST CONTROL Sites with Institutional Controls

Federal ERNS list

ERNS Emergency Response Notification System

State- and tribal - equivalent CERCLIS

SHWS Sites List

State and tribal landfill and/or solid waste disposal site lists

SWF/LF Permitted Landfills in the State of Hawaii

State and tribal leaking storage tank lists

INDIAN LUST Leaking Underground Storage Tanks on Indian Land

State and tribal registered storage tank lists

FEMA UST Underground Storage Tank Listing
UST Underground Storage Tank Database
INDIAN UST Underground Storage Tanks on Indian Land

State and tribal institutional control / engineering control registries

ENG CONTROLS Engineering Control Sites
INST CONTROL Sites with Institutional Controls

State and tribal voluntary cleanup sites

VCP Voluntary Response Program Sites
INDIAN VCP Voluntary Cleanup Priority Listing

State and tribal Brownfields sites

BROWNFIELDS Brownfields Sites

ADDITIONAL ENVIRONMENTAL RECORDS

Local Brownfield lists

US BROWNFIELDS A Listing of Brownfields Sites

Local Lists of Landfill / Solid Waste Disposal Sites

INDIAN ODI Report on the Status of Open Dumps on Indian Lands
ODI Open Dump Inventory
DEBRIS REGION 9 Torres Martinez Reservation Illegal Dump Site Locations

Local Lists of Hazardous waste / Contaminated Sites

US HIST CDL National Clandestine Laboratory Register
CDL Clandestine Drug Lab Listing

US CDL - Clandestine Drug Labs

Local Land Records

LIENS 2 - CERCLA Lien Information

Records of Emergency Release Reports

HMIRS - Hazardous Materials Information Reporting System
SPILLS - Release Notifications
SPILLS 90 - SPILLS 90 data from FirstSearch

Other Ascertainable Records

RCRA NonGen / NLR - RCRA - Non Generators / No Longer Regulated
FUDS - Formerly Used Defense Sites
DOD - Department of Defense Sites
SCRD DRYCLEANERS - State Coalition for Remediation of Drycleaners Listing
US FIN ASSUR - Financial Assurance Information
EPA WATCH LIST - EPA WATCH LIST
2020 COR ACTION - 2020 Corrective Action Program List
TSCA - Toxic Substances Control Act
TRIS - Toxic Chemical Release Inventory System
SSTS - Section 7 Tracking Systems
ROD - Records Of Decision
RMP - Risk Management Plans
RAATS - RCRA Administrative Action Tracking System
PRP - Potentially Responsible Parties
PADS - PCB Activity Database System
ICIS - Integrated Compliance Information System
FTTS - FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
MLTS - Material Licensing Tracking System
COAL ASH DOE - Steam-Electric Plant Operation Data
COAL ASH EPA - Coal Combustion Residues Surface Impoundments List
PCB TRANSFORMER - PCB Transformer Registration Database
RADINFO - Radiation Information Database
HIST FTTS - FIFRA/TSCA Tracking System Administrative Case Listing
DOT OPS - Incident and Accident Data
CONSENT - Superfund (CERCLA) Consent Decrees
INDIAN RESERV - Indian Reservations
UMTRA - Uranium Mill Tailings Sites
LEAD SMELTERS - Lead Smelter Sites
US AIRS - Aerometric Information Retrieval System Facility Subsystem
US MINES - Mines Master Index File
FINDS - Facility Index System/Facility Registry System
AIRS - List of Permitted Facilities
DRYCLEANERS - Permitted Drycleaner Facility Listing
Financial Assurance - Financial Assurance Information Listing
UIC - Underground Injection Wells Listing

EDR HIGH RISK HISTORICAL RECORDS

EDR Exclusive Records

EDR MGP - EDR Proprietary Manufactured Gas Plants

EXECUTIVE SUMMARY

EDR Hist Auto - - - - - - - - EDR Exclusive Historic Gas Stations
EDR Hist Cleaner - - - - - - EDR Exclusive Historic Dry Cleaners

EDR RECOVERED GOVERNMENT ARCHIVES

Exclusive Recovered Govt. Archives

RGA HWS - - - - - - - - - - Recovered Government Archive State Hazardous Waste Facilities List
RGA LF - - - - - - - - - - - Recovered Government Archive Solid Waste Facilities List
RGA LUST - - - - - - - - - Recovered Government Archive Leaking Underground Storage Tank

SURROUNDING SITES: SEARCH RESULTS

Surrounding sites were identified in the following databases.

Elevations have been determined from the USGS Digital Elevation Model and should be evaluated on a relative (not an absolute) basis. Relative elevation information between sites of close proximity should be field verified. Sites with an elevation equal to or higher than the target property have been differentiated below from sites with an elevation lower than the target property.
Page numbers and map identification numbers refer to the EDR Radius Map report where detailed data on individual sites can be reviewed.

Sites listed in ***bold italics*** are in multiple databases.

Unmappable (orphan) sites are not considered in the foregoing analysis.

STANDARD ENVIRONMENTAL RECORDS

State and tribal leaking storage tank lists

LUST: The Leaking Underground Storage Tank Incident Reports contain an inventory of reported leaking underground storage tank incidents. The data come from the Department of Health's Active Leaking Underground Storage Tank Log Listing.

A review of the LUST list, as provided by EDR, and dated 09/04/2015 has revealed that there is 1 LUST site within approximately 0.5 miles of the target property.

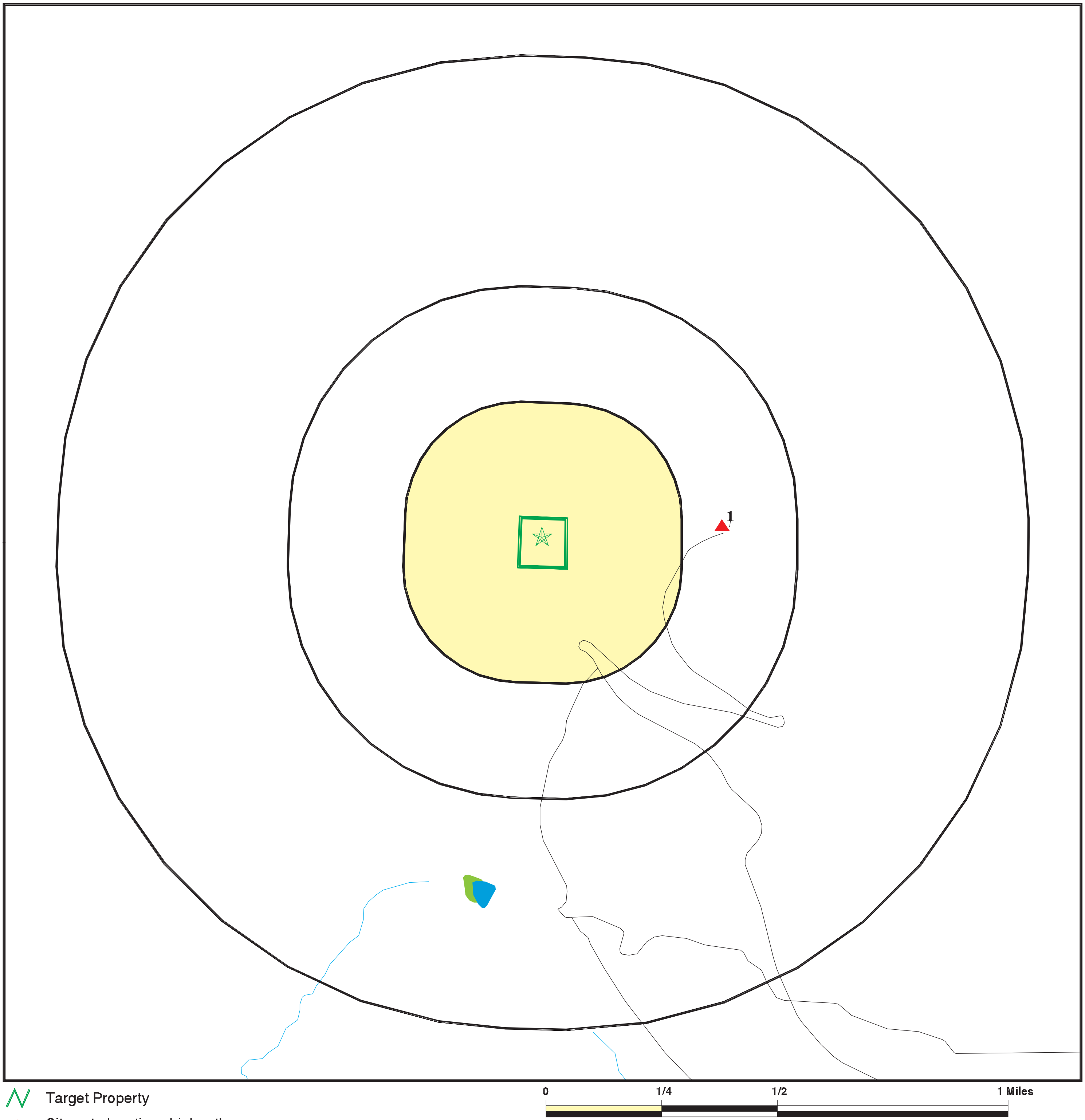
Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
UNIVERSITY OF HAWAII	***MAUNA KEA SUMMIT***	***E 1/4 - 1/2 (0.337 mi.)***	***1***	***7***

Release ID: 020006
Facility Id: 9-603620
Facility Status: Site Cleanup Completed (NFA)

EXECUTIVE SUMMARY

There were no unmapped sites in this report.

OVERVIEW MAP - 4502574.2S



Target Property

Sites at elevations higher than or equal to the target property

Sites at elevations lower than the target property

Manufactured Gas Plants

National Priority List Sites

Dept. Defense Sites

Indian Reservations BIA

100-year flood zone

500-year flood zone

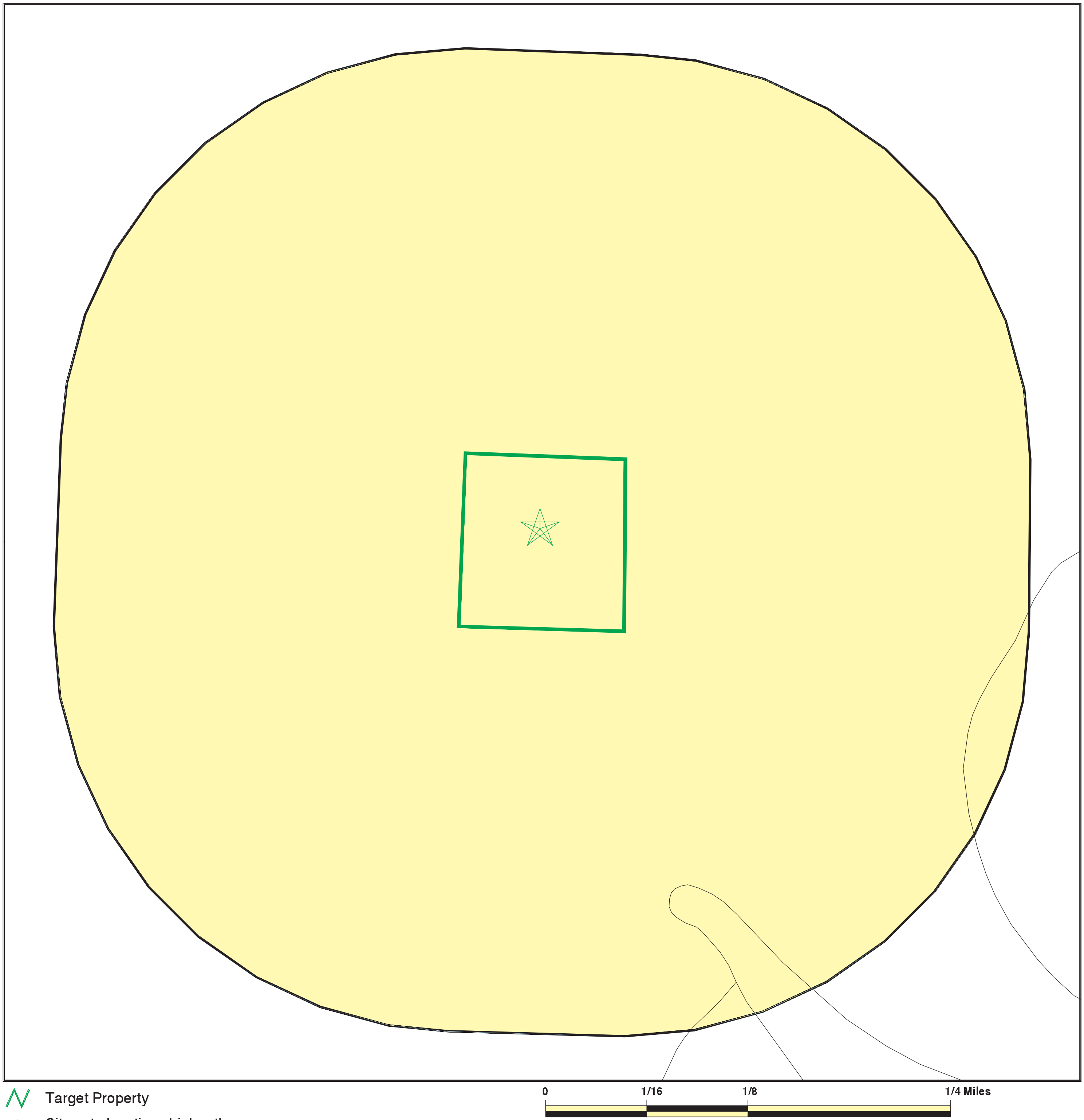
National Wetland Inventory

State Wetlands

This report includes Interactive Map Layers to display and/or hide map information. The legend includes only those icons for the default map view.

SITE NAME: Caltech Submillimeter Observatory ADDRESS: Mauna Kea Access Road Paauilo HI 96776 LAT/LONG: 19.8225 / 155.4754	CLIENT: ENPRO, Env. Professionals CONTACT: Heather Schauer INQUIRY #: 4502574.2s DATE: December 30, 2015 1:34 pm

DETAIL MAP - 4502574.2S



Target Property
Sites at elevations higher than or equal to the target property
Sites at elevations lower than the target property
Manufactured Gas Plants
Sensitive Receptors
National Priority List Sites
Dept. Defense Sites

Indian Reservations BIA
100-year flood zone
500-year flood zone

This report includes Interactive Map Layers to display and/or hide map information. The legend includes only those icons for the default map view.

SITE NAME:	Caltech Submillimeter Observatory	CLIENT:	ENPRO, Env. Professionals
ADDRESS:	Mauna Kea Access Road	CONTACT:	Heather Schauer
	Paauilo HI 96776	INQUIRY #:	4502574.2s
LAT/LONG:	19.8225 / 155.4754	DATE:	December 30, 2015 1:35 pm

MAP FINDINGS SUMMARY

Database	Search Distance (Miles)	Target Property	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
STANDARD ENVIRONMENTAL RECORDS								
Federal NPL site list								
NPL	1.000		0	0	0	0	NR	0
Proposed NPL	1.000		0	0	0	0	NR	0
NPL LIENS	TP		NR	NR	NR	NR	NR	0
Federal Delisted NPL site list								
Delisted NPL	1.000		0	0	0	0	NR	0
Federal CERCLIS list								
FEDERAL FACILITY	0.500		0	0	0	NR	NR	0
CERCLIS	0.500		0	0	0	NR	NR	0
Federal CERCLIS NFRAP site List								
CERCLIS-NFRAP	0.500		0	0	0	NR	NR	0
Federal RCRA CORRACTS facilities list								
CORRACTS	1.000		0	0	0	0	NR	0
Federal RCRA non-CORRACTS TSD facilities list								
RCRA-TSDF	0.500		0	0	0	NR	NR	0
Federal RCRA generators list								
RCRA-LQG	0.250		0	0	NR	NR	NR	0
RCRA-SQG	0.250		0	0	NR	NR	NR	0
RCRA-CESQG	0.250		0	0	NR	NR	NR	0
Federal institutional controls / engineering controls registries								
LUCIS	0.500		0	0	0	NR	NR	0
US ENG CONTROLS	0.500		0	0	0	NR	NR	0
US INST CONTROL	0.500		0	0	0	NR	NR	0
Federal ERNS list								
ERNS	TP		NR	NR	NR	NR	NR	0
State- and tribal - equivalent CERCLIS								
SHWS	1.000		0	0	0	0	NR	0
State and tribal landfill and/or solid waste disposal site lists								
SWF/LF	0.500		0	0	0	NR	NR	0
State and tribal leaking storage tank lists								
LUST	0.500		0	0	1	NR	NR	1
INDIAN LUST	0.500		0	0	0	NR	NR	0
State and tribal registered storage tank lists								
FEMA UST	0.250		0	0	NR	NR	NR	0

MAP FINDINGS SUMMARY

Database	Search Distance (Miles)	Target Property	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
UST	0.250		0	0	NR	NR	NR	0
INDIAN UST	0.250		0	0	NR	NR	NR	0
State and tribal institutional control / engineering control registries								
ENG CONTROLS	0.500		0	0	0	NR	NR	0
INST CONTROL	0.500		0	0	0	NR	NR	0
State and tribal voluntary cleanup sites								
VCP	0.500		0	0	0	NR	NR	0
INDIAN VCP	0.500		0	0	0	NR	NR	0
State and tribal Brownfields sites								
BROWNFIELDS	0.500		0	0	0	NR	NR	0
ADDITIONAL ENVIRONMENTAL RECORDS								
Local Brownfield lists								
US BROWNFIELDS	0.500		0	0	0	NR	NR	0
Local Lists of Landfill / Solid Waste Disposal Sites								
INDIAN ODI	0.500		0	0	0	NR	NR	0
ODI	0.500		0	0	0	NR	NR	0
DEBRIS REGION 9	0.500		0	0	0	NR	NR	0
Local Lists of Hazardous waste / Contaminated Sites								
US HIST CDL	TP		NR	NR	NR	NR	NR	0
CDL	TP		NR	NR	NR	NR	NR	0
US CDL	TP		NR	NR	NR	NR	NR	0
Local Land Records								
LIENS 2	TP		NR	NR	NR	NR	NR	0
Records of Emergency Release Reports								
HMIRS	TP		NR	NR	NR	NR	NR	0
SPILLS	TP		NR	NR	NR	NR	NR	0
SPILLS 90	TP		NR	NR	NR	NR	NR	0
Other Ascertainable Records								
RCRA NonGen / NLR	0.250		0	0	NR	NR	NR	0
FUDS	1.000		0	0	0	0	NR	0
DOD	1.000		0	0	0	0	NR	0
SCRD DRYCLEANERS	0.500		0	0	0	NR	NR	0
US FIN ASSUR	TP		NR	NR	NR	NR	NR	0
EPA WATCH LIST	TP		NR	NR	NR	NR	NR	0
2020 COR ACTION	0.250		0	0	NR	NR	NR	0
TSCA	TP		NR	NR	NR	NR	NR	0
TRIS	TP		NR	NR	NR	NR	NR	0

MAP FINDINGS SUMMARY

Database	Search Distance (Miles)	Target Property	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
SSTS	TP		NR	NR	NR	NR	NR	0
ROD	1.000		0	0	0	0	NR	0
RMP	TP		NR	NR	NR	NR	NR	0
RAATS	TP		NR	NR	NR	NR	NR	0
PRP	TP		NR	NR	NR	NR	NR	0
PADS	TP		NR	NR	NR	NR	NR	0
ICIS	TP		NR	NR	NR	NR	NR	0
FTTS	TP		NR	NR	NR	NR	NR	0
MLTS	TP		NR	NR	NR	NR	NR	0
COAL ASH DOE	TP		NR	NR	NR	NR	NR	0
COAL ASH EPA	0.500		0	0	0	NR	NR	0
PCB TRANSFORMER	TP		NR	NR	NR	NR	NR	0
RADINFO	TP		NR	NR	NR	NR	NR	0
HIST FTTS	TP		NR	NR	NR	NR	NR	0
DOT OPS	TP		NR	NR	NR	NR	NR	0
CONSENT	1.000		0	0	0	0	NR	0
INDIAN RESERV	1.000		0	0	0	0	NR	0
UMTRA	0.500		0	0	0	NR	NR	0
LEAD SMELTERS	TP		NR	NR	NR	NR	NR	0
US AIRS	TP		NR	NR	NR	NR	NR	0
US MINES	0.250		0	0	NR	NR	NR	0
FINDS	TP		NR	NR	NR	NR	NR	0
AIRS	TP		NR	NR	NR	NR	NR	0
DRYCLEANERS	0.250		0	0	NR	NR	NR	0
Financial Assurance	TP		NR	NR	NR	NR	NR	0
UIC	TP		NR	NR	NR	NR	NR	0
EDR HIGH RISK HISTORICAL RECORDS								
EDR Exclusive Records								
EDR MGP	1.000		0	0	0	0	NR	0
EDR Hist Auto	0.125		0	NR	NR	NR	NR	0
EDR Hist Cleaner	0.125		0	NR	NR	NR	NR	0
EDR RECOVERED GOVERNMENT ARCHIVES								
Exclusive Recovered Govt. Archives								
RGA HWS	TP		NR	NR	NR	NR	NR	0
RGA LF	TP		NR	NR	NR	NR	NR	0
RGA LUST	TP		NR	NR	NR	NR	NR	0
- Totals --		0	0	0	1	0	0	1

NOTES:

TP = Target Property

NR = Not Requested at this Search Distance

Sites may be listed in more than one database

MAP FINDINGS

Map ID Direction Distance Elevation	Site	Database(s)	EDR ID Number EPA ID Number
1 **East** **1/4-1/2** **0.337 mi.** **1780 ft.**	**UNIVERSITY OF HAWAII 88" TELESCOPE** **MAUNA KEA SUMMIT** **HILO, HI 96720**	**LUST** **UST**	**U003711786** **N/A**

Relative:
Higher

Actual:
13777 ft.

LUST:

Facility ID:	9-603620
Facility Status:	Site Cleanup Completed (NFA)
Facility Status Date:	09/08/2003
Release ID:	020006
Project Officer:	Shaobin Li

UST:

Facility ID:	9-603620
Owner:	UNIVERSITY OF HAWAII - INSTITUTE OF ASTROMONY
Owner Address:	2680 WOODLAWN DRIVE
Owner City,St,Zip:	Hilo, 96720 96720
Latitude:	19.823195
Longitude:	-155.469895
Horizontal Reference Datum Name:	Not reported
Horizontal Collection Method Name:	Not reported
Tank ID:	R-1
Date Installed:	01/01/1965
Tank Status:	**Permanently Out of Use**
Date Closed:	11/14/2001
Tank Capacity:	4000
Substance:	Diesel

Count: 0 records.

ORPHAN SUMMARY

City	EDR ID	Site Name	Site Address	Zip	Database(s)
		NO SITES FOUND			

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

To maintain currency of the following federal and state databases, EDR contacts the appropriate governmental agency on a monthly or quarterly basis, as required.

Number of Days to Update: Provides confirmation that EDR is reporting records that have been updated within 90 days from the date the government agency made the information available to the public.

STANDARD ENVIRONMENTAL RECORDS

Federal NPL site list

NPL: National Priority List

National Priorities List (Superfund). The NPL is a subset of CERCLIS and identifies over 1,200 sites for priority cleanup under the Superfund Program. NPL sites may encompass relatively large areas. As such, EDR provides polygon coverage for over 1,000 NPL site boundaries produced by EPA's Environmental Photographic Interpretation Center (EPIC) and regional EPA offices.

Date of Government Version: 03/26/2015
Date Data Arrived at EDR: 04/08/2015
Date Made Active in Reports: 06/22/2015
Number of Days to Update: 75

Source: EPA
Telephone: N/A
Last EDR Contact: 11/07/2015
Next Scheduled EDR Contact: 01/18/2016
Data Release Frequency: Quarterly

NPL Site Boundaries

Sources:

EPA's Environmental Photographic Interpretation Center (EPIC)
Telephone: 202-564-7333

EPA Region 1
Telephone 617-918-1143

EPA Region 3
Telephone 215-814-5418

EPA Region 4
Telephone 404-562-8033

EPA Region 5
Telephone 312-886-6686

EPA Region 10
Telephone 206-553-8665

EPA Region 6
Telephone: 214-655-6659

EPA Region 7
Telephone: 913-551-7247

EPA Region 8
Telephone: 303-312-6774

EPA Region 9
Telephone: 415-947-4246

Proposed NPL: Proposed National Priority List Sites

A site that has been proposed for listing on the National Priorities List through the issuance of a proposed rule in the Federal Register. EPA then accepts public comments on the site, responds to the comments, and places on the NPL those sites that continue to meet the requirements for listing.

Date of Government Version: 03/26/2015
Date Data Arrived at EDR: 04/08/2015
Date Made Active in Reports: 06/22/2015
Number of Days to Update: 75

Source: EPA
Telephone: N/A
Last EDR Contact: 11/07/2015
Next Scheduled EDR Contact: 01/18/2016
Data Release Frequency: Quarterly

NPL LIENS: Federal Superfund Liens

Federal Superfund Liens. Under the authority granted the USEPA by CERCLA of 1980, the USEPA has the authority to file liens against real property in order to recover remedial action expenditures or when the property owner received notification of potential liability. USEPA compiles a listing of filed notices of Superfund Liens.

Date of Government Version: 10/15/1991
Date Data Arrived at EDR: 02/02/1994
Date Made Active in Reports: 03/30/1994
Number of Days to Update: 56

Source: EPA
Telephone: 202-564-4267
Last EDR Contact: 08/15/2011
Next Scheduled EDR Contact: 11/28/2011
Data Release Frequency: No Update Planned

Federal Delisted NPL site list

Delisted NPL: National Priority List Deletions

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) establishes the criteria that the EPA uses to delete sites from the NPL. In accordance with 40 CFR 300.425.(e), sites may be deleted from the NPL where no further response is appropriate.

Date of Government Version: 03/26/2015
Date Data Arrived at EDR: 04/08/2015
Date Made Active in Reports: 06/22/2015
Number of Days to Update: 75

Source: EPA
Telephone: N/A
Last EDR Contact: 11/07/2015
Next Scheduled EDR Contact: 01/18/2016
Data Release Frequency: Quarterly

Federal CERCLIS list

FEDERAL FACILITY: Federal Facility Site Information listing

A listing of National Priority List (NPL) and Base Realignment and Closure (BRAC) sites found in the Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) Database where EPA Federal Facilities Restoration and Reuse Office is involved in cleanup activities.

Date of Government Version: 03/26/2015
Date Data Arrived at EDR: 04/08/2015
Date Made Active in Reports: 06/11/2015
Number of Days to Update: 64

Source: Environmental Protection Agency
Telephone: 703-603-8704
Last EDR Contact: 10/09/2015
Next Scheduled EDR Contact: 01/18/2016
Data Release Frequency: Varies

CERCLIS: Comprehensive Environmental Response, Compensation, and Liability Information System

CERCLIS contains data on potentially hazardous waste sites that have been reported to the USEPA by states, municipalities, private companies and private persons, pursuant to Section 103 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). CERCLIS contains sites which are either proposed to or on the National Priorities List (NPL) and sites which are in the screening and assessment phase for possible inclusion on the NPL.

Date of Government Version: 10/25/2013
Date Data Arrived at EDR: 11/11/2013
Date Made Active in Reports: 02/13/2014
Number of Days to Update: 94

Source: EPA
Telephone: 703-412-9810
Last EDR Contact: 11/23/2015
Next Scheduled EDR Contact: 03/07/2016
Data Release Frequency: Quarterly

Federal CERCLIS NFRAP site List

CERCLIS-NFRAP: CERCLIS No Further Remedial Action Planned

Archived sites are sites that have been removed and archived from the inventory of CERCLIS sites. Archived status indicates that, to the best of EPA's knowledge, assessment at a site has been completed and that EPA has determined no further steps will be taken to list this site on the National Priorities List (NPL), unless information indicates this decision was not appropriate or other considerations require a recommendation for listing at a later time. This decision does not necessarily mean that there is no hazard associated with a given site; it only means that, based upon available information, the location is not judged to be a potential NPL site.

Date of Government Version: 10/25/2013
Date Data Arrived at EDR: 11/11/2013
Date Made Active in Reports: 02/13/2014
Number of Days to Update: 94

Source: EPA
Telephone: 703-412-9810
Last EDR Contact: 11/23/2015
Next Scheduled EDR Contact: 03/07/2016
Data Release Frequency: Quarterly

Federal RCRA CORRACTS facilities list

CORRACTS: Corrective Action Report

CORRACTS identifies hazardous waste handlers with RCRA corrective action activity.

Date of Government Version: 06/09/2015
Date Data Arrived at EDR: 06/26/2015
Date Made Active in Reports: 09/16/2015
Number of Days to Update: 82

Source: EPA
Telephone: 800-424-9346
Last EDR Contact: 12/18/2015
Next Scheduled EDR Contact: 01/11/2016
Data Release Frequency: Quarterly

Federal RCRA non-CORRACTS TSD facilities list

RCRA-TSDF: RCRA - Treatment, Storage and Disposal

RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Transporters are individuals or entities that move hazardous waste from the generator offsite to a facility that can recycle, treat, store, or dispose of the waste. TSDFs treat, store, or dispose of the waste.

Date of Government Version: 06/09/2015
Date Data Arrived at EDR: 06/26/2015
Date Made Active in Reports: 09/16/2015
Number of Days to Update: 82

Source: Environmental Protection Agency
Telephone: (415) 495-8895
Last EDR Contact: 12/18/2015
Next Scheduled EDR Contact: 04/11/2016
Data Release Frequency: Quarterly

Federal RCRA generators list

RCRA-LQG: RCRA - Large Quantity Generators

RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Large quantity generators (LQGs) generate over 1,000 kilograms (kg) of hazardous waste, or over 1 kg of acutely hazardous waste per month.

Date of Government Version: 06/09/2015
Date Data Arrived at EDR: 06/26/2015
Date Made Active in Reports: 09/16/2015
Number of Days to Update: 82

Source: Environmental Protection Agency
Telephone: (415) 495-8895
Last EDR Contact: 12/18/2015
Next Scheduled EDR Contact: 04/11/2016
Data Release Frequency: Quarterly

RCRA-SQG: RCRA - Small Quantity Generators

RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Small quantity generators (SQGs) generate between 100 kg and 1,000 kg of hazardous waste per month.

Date of Government Version: 06/09/2015
Date Data Arrived at EDR: 06/26/2015
Date Made Active in Reports: 09/16/2015
Number of Days to Update: 82

Source: Environmental Protection Agency
Telephone: (415) 495-8895
Last EDR Contact: 12/18/2015
Next Scheduled EDR Contact: 04/11/2016
Data Release Frequency: Quarterly

RCRA-CESQG: RCRA - Conditionally Exempt Small Quantity Generators

RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Conditionally exempt small quantity generators (CESQGs) generate less than 100 kg of hazardous waste, or less than 1 kg of acutely hazardous waste per month.

Date of Government Version: 06/09/2015
Date Data Arrived at EDR: 06/26/2015
Date Made Active in Reports: 09/16/2015
Number of Days to Update: 82

Source: Environmental Protection Agency
Telephone: (415) 495-8895
Last EDR Contact: 12/18/2015
Next Scheduled EDR Contact: 04/11/2016
Data Release Frequency: Varies

Federal institutional controls / engineering controls registries

LUCIS: Land Use Control Information System

LUCIS contains records of land use control information pertaining to the former Navy Base Realignment and Closure properties.

Date of Government Version: 05/28/2015
Date Data Arrived at EDR: 05/29/2015
Date Made Active in Reports: 06/11/2015
Number of Days to Update: 13

Source: Department of the Navy
Telephone: 843-820-7326
Last EDR Contact: 11/13/2015
Next Scheduled EDR Contact: 02/29/2016
Data Release Frequency: Varies

US ENG CONTROLS: Engineering Controls Sites List

A listing of sites with engineering controls in place. Engineering controls include various forms of caps, building foundations, liners, and treatment methods to create pathway elimination for regulated substances to enter environmental media or effect human health.

Date of Government Version: 09/10/2015
Date Data Arrived at EDR: 09/11/2015
Date Made Active in Reports: 11/03/2015
Number of Days to Update: 53

Source: Environmental Protection Agency
Telephone: 703-603-0695
Last EDR Contact: 11/24/2015
Next Scheduled EDR Contact: 03/14/2016
Data Release Frequency: Varies

US INST CONTROL: Sites with Institutional Controls

A listing of sites with institutional controls in place. Institutional controls include administrative measures, such as groundwater use restrictions, construction restrictions, property use restrictions, and post remediation care requirements intended to prevent exposure to contaminants remaining on site. Deed restrictions are generally required as part of the institutional controls.

Date of Government Version: 09/10/2015
Date Data Arrived at EDR: 09/11/2015
Date Made Active in Reports: 11/03/2015
Number of Days to Update: 53

Source: Environmental Protection Agency
Telephone: 703-603-0695
Last EDR Contact: 11/24/2015
Next Scheduled EDR Contact: 03/14/2016
Data Release Frequency: Varies

Federal ERNS list

ERNS: Emergency Response Notification System

Emergency Response Notification System. ERNS records and stores information on reported releases of oil and hazardous substances.

Date of Government Version: 06/22/2015
Date Data Arrived at EDR: 06/26/2015
Date Made Active in Reports: 09/16/2015
Number of Days to Update: 82

Source: National Response Center, United States Coast Guard
Telephone: 202-267-2180
Last EDR Contact: 09/29/2015
Next Scheduled EDR Contact: 01/11/2016
Data Release Frequency: Annually

State- and tribal - equivalent CERCLIS

SHWS: Sites List

Facilities, sites or areas in which the Office of Hazard Evaluation and Emergency Response has an interest, has investigated or may investigate under HRS 128D (includes CERCLIS sites).

Date of Government Version: 12/02/2014
Date Data Arrived at EDR: 12/22/2014
Date Made Active in Reports: 01/27/2015
Number of Days to Update: 36

Source: Department of Health
Telephone: 808-586-4249
Last EDR Contact: 11/25/2015
Next Scheduled EDR Contact: 03/07/2016
Data Release Frequency: Semi-Annually

State and tribal landfill and/or solid waste disposal site lists

SWF/LF: Permitted Landfills in the State of Hawaii

Solid Waste Facilities/Landfill Sites. SWF/LF type records typically contain an inventory of solid waste disposal facilities or landfills in a particular state. Depending on the state, these may be active or inactive facilities or open dumps that failed to meet RCRA Subtitle D Section 4004 criteria for solid waste landfills or disposal sites.

Date of Government Version: 09/17/2012
Date Data Arrived at EDR: 04/03/2013
Date Made Active in Reports: 05/10/2013
Number of Days to Update: 37

Source: Department of Health
Telephone: 808-586-4245
Last EDR Contact: 10/02/2015
Next Scheduled EDR Contact: 01/11/2016
Data Release Frequency: Varies

State and tribal leaking storage tank lists

LUST: Leaking Underground Storage Tank Database

Leaking Underground Storage Tank Incident Reports. LUST records contain an inventory of reported leaking underground storage tank incidents. Not all states maintain these records, and the information stored varies by state.

Date of Government Version: 09/04/2015
Date Data Arrived at EDR: 09/25/2015
Date Made Active in Reports: 11/06/2015
Number of Days to Update: 42

Source: Department of Health
Telephone: 808-586-4228
Last EDR Contact: 12/04/2015
Next Scheduled EDR Contact: 03/14/2016
Data Release Frequency: Semi-Annually

INDIAN LUST R8: Leaking Underground Storage Tanks on Indian Land

LUSTs on Indian land in Colorado, Montana, North Dakota, South Dakota, Utah and Wyoming.

Date of Government Version: 04/30/2015
Date Data Arrived at EDR: 05/05/2015
Date Made Active in Reports: 06/22/2015
Number of Days to Update: 48

Source: EPA Region 8
Telephone: 303-312-6271
Last EDR Contact: 10/08/2015
Next Scheduled EDR Contact: 02/08/2016
Data Release Frequency: Quarterly

INDIAN LUST R7: Leaking Underground Storage Tanks on Indian Land

LUSTs on Indian land in Iowa, Kansas, and Nebraska

Date of Government Version: 03/30/2015
Date Data Arrived at EDR: 04/28/2015
Date Made Active in Reports: 06/22/2015
Number of Days to Update: 55

Source: EPA Region 7
Telephone: 913-551-7003
Last EDR Contact: 10/08/2015
Next Scheduled EDR Contact: 02/08/2016
Data Release Frequency: Varies

INDIAN LUST R6: Leaking Underground Storage Tanks on Indian Land

LUSTs on Indian land in New Mexico and Oklahoma.

Date of Government Version: 05/13/2015
Date Data Arrived at EDR: 08/03/2015
Date Made Active in Reports: 10/13/2015
Number of Days to Update: 71

Source: EPA Region 6
Telephone: 214-665-6597
Last EDR Contact: 10/26/2015
Next Scheduled EDR Contact: 02/08/2016
Data Release Frequency: Varies

INDIAN LUST R1: Leaking Underground Storage Tanks on Indian Land

A listing of leaking underground storage tank locations on Indian Land.

Date of Government Version: 02/03/2015
Date Data Arrived at EDR: 04/30/2015
Date Made Active in Reports: 06/22/2015
Number of Days to Update: 53

Source: EPA Region 1
Telephone: 617-918-1313
Last EDR Contact: 10/27/2015
Next Scheduled EDR Contact: 02/08/2016
Data Release Frequency: Varies

INDIAN LUST R4: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Florida, Mississippi and North Carolina.

Date of Government Version: 07/30/2015
Date Data Arrived at EDR: 08/07/2015
Date Made Active in Reports: 10/13/2015
Number of Days to Update: 67

Source: EPA Region 4
Telephone: 404-562-8677
Last EDR Contact: 10/26/2015
Next Scheduled EDR Contact: 02/08/2016
Data Release Frequency: Semi-Annually

INDIAN LUST R10: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Alaska, Idaho, Oregon and Washington.

Date of Government Version: 07/21/2015
Date Data Arrived at EDR: 07/29/2015
Date Made Active in Reports: 10/13/2015
Number of Days to Update: 76

Source: EPA Region 10
Telephone: 206-553-2857
Last EDR Contact: 10/26/2015
Next Scheduled EDR Contact: 02/08/2016
Data Release Frequency: Quarterly

INDIAN LUST R5: Leaking Underground Storage Tanks on Indian Land
Leaking underground storage tanks located on Indian Land in Michigan, Minnesota and Wisconsin.

Date of Government Version: 07/28/2015
Date Data Arrived at EDR: 08/07/2015
Date Made Active in Reports: 10/13/2015
Number of Days to Update: 67

Source: EPA, Region 5
Telephone: 312-886-7439
Last EDR Contact: 10/26/2015
Next Scheduled EDR Contact: 02/08/2016
Data Release Frequency: Varies

INDIAN LUST R9: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Arizona, California, New Mexico and Nevada

Date of Government Version: 01/08/2015
Date Data Arrived at EDR: 01/08/2015
Date Made Active in Reports: 02/09/2015
Number of Days to Update: 32

Source: Environmental Protection Agency
Telephone: 415-972-3372
Last EDR Contact: 10/30/2015
Next Scheduled EDR Contact: 02/08/2016
Data Release Frequency: Quarterly

State and tribal registered storage tank lists

FEMA UST: Underground Storage Tank Listing
A listing of all FEMA owned underground storage tanks.

Date of Government Version: 01/01/2010
Date Data Arrived at EDR: 02/16/2010
Date Made Active in Reports: 04/12/2010
Number of Days to Update: 55

Source: FEMA
Telephone: 202-646-5797
Last EDR Contact: 10/08/2015
Next Scheduled EDR Contact: 01/25/2016
Data Release Frequency: Varies

UST: Underground Storage Tank Database
Registered Underground Storage Tanks. UST's are regulated under Subtitle I of the Resource Conservation and Recovery Act (RCRA) and must be registered with the state department responsible for administering the UST program. Available information varies by state program.

Date of Government Version: 09/04/2015
Date Data Arrived at EDR: 09/25/2015
Date Made Active in Reports: 11/06/2015
Number of Days to Update: 42

Source: Department of Health
Telephone: 808-586-4228
Last EDR Contact: 12/04/2015
Next Scheduled EDR Contact: 03/14/2016
Data Release Frequency: Semi-Annually

INDIAN UST R1: Underground Storage Tanks on Indian Land
The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 1 (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont and ten Tribal Nations).

Date of Government Version: 02/03/2015
Date Data Arrived at EDR: 04/30/2015
Date Made Active in Reports: 06/22/2015
Number of Days to Update: 53

Source: EPA, Region 1
Telephone: 617-918-1313
Last EDR Contact: 10/27/2015
Next Scheduled EDR Contact: 02/08/2016
Data Release Frequency: Varies

INDIAN UST R6: Underground Storage Tanks on Indian Land
The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 6 (Louisiana, Arkansas, Oklahoma, New Mexico, Texas and 65 Tribes).

Date of Government Version: 05/13/2015
Date Data Arrived at EDR: 08/03/2015
Date Made Active in Reports: 10/13/2015
Number of Days to Update: 71

Source: EPA Region 6
Telephone: 214-665-7591
Last EDR Contact: 10/26/2015
Next Scheduled EDR Contact: 02/08/2016
Data Release Frequency: Semi-Annually

INDIAN UST R7: Underground Storage Tanks on Indian Land
The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 7 (Iowa, Kansas, Missouri, Nebraska, and 9 Tribal Nations).

Date of Government Version: 09/23/2014
Date Data Arrived at EDR: 11/25/2014
Date Made Active in Reports: 01/29/2015
Number of Days to Update: 65

Source: EPA Region 7
Telephone: 913-551-7003
Last EDR Contact: 10/26/2015
Next Scheduled EDR Contact: 02/08/2016
Data Release Frequency: Varies

INDIAN UST R4: Underground Storage Tanks on Indian Land
The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 4 (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee and Tribal Nations)

Date of Government Version: 07/30/2015
Date Data Arrived at EDR: 08/07/2015
Date Made Active in Reports: 10/13/2015
Number of Days to Update: 67

Source: EPA Region 4
Telephone: 404-562-9424
Last EDR Contact: 10/26/2015
Next Scheduled EDR Contact: 02/08/2016
Data Release Frequency: Semi-Annually

INDIAN UST R5: Underground Storage Tanks on Indian Land
The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 5 (Michigan, Minnesota and Wisconsin and Tribal Nations).

Date of Government Version: 07/28/2015
Date Data Arrived at EDR: 08/07/2015
Date Made Active in Reports: 10/13/2015
Number of Days to Update: 67

Source: EPA Region 5
Telephone: 312-886-6136
Last EDR Contact: 10/26/2015
Next Scheduled EDR Contact: 02/08/2016
Data Release Frequency: Varies

INDIAN UST R10: Underground Storage Tanks on Indian Land
The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 10 (Alaska, Idaho, Oregon, Washington, and Tribal Nations).

Date of Government Version: 07/21/2015
Date Data Arrived at EDR: 07/29/2015
Date Made Active in Reports: 10/13/2015
Number of Days to Update: 76

Source: EPA Region 10
Telephone: 206-553-2857
Last EDR Contact: 10/26/2015
Next Scheduled EDR Contact: 02/08/2016
Data Release Frequency: Quarterly

INDIAN UST R9: Underground Storage Tanks on Indian Land
The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 9 (Arizona, California, Hawaii, Nevada, the Pacific Islands, and Tribal Nations).

Date of Government Version: 12/14/2014
Date Data Arrived at EDR: 02/13/2015
Date Made Active in Reports: 03/13/2015
Number of Days to Update: 28

Source: EPA Region 9
Telephone: 415-972-3368
Last EDR Contact: 10/30/2015
Next Scheduled EDR Contact: 02/09/2016
Data Release Frequency: Quarterly

INDIAN UST R8: Underground Storage Tanks on Indian Land
The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 8 (Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming and 27 Tribal Nations).

Date of Government Version: 07/28/2015
Date Data Arrived at EDR: 08/14/2015
Date Made Active in Reports: 10/13/2015
Number of Days to Update: 60

Source: EPA Region 8
Telephone: 303-312-6137
Last EDR Contact: 07/22/2015
Next Scheduled EDR Contact: 02/08/2016
Data Release Frequency: Quarterly

State and tribal institutional control / engineering control registries

ENG CONTROLS: Engineering Control Sites
A listing of sites with engineering controls in place.

Date of Government Version: 12/02/2014
Date Data Arrived at EDR: 12/22/2014
Date Made Active in Reports: 01/27/2015
Number of Days to Update: 36

Source: Department of Health
Telephone: 404-586-4249
Last EDR Contact: 11/25/2015
Next Scheduled EDR Contact: 03/07/2016
Data Release Frequency: Varies

INST CONTROL: Sites with Institutional Controls
Voluntary Remediation Program and Brownfields sites with institutional controls in place.

Date of Government Version: 12/02/2014
Date Data Arrived at EDR: 12/22/2014
Date Made Active in Reports: 01/27/2015
Number of Days to Update: 36

Source: Department of Health
Telephone: 808-586-4249
Last EDR Contact: 11/25/2015
Next Scheduled EDR Contact: 03/07/2016
Data Release Frequency: Varies

State and tribal voluntary cleanup sites

INDIAN VCP R7: Voluntary Cleanup Priority Lisitng
A listing of voluntary cleanup priority sites located on Indian Land located in Region 7.

Date of Government Version: 03/20/2008
Date Data Arrived at EDR: 04/22/2008
Date Made Active in Reports: 05/19/2008
Number of Days to Update: 27

Source: EPA, Region 7
Telephone: 913-551-7365
Last EDR Contact: 04/20/2009
Next Scheduled EDR Contact: 07/20/2009
Data Release Frequency: Varies

INDIAN VCP R1: Voluntary Cleanup Priority Listing
A listing of voluntary cleanup priority sites located on Indian Land located in Region 1.

Date of Government Version: 09/29/2014
Date Data Arrived at EDR: 10/01/2014
Date Made Active in Reports: 11/06/2014
Number of Days to Update: 36

Source: EPA, Region 1
Telephone: 617-918-1102
Last EDR Contact: 09/29/2015
Next Scheduled EDR Contact: 01/11/2016
Data Release Frequency: Varies

VCP: Voluntary Response Program Sites
Sites participating in the Voluntary Response Program. The purpose of the VRP is to streamline the cleanup process in a way that will encourage prospective developers, lenders, and purchasers to voluntarily cleanup properties.

Date of Government Version: 12/02/2014
Date Data Arrived at EDR: 12/22/2014
Date Made Active in Reports: 01/27/2015
Number of Days to Update: 36

Source: Department of Health
Telephone: 808-586-4249
Last EDR Contact: 11/25/2015
Next Scheduled EDR Contact: 03/07/2016
Data Release Frequency: Varies

State and tribal Brownfields sites

BROWNFIELDS: Brownfields Sites

With certain legal exclusions and additions, the term 'brownfield site' means real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant.

Date of Government Version: 12/02/2014
Date Data Arrived at EDR: 12/22/2014
Date Made Active in Reports: 01/27/2015
Number of Days to Update: 36

Source: Department of Health
Telephone: 808-586-4249
Last EDR Contact: 11/25/2015
Next Scheduled EDR Contact: 03/07/2016
Data Release Frequency: Varies

ADDITIONAL ENVIRONMENTAL RECORDS

Local Brownfield lists

US BROWNFIELDS: A Listing of Brownfields Sites

Brownfields are real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. Cleaning up and reinvesting in these properties takes development pressures off of undeveloped, open land, and both improves and protects the environment. Assessment, Cleanup and Redevelopment Exchange System (ACRES) stores information reported by EPA Brownfields grant recipients on brownfields properties assessed or cleaned up with grant funding as well as information on Targeted Brownfields Assessments performed by EPA Regions. A listing of ACRES Brownfield sites is obtained from Cleanups in My Community. Cleanups in My Community provides information on Brownfields properties for which information is reported back to EPA, as well as areas served by Brownfields grant programs.

Date of Government Version: 06/22/2015
Date Data Arrived at EDR: 06/24/2015
Date Made Active in Reports: 09/02/2015
Number of Days to Update: 70

Source: Environmental Protection Agency
Telephone: 202-566-2777
Last EDR Contact: 12/21/2015
Next Scheduled EDR Contact: 04/04/2016
Data Release Frequency: Semi-Annually

Local Lists of Landfill / Solid Waste Disposal Sites

INDIAN ODI: Report on the Status of Open Dumps on Indian Lands

Location of open dumps on Indian land.

Date of Government Version: 12/31/1998
Date Data Arrived at EDR: 12/03/2007
Date Made Active in Reports: 01/24/2008
Number of Days to Update: 52

Source: Environmental Protection Agency
Telephone: 703-308-8245
Last EDR Contact: 11/06/2015
Next Scheduled EDR Contact: 02/15/2016
Data Release Frequency: Varies

ODI: Open Dump Inventory

An open dump is defined as a disposal facility that does not comply with one or more of the Part 257 or Part 258 Subtitle D Criteria.

Date of Government Version: 06/30/1985
Date Data Arrived at EDR: 08/09/2004
Date Made Active in Reports: 09/17/2004
Number of Days to Update: 39

Source: Environmental Protection Agency
Telephone: 800-424-9346
Last EDR Contact: 06/09/2004
Next Scheduled EDR Contact: N/A
Data Release Frequency: No Update Planned

DEBRIS REGION 9: Torres Martinez Reservation Illegal Dump Site Locations

A listing of illegal dump sites location on the Torres Martinez Indian Reservation located in eastern Riverside County and northern Imperial County, California.

Date of Government Version: 01/12/2009
Date Data Arrived at EDR: 05/07/2009
Date Made Active in Reports: 09/21/2009
Number of Days to Update: 137

Source: EPA, Region 9
Telephone: 415-947-4219
Last EDR Contact: 10/26/2015
Next Scheduled EDR Contact: 02/08/2016
Data Release Frequency: No Update Planned

Local Lists of Hazardous waste / Contaminated Sites

US HIST CDL: National Clandestine Laboratory Register

A listing of clandestine drug lab locations. The U.S. Department of Justice ("the Department") provides this web site as a public service. It contains addresses of some locations where law enforcement agencies reported they found chemicals or other items that indicated the presence of either clandestine drug laboratories or dumpsites. In most cases, the source of the entries is not the Department, and the Department has not verified the entry and does not guarantee its accuracy. Members of the public must verify the accuracy of all entries by, for example, contacting local law enforcement and local health departments.

Date of Government Version: 08/12/2015
Date Data Arrived at EDR: 09/04/2015
Date Made Active in Reports: 11/03/2015
Number of Days to Update: 60

Source: Drug Enforcement Administration
Telephone: 202-307-1000
Last EDR Contact: 08/31/2015
Next Scheduled EDR Contact: 12/14/2015
Data Release Frequency: No Update Planned

CDL: Clandestine Drug Lab Listing

A listing of clandestine drug lab site locations.

Date of Government Version: 08/04/2010
Date Data Arrived at EDR: 09/10/2010
Date Made Active in Reports: 10/22/2010
Number of Days to Update: 42

Source: Department of Health
Telephone: 808-586-4249
Last EDR Contact: 11/24/2015
Next Scheduled EDR Contact: 03/14/2016
Data Release Frequency: Varies

US CDL: Clandestine Drug Labs

A listing of clandestine drug lab locations. The U.S. Department of Justice ("the Department") provides this web site as a public service. It contains addresses of some locations where law enforcement agencies reported they found chemicals or other items that indicated the presence of either clandestine drug laboratories or dumpsites. In most cases, the source of the entries is not the Department, and the Department has not verified the entry and does not guarantee its accuracy. Members of the public must verify the accuracy of all entries by, for example, contacting local law enforcement and local health departments.

Date of Government Version: 08/12/2015
Date Data Arrived at EDR: 09/04/2015
Date Made Active in Reports: 11/03/2015
Number of Days to Update: 60

Source: Drug Enforcement Administration
Telephone: 202-307-1000
Last EDR Contact: 11/25/2015
Next Scheduled EDR Contact: 03/14/2016
Data Release Frequency: Quarterly

Local Land Records

LIENS 2: CERCLA Lien Information

A Federal CERCLA ('Superfund') lien can exist by operation of law at any site or property at which EPA has spent Superfund monies. These monies are spent to investigate and address releases and threatened releases of contamination. CERCLIS provides information as to the identity of these sites and properties.

Date of Government Version: 02/18/2014
Date Data Arrived at EDR: 03/18/2014
Date Made Active in Reports: 04/24/2014
Number of Days to Update: 37

Source: Environmental Protection Agency
Telephone: 202-564-6023
Last EDR Contact: 10/30/2015
Next Scheduled EDR Contact: 02/08/2016
Data Release Frequency: Varies

Records of Emergency Release Reports

HMIRS: Hazardous Materials Information Reporting System
Hazardous Materials Incident Report System. HMIRS contains hazardous material spill incidents reported to DOT.

Date of Government Version: 06/24/2015
Date Data Arrived at EDR: 06/26/2015
Date Made Active in Reports: 09/02/2015
Number of Days to Update: 68

Source: U.S. Department of Transportation
Telephone: 202-366-4555
Last EDR Contact: 09/29/2015
Next Scheduled EDR Contact: 01/11/2016
Data Release Frequency: Annually

SPILLS: Release Notifications
Releases of hazardous substances to the environment reported to the Office of Hazard Evaluation and Emergency Response since 1988.

Date of Government Version: 12/02/2014
Date Data Arrived at EDR: 12/22/2014
Date Made Active in Reports: 01/28/2015
Number of Days to Update: 37

Source: Department of Health
Telephone: 808-586-4249
Last EDR Contact: 11/25/2015
Next Scheduled EDR Contact: 03/07/2016
Data Release Frequency: Varies

SPILLS 90: SPILLS90 data from FirstSearch
Spills 90 includes those spill and release records available exclusively from FirstSearch databases. Typically, they may include chemical, oil and/or hazardous substance spills recorded after 1990. Duplicate records that are already included in EDR incident and release records are not included in Spills 90.

Date of Government Version: 03/10/2012
Date Data Arrived at EDR: 01/03/2013
Date Made Active in Reports: 02/11/2013
Number of Days to Update: 39

Source: FirstSearch
Telephone: N/A
Last EDR Contact: 01/03/2013
Next Scheduled EDR Contact: N/A
Data Release Frequency: No Update Planned

Other Ascertainable Records

RCRA NonGen / NLR: RCRA - Non Generators / No Longer Regulated
RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Non-Generators do not presently generate hazardous waste.

Date of Government Version: 06/09/2015
Date Data Arrived at EDR: 06/26/2015
Date Made Active in Reports: 09/16/2015
Number of Days to Update: 82

Source: Environmental Protection Agency
Telephone: (415) 495-8895
Last EDR Contact: 12/18/2015
Next Scheduled EDR Contact: 04/11/2016
Data Release Frequency: Varies

FUDS: Formerly Used Defense Sites
The listing includes locations of Formerly Used Defense Sites properties where the US Army Corps of Engineers is actively working or will take necessary cleanup actions.

Date of Government Version: 01/31/2015
Date Data Arrived at EDR: 07/08/2015
Date Made Active in Reports: 10/13/2015
Number of Days to Update: 97

Source: U.S. Army Corps of Engineers
Telephone: 202-528-4285
Last EDR Contact: 12/11/2015
Next Scheduled EDR Contact: 03/21/2016
Data Release Frequency: Varies

DOD: Department of Defense Sites
This data set consists of federally owned or administered lands, administered by the Department of Defense, that have any area equal to or greater than 640 acres of the United States, Puerto Rico, and the U.S. Virgin Islands.

Date of Government Version: 12/31/2005
Date Data Arrived at EDR: 11/10/2006
Date Made Active in Reports: 01/11/2007
Number of Days to Update: 62

Source: USGS
Telephone: 888-275-8747
Last EDR Contact: 10/16/2015
Next Scheduled EDR Contact: 01/25/2016
Data Release Frequency: Semi-Annually

FEDLAND: Federal and Indian Lands

Federally and Indian administrated lands of the United States. Lands included are administrated by: Army Corps of Engineers, Bureau of Reclamation, National Wild and Scenic River, National Wildlife Refuge, Public Domain Land, Wilderness, Wilderness Study Area, Wildlife Management Area, Bureau of Indian Affairs, Bureau of Land Management, Department of Justice, Forest Service, Fish and Wildlife Service, National Park Service.

Date of Government Version: 12/31/2005
Date Data Arrived at EDR: 02/06/2006
Date Made Active in Reports: 01/11/2007
Number of Days to Update: 339

Source: U.S. Geological Survey
Telephone: 888-275-8747
Last EDR Contact: 10/16/2015
Next Scheduled EDR Contact: 01/25/2016
Data Release Frequency: N/A

SCRD DRYCLEANERS: State Coalition for Remediation of Drycleaners Listing

The State Coalition for Remediation of Drycleaners was established in 1998, with support from the U.S. EPA Office of Superfund Remediation and Technology Innovation. It is comprised of representatives of states with established drycleaner remediation programs. Currently the member states are Alabama, Connecticut, Florida, Illinois, Kansas, Minnesota, Missouri, North Carolina, Oregon, South Carolina, Tennessee, Texas, and Wisconsin.

Date of Government Version: 03/07/2011
Date Data Arrived at EDR: 03/09/2011
Date Made Active in Reports: 05/02/2011
Number of Days to Update: 54

Source: Environmental Protection Agency
Telephone: 615-532-8599
Last EDR Contact: 11/19/2015
Next Scheduled EDR Contact: 02/29/2016
Data Release Frequency: Varies

US FIN ASSUR: Financial Assurance Information

All owners and operators of facilities that treat, store, or dispose of hazardous waste are required to provide proof that they will have sufficient funds to pay for the clean up, closure, and post-closure care of their facilities.

Date of Government Version: 09/01/2015
Date Data Arrived at EDR: 09/03/2015
Date Made Active in Reports: 11/03/2015
Number of Days to Update: 61

Source: Environmental Protection Agency
Telephone: 202-566-1917
Last EDR Contact: 11/13/2015
Next Scheduled EDR Contact: 02/29/2016
Data Release Frequency: Quarterly

EPA WATCH LIST: EPA WATCH LIST

EPA maintains a "Watch List" to facilitate dialogue between EPA, state and local environmental agencies on enforcement matters relating to facilities with alleged violations identified as either significant or high priority. Being on the Watch List does not mean that the facility has actually violated the law only that an investigation by EPA or a state or local environmental agency has led those organizations to allege that an unproven violation has in fact occurred. Being on the Watch List does not represent a higher level of concern regarding the alleged violations that were detected, but instead indicates cases requiring additional dialogue between EPA, state and local agencies - primarily because of the length of time the alleged violation has gone unaddressed or unresolved.

Date of Government Version: 08/30/2013
Date Data Arrived at EDR: 03/21/2014
Date Made Active in Reports: 06/17/2014
Number of Days to Update: 88

Source: Environmental Protection Agency
Telephone: 617-520-3000
Last EDR Contact: 11/10/2015
Next Scheduled EDR Contact: 02/22/2016
Data Release Frequency: Quarterly

2020 COR ACTION: 2020 Corrective Action Program List

The EPA has set ambitious goals for the RCRA Corrective Action program by creating the 2020 Corrective Action Universe. This RCRA cleanup baseline includes facilities expected to need corrective action. The 2020 universe contains a wide variety of sites. Some properties are heavily contaminated while others were contaminated but have since been cleaned up. Still others have not been fully investigated yet, and may require little or no remediation. Inclusion in the 2020 Universe does not necessarily imply failure on the part of a facility to meet its RCRA obligations.

Date of Government Version: 04/22/2013
Date Data Arrived at EDR: 03/03/2015
Date Made Active in Reports: 03/09/2015
Number of Days to Update: 6

Source: Environmental Protection Agency
Telephone: 703-308-4044
Last EDR Contact: 11/13/2015
Next Scheduled EDR Contact: 02/22/2016
Data Release Frequency: Varies

TSCA: Toxic Substances Control Act

Toxic Substances Control Act. TSCA identifies manufacturers and importers of chemical substances included on the TSCA Chemical Substance Inventory list. It includes data on the production volume of these substances by plant site.

Date of Government Version: 12/31/2012
Date Data Arrived at EDR: 01/15/2015
Date Made Active in Reports: 01/29/2015
Number of Days to Update: 14

Source: EPA
Telephone: 202-260-5521
Last EDR Contact: 09/25/2015
Next Scheduled EDR Contact: 01/04/2016
Data Release Frequency: Every 4 Years

TRIS: Toxic Chemical Release Inventory System

Toxic Release Inventory System. TRIS identifies facilities which release toxic chemicals to the air, water and land in reportable quantities under SARA Title III Section 313.

Date of Government Version: 12/31/2013
Date Data Arrived at EDR: 02/12/2015
Date Made Active in Reports: 06/02/2015
Number of Days to Update: 110

Source: EPA
Telephone: 202-566-0250
Last EDR Contact: 11/24/2015
Next Scheduled EDR Contact: 03/07/2016
Data Release Frequency: Annually

SSTS: Section 7 Tracking Systems

Section 7 of the Federal Insecticide, Fungicide and Rodenticide Act, as amended (92 Stat. 829) requires all registered pesticide-producing establishments to submit a report to the Environmental Protection Agency by March 1st each year. Each establishment must report the types and amounts of pesticides, active ingredients and devices being produced, and those having been produced and sold or distributed in the past year.

Date of Government Version: 12/31/2009
Date Data Arrived at EDR: 12/10/2010
Date Made Active in Reports: 02/25/2011
Number of Days to Update: 77

Source: EPA
Telephone: 202-564-4203
Last EDR Contact: 10/26/2015
Next Scheduled EDR Contact: 02/08/2016
Data Release Frequency: Annually

ROD: Records Of Decision

Record of Decision. ROD documents mandate a permanent remedy at an NPL (Superfund) site containing technical and health information to aid in the cleanup.

Date of Government Version: 11/25/2013
Date Data Arrived at EDR: 12/12/2013
Date Made Active in Reports: 02/24/2014
Number of Days to Update: 74

Source: EPA
Telephone: 703-416-0223
Last EDR Contact: 12/11/2015
Next Scheduled EDR Contact: 03/21/2016
Data Release Frequency: Annually

RMP: Risk Management Plans

When Congress passed the Clean Air Act Amendments of 1990, it required EPA to publish regulations and guidance for chemical accident prevention at facilities using extremely hazardous substances. The Risk Management Program Rule (RMP Rule) was written to implement Section 112(r) of these amendments. The rule, which built upon existing industry codes and standards, requires companies of all sizes that use certain flammable and toxic substances to develop a Risk Management Program, which includes a(n): Hazard assessment that details the potential effects of an accidental release, an accident history of the last five years, and an evaluation of worst-case and alternative accidental releases; Prevention program that includes safety precautions and maintenance, monitoring, and employee training measures; and Emergency response program that spells out emergency health care, employee training measures and procedures for informing the public and response agencies (e.g the fire department) should an accident occur.

Date of Government Version: 08/01/2015
Date Data Arrived at EDR: 08/26/2015
Date Made Active in Reports: 11/03/2015
Number of Days to Update: 69

Source: Environmental Protection Agency
Telephone: 202-564-8600
Last EDR Contact: 10/26/2015
Next Scheduled EDR Contact: 02/08/2016
Data Release Frequency: Varies

RAATS: RCRA Administrative Action Tracking System

RCRA Administration Action Tracking System. RAATS contains records based on enforcement actions issued under RCRA pertaining to major violators and includes administrative and civil actions brought by the EPA. For administration actions after September 30, 1995, data entry in the RAATS database was discontinued. EPA will retain a copy of the database for historical records. It was necessary to terminate RAATS because a decrease in agency resources made it impossible to continue to update the information contained in the database.

Date of Government Version: 04/17/1995
Date Data Arrived at EDR: 07/03/1995
Date Made Active in Reports: 08/07/1995
Number of Days to Update: 35

Source: EPA
Telephone: 202-564-4104
Last EDR Contact: 06/02/2008
Next Scheduled EDR Contact: 09/01/2008
Data Release Frequency: No Update Planned

PRP: Potentially Responsible Parties

A listing of verified Potentially Responsible Parties

Date of Government Version: 10/25/2013
Date Data Arrived at EDR: 10/17/2014
Date Made Active in Reports: 10/20/2014
Number of Days to Update: 3

Source: EPA
Telephone: 202-564-6023
Last EDR Contact: 11/13/2015
Next Scheduled EDR Contact: 02/22/2016
Data Release Frequency: Quarterly

PADS: PCB Activity Database System

PCB Activity Database. PADS Identifies generators, transporters, commercial storers and/or brokers and disposers of PCB's who are required to notify the EPA of such activities.

Date of Government Version: 07/01/2014
Date Data Arrived at EDR: 10/15/2014
Date Made Active in Reports: 11/17/2014
Number of Days to Update: 33

Source: EPA
Telephone: 202-566-0500
Last EDR Contact: 10/29/2015
Next Scheduled EDR Contact: 01/25/2016
Data Release Frequency: Annually

ICIS: Integrated Compliance Information System

The Integrated Compliance Information System (ICIS) supports the information needs of the national enforcement and compliance program as well as the unique needs of the National Pollutant Discharge Elimination System (NPDES) program.

Date of Government Version: 01/23/2015
Date Data Arrived at EDR: 02/06/2015
Date Made Active in Reports: 03/09/2015
Number of Days to Update: 31

Source: Environmental Protection Agency
Telephone: 202-564-5088
Last EDR Contact: 10/08/2015
Next Scheduled EDR Contact: 01/25/2016
Data Release Frequency: Quarterly

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

FTTS: FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
FTTS tracks administrative cases and pesticide enforcement actions and compliance activities related to FIFRA, TSCA and EPCRA (Emergency Planning and Community Right-to-Know Act). To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 04/09/2009
Date Data Arrived at EDR: 04/16/2009
Date Made Active in Reports: 05/11/2009
Number of Days to Update: 25

Source: EPA/Office of Prevention, Pesticides and Toxic Substances
Telephone: 202-566-1667
Last EDR Contact: 11/18/2015
Next Scheduled EDR Contact: 03/07/2016
Data Release Frequency: Quarterly

FTTS INSP: FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
A listing of FIFRA/TSCA Tracking System (FTTS) inspections and enforcements.

Date of Government Version: 04/09/2009
Date Data Arrived at EDR: 04/16/2009
Date Made Active in Reports: 05/11/2009
Number of Days to Update: 25

Source: EPA
Telephone: 202-566-1667
Last EDR Contact: 11/18/2015
Next Scheduled EDR Contact: 03/07/2016
Data Release Frequency: Quarterly

MLTS: Material Licensing Tracking System
MLTS is maintained by the Nuclear Regulatory Commission and contains a list of approximately 8,100 sites which possess or use radioactive materials and which are subject to NRC licensing requirements. To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 06/26/2015
Date Data Arrived at EDR: 07/10/2015
Date Made Active in Reports: 10/13/2015
Number of Days to Update: 95

Source: Nuclear Regulatory Commission
Telephone: 301-415-7169
Last EDR Contact: 12/07/2015
Next Scheduled EDR Contact: 03/21/2016
Data Release Frequency: Quarterly

COAL ASH DOE: Steam-Electric Plant Operation Data
A listing of power plants that store ash in surface ponds.

Date of Government Version: 12/31/2005
Date Data Arrived at EDR: 08/07/2009
Date Made Active in Reports: 10/22/2009
Number of Days to Update: 76

Source: Department of Energy
Telephone: 202-586-8719
Last EDR Contact: 07/13/2015
Next Scheduled EDR Contact: 10/28/2015
Data Release Frequency: Varies

COAL ASH EPA: Coal Combustion Residues Surface Impoundments List
A listing of coal combustion residues surface impoundments with high hazard potential ratings.

Date of Government Version: 07/01/2014
Date Data Arrived at EDR: 09/10/2014
Date Made Active in Reports: 10/20/2014
Number of Days to Update: 40

Source: Environmental Protection Agency
Telephone: N/A
Last EDR Contact: 12/11/2015
Next Scheduled EDR Contact: 03/21/2016
Data Release Frequency: Varies

PCB TRANSFORMER: PCB Transformer Registration Database
The database of PCB transformer registrations that includes all PCB registration submittals.

Date of Government Version: 02/01/2011
Date Data Arrived at EDR: 10/19/2011
Date Made Active in Reports: 01/10/2012
Number of Days to Update: 83

Source: Environmental Protection Agency
Telephone: 202-566-0517
Last EDR Contact: 10/29/2015
Next Scheduled EDR Contact: 02/08/2016
Data Release Frequency: Varies

RADINFO: Radiation Information Database
The Radiation Information Database (RADINFO) contains information about facilities that are regulated by U.S. Environmental Protection Agency (EPA) regulations for radiation and radioactivity.

Date of Government Version: 07/07/2015
Date Data Arrived at EDR: 07/09/2015
Date Made Active in Reports: 09/16/2015
Number of Days to Update: 69

Source: Environmental Protection Agency
Telephone: 202-343-9775
Last EDR Contact: 10/07/2015
Next Scheduled EDR Contact: 01/18/2016
Data Release Frequency: Quarterly

HIST FTTS: FIFRA/TSCA Tracking System Administrative Case Listing

A complete administrative case listing from the FIFRA/TSCA Tracking System (FTTS) for all ten EPA regions. The information was obtained from the National Compliance Database (NCDB). NCDB supports the implementation of FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) and TSCA (Toxic Substances Control Act). Some EPA regions are now closing out records. Because of that, and the fact that some EPA regions are not providing EPA Headquarters with updated records, it was decided to create a HIST FTTS database. It included records that may not be included in the newer FTTS database updates. This database is no longer updated.

Date of Government Version: 10/19/2006
Date Data Arrived at EDR: 03/01/2007
Date Made Active in Reports: 04/10/2007
Number of Days to Update: 40

Source: Environmental Protection Agency
Telephone: 202-564-2501
Last EDR Contact: 12/17/2007
Next Scheduled EDR Contact: 03/17/2008
Data Release Frequency: No Update Planned

HIST FTTS INSP: FIFRA/TSCA Tracking System Inspection & Enforcement Case Listing

A complete inspection and enforcement case listing from the FIFRA/TSCA Tracking System (FTTS) for all ten EPA regions. The information was obtained from the National Compliance Database (NCDB). NCDB supports the implementation of FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) and TSCA (Toxic Substances Control Act). Some EPA regions are now closing out records. Because of that, and the fact that some EPA regions are not providing EPA Headquarters with updated records, it was decided to create a HIST FTTS database. It included records that may not be included in the newer FTTS database updates. This database is no longer updated.

Date of Government Version: 10/19/2006
Date Data Arrived at EDR: 03/01/2007
Date Made Active in Reports: 04/10/2007
Number of Days to Update: 40

Source: Environmental Protection Agency
Telephone: 202-564-2501
Last EDR Contact: 12/17/2008
Next Scheduled EDR Contact: 03/17/2008
Data Release Frequency: No Update Planned

DOT OPS: Incident and Accident Data

Department of Transporation, Office of Pipeline Safety Incident and Accident data.

Date of Government Version: 07/31/2012
Date Data Arrived at EDR: 08/07/2012
Date Made Active in Reports: 09/18/2012
Number of Days to Update: 42

Source: Department of Transporation, Office of Pipeline Safety
Telephone: 202-366-4595
Last EDR Contact: 11/07/2015
Next Scheduled EDR Contact: 02/15/2016
Data Release Frequency: Varies

CONSENT: Superfund (CERCLA) Consent Decrees

Major legal settlements that establish responsibility and standards for cleanup at NPL (Superfund) sites. Released periodically by United States District Courts after settlement by parties to litigation matters.

Date of Government Version: 12/31/2014
Date Data Arrived at EDR: 04/17/2015
Date Made Active in Reports: 06/02/2015
Number of Days to Update: 46

Source: Department of Justice, Consent Decree Library
Telephone: Varies
Last EDR Contact: 09/28/2015
Next Scheduled EDR Contact: 01/11/2016
Data Release Frequency: Varies

BRS: Biennial Reporting System

The Biennial Reporting System is a national system administered by the EPA that collects data on the generation and management of hazardous waste. BRS captures detailed data from two groups: Large Quantity Generators (LQG) and Treatment, Storage, and Disposal Facilities.

Date of Government Version: 12/31/2013
Date Data Arrived at EDR: 02/24/2015
Date Made Active in Reports: 09/30/2015
Number of Days to Update: 218

Source: EPA/NTIS
Telephone: 800-424-9346
Last EDR Contact: 11/24/2015
Next Scheduled EDR Contact: 03/07/2016
Data Release Frequency: Biennially

INDIAN RESERV: Indian Reservations

This map layer portrays Indian administered lands of the United States that have any area equal to or greater than 640 acres.

Date of Government Version: 12/31/2005
Date Data Arrived at EDR: 12/08/2006
Date Made Active in Reports: 01/11/2007
Number of Days to Update: 34

Source: USGS
Telephone: 202-208-3710
Last EDR Contact: 10/16/2015
Next Scheduled EDR Contact: 01/25/2016
Data Release Frequency: Semi-Annually

UMTRA: Uranium Mill Tailings Sites

Uranium ore was mined by private companies for federal government use in national defense programs. When the mills shut down, large piles of the sand-like material (mill tailings) remain after uranium has been extracted from the ore. Levels of human exposure to radioactive materials from the piles are low; however, in some cases tailings were used as construction materials before the potential health hazards of the tailings were recognized.

Date of Government Version: 09/14/2010
Date Data Arrived at EDR: 10/07/2011
Date Made Active in Reports: 03/01/2012
Number of Days to Update: 146

Source: Department of Energy
Telephone: 505-845-0011
Last EDR Contact: 11/19/2015
Next Scheduled EDR Contact: 03/07/2016
Data Release Frequency: Varies

LEAD SMELTER 1: Lead Smelter Sites

A listing of former lead smelter site locations.

Date of Government Version: 11/25/2014
Date Data Arrived at EDR: 11/26/2014
Date Made Active in Reports: 01/29/2015
Number of Days to Update: 64

Source: Environmental Protection Agency
Telephone: 703-603-8787
Last EDR Contact: 10/05/2015
Next Scheduled EDR Contact: 01/18/2016
Data Release Frequency: Varies

LEAD SMELTER 2: Lead Smelter Sites

A list of several hundred sites in the U.S. where secondary lead smelting was done from 1931and 1964. These sites may pose a threat to public health through ingestion or inhalation of contaminated soil or dust

Date of Government Version: 04/05/2001
Date Data Arrived at EDR: 10/27/2010
Date Made Active in Reports: 12/02/2010
Number of Days to Update: 36

Source: American Journal of Public Health
Telephone: 703-305-6451
Last EDR Contact: 12/02/2009
Next Scheduled EDR Contact: N/A
Data Release Frequency: No Update Planned

US AIRS (AFS): Aerometric Information Retrieval System Facility Subsystem (AFS)

The database is a sub-system of Aerometric Information Retrieval System (AIRS). AFS contains compliance data on air pollution point sources regulated by the U.S. EPA and/or state and local air regulatory agencies. This information comes from source reports by various stationary sources of air pollution, such as electric power plants, steel mills, factories, and universities, and provides information about the air pollutants they produce. Action, air program, air program pollutant, and general level plant data. It is used to track emissions and compliance data from industrial plants.

Date of Government Version: 07/22/2015
Date Data Arrived at EDR: 07/24/2015
Date Made Active in Reports: 09/02/2015
Number of Days to Update: 40

Source: EPA
Telephone: 202-564-2496
Last EDR Contact: 12/22/2015
Next Scheduled EDR Contact: 04/11/2016
Data Release Frequency: Annually

US AIRS MINOR: Air Facility System Data

A listing of minor source facilities.

Date of Government Version: 07/22/2015
Date Data Arrived at EDR: 07/24/2015
Date Made Active in Reports: 09/02/2015
Number of Days to Update: 40

Source: EPA
Telephone: 202-564-2496
Last EDR Contact: 12/22/2015
Next Scheduled EDR Contact: 04/11/2016
Data Release Frequency: Annually

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

US MINES: Mines Master Index File

Contains all mine identification numbers issued for mines active or opened since 1971. The data also includes violation information.

Date of Government Version: 05/14/2015
Date Data Arrived at EDR: 06/03/2015
Date Made Active in Reports: 09/02/2015
Number of Days to Update: 91

Source: Department of Labor, Mine Safety and Health Administration
Telephone: 303-231-5959
Last EDR Contact: 12/03/2015
Next Scheduled EDR Contact: 03/14/2016
Data Release Frequency: Semi-Annually

US MINES 2: Ferrous and Nonferrous Metal Mines Database Listing

This map layer includes ferrous (ferrous metal mines are facilities that extract ferrous metals, such as iron ore or molybdenum) and nonferrous (Nonferrous metal mines are facilities that extract nonferrous metals, such as gold, silver, copper, zinc, and lead) metal mines in the United States.

Date of Government Version: 12/05/2005
Date Data Arrived at EDR: 02/29/2008
Date Made Active in Reports: 04/18/2008
Number of Days to Update: 49

Source: USGS
Telephone: 703-648-7709
Last EDR Contact: 12/04/2015
Next Scheduled EDR Contact: 03/14/2016
Data Release Frequency: Varies

US MINES 3: Active Mines & Mineral Plants Database Listing

Active Mines and Mineral Processing Plant operations for commodities monitored by the Minerals Information Team of the USGS.

Date of Government Version: 04/14/2011
Date Data Arrived at EDR: 06/08/2011
Date Made Active in Reports: 09/13/2011
Number of Days to Update: 97

Source: USGS
Telephone: 703-648-7709
Last EDR Contact: 12/04/2015
Next Scheduled EDR Contact: 03/14/2016
Data Release Frequency: Varies

FINDS: Facility Index System/Facility Registry System

Facility Index System. FINDS contains both facility information and ’pointers’ to other sources that contain more detail. EDR includes the following FINDS databases in this report: PCS (Permit Compliance System), AIRS (Aerometric Information Retrieval System), DOCKET (Enforcement Docket used to manage and track information on civil judicial enforcement cases for all environmental statutes), FURS (Federal Underground Injection Control), C-DOCKET (Criminal Docket System used to track criminal enforcement actions for all environmental statutes), FFIS (Federal Facilities Information System), STATE (State Environmental Laws and Statutes), and PADS (PCB Activity Data System).

Date of Government Version: 07/20/2015
Date Data Arrived at EDR: 09/09/2015
Date Made Active in Reports: 11/03/2015
Number of Days to Update: 55

Source: EPA
Telephone: (415) 947-8000
Last EDR Contact: 12/10/2015
Next Scheduled EDR Contact: 03/21/2016
Data Release Frequency: Quarterly

AIRS: List of Permitted Facilities

A listing of permitted facilities in the state.

Date of Government Version: 10/06/2015
Date Data Arrived at EDR: 10/08/2015
Date Made Active in Reports: 11/06/2015
Number of Days to Update: 29

Source: Department of Health
Telephone: 808-586-4200
Last EDR Contact: 10/05/2015
Next Scheduled EDR Contact: 01/18/2016
Data Release Frequency: Varies

DRYCLEANERS: Permitted Drycleaner Facility Listing

A listing of permitted drycleaner facilities in the state.

Date of Government Version: 10/05/2015
Date Data Arrived at EDR: 10/08/2015
Date Made Active in Reports: 11/16/2015
Number of Days to Update: 39

Source: Department of Health
Telephone: 808-586-4200
Last EDR Contact: 10/05/2015
Next Scheduled EDR Contact: 01/18/2016
Data Release Frequency: Varies

Financial Assurance: Financial Assurance Information Listing

A listing of financial assurance information for underground storage tank facilities. Financial assurance is intended to ensure that resources are available to pay for the cost of closure, post-closure care, and corrective measures if the owner or operator of a regulated facility is unable or unwilling to pay.

Date of Government Version: 09/28/2015
Date Data Arrived at EDR: 09/29/2015
Date Made Active in Reports: 11/06/2015
Number of Days to Update: 38

Source: Department of Health
Telephone: 808-586-4226
Last EDR Contact: 12/11/2015
Next Scheduled EDR Contact: 03/28/2016
Data Release Frequency: Varies

UIC: Underground Injection Wells Listing

A listing of underground injection well locations.

Date of Government Version: 02/07/2013
Date Data Arrived at EDR: 02/12/2013
Date Made Active in Reports: 04/09/2013
Number of Days to Update: 56

Source: Department of Health
Telephone: 808-586-4258
Last EDR Contact: 11/24/2015
Next Scheduled EDR Contact: 03/14/2016
Data Release Frequency: Varies

EDR HIGH RISK HISTORICAL RECORDS

EDR Exclusive Records

EDR MGP: EDR Proprietary Manufactured Gas Plants

The EDR Proprietary Manufactured Gas Plant Database includes records of coal gas plants (manufactured gas plants) compiled by EDR’s researchers. Manufactured gas sites were used in the United States from the 1800’s to 1950’s to produce a gas that could be distributed and used as fuel. These plants used whale oil, rosin, coal, or a mixture of coal, oil, and water that also produced a significant amount of waste. Many of the byproducts of the gas production, such as coal tar (oily waste containing volatile and non-volatile chemicals), sludges, oils and other compounds are potentially hazardous to human health and the environment. The byproduct from this process was frequently disposed of directly at the plant site and can remain or spread slowly, serving as a continuous source of soil and groundwater contamination.

Date of Government Version: N/A
Date Data Arrived at EDR: N/A
Date Made Active in Reports: N/A
Number of Days to Update: N/A

Source: EDR, Inc.
Telephone: N/A
Last EDR Contact: N/A
Next Scheduled EDR Contact: N/A
Data Release Frequency: No Update Planned

EDR Hist Auto: EDR Exclusive Historic Gas Stations

EDR has searched selected national collections of business directories and has collected listings of potential gas station/filling station/service station sites that were available to EDR researchers. EDR’s review was limited to those categories of sources that might, in EDR’s opinion, include gas station/filling station/service station establishments. The categories reviewed included, but were not limited to gas, gas station, gasoline station, filling station, auto, automobile repair, auto service station, service station, etc. This database falls within a category of information EDR classifies as "High Risk Historical Records", or HRHR. EDR’s HRHR effort presents unique and sometimes proprietary data about past sites and operations that typically create environmental concerns, but may not show up in current government records searches.

Date of Government Version: N/A
Date Data Arrived at EDR: N/A
Date Made Active in Reports: N/A
Number of Days to Update: N/A

Source: EDR, Inc.
Telephone: N/A
Last EDR Contact: N/A
Next Scheduled EDR Contact: N/A
Data Release Frequency: Varies

EDR Hist Cleaner: EDR Exclusive Historic Dry Cleaners

EDR has searched selected national collections of business directories and has collected listings of potential dry cleaner sites that were available to EDR researchers. EDR’s review was limited to those categories of sources that might, in EDR’s opinion, include dry cleaning establishments. The categories reviewed included, but were not limited to dry cleaners, cleaners, laundry, laundromat, cleaning/laundry, wash & dry etc. This database falls within a category of information EDR classifies as "High Risk Historical Records", or HRHR. EDR’s HRHR effort presents unique and sometimes proprietary data about past sites and operations that typically create environmental concerns, but may not show up in current government records searches.

Date of Government Version: N/A
Date Data Arrived at EDR: N/A
Date Made Active in Reports: N/A
Number of Days to Update: N/A

Source: EDR, Inc.
Telephone: N/A
Last EDR Contact: N/A
Next Scheduled EDR Contact: N/A
Data Release Frequency: Varies

EDR RECOVERED GOVERNMENT ARCHIVES

Exclusive Recovered Govt. Archives

RGA HWS: Recovered Government Archive State Hazardous Waste Facilities List

The EDR Recovered Government Archive State Hazardous Waste database provides a list of SHWS incidents derived from historical databases and includes many records that no longer appear in current government lists. Compiled from Records formerly available from the Department of Health in Hawaii.

Date of Government Version: N/A
Date Data Arrived at EDR: 07/01/2013
Date Made Active in Reports: 01/08/2014
Number of Days to Update: 191

Source: Department of Health
Telephone: N/A
Last EDR Contact: 06/01/2012
Next Scheduled EDR Contact: N/A
Data Release Frequency: Varies

RGA LF: Recovered Government Archive Solid Waste Facilities List

The EDR Recovered Government Archive Landfill database provides a list of landfills derived from historical databases and includes many records that no longer appear in current government lists. Compiled from Records formerly available from the Department of Health in Hawaii.

Date of Government Version: N/A
Date Data Arrived at EDR: 07/01/2013
Date Made Active in Reports: 01/17/2014
Number of Days to Update: 200

Source: Department of Health
Telephone: N/A
Last EDR Contact: 06/01/2012
Next Scheduled EDR Contact: N/A
Data Release Frequency: Varies

RGA LUST: Recovered Government Archive Leaking Underground Storage Tank

The EDR Recovered Government Archive Leaking Underground Storage Tank database provides a list of LUST incidents derived from historical databases and includes many records that no longer appear in current government lists. Compiled from Records formerly available from the Department of Health in Hawaii.

Date of Government Version: N/A
Date Data Arrived at EDR: 07/01/2013
Date Made Active in Reports: 01/03/2014
Number of Days to Update: 186

Source: Department of Health
Telephone: N/A
Last EDR Contact: 06/01/2012
Next Scheduled EDR Contact: N/A
Data Release Frequency: Varies

OTHER DATABASE(S)

Depending on the geographic area covered by this report, the data provided in these specialty databases may or may not be complete. For example, the existence of wetlands information data in a specific report does not mean that all wetlands in the area covered by the report are included. Moreover, the absence of any reported wetlands information does not necessarily mean that wetlands do not exist in the area covered by the report.

Oil/Gas Pipelines

Source: PennWell Corporation

Petroleum Bundle (Crude Oil, Refined Products, Petrochemicals, Gas Liquids (LPG/NGL), and Specialty Gases (Miscellaneous)) N = Natural Gas Bundle (Natural Gas, Gas Liquids (LPG/NGL), and Specialty Gases (Miscellaneous)). This map includes information copyrighted by PennWell Corporation. This information is provided on a best effort basis and PennWell Corporation does not guarantee its accuracy nor warrant its fitness for any particular purpose. Such information has been reprinted with the permission of PennWell.

Electric Power Transmission Line Data

Source: PennWell Corporation

This map includes information copyrighted by PennWell Corporation. This information is provided on a best effort basis and PennWell Corporation does not guarantee its accuracy nor warrant its fitness for any particular purpose. Such information has been reprinted with the permission of PennWell.

Sensitive Receptors: There are individuals deemed sensitive receptors due to their fragile immune systems and special sensitivity to environmental discharges. These sensitive receptors typically include the elderly, the sick, and children. While the location of all sensitive receptors cannot be determined, EDR indicates those buildings and facilities - schools, daycares, hospitals, medical centers, and nursing homes - where individuals who are sensitive receptors are likely to be located.

AHA Hospitals:
Source: American Hospital Association, Inc.
Telephone: 312-280-5991
The database includes a listing of hospitals based on the American Hospital Association's annual survey of hospitals.

Medical Centers: Provider of Services Listing
Source: Centers for Medicare & Medicaid Services
Telephone: 410-786-3000
A listing of hospitals with Medicare provider number, produced by Centers of Medicare & Medicaid Services, a federal agency within the U.S. Department of Health and Human Services.

Nursing Homes
Source: National Institutes of Health
Telephone: 301-594-6248
Information on Medicare and Medicaid certified nursing homes in the United States.

Public Schools
Source: National Center for Education Statistics
Telephone: 202-502-7300
The National Center for Education Statistics' primary database on elementary and secondary public education in the United States. It is a comprehensive, annual, national statistical database of all public elementary and secondary schools and school districts, which contains data that are comparable across all states.

Private Schools
Source: National Center for Education Statistics
Telephone: 202-502-7300
The National Center for Education Statistics' primary database on private school locations in the United States.

Flood Zone Data: This data, available in select counties across the country, was obtained by EDR in 2003 & 2011 from the Federal Emergency Management Agency (FEMA). Data depicts 100-year and 500-year flood zones as defined by FEMA.

NWI: National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in 2002, 2005 and 2010 from the U.S. Fish and Wildlife Service.

State Wetlands Data: Wetlands Inventory
Source: Office of Planning
Telephone: 808-587-2895

Current USGS 7.5 Minute Topographic Map
Source: U.S. Geological Survey

STREET AND ADDRESS INFORMATION

GEOCHECK ®- PHYSICAL SETTING SOURCE ADDENDUM

TARGET PROPERTY ADDRESS

CALTECH SUBMILLIMETER OBSERVATORY
MAUNA KEA ACCESS ROAD
PAAUILO, HI 96776

TARGET PROPERTY COORDINATES

Latitude (North):	19.8225 - 19˚ 49’ 21.00’’
Longitude (West):	155.4754 - 155˚ 28’ 31.44’’
Universal Tranverse Mercator:	Zone 5
UTM X (Meters):	240704.7
UTM Y (Meters):	2193609.0
Elevation:	13343 ft. above sea level

USGS TOPOGRAPHIC MAP

Target Property Map:	5949268 MAUNA KEA, HI
Version Date:	2013

EDR’s GeoCheck Physical Setting Source Addendum is provided to assist the environmental professional in forming an opinion about the impact of potential contaminant migration.

Assessment of the impact of contaminant migration generally has two principal investigative components:

1. Groundwater flow direction, and
2. Groundwater flow velocity.

Groundwater flow direction may be impacted by surface topography, hydrology, hydrogeology, characteristics of the soil, and nearby wells. Groundwater flow velocity is generally impacted by the nature of the geologic strata.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

GROUNDWATER FLOW DIRECTION INFORMATION

Groundwater flow direction for a particular site is best determined by a qualified environmental professional using site-specific well data. If such data is not reasonably ascertainable, it may be necessary to rely on other sources of information, such as surface topographic information, hydrologic information, hydrogeologic data collected on nearby properties, and regional groundwater flow information (from deep aquifers).

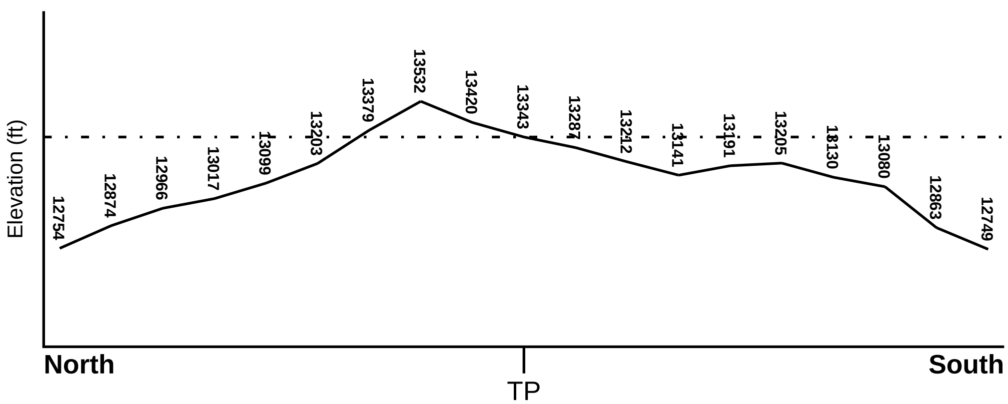
TOPOGRAPHIC INFORMATION

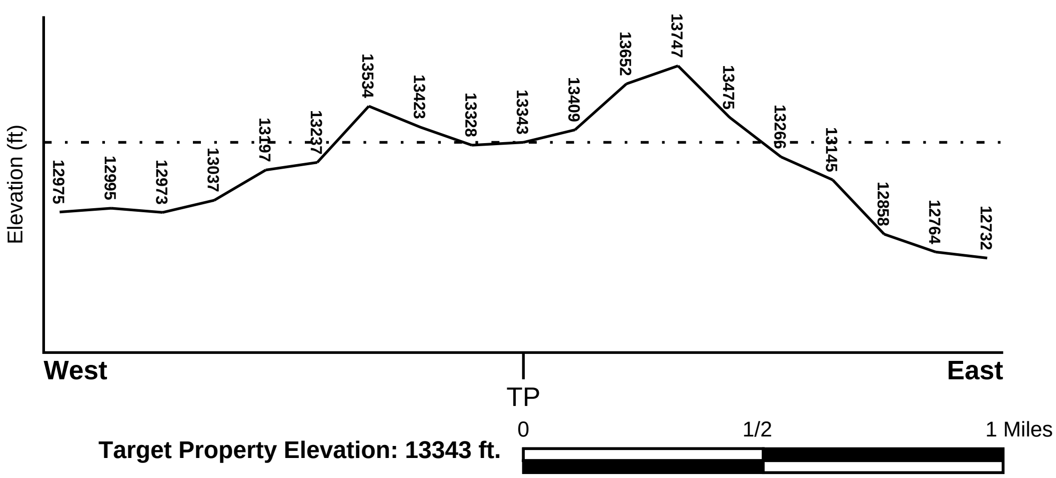
Surface topography may be indicative of the direction of surficial groundwater flow. This information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

TARGET PROPERTY TOPOGRAPHY

General Topographic Gradient: General SSW

SURROUNDING TOPOGRAPHY: ELEVATION PROFILES





Target Property Elevation: 13343 ft.

Source: Topography has been determined from the USGS 7.5' Digital Elevation Model and should be evaluated on a relative (not an absolute) basis. Relative elevation information between sites of close proximity should be field verified.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

HYDROLOGIC INFORMATION

Surface water can act as a hydrologic barrier to groundwater flow. Such hydrologic information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

Refer to the Physical Setting Source Map following this summary for hydrologic information (major waterways and bodies of water).

FEMA FLOOD ZONE

Target Property County	FEMA Flood Electronic Data
HAWAII, HI	YES - refer to the Overview Map and Detail Map

Flood Plain Panel at Target Property: 1551660600C - FEMA Q3 Flood data

Additional Panels in search area: Not Reported

NATIONAL WETLAND INVENTORY

NWI Quad at Target Property	NWI Electronic Data Coverage
MAUNA KEA	YES - refer to the Overview Map and Detail Map

HYDROGEOLOGIC INFORMATION

Hydrogeologic information obtained by installation of wells on a specific site can often be an indicator of groundwater flow direction in the immediate area. Such hydrogeologic information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

AQUIFLOW®

Search Radius: 1.000 Mile.

EDR has developed the AQUIFLOW Information System to provide data on the general direction of groundwater flow at specific points. EDR has reviewed reports submitted by environmental professionals to regulatory authorities at select sites and has extracted the date of the report, groundwater flow direction as determined hydrogeologically, and the depth to water table.

MAP ID	LOCATION FROM TP	GENERAL DIRECTION GROUNDWATER FLOW
Not Reported		

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

GROUNDWATER FLOW VELOCITY INFORMATION

Groundwater flow velocity information for a particular site is best determined by a qualified environmental professional using site specific geologic and soil strata data. If such data are not reasonably ascertainable, it may be necessary to rely on other sources of information, including geologic age identification, rock stratigraphic unit and soil characteristics data collected on nearby properties and regional soil information. In general, contaminant plumes move more quickly through sandy-gravelly types of soils than silty-clayey types of soils.

GEOLOGIC INFORMATION IN GENERAL AREA OF TARGET PROPERTY

Geologic information can be used by the environmental professional in forming an opinion about the relative speed at which contaminant migration may be occurring.

ROCK STRATIGRAPHIC UNIT

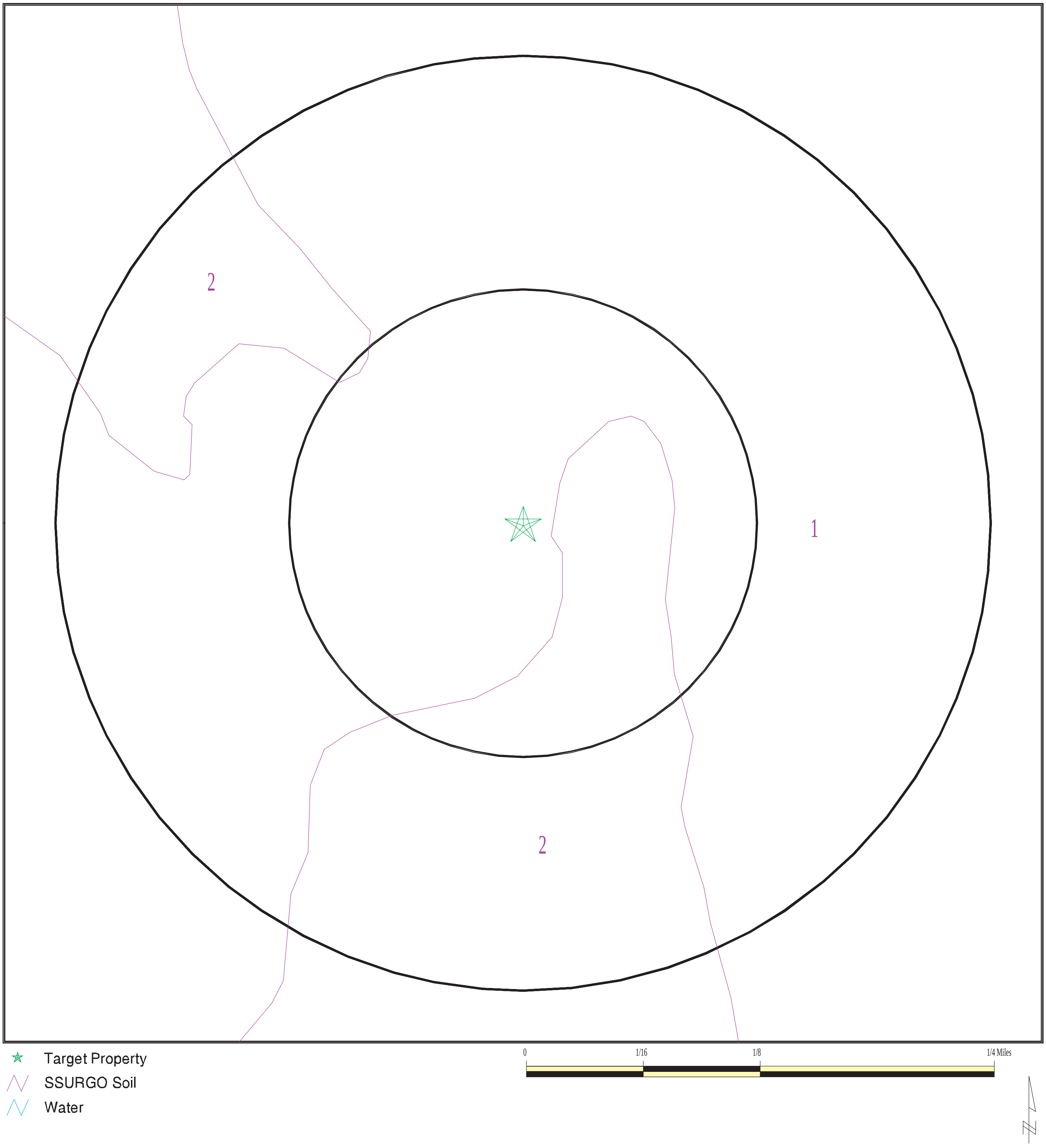
Era:	-
System:	-
Series:	-
Code:	N/A *(decoded above as Era, System & Series)*

GEOLOGIC AGE IDENTIFICATION

Category: -

Geologic Age and Rock Stratigraphic Unit Source: P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S. at 1:2,500,000 Scale - a digital representation of the 1974 P.B. King and H.M. Beikman Map, USGS Digital Data Series DDS - 11 (1994).

SSURGO SOIL MAP - 4502574.2s



SITE NAME: Caltech Submillimeter Observatory ADDRESS: Mauna Kea Access Road Paauilo HI 96776 LAT/LONG: 19.8225 / 155.4754	CLIENT: ENPRO, Env. Professionals CONTACT: Heather Schauer INQUIRY #: 4502574.2s DATE: December 30, 2015 1:35 pm

DOMINANT SOIL COMPOSITION IN GENERAL AREA OF TARGET PROPERTY

The U.S. Department of Agriculture's (USDA) Soil Conservation Service (SCS) leads the National Cooperative Soil Survey (NCSS) and is responsible for collecting, storing, maintaining and distributing soil survey information for privately owned lands in the United States. A soil map in a soil survey is a representation of soil patterns in a landscape. The following information is based on Soil Conservation Service SSURGO data.

Soil Map ID: 1

Soil Component Name: Cinder land

Soil Surface Texture: paragravelly material

Hydrologic Group: Class A - High infiltration rates. Soils are deep, well drained to excessively drained sands and gravels.

Soil Drainage Class: Excessively drained

Hydric Status: Not hydric

Corrosion Potential - Uncoated Steel: Low

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 0 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
1	0 inches	59 inches	paragravelly material	Granular materials (35 pct. or less passing No. 200), Stone Fragments, Gravel and Sand.	COARSE-GRAINED SOILS, Gravels, Clean gravels, Poorly Graded Gravel. COARSE-GRAINED SOILS, Gravels, Gravels with fines, Silty Gravel.	Max: 141 Min: 42	Max: 7.3 Min: 6.1

Soil Map ID: 2

Soil Component Name: Very stony land

Soil Surface Texture: extremely stony fine sandy loam

Hydrologic Group: Class A - High infiltration rates. Soils are deep, well drained to excessively drained sands and gravels.

Soil Drainage Class: Well drained

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

Hydric Status: Not hydric

Corrosion Potential - Uncoated Steel: Moderate

Depth to Bedrock Min: > 152 inches

Depth to Watertable Min: > 0 inches

Soil Layer Information

	Boundary			Classification			
Layer	**Upper**	**Lower**	**Soil Texture Class**	**AASHTO Group**	**Unified Soil**	**Saturated hydraulic conductivity micro m/sec**	**Soil Reaction (pH)**
1	0 inches	9 inches	extremely stony fine sandy loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	COARSE-GRAINED SOILS, Sands, Sands with fines, Silty Sand.	Max: 141 Min: 42	Max: 7.8 Min: 5.6
2	9 inches	59 inches	extremely cobbly material	Granular materials (35 pct. or less passing No. 200), Stone Fragments, Gravel and Sand.	COARSE-GRAINED SOILS, Gravels, Clean gravels, Poorly Graded Gravel. COARSE-GRAINED SOILS, Gravels, Gravels with fines, Silty Gravel.	Max: 141 Min: 42	Max: 7.8 Min: 5.6

LOCAL / REGIONAL WATER AGENCY RECORDS

EDR Local/Regional Water Agency records provide water well information to assist the environmental professional in assessing sources that may impact ground water flow direction, and in forming an opinion about the impact of contaminant migration on nearby drinking water wells.

WELL SEARCH DISTANCE INFORMATION

DATABASE	SEARCH DISTANCE (miles)
Federal USGS	1.000
Federal FRDS PWS	Nearest PWS within 1 mile
State Database	1.000

FEDERAL USGS WELL INFORMATION

MAP ID	WELL ID	LOCATION FROM TP
No Wells Found		

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

FEDERAL FRDS PUBLIC WATER SUPPLY SYSTEM INFORMATION

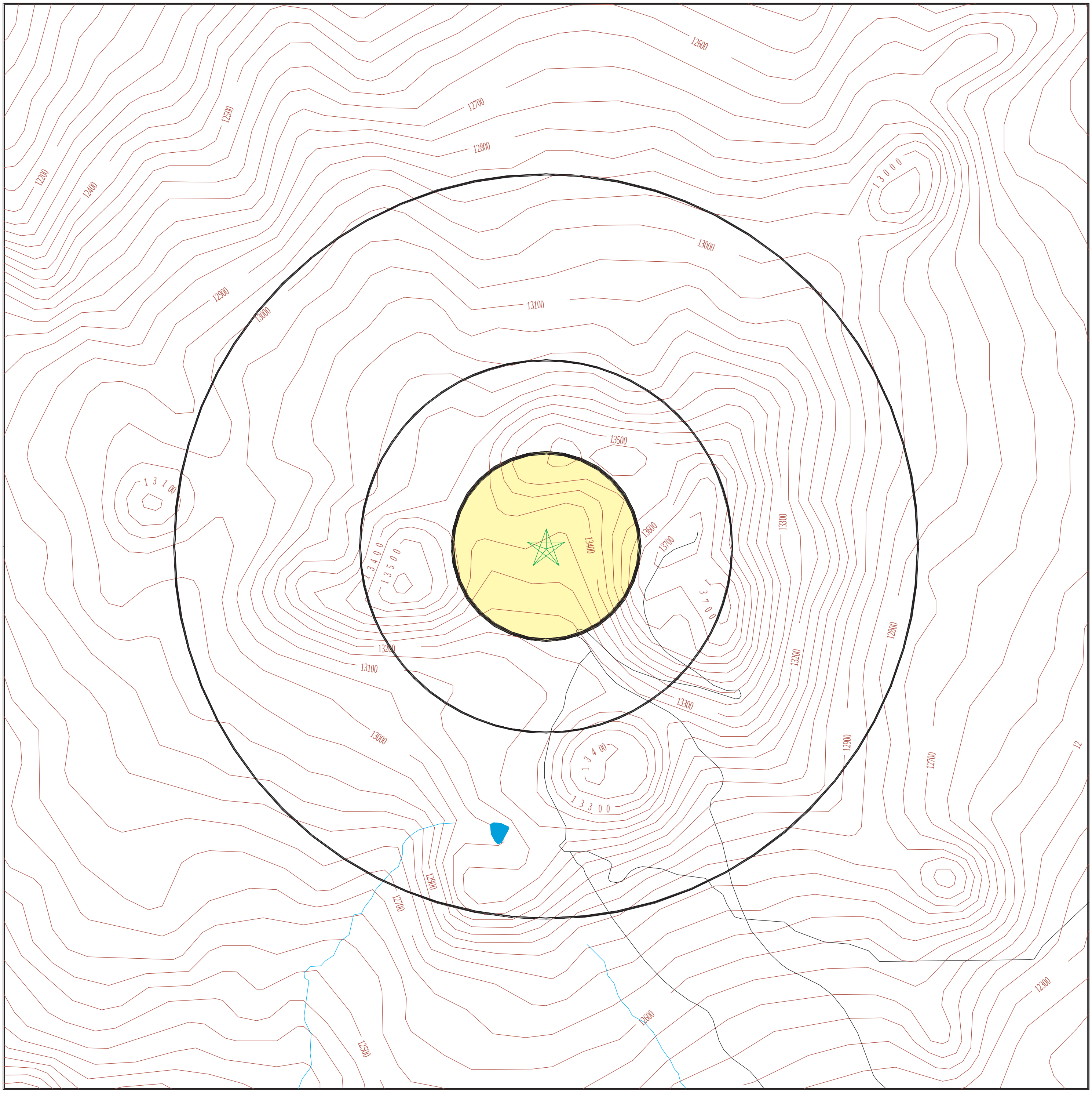
MAP ID	WELL ID	LOCATION FROM TP
No PWS System Found		

Note: PWS System location is not always the same as well location.

STATE DATABASE WELL INFORMATION

MAP ID	WELL ID	LOCATION FROM TP
No Wells Found		

PHYSICAL SETTING SOURCE MAP - 4502574.2s



0 1/4 1/2 1 Miles

- County Boundary
- Major Roads
- Contour Lines
- Earthquake epicenter, Richter 5 or greater
- Water Wells
- Public Water Supply Wells
- Cluster of Multiple Icons

- Groundwater Flow Direction
- GI Indeterminate Groundwater Flow at Location
- GV Groundwater Flow Varies at Location

SITE NAME: Caltech Submillimeter Observatory	CLIENT: ENPRO, Env. Professionals
ADDRESS: Mauna Kea Access Road	CONTACT: Heather Schauer
Paauilo HI 96776	INQUIRY #: 4502574.2s
LAT/LONG: 19.8225 / 155.4754	DATE: December 30, 2015 1:35 pm

GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS
RADON

AREA RADON INFORMATION

Federal EPA Radon Zone for HAWAII County: 3

Note: Zone 1 indoor average level > 4 pCi/L.
: Zone 2 indoor average level >= 2 pCi/L and <= 4 pCi/L.
: Zone 3 indoor average level < 2 pCi/L.

Federal Area Radon Information for HAWAII COUNTY, HI

Number of sites tested: 97

Area	Average Activity	% <4 pCi/L	% 4-20 pCi/L	% >20 pCi/L
Living Area - 1st Floor	0.054 pCi/L	99%	1%	0%
Living Area - 2nd Floor	1.100 pCi/L	100%	0%	0%
Basement	-0.247 pCi/L	100%	0%	0%

PHYSICAL SETTING SOURCE RECORDS SEARCHED

TOPOGRAPHIC INFORMATION

USGS 7.5' Digital Elevation Model (DEM)
Source: United States Geologic Survey
EDR acquired the USGS 7.5' Digital Elevation Model in 2002 and updated it in 2006. The 7.5 minute DEM corresponds to the USGS 1:24,000- and 1:25,000-scale topographic quadrangle maps. The DEM provides elevation data with consistent elevation units and projection.

Current USGS 7.5 Minute Topographic Map
Source: U.S. Geological Survey

HYDROLOGIC INFORMATION

Flood Zone Data: This data, available in select counties across the country, was obtained by EDR in 2003 & 2011 from the Federal Emergency Management Agency (FEMA). Data depicts 100-year and 500-year flood zones as defined by FEMA.

NWI: National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in 2002, 2005 and 2010 from the U.S. Fish and Wildlife Service.

State Wetlands Data: Wetlands Inventory
Source: Office of Planning
Telephone: 808-587-2895

HYDROGEOLOGIC INFORMATION

AQUIFLOW[R] Information System
Source: EDR proprietary database of groundwater flow information
EDR has developed the AQUIFLOW Information System (AIS) to provide data on the general direction of groundwater flow at specific points. EDR has reviewed reports submitted to regulatory authorities at select sites and has extracted the date of the report, hydrogeologically determined groundwater flow direction and depth to water table information.

GEOLOGIC INFORMATION

Geologic Age and Rock Stratigraphic Unit
Source: P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S. at 1:2,500,000 Scale - A digital representation of the 1974 P.B. King and H.M. Beikman Map, USGS Digital Data Series DDS - 11 (1994).

STATSGO: State Soil Geographic Database
Source: Department of Agriculture, Natural Resources Conservation Service (NRCS)
The U.S. Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) leads the national Conservation Soil Survey (NCSS) and is responsible for collecting, storing, maintaining and distributing soil survey information for privately owned lands in the United States. A soil map in a soil survey is a representation of soil patterns in a landscape. Soil maps for STATSGO are compiled by generalizing more detailed (SSURGO) soil survey maps.

SSURGO: Soil Survey Geographic Database
Source: Department of Agriculture, Natural Resources Conservation Service (NRCS)
Telephone: 800-672-5559
SSURGO is the most detailed level of mapping done by the Natural Resources Conservation Service, mapping scales generally range from 1:12,000 to 1:63,360. Field mapping methods using national standards are used to construct the soil maps in the Soil Survey Geographic (SSURGO) database. SSURGO digitizing duplicates the original soil survey maps. This level of mapping is designed for use by landowners, townships and county natural resource planning and management.

PHYSICAL SETTING SOURCE RECORDS SEARCHED

LOCAL / REGIONAL WATER AGENCY RECORDS

FEDERAL WATER WELLS

PWS: Public Water Systems
Source: EPA/Office of Drinking Water
Telephone: 202-564-3750
Public Water System data from the Federal Reporting Data System. A PWS is any water system which provides water to at least 25 people for at least 60 days annually. PWSs provide water from wells, rivers and other sources.

PWS ENF: Public Water Systems Violation and Enforcement Data
Source: EPA/Office of Drinking Water
Telephone: 202-564-3750
Violation and Enforcement data for Public Water Systems from the Safe Drinking Water Information System (SDWIS) after August 1995. Prior to August 1995, the data came from the Federal Reporting Data System (FRDS).

USGS Water Wells: USGS National Water Inventory System (NWIS)
This database contains descriptive information on sites where the USGS collects or has collected data on surface water and/or groundwater. The groundwater data includes information on wells, springs, and other sources of groundwater.

STATE RECORDS

Well Index Database
Source: Commission on Water Resource Management
Telephone: 808-587-0214
CWRM maintains a Well Index Database to track specific information pertaining to the construction and installation of production wells in Hawaii

OTHER STATE DATABASE INFORMATION

RADON

Area Radon Information
Source: USGS
Telephone: 703-356-4020
The National Radon Database has been developed by the U.S. Environmental Protection Agency (USEPA) and is a compilation of the EPA/State Residential Radon Survey and the National Residential Radon Survey. The study covers the years 1986 - 1992. Where necessary data has been supplemented by information collected at private sources such as universities and research institutions.

EPA Radon Zones
Source: EPA
Telephone: 703-356-4020
Sections 307 & 309 of IRAA directed EPA to list and identify areas of U.S. with the potential for elevated indoor radon levels.

OTHER

Airport Landing Facilities: Private and public use landing facilities
Source: Federal Aviation Administration, 800-457-6656

Epicenters: World earthquake epicenters, Richter 5 or greater
Source: Department of Commerce, National Oceanic and Atmospheric Administration

Earthquake Fault Lines: The fault lines displayed on EDR’s Topographic map are digitized quaternary faultlines, prepared in 1975 by the United State Geological Survey

PHYSICAL SETTING SOURCE RECORDS SEARCHED

STREET AND ADDRESS INFORMATION

Caltech Submillimeter Observatory

Mauna Kea Access Road

Paauilo, HI 96776

Inquiry Number: 4502574.9

December 31, 2015

The EDR Aerial Photo Decade Package

EDR®

6 Armstrong Road, 4th Floor
Shelton, Connecticut 06484
Toll Free: 800.352.0050
www.edrnet.com

EDR Aerial Photo Decade Package

Environmental Data Resources, Inc. (EDR) Aerial Photo Decade Package is a screening tool designed to assist environmental professionals in evaluating potential liability on a target property resulting from past activities. EDR's professional researchers provide digitally reproduced historical aerial photographs, and when available, provide one photo per decade.

When delivered electronically by EDR, the aerial photo images included with this report are for ONE TIME USE ONLY. Further reproduction of these aerial photo images is prohibited without permission from EDR. For more information contact your EDR Account Executive.

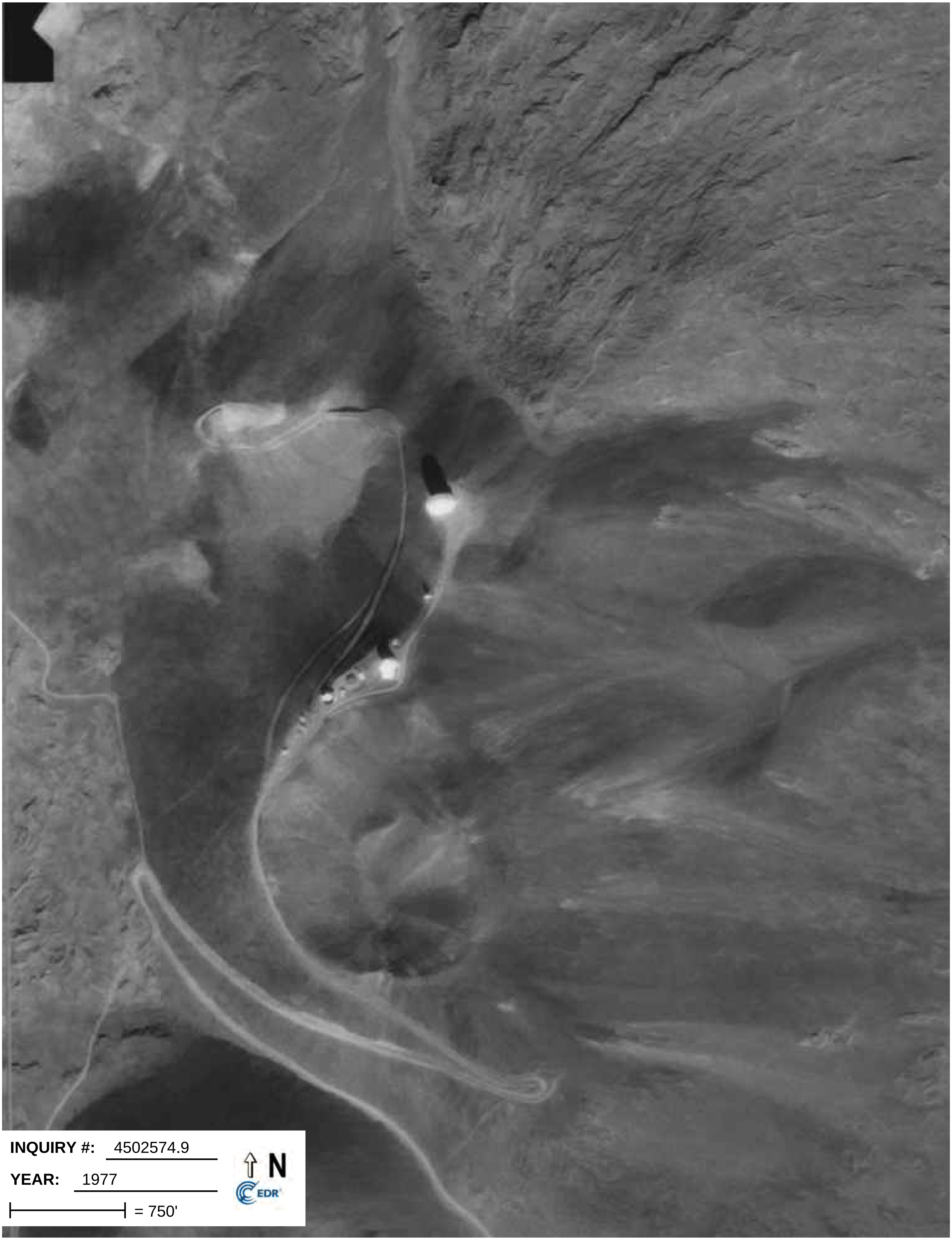
Thank you for your business.
Please contact EDR at 1-800-352-0050
with any questions or comments.

Date EDR Searched Historical Sources:
Aerial Photography December 31, 2015

Target Property:
Mauna Kea Access Road
Paauilo, HI 96776

Year	***Scale***	***Details***	***Source***
1954	Aerial Photograph. Scale: 1"=750'	Flight Date: October 19, 1954	EDR
1977	Aerial Photograph. Scale: 1"=750'	Flight Date: January 01, 1977	EDR
1992	Aerial Photograph. Scale: 1"=1000'	Flight Date: September 30, 1992	EDR
1995	Aerial Photograph. Scale: 1"=1000'	Flight Date: September 09, 1995	EDR
2001	Aerial Photograph. Scale: 1"=500'	DOQQ - acquisition dates: April 28, 2001	USGS/DOQQ


INQUIRY #: 4502574.9
YEAR: 1954
= 750'
N
EDR

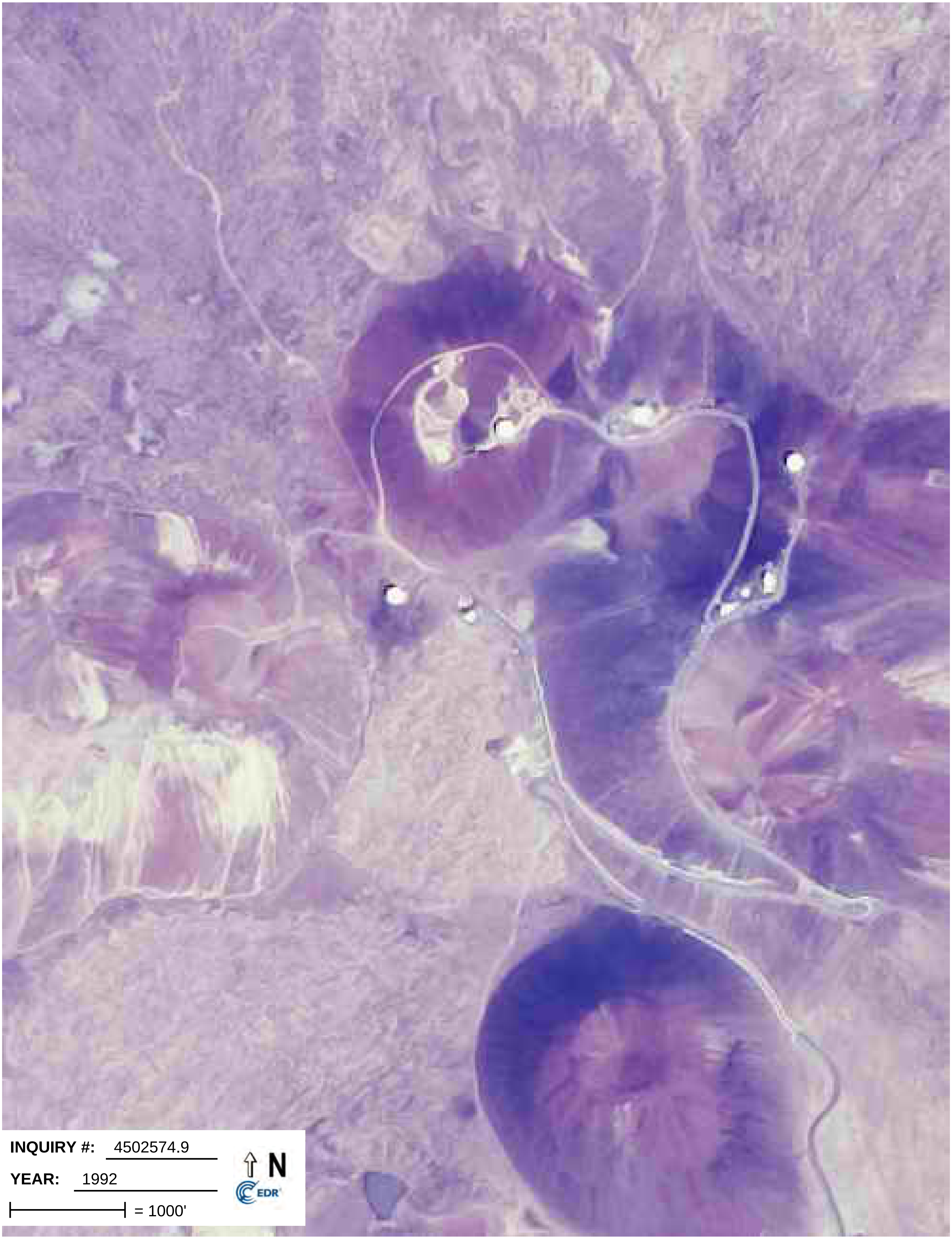


INQUIRY #: 4502574.9

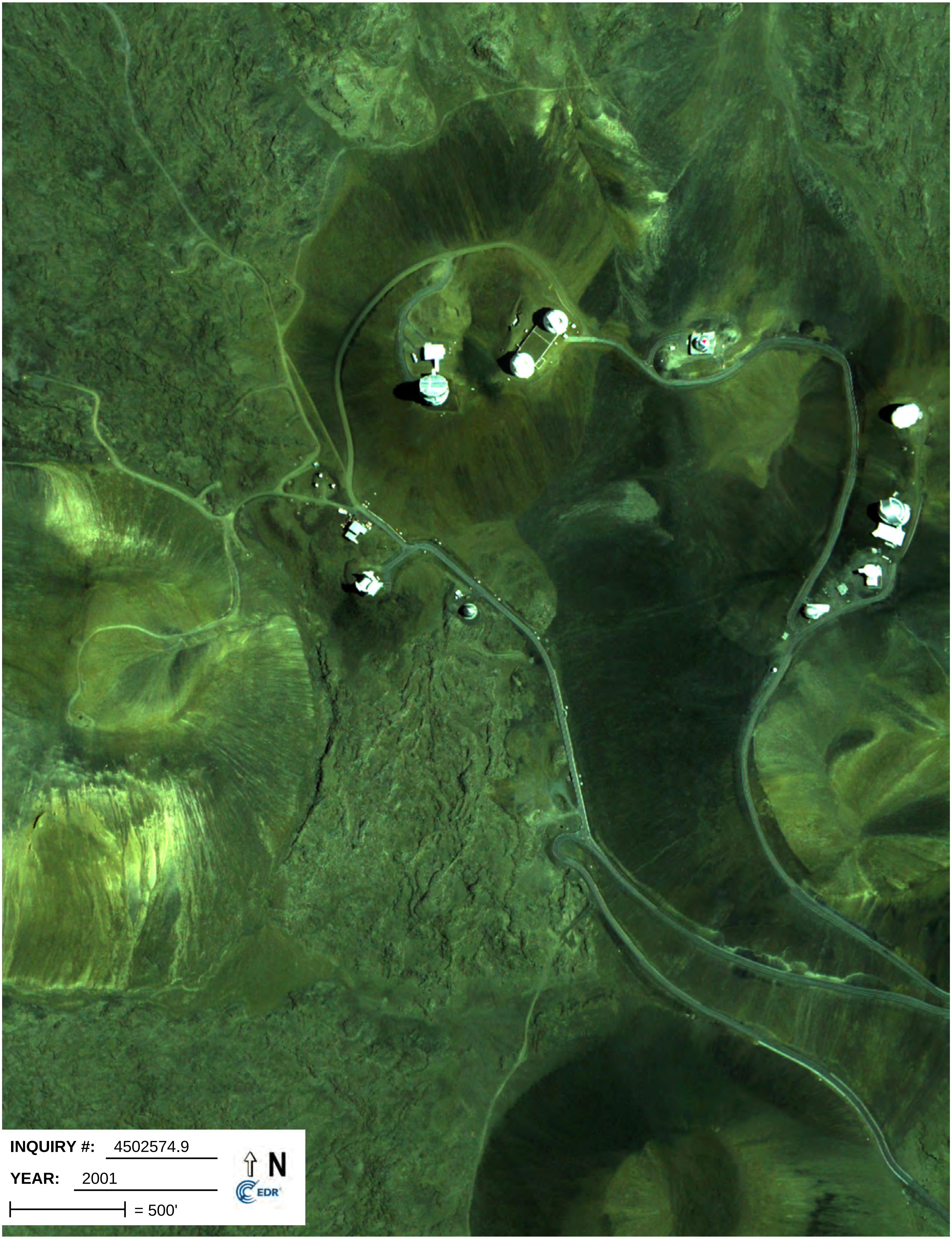
YEAR: 1977

= 750'

N


INQUIRY #: 4502574.9
YEAR: 1992
= 1000'
N
EDR


INQUIRY #: 4502574.9
YEAR: 1995
= 1000'
N
EDR



INQUIRY #: 4502574.9

YEAR: 2001

= 500'

N

EDR

Caltech Submillimeter Observatory

Mauna Kea Access Road

Paauilo, HI 96776

Inquiry Number: 4502574.4

December 30, 2015

EDR Historical Topo Map Report

with QuadMatch™

EDR

6 Armstrong Road, 4th floor
Shelton, CT 06484
Toll Free: 800.352.0050
www.edrnet.com

EDR Historical Topo Map Report

12/30/15

Site Name:	**Client Name:**
Caltech Submillimeter Observa	ENPRO, Env. Professionals
Mauna Kea Access Road	151 Hekili Street Suite 210
Paauilo, HI 96776	Kailua, HI 96734
EDR Inquiry # 4502574.4	Contact: Heather Schauer

EDR Topographic Map Library has been searched by EDR and maps covering the target property location as provided by ENPRO, Env. Professionals were identified for the years listed below. EDR's Historical Topo Map Report is designed to assist professionals in evaluating potential liability on a target property resulting from past activities. EDRs Historical Topo Map Report includes a search of a collection of public and private color historical topographic maps, dating back to the late 1800s.

Search Results:		***Coordinates:***	
Site Name:	Caltech Submillimeter Observa	**Latitude:**	19.8225 19° 49' 21" North
Address:	Mauna Kea Access Road	**Longitude:**	-155.4754 -155° 28' 31" West
City,State,Zip:	Paauilo, HI 96776	**UTM Zone:**	Zone 5 North
P.O.#	NA	**UTM X Meters:**	240708.67
Project:	1512-00532-PH1	**UTM Y Meters:**	2193739.59
		Elevation:	13342.64' above sea level

Maps Provided:

2013
1993
1982
1956

Topo Sheet Thumbnails

This EDR Topo Map Report is based upon the following USGS topographic map sheets.

2013 Source Sheets

Mauna Kea
2013
7.5-minute, 24000

1993 Source Sheets

Mauna Kea
1993
7.5-minute, 24000
Aerial Photo Revised 1993

1982 Source Sheets

Ahumoa
1982
7.5-minute, 24000
Aerial Photo Revised 1977
Edited 1982

Mauna Kea
1982
7.5-minute, 24000
Aerial Photo Revised 1978
Edited 1982

1956 Source Sheets

Mauna Kea
1956
7.5-minute, 24000
Aerial Photo Revised 1954

Ahumoa
1956
7.5-minute, 24000
Aerial Photo Revised 1954

Historical Topo Map

2013

This report includes information from the following map sheet(s).

Miles 0.25 0.5 1 1.5

NW N NE
W E
SW S SE

TP, Mauna Kea, 2013, 7.5-minute

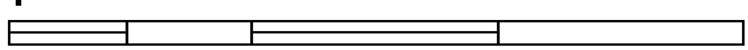
SITE NAME: Caltech Submillimeter Observatory
ADDRESS: Mauna Kea Access Road
Paauilo, HI 96776
CLIENT: ENPRO, Env. Professionals

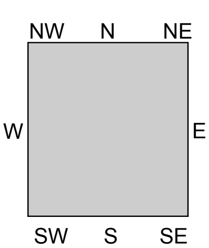
N

Historical Topo Map

1993

This report includes information from the following map sheet(s).



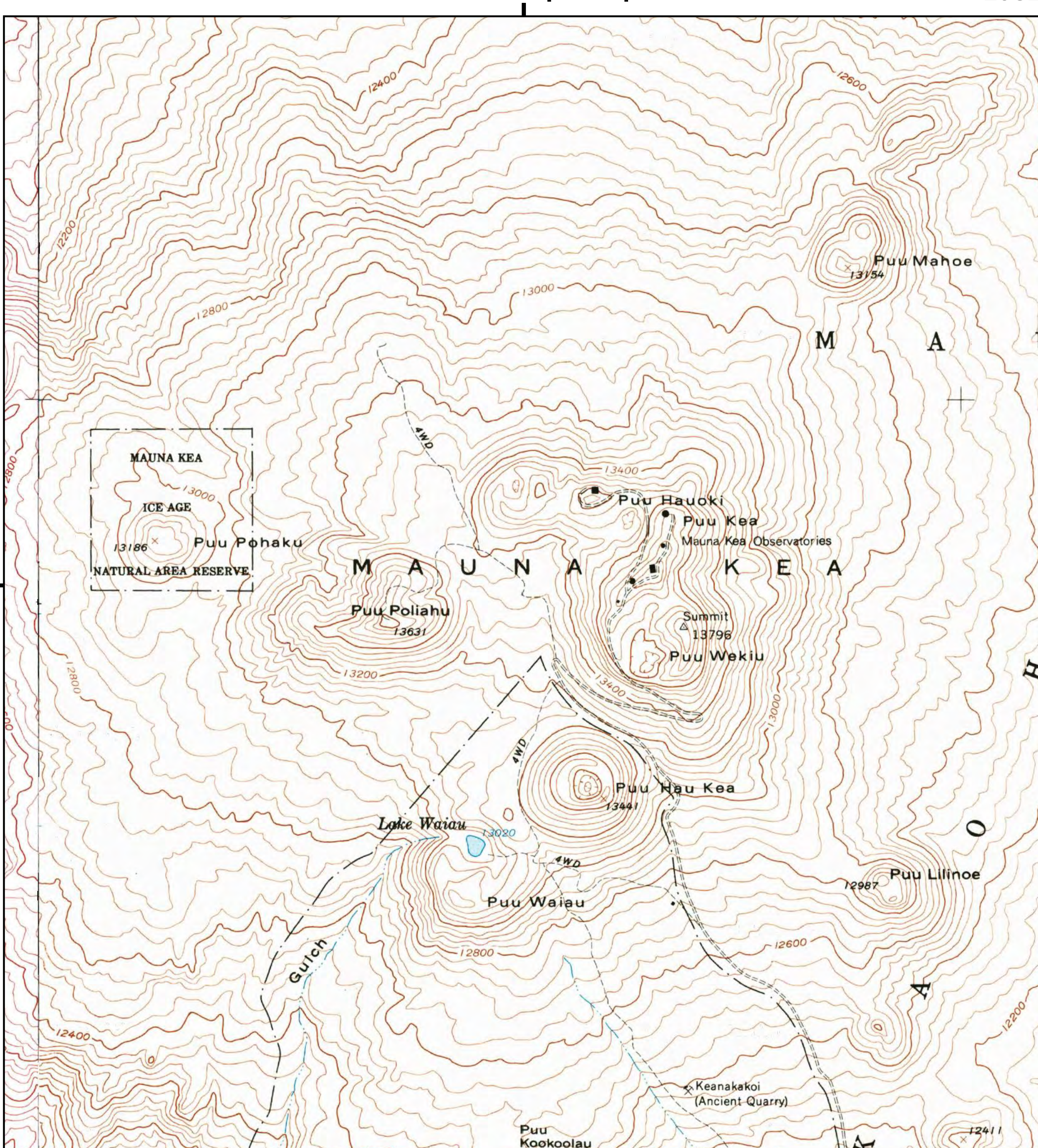


TP, Mauna Kea, 1993, 7.5-minute

SITE NAME: Caltech Submillimeter Observatory
ADDRESS: Mauna Kea Access Road
Paauilo, HI 96776
CLIENT: ENPRO, Env. Professionals

Historical Topo Map

1982



This report includes information from the following map sheet(s).

Miles 0.25 0.5 1 1.5

NW N NE
W E
SW S SE

TP, Mauna Kea, 1982, 7.5-minute

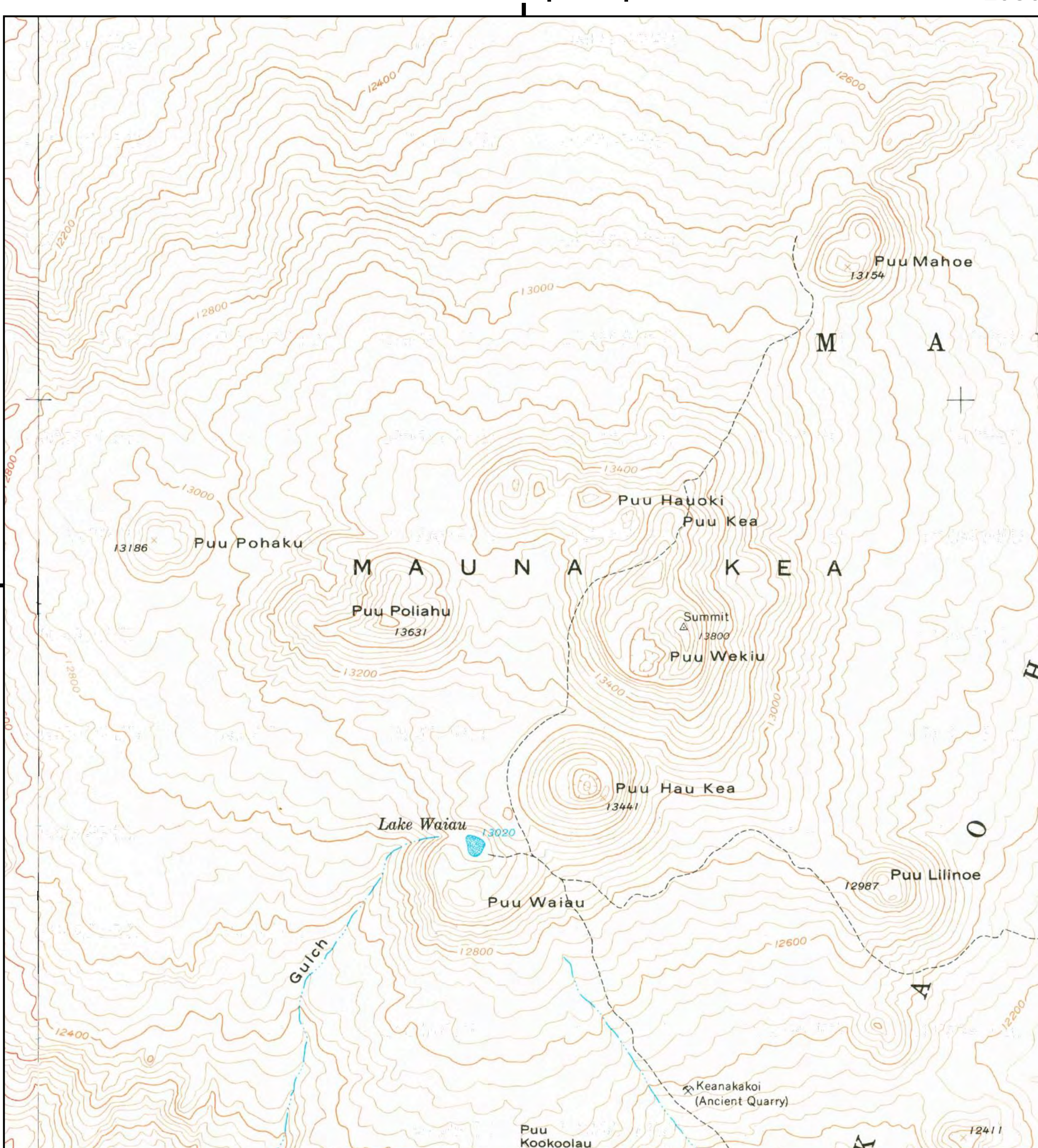
W, Ahumoa, 1982, 7.5-minute

SITE NAME: Caltech Submillimeter Observatory
ADDRESS: Mauna Kea Access Road
Paauilo, HI 96776
CLIENT: ENPRO, Env. Professionals

N

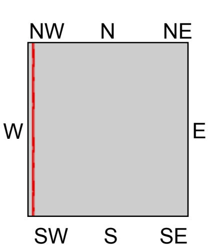
Historical Topo Map

1956



This report includes information from the following map sheet(s).

Miles	0.25	0.5	1	1.5



TP, Mauna Kea, 1956, 7.5-minute

W, Ahumoa, 1956, 7.5-minute

SITE NAME: Caltech Submillimeter Observatory
ADDRESS: Mauna Kea Access Road
Paauilo, HI 96776
CLIENT: ENPRO, Env. Professionals

REGULATORY RECORDS DOCUMENTATION

DEPARTMENTAL FORM P-26

RESIDENTIAL APPRAISAL CARD

CARD ____ OF ____ CARDS

ZONE	SEC.	PLAT	PARCEL
4	4	015	009

1. TOPOGRAPHY	2. ST. IMPVTS	3. UTILITIES	4. USE	5. ADD'L L. IMPVTS	
LEVEL ☐	GRAVEL ☐	WATER ☐	RES. ☐	PAVED AREAS ☐	
SLOPING FT.	PAVED ☐	ELEC. ☐	COM'L ☐	RET. WALLS ☐	TERR/PATIOS ____ SQ. FT.
GRADE "	CURB ☐	GAS ☐	IND. ☐	LAWN-LDSC. ☐	FENCES ____ LIN. FT.
H ☐ L ☐	GUTTER ☐	SEWER ☐	AGR. ☐	WALK WAYS ☐	BARBEC. ____ CU. FT.
	SIDE WK ☐	UNDERG'D ☐	INST. ☐	SPRINKLERS ☐	SWIM. POOL ____ SQ. FT.
					SHAPE ____

6. 4 4 015 009

7. ____

8. ADDR ZONING ____

9. MOD. FACTOR ____

ST. DEPTH ____ CORNER ____

OTHER ____

DESCRIPTION S. H. Mauna Kea Science Reserve Hamakua, Hawaii
G/L#S-4191

OWNER	TITLE HISTORY	NET AREA
State of Hawaii	For 1969: 13,321.054 ac fr por par-001 same owner	13,321.054ac
(University of Hawaii) Le	G/L#S-4191 for 65yrs bg 6/21/68 to 6/20/2033 Cons:Gratis	
MAUNA KEA SCIENCE RESERVE		
	For 1982: R/S: To 4415-10(new) 1962.0 Ac.	
	-11(new) 143.5 Ac. TMB M-452'81;	11,215.55 Ac.
(Science and Engineering Research	Sublease 2/10/84 fr University of Hawaii until 12/31/2033 $1 per yr	
Council) Sub-le	R 4/13/84 Liber 17801/631 TMB 4430'84	

On Adj. $131296.59
Date: 1/31/86

YEAR		1979	1985							YEAR
AREA		1980 1981								AREA
LAND	/	/	1 ~~136848~~							LAND
IMP.	—	—	~~15293895~~							IMP.
TOT.	/	/	1 ~~15424743~~							TOT.
EX.	/	/	1 -							EX.
NET	—	—	- ~~15424743~~							NET
TAX										TAX

REQUEST TO ACCESS A GOVERNMENT RECORD

DATE: December 30, 2015

TO: **Hazard Evaluation & Emergency Response Office (Fax: 586-7537)**

FROM: Heather Schauer ENPRO Environmental

Name or Alias
151 Hekili Street, Suite 210 (808) 748-2108 phone

Contact Information
Kailua, Hawaii 96734 (808) 262-4449 fax

Although you are not required to provide any personal information, you should provide enough information to allow the agency to contact you about this request. The processing of this request may be stopped if the agency is unable to contact you. Therefore, please provide any information that will allow the agency to contact you (name or alias, telephone or fax number, mailing address, e-mail address, etc.).

I WOULD LIKE THE FOLLOWING GOVERNMENT RECORD:

Describe the government record as specifically as possible so that it can be located. Try to provide a record name, subject matter, date, location, purpose, or names of persons to whom the record refers, or other information that could help the agency identify the record. A complete and accurate description of the government record you request will prevent delays in locating the record. Attach a second page if needed.

Aloha,

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- TMK: (3) 4-4-015: 009

My report is due January 15, 2016. In light of my timeline, I would greatly appreciate any assistance you can provide in expediting access to the files. Mahalo for you time and assistance,

Heather Schauer

I WOULD LIKE: (please check one or more of the options below)

☐ **To inspect the government record.**

☐ **A copy of the government record:** (Please check one of the options below.) See the back of this page for information about fees that you may be required to pay for agency services to process your record request. Note: Copying and transmission charges may also apply to certain options.

- ☐ Pick up at agency (**date and time**): ____________
- ☐ Mail
- ☐ Fax (toll free and only if available)
- ☐ Other, if available (please specify): ____________

☐ If the agency maintains the records in a form other than paper, please advise in which format you would prefer to have the record.

☐ Electronic ☐ Audio ☐ Other (please specify): ____________

☐ Check this box if you are attaching a request for waiver of fees in the public interest (see waiver information on back).

OFFICIAL USE ONLY: **SEE BACK FOR IMPORTANT INFORMATION**

Office Manager: ____________ Date: ____________ OIP (rev. 07/29/99)

Release Notification

15-Jan-16

Case No: 20090527-1500

Release Name: Hydraulic fluid release NRC 905897

Filing Information:

Section:	Central
Island:	Hawaii
Areawide Name:	
Type:	Private
File Under:	California Institute of Technology
Facility/Site Name:	Caltech Submillimeter Observatory

	Facility/Site	Reported
Line One:	111 Nowelo St	Mauna Kea
Line Two:		Inside dome of Caltech Submillimeter Observatory
City:	Hilo	Mauna Kea
Zip Code:	96720	
Supplemental:	Summit	Lat 19 49' 21" N Long 155 28' 33 W
Island:	Hawaii	Hawaii

Substances Involved

Hydraulic Oil	22.7 Gallons

Media: Concrete **Uniform Hazardous Waste Manifest Number:** **Associated NRC #:** 905897

Notification

Does this release exceed the RQ and qualify as a release to the environment? Yes

Is this fugitive dumping or can a PRP be identified for purposes of followup? RP

Is the reporter calling for the RP? Yes

Was initial notification given immediately following discovery of the incident? Yes

Date of the Written Followup: 5/27/2009

Will this require follow up for notification? Initial: **Written:**

Reported By

Reporter's Name: Evan Pfaff

Reporter's Affiliation:

Release Date: **Release Time:** **Duration:** **ER:** None

Activity History

Notices

Response	5/27/2009	Liz Galvez	10/6/2009	Pending further action	

Release Comments

8/26/2009	Liz Galvez	Spoke with Evan Pfaff. Excavation and removal of contaminated soil has been completed. There is remaining impacted soil under concrete believed to be from previous releases and they would like to leave in place until decommisioning of facility in about seven years. I requested that lat and long positions of the impacted soil be taken and included in the report; also requested that the documented disposal of the soil be included in the report. A supplement report will be provided.

		SOSC to discuss with DLNR prior to giving a NFA for the release.
10/6/2009	Liz Galvez	Received letter from Richard Chamberlin of Caltech Submillimeter Observatory, dated September 29, 2009 regarding disposal documentation and site location information for the 22.7 gallons of hydraulic spill that occurred at the Caltech Submillimeter Observatory. 3,500 pounds of potentially contaminated soil was excavated and disposed of at West Hawaii Sanitary Landfill. A map indicating where the spill occurred is documented. At this time, it is known that additional contamination from previous releases is still present and will remain in place until such time that the CSO is being decommissioned.
10/7/2009	Liz Galvez	Completion of the removal actions for the hydraulic spill that occurred on or about May 27, 2009 has been completed. A "No Further Action" is pending upon completion of additional investigation and/or cleanup actions that will be undertaken when the CSO will be decommissioned.
6/3/2009	Liz Galvez	

REQUEST TO ACCESS A GOVERNMENT RECORD

DATE: December 30, 2015

TO: **DOH/EMD/Solid & Hazardous Waste Branch (Fax: 808-586-7509)**

FROM: Heather Schauer ENPRO Environmental

Name or Alias

151 Hekili Street, Suite 210 (808) 748-2108 phone

Contact Information

Kailua, Hawaii 96734 (808) 262-4449 fax

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- ☐ Fax (toll free and only if available)
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☐ Check this box if you are attaching a request for waiver of fees in the public interest (see waiver information on back).

SEE BACK FOR IMPORTANT INFORMATION

OFFICIAL USE ONLY:

Office Manager: ____________ Date: ________ OIP (rev. 07/29/99)

NOTICE TO REQUESTER

(Use multiple forms if necessary)

TO: Heather Schauer, ENPRO / Fax No. 262-4449 UST Section
FROM: Hawaii Dept. of Health, Solid & Hazardous Waste Branch, 586-4226
(Agency/name & telephone number of contact person at agency)

DATE REQUEST RECEIVED: 12/30/15
DATE OF THIS NOTICE: 1/11/16

GOVERNMENT RECORDS YOU REQUESTED (attach copy of request or provide brief description below):
1.
2.
3. See attachment
4.

There are no UST records.

NOTICE IS PROVIDED TO YOU THAT YOUR REQUEST:

☐ **Will be granted in its entirety.**
☑ **Cannot be granted because**
 ☒ Agency does not maintain the records. Agency believed to maintain records:
 ☐ Agency needs a further description or clarification of the records requested. Please contact the agency and provide the following information:
 ☐ Request requires agency to create a summary or compilation from records not readily retrievable.

☐ **Is denied in its entirety** ☐ **Will be granted only as to certain parts**
based upon the following exemption provided in HRS § 92F-13 and/or § 92F-22 and other laws cited below (portions of records that agency will not disclose should be described in general terms).

RECORDS OR INFORMATION WITHHELD	APPLICABLE STATUTES	AGENCY JUSTIFICATION

REQUESTER'S RESPONSIBILITIES:

You are required to (1) pay any lawful fees assessed; (2) make any necessary arrangements with the agency to inspect, copy or receive copies as instructed below; and (3) provide the agency any additional information requested. If you do not comply with the requirements set forth in this notice within 20 business days after the postmark date of this notice or the date the agency makes the records available, you will be presumed to have abandoned your request and the agency shall have no further duty to process your request. Once the agency begins to process your request, you may be liable for any fees incurred. If you wish to cancel or modify your request, you must advise the agency upon receipt of this notice.

METHOD & TIMING OF DISCLOSURE:

Records available for public access in their entireties must be disclosed within a reasonable time, not to exceed 10 business days, or after receipt of any prepayment required. Records not available in their entireties must be disclosed within 5 business days of this notice or after receipt of any prepayment required. If incremental disclosure is authorized by HAR § 2-71-15, the first increment must be disclosed within 5 business days of this notice or after receipt of any prepayment required.

Method of Disclosure:

☒ Inspection at the following location: 919 Ala Moana Blvd, Rm 212, Honolulu.

☐ As requested, a copy of the record(s) will be provided in the following manner:

- ☐ Available for pick-up at the following location: _____.
- ☐ Will be mailed to you.
- ☐ Will be transmitted to you by other means requested: _____.

Timing of Disclosure: All records, or first increment where applicable, will be made available or provided to you:

☒ On please call for appointment.

☐ After prepayment of fees and costs of $ _____ (50% of fees +100% of costs, as estimated below).

Payment may be made by cash or: ☐ personal check ☐ other ____________.

For incremental disclosures, each subsequent increment will be disclosed within 20 business days after:

- ☐ The prior increment (if one prepayment of fees is required and received).
- ☐ Receipt of each incremental prepayment required.

Disclosure is being made in increments because the records are voluminous and the following extenuating circumstances exist:

- ☐ Agency must consult with another person to determine whether the record is exempt from disclosure under HRS chapter 92F.
- ☐ Request requires extensive agency efforts to search, review, or segregate the records or otherwise prepare the records for inspection or copying.
- ☐ Agency requires additional time to respond to the request in order to avoid an unreasonable interference with its other statutory duties and functions.
- ☐ A natural disaster or other situation beyond agency's control prevents agency from responding to the request within 10 business days.

ESTIMATED FEES & COSTS:

The agency is authorized to charge you certain fees and costs to process your request (even if no record is subsequently found to exist), but must waive the first $30 in fees assessed for general requesters and the first $60 in fees when the agency finds that the request made is in the public interest. See HAR §§ 2-71-19, -31 and -32. The agency may require prepayment of 50% of the total estimated fees and 100% of the total estimated costs prior to processing your request. The following is the estimate of the fees and costs that the agency will charge you, with the applicable waiver amount deducted:

Fees:	Search	Estimate of time to be spent: 15 ($2.50 for each 15-minute period)	$2.50
	Review & segregation	Estimate of time to be spent: _____ ($5.00 for each 15-minute period)	$
	Fees waived	☑ general ($30) ☐ public interest ($60)	<$ 30.00 >
	Other	_____ (Pursuant to HAR §§ 2-71-19 & 2-71-31)	$
	Total Estimated Fees:		$ 0
Costs:	Copying	Estimate of # of pages to be copied: _____ (@ $_____ per page.)	$
	Other	_____	$
	Total Estimated Costs:		$

For questions about this notice, please contact the person named above. Questions regarding compliance with the UIPA may be directed to the Office of Information Practices at 808-586-1400 or oip@hawaii.gov.

DEC 30 2015 (1)

REQUEST TO ACCESS A GOVERNMENT RECORD

HG: 0

HW: ____

SW: ____

DATE: December 30, 2015

TO: DOH/EMD/Solid & Hazardous Waste Branch (Fax: 808-586-7509)

FROM: Heather Schauer ENPRO Environmental

Name or Alias: 151 Hekili Street, Suite 210 (808) 748-2108 phone

Contact Information: Kailua, Hawaii 96734 (808) 262-4449 fax

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- ☐ Other, if available (please specify): ____

☐ If the agency maintains the records in a form other than paper, please advise in which format you would prefer to have the record.

☐ Electronic ☐ Audio ☐ Other (please specify): ____

☐ Check this box if you are attaching a request for waiver of fees in the public interest (see waiver information on back).

SEE BACK FOR IMPORTANT INFORMATION

OFFICIAL USE ONLY:

Office Manager: ____ Date: ____ OIP (rev. 07/29/99)

12/31

NOTICE TO REQUESTER

(Use multiple forms if necessary)

TO: Heather Schauer, ENPRO / Fax No. 262-4449 HW Section
FROM: Hawaii Dept. of Health, Solid & Hazardous Waste Branch, 586-4226
(Agency/name & telephone number of contact person at agency)

DATE REQUEST RECEIVED: 12/30/15
DATE OF THIS NOTICE: 1/11/16

GOVERNMENT RECORDS YOU REQUESTED (attach copy of request or provide brief description below):

1.
2.
3. See attachment
4.

NOTICE IS PROVIDED TO YOU THAT YOUR REQUEST: There are no HW records.

☐ **Will be granted in its entirety.**
☑ **Cannot be granted because**
- ☑ Agency does not maintain the records. Agency believed to maintain records:
- ☐ Agency needs a further description or clarification of the records requested. Please contact the agency and provide the following information:
- ☐ Request requires agency to create a summary or compilation from records not readily retrievable.

☐ **Is denied in its entirety** ☐ **Will be granted only as to certain parts**
based upon the following exemption provided in HRS § 92F-13 and/or § 92F-22 and other laws cited below (portions of records that agency will not disclose should be described in general terms).

RECORDS OR INFORMATION WITHHELD	APPLICABLE STATUTES	AGENCY JUSTIFICATION

REQUESTER'S RESPONSIBILITIES:

You are required to (1) pay any lawful fees assessed; (2) make any necessary arrangements with the agency to inspect, copy or receive copies as instructed below; and (3) provide the agency any additional information requested. If you do not comply with the requirements set forth in this notice within 20 business days after the postmark date of this notice or the date the agency makes the records available, you will be presumed to have abandoned your request and the agency shall have no further duty to process your request. Once the agency begins to process your request, you may be liable for any fees incurred. If you wish to cancel or modify your request, you must advise the agency upon receipt of this notice.

METHOD & TIMING OF DISCLOSURE:

Records available for public access in their entireties must be disclosed within a reasonable time, not to exceed 10 business days, or after receipt of any prepayment required. Records not available in their entireties must be disclosed within 5 business days of this notice or after receipt of any prepayment required. If incremental disclosure is authorized by HAR § 2-71-15, the first increment must be disclosed within 5 business days of this notice or after receipt of any prepayment required.

Method of Disclosure:

☒ Inspection at the following location: 919 Ala Moana Blvd, Rm 212, Honolulu.

☐ As requested, a copy of the record(s) will be provided in the following manner:

- ☐ Available for pick-up at the following location: _____.
- ☐ Will be mailed to you.
- ☐ Will be transmitted to you by other means requested: _____.

Timing of Disclosure: All records, or first increment where applicable, will be made available or provided to you:

☒ On please call for appointment.

☐ After prepayment of fees and costs of $_____ (50% of fees +100% of costs, as estimated below).

Payment may be made by cash or: ☐ personal check ☐ other ___________.

For incremental disclosures, each subsequent increment will be disclosed within 20 business days after:

- ☐ The prior increment (if one prepayment of fees is required and received).
- ☐ Receipt of each incremental prepayment required.

Disclosure is being made in increments because the records are voluminous and the following extenuating circumstances exist:

- ☐ Agency must consult with another person to determine whether the record is exempt from disclosure under HRS chapter 92F.
- ☐ Request requires extensive agency efforts to search, review, or segregate the records or otherwise prepare the records for inspection or copying.
- ☐ Agency requires additional time to respond to the request in order to avoid an unreasonable interference with its other statutory duties and functions.
- ☐ A natural disaster or other situation beyond agency's control prevents agency from responding to the request within 10 business days.

ESTIMATED FEES & COSTS:

The agency is authorized to charge you certain fees and costs to process your request (even if no record is subsequently found to exist), but must waive the first $30 in fees assessed for general requesters and the first $60 in fees when the agency finds that the request made is in the public interest. See HAR §§ 2-71-19, -31 and -32. The agency may require prepayment of 50% of the total estimated fees and 100% of the total estimated costs prior to processing your request. The following is the estimate of the fees and costs that the agency will charge you, with the applicable waiver amount deducted:

Fees:	Search	Estimate of time to be spent: 15 ($2.50 for each 15-minute period)	$2.50
	Review & segregation	Estimate of time to be spent: _____ ($5.00 for each 15-minute period)	$
	Fees waived	☑ general ($30) ☐ public interest ($60)	<$30.00>
	Other	_____ (Pursuant to HAR §§ 2-71-19 & 2-71-31)	$
	Total Estimated Fees:		$ 0
Costs:	Copying	Estimate of # of pages to be copied: _____ (@ $_____ per page.)	$
	Other	_____	$
	Total Estimated Costs:		$

For questions about this notice, please contact the person named above. Questions regarding compliance with the UIPA may be directed to the Office of Information Practices at 808-586-1400 or oip@hawaii.gov.

DEC 30 2015 (1)

REQUEST TO ACCESS A GOVERNMENT RECORD

UG: ____
HW: 0 ____
SW: ____

DATE: December 30, 2015

TO: DOH/EMD/Solid & Hazardous Waste Branch (Fax: 808-586-7509)

FROM: Heather Schauer ENPRO Environmental
Name or Alias
Contact Information 151 Hekili Street, Suite 210 (808) 748-2108 phone
Kailua, Hawaii 96734 (808) 262-4449 fax

Although you are not required to provide any personal information, you should provide enough information to allow the agency to contact you about this request. The processing of this request may be stopped if the agency is unable to contact you. Therefore, please provide any Information that will allow the agency to contact you (name or alias, telephone or fax number, mailing address, e-mail address, etc.).

I WOULD LIKE THE FOLLOWING GOVERNMENT RECORD:

Describe the government record as specifically as possible so that it can be located. Try to provide a record name, subject matter, date, location, purpose, or names of persons to whom the record refers, or other information that could help the agency identify the record. A complete and accurate description of the government record you request will prevent delays in locating the record. Attach a second page if needed.

Aloha,

I am currently working on an Environmental Site Assessment for the Caltech Submillimeter Observatory located within a large TMK on the summit of Mauna Kea on the island of Hawaii, Hawaii. I would like to review the regulatory records for the following TMK:

- TMK: (3) 4-4-015: 009

My report is due January 15, 2016. In light of my timeline, I would greatly appreciate any assistance you can provide in expediting access to the files. Mahalo for you time and assistance,

Heather Schauer

I WOULD LIKE: (please check one or more of the options below)

☐ **To inspect the government record.**

☐ **A copy of the government record:** (Please check one of the options below.) See the back of this page for information about fees that you may be required to pay for agency services to process your record request. Note: Copying and transmission charges may also apply to certain options.

- ☐ Pick up at agency (**date and time**): ____
- ☐ Mail
- ☐ Fax (toll free and only if available)
- ☐ Other, if available (please specify): ____

☐ If the agency maintains the records in a form other than paper, please advise in which format you would prefer to have the record.

☐ Electronic ☐ Audio ☐ Other (please specify): ____

☐ Check this box if you are attaching a request for waiver of fees in the public interest (see waiver information on back).

SEE BACK FOR IMPORTANT INFORMATION

OFFICIAL USE ONLY:

Office Manager: ____ Date: ____ OIP (rev. 07/29/99)

12/31

NOTICE TO REQUESTER

(Use multiple forms if necessary)

TO: Heather Schauer, ENPRO / Fax No. 262-4449 SW Section

FROM: Hawaii Dept. of Health, Solid & Hazardous Waste Branch, 586-4226

(Agency/name & telephone number of contact person at agency)

DATE REQUEST RECEIVED: 12/30/15

DATE OF THIS NOTICE: 1/11/16

GOVERNMENT RECORDS YOU REQUESTED (attach copy of request or provide brief description below):

1.
2.
3. See attachment
4.

NOTICE IS PROVIDED TO YOU THAT YOUR REQUEST: There are no SW records.

☐ **Will be granted in its entirety.**

☒ **Cannot be granted because**

- ☒ Agency does not maintain the records. Agency believed to maintain records:
- ☐ Agency needs a further description or clarification of the records requested. Please contact the agency and provide the following information:
- ☐ Request requires agency to create a summary or compilation from records not readily retrievable.

☐ **Is denied in its entirety** ☐ **Will be granted only as to certain parts**

based upon the following exemption provided in HRS § 92F-13 and/or § 92F-22 and other laws cited below (portions of records that agency will not disclose should be described in general terms).

RECORDS OR INFORMATION WITHHELD	APPLICABLE STATUTES	AGENCY JUSTIFICATION

REQUESTER'S RESPONSIBILITIES:

You are required to (1) pay any lawful fees assessed; (2) make any necessary arrangements with the agency to inspect, copy or receive copies as instructed below; and (3) provide the agency any additional information requested. If you do not comply with the requirements set forth in this notice within 20 business days after the postmark date of this notice or the date the agency makes the records available, you will be presumed to have abandoned your request and the agency shall have no further duty to process your request. Once the agency begins to process your request, you may be liable for any fees incurred. If you wish to cancel or modify your request, you must advise the agency upon receipt of this notice.

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Records available for public access in their entireties must be disclosed within a reasonable time, not to exceed 10 business days, or after receipt of any prepayment required. Records not available in their entireties must be disclosed within 5 business days of this notice or after receipt of any prepayment required. If incremental disclosure is authorized by HAR § 2-71-15, the first increment must be disclosed within 5 business days of this notice or after receipt of any prepayment required.

Method of Disclosure:

☒ Inspection at the following location: 919 Ala Moana Blvd, Rm 212, Honolulu .

☐ As requested, a copy of the record(s) will be provided in the following manner:

- ☐ Available for pick-up at the following location: _____.
- ☐ Will be mailed to you.
- ☐ Will be transmitted to you by other means requested: _____.

Timing of Disclosure: All records, or first increment where applicable, will be made available or provided to you:

☒ On please call for appointment .

☐ After prepayment of fees and costs of $_____ (50% of fees +100% of costs, as estimated below).

Payment may be made by cash or: ☐ personal check ☐ other ___________.

For incremental disclosures, each subsequent increment will be disclosed within 20 business days after:

- ☐ The prior increment (if one prepayment of fees is required and received).
- ☐ Receipt of each incremental prepayment required.

Disclosure is being made in increments because the records are voluminous and the following extenuating circumstances exist:

- ☐ Agency must consult with another person to determine whether the record is exempt from disclosure under HRS chapter 92F.
- ☐ Request requires extensive agency efforts to search, review, or segregate the records or otherwise prepare the records for inspection or copying.
- ☐ Agency requires additional time to respond to the request in order to avoid an unreasonable interference with its other statutory duties and functions.
- ☐ A natural disaster or other situation beyond agency's control prevents agency from responding to the request within 10 business days.

ESTIMATED FEES & COSTS:

The agency is authorized to charge you certain fees and costs to process your request (even if no record is subsequently found to exist), but must waive the first $30 in fees assessed for general requesters and the first $60 in fees when the agency finds that the request made is in the public interest. See HAR §§ 2-71-19, -31 and -32. The agency may require prepayment of 50% of the total estimated fees and 100% of the total estimated costs prior to processing your request. The following is the estimate of the fees and costs that the agency will charge you, with the applicable waiver amount deducted:

Fees:	Search	Estimate of time to be spent: 15 ($2.50 for each 15-minute period)	$ 2.50
	Review & segregation	Estimate of time to be spent: _____ ($5.00 for each 15-minute period)	$
	Fees waived	☒ general ($30) ☐ public interest ($60)	<$ 30.00 >
	Other	_____ (Pursuant to HAR §§ 2-71-19 & 2-71-31)	$
	Total Estimated Fees:		**$** 0
Costs:	Copying	Estimate of # of pages to be copied: _____ (@ $_____ per page.)	$
	Other	_____	$
	Total Estimated Costs:		**$**

For questions about this notice, please contact the person named above. Questions regarding compliance with the UIPA may be directed to the Office of Information Practices at 808-586-1400 or oip@hawaii.gov.

DEC 30 2015 (1)

REQUEST TO ACCESS A GOVERNMENT RECORD

UG: ______

HW: ______

SW: NONE

DATE: December 30, 2015

TO: DOH/EMD/Solid & Hazardous Waste Branch (Fax: 808-586-7509)

FROM: Heather Schauer ENPRO Environmental

Name or Alias: 151 Hekili Street, Suite 210 (808) 748-2108 phone

Contact Information: Kailua, Hawaii 96734 (808) 262-4449 fax

Although you are not required to provide any personal information, you should provide enough information to allow the agency to contact you about this request. The processing of this request may be stopped if the agency is unable to contact you. Therefore, please provide any information that will allow the agency to contact you (name or alias, telephone or fax number, mailing address, e-mail address, etc.).

I WOULD LIKE THE FOLLOWING GOVERNMENT RECORD:

Describe the government record as specifically as possible so that it can be located. Try to provide a record name, subject matter, date, location, purpose, or names of persons to whom the record refers, or other information that could help the agency identify the record. A complete and accurate description of the government record you request will prevent delays in locating the record. Attach a second page if needed.

Aloha,

I am currently working on an Environmental Site Assessment for the Caltech Submillimeter Observatory located within a large TMK on the summit of Mauna Kea on the island of Hawaii, Hawaii. I would like to review the regulatory records for the following TMK:

- TMK: (3) 4-4-015: 009

My report is due January 15, 2016. In light of my timeline, I would greatly appreciate any assistance you can provide in expediting access to the files. Mahalo for you time and assistance,

Heather Schauer

I WOULD LIKE: (please check one or more of the options below)

- ☐ **To inspect the government record.**
- ☐ **A copy of the government record:** (Please check one of the options below.) See the back of this page for information about fees that you may be required to pay for agency services to process your record request. Note: Copying and transmission charges may also apply to certain options.
  - ☐ Pick up at agency (**date and time**): ______
  - ☐ Mail
  - ☐ Fax (toll free and only if available)
  - ☐ Other, if available (please specify): ______
- ☐ If the agency maintains the records in a form other than paper, please advise in which format you would prefer to have the record.
  - ☐ Electronic ☐ Audio ☐ Other (please specify): ______
- ☐ Check this box if you are attaching a request for walver of fees in the public interest (see walver information on back).

SEE BACK FOR IMPORTANT INFORMATION

OFFICIAL USE ONLY:

Office Manager: ______ Date: ______ OIP (rev. 07/29/99)

12/31

REQUEST TO ACCESS A GOVERNMENT RECORD

DATE: December 30, 2015

TO: **Hawaii Fire Prevention Bureau (Fax: 808-932-2927)**

FROM: Heather Schauer ENPRO Environmental
Name or Alias
151 Hekili Street, Suite 210 (808) 748-2108 phone
Contact Information
Kailua, Hawaii 96734 (808) 262-4449 fax

Although you are not required to provide any personal information, you should provide enough information to allow the agency to contact you about this request. The processing of this request may be stopped if the agency is unable to contact you. Therefore, please provide any information that will allow the agency to contact you (name or alias, telephone or fax number, mailing address, e-mail address, etc.).

I WOULD LIKE THE FOLLOWING GOVERNMENT RECORD:

Describe the government record as specifically as possible so that it can be located. Try to provide a record name, subject matter, date, location, purpose, or names of persons to whom the record refers, or other information that could help the agency identify the record. A complete and accurate description of the government record you request will prevent delays in locating the record. Attach a second page if needed.

Aloha,

I am currently working on an Environmental Site Assessment for the Caltech Submillimeter Observatory located within a large TMK on the summit of Mauna Kea on the island of Hawaii, Hawaii. I would like to review the regulatory records for the following TMK:

- TMK: (3) 4-4-015: 009

I wanted to know if your office had any information regarding any fires, complaints, permits, violations involving hazardous materials use, USTs or ASTs on record for the subject properties and/or adjoining properties.

My report is due January 15, 2015. In light of my timeline, I would greatly appreciate any assistance you can provide in expediting access to the files. Mahalo

Heather Schauer

I WOULD LIKE: (please check one or more of the options below)

☐ **To inspect the government record.**

☐ **A copy of the government record:** (Please check one of the options below.) See the back of this page for information about fees that you may be required to pay for agency services to process your record request. Note: Copying and transmission charges may also apply to certain options.

- ☐ Pick up at agency (**date and time**): ______________________
- ☐ Mail
- ☐ Fax (toll free and only if available)
- ☐ Other, if available (please specify): ______________________

☐ If the agency maintains the records in a form other than paper, please advise in which format you would prefer to have the record.

☐ Electronic ☐ Audio ☐ Other (please specify): ______________

☐ Check this box if you are attaching a request for waiver of fees in the public interest (see waiver information on back).

SEE BACK FOR IMPORTANT INFORMATION

OFFICIAL USE ONLY: SEE BACK FOR IMPORTANT INFORMATION

ENVIRONMENTAL LIENS / AUL REPORT

AFX Corp., Inc. TitleSearch.com - EnvironmentalLiens.com

Order Number	79-16929-47	**Effective Date**	1/6/2016		
Last name	STATE OF HAWAII / UNIVERSITY OF HAWAII				
First name		**County**	HAWAII		
Street address		**City**		**State**	HAWAII
Mailing address	101 AUPUNI ST #126, HILO HI 96720-4265				
Parcel Number	(3) 4-4-015:009	**Alternate parcel number**			
Legal Desc.	MAUNA KEA SCIENCE RESERVE				

Federal, state, and local environmental records have been researched, resulting in the following list of recorded environmental liens and AUL's (activity and usage limitations) for the subject property having been found:

ENVIRONMENTAL LIENS, IC s, LUC s, AUL s, & DEUR s

1 NONE FOUND WITH UNITED STATES EPA
2 NONE FOUND WITH HAWAII OFFICE OF ENVIRONMENTAL QUALITY CONTROL
3 NONE FOUND IN THE HAWAII COUNTY OFFICIAL LAND RECORDS
4

JUDGMENTS, LIENS

1 NONE FOUND WITH HAWAII OFFICE OF ENVIRONMENTAL QUALITY CONTROL
2 NO PENDING ENFORCEMENT ACTION LOCATED
3
4

OTHER INFORMATION:

This search is subject to the terms and conditions at TitleSearch.com.

RECORDS OF COMMUNICATION/INTERVIEW

Phase I Environmental Site Assessment Property Questionnaire

Circle all that apply: User ● Owner ● Key Site Manager

Please complete **ALL** sections of this questionnaire and return a **signed and dated** copy to ENPRO Environmental via FAX at **808-262-4449** or e-mail at **info@enproenvironmental.com** as soon as possible.

Communication with:

Name:	Simon Radford
Company:	California Institute of Technology
Phone Number:	808 935 1909
Date:	2016-01-06
Amount of Time Familiar With Site:	5 ½ years
Relationship to Site:	Operations Manager

PROJECT NO.: **1512-00532-PH1**

PROJECT NAME/ADDRESS: **Caltech Submilimeter Observatory**
Mauna Kea
Hawaii Island, Hawaii

Prior to answering the questions supplied in the table below, please provide ENPRO with the following information:

A. What is your purpose/reason for requesting a Phase I Environmental Site Assessment of the above referenced property? _ Due diligence prior to observatory decommissioning; requirement of MK observatories decommissioning plan. ____

B. Can you supply a floor plan diagram and list of tenants for the structures at the property? If so, please attach copies with your questionnaire responses or send separately prior to the site visit.

DIRECTIONS: Please answer all questions to the best of your knowledge and in good faith. Mark the appropriate response with an "**X**". (Note: **U/NR** indicates "Unknown" or "No Response").
If you not know the answer, please check the **U/NR** box rather than the **No** box.
Please also elaborate on ALL **Yes** responses in the **Comment** box (for example, if the response to "Is the adjoining property used for an industrial use?" is **Yes**, please explain, e.g., "The building next door is used for canning tomatoes"). You may also provide additional information to **U/NR** and **No** responses as necessary. If you have any questions while completing the questionnaire, please contact us.

Question		Response			Comment
		Yes	No	U/NR	
1.	Are you aware of any pending, threatened, or past ***litigation*** relevant to hazardous substances or petroleum products in, on, or from the property?		No		
2.	Are you aware of any pending, threatened, or past ***administrative proceedings*** relevant to hazardous substances or petroleum products in, on, or from the property?		No		
3.	Are you aware of any ***notices from any governmental entity*** regarding any possible violation(s) of environmental laws or possible liability relating to hazardous substances or petroleum products in, on, or from the property?		No		

151 Hekili Street ▪ Suite 210 ▪ Kailua, HI 96734
Telephone 808.262.0909 ▪ Fax 808.262.4449 ▪ www.enproenvironmental.com

PROJECT NO.: **1512-00532--PH1**
PROJECT NAME/ADDRESS: **Caltech Submilimeter Observatory**
Mauna Kea
Hawaii Island, Hawaii

Question		Response: Yes	No	U/ NR	Comment
4.	Are you aware of any ***environmental cleanup liens*** against the property that are filed or recorded under federal, tribal, state, or local law?		No		
5.	Are you aware of any ***Activity and Use Limitations (AULs)***, including engineering controls, land use restrictions, or institutional controls that are in place at the property and/or have been filed or recorded in a registry under federal, tribal, state, or local law?		No		
6.	Do you have any ***specialized knowledge*** or experience related to possible environmental concerns at the property or nearby properties? (For example, are you involved in the same line of business as the current or former occupants at the property or adjacent/nearby properties such that you would have specialized knowledge of the chemicals and processes used by this type of business?)		No		
7.	Does the purchase price being paid for this property reasonably reflect the fair market value of the property? If you conclude that there is a difference, have you considered whether the ***devalued purchase price*** is because contamination is known or believed to be present at the property? (Please reply in **Comment** section)				Not applicable
8.	Are you aware of ***commonly known or reasonably ascertainable information*** about the property or nearby properties that would help ENPRO to identify conditions indicative of releases or threatened releases? (For example, neighboring property is known to have once been a vehicle junk yard)		No		
9.	Do you know any ***past uses*** of the property which may have contributed to potential contaminant releases?		No		
10.	Do you know of any ***specific chemicals*** that are present or once were present at the property?		No		
11.	Do you know of any ***spills or other chemical releases*** that have taken place at the property?	Yes			Hydraulic oil spill, 2009 May 17
12.	Do you know of any ***environmental cleanups*** that have taken place at the property?	Yes			Hydraulic oil cleanup, 2009 May-Sept.
13.	Based on your knowledge and experience related to the property, are there any ***obvious indicators*** that point to the presence or likely presence of contamination at the property?		No		
14.	a.) Is the ***property*** used for an industrial use?		No		Other: Scientific Obs.
	b.) Are any ***adjacent properties*** used for an industrial use?		No		Not applicable
15.	a.) Has the ***property*** been used for an industrial use ***in the past***?		No		
	b.) Have any of the ***adjacent properties*** been used for an industrial use ***in the past***?		No		Not applicable

151 Hekili Street ▪ Suite 210 ▪ Kailua, HI 96734
Telephone 808.262.0909 ▪ Fax 808.262.4449 ▪ www.enproenvironmental.com

PROJECT NO.: **1512-00532-PH1**
PROJECT NAME/ADDRESS: **Caltech Submilimeter Observatory**
Mauna Kea
Hawaii Island, Hawaii

Question		Response Yes	No	U/ NR	Comment
16.	a.) Is the ***property*** used as a gasoline station, motor repair facility, commercial printing facility, dry cleaners, photo developing laboratory, junkyard or landfill, or as a waste treatment, storage, disposal, processing, or recycling facility?		No		
	b.) Are any of the ***adjacent properties*** used as a gasoline station, motor repair facility, commercial printing facility, dry cleaners, photo developing laboratory, junkyard or landfill, or as a waste treatment, storage, disposal, processing, or recycling facility?		No		
17.	a.) Has the ***property*** been used ***in the past*** as a gasoline station, motor repair facility, commercial printing facility, dry cleaners, photo developing laboratory, junkyard or landfill, or as a waste treatment, storage, disposal, processing, or recycling facility?		No		
	b.) Have any of the ***adjacent properties*** been used ***in the past*** as a gasoline station, motor repair facility, commercial printing facility, dry cleaners, photo developing laboratory, junkyard or landfill, or as a waste treatment, storage, disposal, processing, or recycling facility?		No		
18.	a.) Are there ***currently*** any automotive or industrial **batteries** damaged or discarded, or **pesticides, paints, or other chemicals** in individual containers of greater than five gallons in volume or fifty gallons in the aggregate, stored on, or used at the ***property*** or at the *facility*?		No		
	b.) Have there been ***previously*** any automotive or industrial **batteries** damaged or discarded, or **pesticides, paints, or other chemicals** in individual containers of greater than five gallons in volume or fifty gallons in the aggregate, stored on or used at the ***property*** or at the *facility*?		No		
19.	a.) Are there ***currently*** any industrial **drums** (typically 55-gallon) or **sacks of chemical** located on the ***property?***		No		
	b.) Have there been ***previously*** any industrial **drums** (typically 55-gallon) or **sacks of chemical** located on the ***property?***		No		
20.	a.) Are there ***currently*** any ground water monitoring wells or other **ground water wells** (e.g., drinking water wells) located on the ***property***?		No		
	b.) Have there been ***previously*** any ground water monitoring wells or other **ground water wells** (e.g., drinking water wells) located on the ***property***?		No		
21.	a.) Are there ***currently*** any ground water monitoring wells or other **ground water wells** (e.g., drinking water wells) located on any of the ***adjacent properties?***		No		
	b.) Have there been ***previously*** any ground water monitoring wells or other **ground water wells** (e.g., drinking water wells) located on any of the ***adjacent properties?***		No		

151 Hekili Street ▪ Suite 210 ▪ Kailua, HI 96734
Telephone 808.262.0909 ▪ Fax 808.262.4449 ▪ www.enproenvironmental.com

PROJECT NO.: **1512-00532-PH1**
PROJECT NAME/ADDRESS: **Caltech Submilimeter Observatory**
Mauna Kea
Hawaii Island, Hawaii

	Question	Response Yes	No	U/ NR	Comment
22.	a.) Has ***fill dirt*** been brought onto the property which originated from a ***contaminated site?***		No		
	b.) Has ***fill dirt*** been brought onto the property which is of ***unknown origin?***		No		
23.	a.) Are there ***currently*** any ***pits, ponds or lagoons*** on the property in connection with waste treatment or waste disposal?		No		
	b.) Have there been ***previously*** any ***pits, ponds or lagoons*** on the property in connection with waste treatment or waste disposal?		No		
24.	a.) Is there ***currently*** any ***stained soil*** on the property?		No		
	b.) Has there been ***previously*** any ***stained soil*** on the property?		No		
25. .	a.) Are there ***currently*** any registered or unregistered ***storage tanks*** (above ground or underground) located on the property?				Water tank only
	a.) Have there been ***previously*** any registered or unregistered ***storage tanks*** (above ground or underground) located on the property?		No		
26.	a.) Are there ***currently*** any ***vent pipes, fill pipes, or access ways indicating a fill pipe*** protruding from the ground on the property ***or*** adjacent to any structures on the property?				Fill pipe for water tank and for cesspool
	b.) Have there been ***previously*** any ***vent pipes, fill pipes, or access ways indicating a fill pipe*** protruding from the ground on the property ***or*** adjacent to any structures on the property?		No		
27.	a.) Are there ***currently*** any ***flooring, drains, or walls*** located within the structure(s) on the property that are stained by substances other than water ***or*** are emitting foul odors?				Lubrication and hydraulic residues on concrete floor
	b.) Have there been ***previously*** any ***flooring, drains, or walls*** located within the structure(s) on the property that are stained by substances other than water ***or*** are emitting foul odors?		No		
28.	a.) ***If the property is served by a private well*** or non-public water system, ***have contaminants been identified*** in the well or system that exceed guidelines applicable to the water system?				Not applicable
	b.) ***If the property is served by a private well*** or non-public water system, ***has the well been designated as contaminated*** by any government environmental/health agency?				Not applicable
29.	a.) Are there any ***environmental liens or government notifications*** relating to ***current violations*** of environmental laws with respect to the property or any facility located on the property?		No		
	b.) Are you aware of the ***past existence*** of any ***environmental violations*** of environmental laws with respect to the property or any facility located on the property?		No		

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PROJECT NO.: 1512-00532-PH1

PROJECT NAME/ADDRESS: Caltech Submilimeter Observatory
Mauna Kea
Hawaii Island, Hawaii

Question		Response			Comment
		Yes	No	U/NR	
30.	a.) Have you been informed of the existence of any ***hazardous substances or petroleum products*** which are ***currently*** used or stored on the property?				Small quantities paints, lubricants, hydr. oil, etc.
	b.) Have you been informed of the ***past*** existence of any ***hazardous substances or petroleum products*** used or stored on the property?		No		
31.	a.) Are you aware of any ***previous Environmental Site Assessments*** of the property or facility which indicated the presence of ***hazardous materials or petroleum products?***		No		
	b.) Are you aware of any ***previous Environmental Site Assessments*** which indicated the ***contamination of the property or facility?***		No		
	c.) Are you aware of any ***previous Environmental Site Assessments*** which ***recommended further assessment*** of the property or facility?		No		
32.	a.) Are you aware of any ***pending, threatened, or past litigation*** relevant to hazardous substances or petroleum products involving the property?		No		
	b.) Are you aware of any ***pending, threatened, or past administrative proceedings*** relevant to hazardous substances or petroleum products involving the property?		No		
	c.) Are you aware of any notices from any government entity regarding any ***possible violations*** of environmental laws or ***possible liability*** relevant to hazardous substances or petroleum products involving the property?		No		
33. .	a.) Does the property ***discharge waste water*** on or adjacent to the property, other than storm water, into a ***storm water sewer system?***		No		
	b.) Does the property ***discharge waste water*** on or adjacent to the property, other than storm water, into a ***sanitary sewer system?***	Yes			Cesspool on site.
34.	Have any hazardous substances or petroleum products, unidentified waste materials, tires, automotive or industrial batteries, or any other waste materials been ***dumped above grade, buried, and/or burned on the property?***		No		
35.	Is there any ***transformer, capacitor, or any hydraulic equipment*** on the property for which there are any records of the presence of ***PCBs?***		No		Helco Xformer; hydraulic sys; no record of PCBs
36.	a.) Is there now, or have there ever been any ***asbestos-containing materials (ACM)*** in any application on the property?			U	
	b.) Has there ever been any ***testing for ACM*** conducted on the property?		No		

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PROJECT NO.: **1512-00532-PH1**

PROJECT NAME/ADDRESS: **Caltech Submilimeter Observatory**
Mauna Kea
Hawaii Island, Hawaii

Question		Response			Comment
		Yes	No	U/ NR	
36.	c.) Is there an ***asbestos Operations and Maintenance*** (O & M) program in place at the property?		No		
37.	a.) Is there now, or have there ever been any ***Lead-Based Paint (LBP)*** in any application on the property?			U	
	b.) Has there ever been any ***testing for LBP*** conducted on the property?		No		
	c.) Is there a ***LBP O & M*** program in place at the property?		No		
38.	Has the ***water*** at the property ever been tested for ***lead?***			U	
39.	Has ***radon testing*** ever been conducted at the property?			U	
40.	Is the property, or any portion of the property, located or involved in any ***Ecologically Sensitive Areas*** (i.e., wetlands, coastal barrier resource areas, coastal barrier improvement act areas, flood plain, endangered species, etc.)?	Yes			Conservation District
41.	a.) Is the property, ***or*** any property within 1.0 mile of the property, listed on the Federal ***National Priorities List (NPL)?***		No		
	b.) Is the property, ***or*** any property within 0.5 miles of the property, listed on the Federal ***CERCLIS List?***		No		
	c.) Is the property, ***or*** any property within 1.0 mile of the property, listed by the Federal government as a ***RCRA TSD Facility?***		No		
42.	a.) Is the property, ***or*** any property within 1.0 mile of the property, listed by the State government as a ***Hazardous Waste site?***		No		
	b.) Is the property, ***or*** any property within 0.5 miles of the property, listed by the State government as a ***CERCLIS-equivalent site?***		No		
	c.) Is the property, ***or*** any property within 0.5 miles of the property, listed by the State as a ***Leaking Underground Storage Tank (LUST) site?***		No		
	c.) Is the property, ***or*** any property within 0.5 miles of the property, listed by the State as a ***Solid Waste/Landfill facility?***		No		

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PROJECT NO.: 1512-00532-PH1

PROJECT NAME/ADDRESS: **Caltech Submillimeter Observatory**
Mauna Kea
Hawaii Island, Hawaii

Respondent Affirmation:

Respondent represents that to the best of the respondent's knowledge the above statements and facts are true and correct and to the best of the respondent's actual knowledge, no material facts have been suppressed or misstated.

Signature ___________________________ Date 2016-01-06 ___________

(For oral communications, the word "Affirmed" appears on the signature line)

or

Answers to this questionnaire have been orally communicated to a representative of Environmental Professionals, completed by:

Name _______________ Signature _______________________ Date_________

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Phase I Environmental Site Assessment Property Questionnaire

Circle all that apply: User ● Owner ● Key Site Manager

Please complete **ALL** sections of this questionnaire and return a **signed and dated** copy to ENPRO Environmental via FAX at **808-262-4449** or e-mail at **hschauer@enproenvironmental.com** as soon as possible.

Communication with:

Name:	Stephanie Nagata
Company:	Office of Maunakea Management
Phone Number:	808-933-0734
Date:	January 28, 2016
Amount of Time Familiar With Site:	15.5 years
Relationship to Site:	OMMK has oversight of observatory activities that impact the external environment.

PROJECT NO.: **1512-00532-PH1**

PROJECT NAME/ADDRESS: **Caltech Submilimeter Observatory**
Mauna Kea
Hawaii Island, Hawaii

Prior to answering the questions supplied in the table below, please provide ENPRO with the following information:

A. What is your purpose/reason for requesting a Phase I Environmental Site Assessment of the above referenced property? ______________________________

B. Can you supply a floor plan diagram and list of tenants for the structures at the property? If so, please attach copies with your questionnaire responses or send separately prior to the site visit.

DIRECTIONS: Please answer all questions to the best of your knowledge and in good faith. Mark the appropriate response with an "**X**". (Note: **U/NR** indicates "Unknown" or "No Response").
If you not know the answer, please check the **U/NR** box rather than the **No** box.
Please also elaborate on ALL **Yes** responses in the **Comment** box (for example, if the response to "Is the adjoining property used for an industrial use?" is **Yes**, please explain, e.g., "The building next door is used for canning tomatoes"). You may also provide additional information to **U/NR** and **No** responses as necessary. If you have any questions while completing the questionnaire, please contact us.

Question		Response			Comment
		Yes	No	U/NR	
1.	Are you aware of any pending, threatened, or past ***litigation*** relevant to hazardous substances or petroleum products in, on, or from the property?		X		
2.	Are you aware of any pending, threatened, or past ***administrative proceedings*** relevant to hazardous substances or petroleum products in, on, or from the property?		X		
3.	Are you aware of any ***notices from any governmental entity*** regarding any possible violation(s) of environmental laws or possible liability relating to hazardous substances or petroleum products in, on, or from the property?		X		

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PROJECT NO.: **1512-00532--PH1**
PROJECT NAME/ADDRESS: **Caltech Submilimeter Observatory**
Mauna Kea
Hawaii Island, Hawaii

Question		Response Yes	Response No	Response U/ NR	Comment
4.	Are you aware of any ***environmental cleanup liens*** against the property that are filed or recorded under federal, tribal, state, or local law?		X		
5.	Are you aware of any ***Activity and Use Limitations (AULs)***, including engineering controls, land use restrictions, or institutional controls that are in place at the property and/or have been filed or recorded in a registry under federal, tribal, state, or local law?	X			Any land use defined under Conservation District rules are subject to review and a permit from DLNR
6.	Do you have any ***specialized knowledge*** or experience related to possible environmental concerns at the property or nearby properties? (For example, are you involved in the same line of business as the current or former occupants at the property or adjacent/nearby properties such that you would have specialized knowledge of the chemicals and processes used by this type of business?)	X			Possible. In May 2009, there was a hydraulic leak that spilled onto the floor of the telescope facility. An estimated 7 gallons may have been released into the cinder through a drain hole. The majority of nearly 23 gallons were recovered. Also see page 6-9 of the 2009 Maunakea CMP for additional information on other facilities.
7.	Does the purchase price being paid for this property reasonably reflect the fair market value of the property? If you conclude that there is a difference, have you considered whether the ***devalued purchase price*** is because contamination is known or believed to be present at the property? (Please reply in **Comment** section)			X	
8.	Are you aware of ***commonly known or reasonably ascertainable information*** about the property or nearby properties that would help ENPRO to identify conditions indicative of releases or threatened releases? (For example, neighboring property is known to have once been a vehicle junk yard)		X		
9.	Do you know any ***past uses*** of the property which may have contributed to potential contaminant releases?	X			See no. 5 above
10.	Do you know of any ***specific chemicals*** that are present or once were present at the property?	X			Only the hydraulic fluid mentioned in no. 6 above
11.	Do you know of any ***spills or other chemical releases*** that have taken place at the property?	X			See No. 6 above
12.	Do you know of any ***environmental cleanups*** that have taken place at the property?	X			See No. 6 above.

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13.	Based on your knowledge and experience related to the property, are there any ***obvious indicators*** that point to the presence or likely presence of contamination at the property?		X		
14.	a.) Is the ***property*** used for an industrial use?		X		
	b.) Are any ***adjacent properties*** used for an industrial use?		X		
15.	a.) Has the ***property*** been used for an industrial use ***in the past***?		X		
	b.) Have any of the ***adjacent properties*** been used for an industrial use ***in the past***?		X		
Question		**Response**			**Comment**
		Yes		**U/ NR**	
16.	a.) Is the ***property*** used as a gasoline station, motor repair facility, commercial printing facility, dry cleaners, photo developing laboratory, junkyard or landfill, or as a waste treatment, storage, disposal, processing, or recycling facility?		X		
	b.) Are any of the ***adjacent properties*** used as a gasoline station, motor repair facility, commercial printing facility, dry cleaners, photo developing laboratory, junkyard or landfill, or as a waste treatment, storage, disposal, processing, or recycling facility?		X		
17.	a.) Has the ***property*** been used ***in the past*** as a gasoline station, motor repair facility, commercial printing facility, dry cleaners, photo developing laboratory, junkyard or landfill, or as a waste treatment, storage, disposal, processing, or recycling facility?		X		
	b.) Have any of the ***adjacent properties*** been used ***in the past*** as a gasoline station, motor repair facility, commercial printing facility, dry cleaners, photo developing laboratory, junkyard or landfill, or as a waste treatment, storage, disposal, processing, or recycling facility?		X		
18.	a.) Are there ***currently*** any automotive or industrial **batteries** damaged or discarded, or **pesticides, paints, or other chemicals** in individual containers of greater than five gallons in volume or fifty gallons in the aggregate, stored on, or used at the ***property*** or at the *facility*?		X		
	b.) Have there been ***previously*** any automotive or industrial **batteries** damaged or discarded, or **pesticides, paints, or other chemicals** in individual containers of greater than five gallons in volume or fifty gallons in the aggregate, stored on or used at the ***property*** or at the *facility*?		X		
19.	a.) Are there ***currently*** any industrial **drums** (typically 55-gallon) or **sacks of chemical** located on the ***property?***		X		
	b.) Have there been ***previously*** any industrial **drums** (typically 55-gallon) or **sacks of chemical** located on the ***property?***		X		
20.	a.) Are there ***currently*** any ground water monitoring wells or other **ground water wells** (e.g., drinking water wells) located on the ***property***?		X		
	b.) Have there been ***previously*** any ground water monitoring wells or other **ground water wells** (e.g., drinking water wells) located on the ***property***?		X		
21.	a.) Are there ***currently*** any ground water monitoring wells or other **ground water wells** (e.g., drinking water wells) located on any of the ***adjacent properties?***		X		
	b.) Have there been ***previously*** any ground water monitoring wells or other **ground water wells** (e.g., drinking water wells) located on any of the ***adjacent properties?***		X		

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PROJECT NO.: 1512-00532-PH1
PROJECT NAME/ADDRESS: Caltech Submilimeter Observatory
Mauna Kea
Hawaii Island, Hawaii

	Question	Response			Comment
		Yes	No	U/ NR	
22.	a.) Has ***fill dirt*** been brought onto the property which originated from a ***contaminated site?***		X		
	b.) Has ***fill dirt*** been brought onto the property which is of ***unknown origin?***		X		
23.	a.) Are there ***currently*** any ***pits, ponds or lagoons*** on the property in connection with waste treatment or waste disposal?		X		
	b.) Have there been ***previously*** any ***pits, ponds or lagoons*** on the property in connection with waste treatment or waste disposal?		X		
24.	a.) Is there ***currently*** any ***stained soil*** on the property?				Possible stained soil below concrete floor due to a hydraulic leak. See comment under No. 6 above
	b.) Has there been ***previously*** any ***stained soil*** on the property?				See No. 6 and 24 above
25. .	a.) Are there ***currently*** any registered or unregistered ***storage tanks*** (above ground or underground) located on the property?		X		
	a.) Have there been ***previously*** any registered or unregistered ***storage tanks*** (above ground or underground) located on the property?		X		
26.	a.) Are there ***currently*** any ***vent pipes, fill pipes, or access ways indicating a fill pipe*** protruding from the ground on the property ***or*** adjacent to any structures on the property?	X			Water and septic (cesspool).
	b.) Have there been ***previously*** any ***vent pipes, fill pipes, or access ways indicating a fill pipe*** protruding from the ground on the property ***or*** adjacent to any structures on the property?		X		
27.	a.) Are there ***currently*** any ***flooring, drains, or walls*** located within the structure(s) on the property that are stained by substances other than water ***or*** are emitting foul odors?		X		
	b.) Have there been ***previously*** any ***flooring, drains, or walls*** located within the structure(s) on the property that are stained by substances other than water ***or*** are emitting foul odors?		X		
28.	a.) ***If the property is served by a private well*** or non-public water system, ***have contaminants been identified*** in the well or system that exceed guidelines applicable to the water system?		X		
	b.) ***If the property is served by a private well*** or non-public water system, ***has the well been designated as contaminated*** by any government environmental/health agency?		X		
29.	a.) Are there any ***environmental liens or government***		X		

	notifications relating to ***current violations*** of environmental laws with respect to the property or any facility located on the property?				
	b.) Are you aware of the ***past existence*** of any ***environmental violations*** of environmental laws with respect to the property or any facility located on the property?		X		See 2009 Maunakea CMP

PROJECT NO.: **1512-00532-PH1**

PROJECT NAME/ADDRESS: **Caltech Submilimeter Observatory**
Mauna Kea
Hawaii Island, Hawaii

Question		Response			Comment
		Yes	No	U/ NR	
30.	a.) Have you been informed of the existence of any ***hazardous substances or petroleum products*** which are ***currently*** used or stored on the property?	X			See Maunakea Natural Resources Management Plan pg 3-12.
	b.) Have you been informed of the ***past*** existence of any ***hazardous substances or petroleum products*** used or stored on the property?		X		
31.	a.) Are you aware of any ***previous Environmental Site Assessments*** of the property or facility which indicated the presence of ***hazardous materials or petroleum products?***		X		
	b.) Are you aware of any ***previous Environmental Site Assessments*** which indicated the ***contamination of the property or facility?***				See comment under No. 6 and 24 above
	c.) Are you aware of any ***previous Environmental Site Assessments*** which ***recommended further assessment*** of the property or facility?	X			See comment under No. 6 and 24 above. Also see letter from DLNR
32.	a.) Are you aware of any ***pending, threatened, or past litigation*** relevant to hazardous substances or petroleum products involving the property?		X		
	b.) Are you aware of any ***pending, threatened, or past administrative proceedings*** relevant to hazardous substances or petroleum products involving the property?		X		
	c.) Are you aware of any notices from any government entity regarding any ***possible violations*** of environmental laws or ***possible liability*** relevant to hazardous substances or petroleum products involving the property?		X		
33. .	a.) Does the property ***discharge waste water*** on or adjacent to the property, other than storm water, into a ***storm water sewer system?***		X		
	b.) Does the property ***discharge waste water*** on or adjacent to the property, other than storm water, into a ***sanitary sewer system?***	X			Into cesspool.
34.	Have any hazardous substances or petroleum products, unidentified waste materials, tires, automotive or industrial batteries, or any other waste materials been ***dumped above***		X		

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	grade, buried, and/or burned on the property?				
35.	Is there any ***transformer, capacitor, or any hydraulic equipment*** on the property for which there are any records of the presence of ***PCBs?***		X		
36.	a.) Is there now, or have there ever been any ***asbestos-containing materials (ACM)*** in any application on the property?			X	
	b.) Has there ever been any ***testing for ACM*** conducted on the property?		X		

PROJECT NO.: **1512-00532-PH1**
PROJECT NAME/ADDRESS: **Caltech Submilimeter Observatory**
Mauna Kea
Hawaii Island, Hawaii

Question		Response			Comment
		Yes	No	U/ NR	
36.	c.) Is there an ***asbestos Operations and Maintenance*** (O & M) program in place at the property?		X		
37.	a.) Is there now, or have there ever been any ***Lead-Based Paint (LBP)*** in any application on the property?		X		
	b.) Has there ever been any ***testing for LBP*** conducted on the property?		X		
	c.) Is there a ***LBP O & M*** program in place at the property?		X		
38.	Has the ***water*** at the property ever been tested for ***lead?***		X		
39.	Has ***radon testing*** ever been conducted at the property?		X		
40.	Is the property, or any portion of the property, located or involved in any ***Ecologically Sensitive Areas*** (i.e., wetlands, coastal barrier resource areas, coastal barrier improvement act areas, flood plain, endangered species, etc.)?	X			Near wekiu bug habitat
41.	a.) Is the property, ***or*** any property within 1.0 mile of the property, listed on the Federal ***National Priorities List (NPL)?***		X		
	b.) Is the property, ***or*** any property within 0.5 miles of the property, listed on the Federal ***CERCLIS List?***		X		
	c.) Is the property, ***or*** any property within 1.0 mile of the property, listed by the Federal government as a ***RCRA TSD Facility?***		X		
42.	a.) Is the property, ***or*** any property within 1.0 mile of the property, listed by the State government as a ***Hazardous Waste site?***		X		
	b.) Is the property, ***or*** any property within 0.5 miles of the property, listed by the State government as a ***CERCLIS-equivalent site?***		X		
	c.) Is the property, ***or*** any property within 0.5 miles of the property, listed by the State as a ***Leaking Underground Storage Tank (LUST) site?***		X		
	c.) Is the property, ***or*** any property within 0.5 miles of the property,		X		

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	listed by the State as a ***Solid Waste/Landfill facility?***					

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ENPRO

PROJECT NO.: 1512-00532-PH1

PROJECT NAME/ADDRESS: **Caltech Submilitmeter Observatory**
Mauna Kea
Hawaii Island, Hawaii

Respondent Affirmation:

Respondent represents that to the best of the respondent's knowledge the above statements and facts are true and correct and to the best of the respondent's actual knowledge, no material facts have been suppressed or misstated.

Signature Stephanie Sagata Date 2/4/16
(For oral communications, the word "Affirmed" appears on the signature line)

or

Answers to this questionnaire have been orally communicated to a representative of Environmental Professionals, completed by:

Name __________ Signature __________ Date __________

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Phase I Environmental Site Assessment Property Questionnaire

Circle all that apply: User ● Owner ● Key Site Manager

Please complete **ALL** sections of this questionnaire and return a **signed and dated** copy to ENPRO Environmental via FAX at **808-262-4449** or e-mail at **hschauer@enproenvironmental.com** as soon as possible.

Communication with:		
	Name:	Russell Y. Tsuji
	Company:	DLNR Land Division
	Phone Number:	(808) 587-0422
	Date:	March 7, 2016
	Amount of Time Familiar With Site:	Aware of the general leased area since 2015 as an employee of DLNR
	Relationship to Site:	Land Division Administrator

PROJECT NO.: **1512-00532-PH1**

PROJECT NAME/ADDRESS: **Caltech Submilimeter Observatory**
Mauna Kea
Hawaii Island, Hawaii

Prior to answering the questions supplied in the table below, please provide ENPRO with the following information:

A. What is your purpose/reason for requesting a Phase I Environmental Site Assessment of the above referenced property? **We understand that either UH or its sublessee has initiated the request for the Phase I. CAVEAT: please note that UH and its sublessee have had exclusive use of the property since at least the commencement of General Lease No. S-4191 between the Board of Land and Natural Resources (BLNR), as lessor, and UH, as lessee, on June 21, 1968. Our files indicate that the BLNR, as lessor under the aforesaid General Lease never received notice, written or otherwise, of any spills of hazardous materials or other episodes of possible environmental contamination at the property.**

B. Can you supply a floor plan diagram and list of tenants for the structures at the property? If so, please attach copies with your questionnaire responses or send separately prior to the site visit.

DIRECTIONS: Please answer all questions to the best of your knowledge and in good faith. Mark the appropriate response with an "**X**". (Note: **U/NR** indicates "Unknown" or "No Response").
If you not know the answer, please check the **U/NR** box rather than the **No** box.
Please also elaborate on ALL **Yes** responses in the **Comment** box (for example, if the response to "Is the adjoining property used for an industrial use?" is **Yes**, please explain, e.g., "The building next door is used for canning tomatoes"). You may also provide additional information to **U/NR** and **No** responses as necessary. If you have any questions while completing the questionnaire, please contact us.

Question		Response			Comment
		Yes	No	U/NR	
1.	Are you aware of any pending, threatened, or past ***litigation*** relevant to hazardous substances or petroleum products in, on, or from the property?		X		See caveat in item A above.
2.	Are you aware of any pending, threatened, or past ***administrative***		X		See caveat in item A

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	proceedings relevant to hazardous substances or petroleum products in, on, or from the property?				above.
3.	Are you aware of any ***notices from any governmental entity*** regarding any possible violation(s) of environmental laws or possible liability relating to hazardous substances or petroleum products in, on, or from the property?		X		See caveat in item A above.

PROJECT NO.: **1512-00532--PH1**

PROJECT NAME/ADDRESS: **Caltech Submilimeter Observatory**
Mauna Kea
Hawaii Island, Hawaii

Question		Response			Comment
		Yes	No	U/ NR	
4.	Are you aware of any ***environmental cleanup liens*** against the property that are filed or recorded under federal, tribal, state, or local law?		X		See caveat in item A above.
5.	Are you aware of any ***Activity and Use Limitations (AULs)***, including engineering controls, land use restrictions, or institutional controls that are in place at the property and/or have been filed or recorded in a registry under federal, tribal, state, or local law?		X		See caveat in item A above.
6.	Do you have any ***specialized knowledge*** or experience related to possible environmental concerns at the property or nearby properties? (For example, are you involved in the same line of business as the current or former occupants at the property or adjacent/nearby properties such that you would have specialized knowledge of the chemicals and processes used by this type of business?)		X		See caveat in item A above.
7.	Does the purchase price being paid for this property reasonably reflect the fair market value of the property? If you conclude that there is a difference, have you considered whether the ***devalued purchase price*** is because contamination is known or believed to be present at the property? (Please reply in **Comment** section)			X	Probably not applicable. See caveat in item A above.
8.	Are you aware of ***commonly known or reasonably ascertainable information*** about the property or nearby properties that would help ENPRO to identify conditions indicative of releases or threatened releases? (For example, neighboring property is known to have once been a vehicle junk yard)		X		See caveat in item A above.
9.	Do you know any ***past uses*** of the property which may have contributed to potential contaminant releases?		X		See caveat in item A above.
10.	Do you know of any ***specific chemicals*** that are present or once were present at the property?		X		See caveat in item A above.
11.	Do you know of any ***spills or other chemical releases*** that have taken place at the property?		X		See caveat in item A above.
12.	Do you know of any ***environmental cleanups*** that have taken place at the property?		X		See caveat in item A above.
13.	Based on your knowledge and experience related to the property, are there any ***obvious indicators*** that point to the presence or likely presence of contamination at the property?		X		See caveat in item A above.
14.	a.) Is the ***property*** used for an industrial use?			X	See caveat in item A

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					above.
	b.) Are any ***adjacent properties*** used for an industrial use?			X	See caveat in item A above.
15.	a.) Has the ***property*** been used for an industrial use ***in the past***?			X	See caveat in item A above.
	b.) Have any of the ***adjacent properties*** been used for an industrial use ***in the past***?			X	See caveat in item A above.

PROJECT NO.: **1512-00532-PH1**

PROJECT NAME/ADDRESS: **Caltech Submilimeter Observatory**
Mauna Kea
Hawaii Island, Hawaii

Question		Response			Comment
		Yes	No	U/ NR	
16.	a.) Is the ***property*** used as a gasoline station, motor repair facility, commercial printing facility, dry cleaners, photo developing laboratory, junkyard or landfill, or as a waste treatment, storage, disposal, processing, or recycling facility?			X	See caveat in item A above.
	b.) Are any of the ***adjacent properties*** used as a gasoline station, motor repair facility, commercial printing facility, dry cleaners, photo developing laboratory, junkyard or landfill, or as a waste treatment, storage, disposal, processing, or recycling facility?			X	See caveat in item A above.
17.	a.) Has the ***property*** been used ***in the past*** as a gasoline station, motor repair facility, commercial printing facility, dry cleaners, photo developing laboratory, junkyard or landfill, or as a waste treatment, storage, disposal, processing, or recycling facility?			X	See caveat in item A above.
	b.) Have any of the ***adjacent properties*** been used ***in the past*** as a gasoline station, motor repair facility, commercial printing facility, dry cleaners, photo developing laboratory, junkyard or landfill, or as a waste treatment, storage, disposal, processing, or recycling facility?			X	See caveat in item A above.
18.	a.) Are there ***currently*** any automotive or industrial **batteries** damaged or discarded, or **pesticides, paints, or other chemicals** in individual containers of greater than five gallons in volume or fifty gallons in the aggregate, stored on, or used at the ***property*** or at the *facility*?			X	See caveat in item A above.
	b.) Have there been ***previously*** any automotive or industrial **batteries** damaged or discarded, or **pesticides, paints, or other chemicals** in individual containers of greater than five gallons in volume or fifty gallons in the aggregate, stored on or used at the ***property*** or at the *facility*?			X	See caveat in item A above.
19.	a.) Are there ***currently*** any industrial **drums** (typically 55-gallon) or **sacks of chemical** located on the ***property?***			X	See caveat in item A above.
	b.) Have there been ***previously*** any industrial **drums** (typically 55-gallon) or **sacks of chemical** located on the ***property?***			X	See caveat in item A above.
20.	a.) Are there ***currently*** any ground water monitoring wells or other **ground water wells** (e.g., drinking water wells) located on the ***property***?			X	Contact CWRM. See caveat in item A above.
	b.) Have there been ***previously*** any ground water monitoring wells			X	Contact CWRM. See

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	or other **ground water wells** (e.g., drinking water wells) located on the ***property***?				caveat in item A above.
21.	a.) Are there ***currently*** any ground water monitoring wells or other **ground water wells** (e.g., drinking water wells) located on any of the ***adjacent properties?***			X	Contact CWRM. See caveat in item A above.
	b.) Have there been ***previously*** any ground water monitoring wells or other **ground water wells** (e.g., drinking water wells) located on any of the ***adjacent properties?***			X	Contact CWRM. See caveat in item A above.

PROJECT NO.: **1512-00532-PH1**

PROJECT NAME/ADDRESS: **Caltech Submilimeter Observatory**
Mauna Kea
Hawaii Island, Hawaii

Question		Response			Comment
		Yes	No	U/ NR	
22.	a.) Has ***fill dirt*** been brought onto the property which originated from a ***contaminated site?***			X	See caveat in item A above.
	b.) Has ***fill dirt*** been brought onto the property which is of ***unknown origin?***			X	See caveat in item A above.
23.	a.) Are there ***currently*** any ***pits, ponds or lagoons*** on the property in connection with waste treatment or waste disposal?			X	See caveat in item A above.
	b.) Have there been ***previously*** any ***pits, ponds or lagoons*** on the property in connection with waste treatment or waste disposal?			X	See caveat in item A above.
24.	a.) Is there ***currently*** any ***stained soil*** on the property?			X	See caveat in item A above.
	b.) Has there been ***previously*** any ***stained soil*** on the property?			X	See caveat in item A above.
25. .	a.) Are there ***currently*** any registered or unregistered ***storage tanks*** (above ground or underground) located on the property?			X	See caveat in item A above.
	a.) Have there been ***previously*** any registered or unregistered ***storage tanks*** (above ground or underground) located on the property?			X	See caveat in item A above.
26.	a.) Are there ***currently*** any ***vent pipes, fill pipes, or access ways indicating a fill pipe*** protruding from the ground on the property ***or*** adjacent to any structures on the property?			X	See caveat in item A above.
	b.) Have there been ***previously*** any ***vent pipes, fill pipes, or access ways indicating a fill pipe*** protruding from the ground on the property ***or*** adjacent to any structures on the property?			X	See caveat in item A above.
27.	a.) Are there ***currently*** any ***flooring, drains, or walls*** located within the structure(s) on the property that are stained by substances other than water ***or*** are emitting foul odors?			X	See caveat in item A above.
	b.) Have there been ***previously*** any ***flooring, drains, or walls***			X	See caveat in item A

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	located within the structure(s) on the property that are stained by substances other than water ***or*** are emitting foul odors?				above.
28.	a.) ***If the property is served by a private well*** or non-public water system, ***have contaminants been identified*** in the well or system that exceed guidelines applicable to the water system?			X	See caveat in item A above.
	b.) ***If the property is served by a private well*** or non-public water system, ***has the well been designated as contaminated*** by any government environmental/health agency?			X	See caveat in item A above.
29.	a.) Are there any ***environmental liens or government notifications*** relating to ***current violations*** of environmental laws with respect to the property or any facility located on the property?			X	See caveat in item A above.
	b.) Are you aware of the ***past existence*** of any ***environmental violations*** of environmental laws with respect to the property or any facility located on the property?			X	See caveat in item A above.

PROJECT NO.: **1512-00532-PH1**

PROJECT NAME/ADDRESS: **Caltech Submilimeter Observatory**
Mauna Kea
Hawaii Island, Hawaii

Question		Response			Comment
		Yes	No	U/ NR	
30.	a.) Have you been informed of the existence of any ***hazardous substances or petroleum products*** which are ***currently*** used or stored on the property?		X		See caveat in item A above.
	b.) Have you been informed of the ***past*** existence of any ***hazardous substances or petroleum products*** used or stored on the property?		X		See caveat in item A above.
31.	a.) Are you aware of any ***previous Environmental Site Assessments*** of the property or facility which indicated the presence of ***hazardous materials or petroleum products?***		X		See caveat in item A above.
	b.) Are you aware of any ***previous Environmental Site Assessments*** which indicated the ***contamination of the property or facility?***		X		See caveat in item A above.
	c.) Are you aware of any ***previous Environmental Site Assessments*** which ***recommended further assessment*** of the property or facility?		X		See caveat in item A above.
32.	a.) Are you aware of any ***pending, threatened, or past litigation*** relevant to hazardous substances or petroleum products involving the property?		X		See caveat in item A above.
	b.) Are you aware of any ***pending, threatened, or past administrative proceedings*** relevant to hazardous substances or petroleum products involving the property?		X		See caveat in item A above.
	c.) Are you aware of any notices from any government entity regarding any ***possible violations*** of environmental laws or ***possible liability*** relevant to hazardous substances or petroleum products involving the property?		X		See caveat in item A above.
33. .	a.) Does the property ***discharge waste water*** on or adjacent to the property, other than storm water, into a ***storm water sewer system?***			X	See caveat in item A above.

	b.) Does the property ***discharge waste water*** on or adjacent to the property, other than storm water, into a ***sanitary sewer system?***			X	See caveat in item A above.
34.	Have any hazardous substances or petroleum products, unidentified waste materials, tires, automotive or industrial batteries, or any other waste materials been ***dumped above grade, buried, and/or burned on the property?***			X	See caveat in item A above.
35.	Is there any ***transformer, capacitor, or any hydraulic equipment*** on the property for which there are any records of the presence of ***PCBs?***			X	See caveat in item A above.
36.	a.) Is there now, or have there ever been any ***asbestos-containing materials (ACM)*** in any application on the property?			X	See caveat in item A above.
	b.) Has there ever been any ***testing for ACM*** conducted on the property?			X	See caveat in item A above.

PROJECT NO.: **1512-00532-PH1**

PROJECT NAME/ADDRESS: **Caltech Submilimeter Observatory**
Mauna Kea
Hawaii Island, Hawaii

Question		Response			Comment
		Yes	No	U/ NR	
36.	c.) Is there an ***asbestos Operations and Maintenance*** (O & M) program in place at the property?			X	See caveat in item A above.
37.	a.) Is there now, or have there ever been any ***Lead-Based Paint (LBP)*** in any application on the property?			X	See caveat in item A above.
	b.) Has there ever been any ***testing for LBP*** conducted on the property?			X	See caveat in item A above.
	c.) Is there a ***LBP O & M*** program in place at the property?			X	See caveat in item A above.
38.	Has the ***water*** at the property ever been tested for ***lead?***			X	See caveat in item A above.
39.	Has ***radon testing*** ever been conducted at the property?			X	See caveat in item A above.
40.	Is the property, or any portion of the property, located or involved in any ***Ecologically Sensitive Areas*** (i.e., wetlands, coastal barrier resource areas, coastal barrier improvement act areas, flood plain, endangered species, etc.)?	X			Conservation district. Contact OCCL. See caveat in item A above.
41.	a.) Is the property, ***or*** any property within 1.0 mile of the property, listed on the Federal ***National Priorities List (NPL)?***			X	See caveat in item A above.
	b.) Is the property, ***or*** any property within 0.5 miles of the property, listed on the Federal ***CERCLIS List?***			X	See caveat in item A above.
	c.) Is the property, ***or*** any property within 1.0 mile of the property,			X	See caveat in item A

	listed by the Federal government as a ***RCRA TSD Facility?***				above.
42.	a.) Is the property, ***or*** any property within 1.0 mile of the property, listed by the State government as a ***Hazardous Waste site?***			X	See caveat in item A above.
	b.) Is the property, ***or*** any property within 0.5 miles of the property, listed by the State government as a ***CERCLIS-equivalent site?***			X	See caveat in item A above.
	c.) Is the property, ***or*** any property within 0.5 miles of the property, listed by the State as a ***Leaking Underground Storage Tank (LUST) site?***			X	See caveat in item A above.
	c.) Is the property, ***or*** any property within 0.5 miles of the property, listed by the State as a ***Solid Waste/Landfill facility?***			X	See caveat in item A above.

PROJECT NO.: 1512-00532-PH1

PROJECT NAME/ADDRESS: **Caltech Submilitmeter Observatory**
Mauna Kea
Hawaii Island, Hawaii

Respondent Affirmation:

Respondent represents that to the best of the respondent's knowledge the above statements and facts are true and correct and to the best of the respondent's actual knowledge, no material facts have been suppressed or misstated.

Signature /s/ Russell Y. Tsuji __________ Date 03-08-16___________
(For oral communications, the word "Affirmed" appears on the signature line)

or

Answers to this questionnaire have been orally communicated to a representative of Environmental Professionals, completed by:

Name _______________ Signature ______________________ Date_________

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QUALIFICATIONS OF ENVIRONMENTAL PROFESSIONALS

Kenton Beal
Executive Vice President

CAREER HISTORY

More than twenty-five years of professional environmental project development and management. Strong emphasis on risk evaluation, risk ranking and environmental hazard assessment. Experienced in portfolio-wide environmental management and prioritizing resource allocation to address environmental liabilities in a cost effective manner. Has developed thousands of project budgets for planning and implementation purposes. Performed numerous RCRA hazardous waste characterization investigations, Phase I and II environmental investigations, remediation of soil and groundwater and environmental management of large construction projects. Projects have included urban renewal, remediation management at petroleum refineries, best management practices, storm water management, solid waste management, construction-related permitting, indoor air quality evaluations, closure of RCRA Treatment Storage and Disposal (TSD) facilities, remediation management for fungal contamination, evaluation of environmental issues related to lease disputes and commercial property transactions. Has performed and managed thousands of mold and moisture investigations ranging from single-family residential properties to high-rise commercial and resort properties.

PROFESSIONAL AFFILIATIONS

Registered Environmental Assessor (California)
Past President, Hawaii Chapter of the Institute of Hazardous Materials Managers
Registered Geologist (California)
Certified Professional Geologist (American Institute of Professional Geologists)
American Indoor Air Quality Council (Board of Directors, Hawaii Chapter)
Certified Indoor Environmentalist (Indoor Air Quality Association)
Certified in Mold Loss Prevention (Indoor Air Quality Association)
American Industrial Hygiene Association

EDUCATION

MBA, Hawaii Pacific University, 2001
M.S., Geology and Geophysics, University of Hawaii, 1987
B.A., Geology, University of California at Santa Barbara, 1984

GEOGRAPHIC EXPERIENCE

Successfully completed projects throughout the major Hawaiian Islands, Guam, Saipan, CNMI, Puerto Rico, Japan, and throughout the United States

ENVIRONMENTAL INVESTIGATION/ REMEDIATION EXPERIENCE

Projects have included wood treatment facilities, petroleum refineries, underground storage tank (UST) sites, agricultural facilities, urban renewal projects, petroleum bulk storage terminals impacted with free floating petroleum hydrocarbons, dry cleaners, and a variety of commercial/industrial facilities. Received No Further Action status at multiple sites from the State of Hawaii Department of Health. Successful experience with investigation and remediation projects for real property transfers and redevelopment. Design of corrective measures for indoor air quality complaints. Mold and moisture training, prevention and response planning.

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Kenton Beal
Executive Vice President

SPECIALIZED TRAINING

Mold Loss Prevention, Indoor Air Quality Association
Groundwater Flow through Porous and Fractured Media, University of Wisconsin-Madison
Corrective Action for Containing and Controlling Ground Water Contamination, National Water Well Association
Basic Ground Water Modeling, National Water Well Association
Project Management, University of Hawaii
Clean Air Act Amendment 112 ®, U.S. EPA
Management & Supervision of Hazardous Waste Operations, Unitek Environmental Consultants
AHERA Asbestos Management Planner
AHERA Asbestos Inspector
HVAC and the Indoor Environment, American Indoor Air Quality Council
IICRC S520 Mold Remediation Guideline, American Indoor Air Quality Council
Case Studies in Environmental Mold, American Industrial Hygiene Association
Health Effects of Mold, American Indoor Air Quality Council
40-hour Hazwoper Training and Refreshers, Various
Understanding Environmental Sampling and Data Analysis
Managing Uncertainty with Systematic Planning

PROFESSIONAL PRESENTATIONS

Building Operator Certification, Indoor Environmental Quality, University of Hawaii
Environmental Game Changers, Honolulu, Hawaii
Indoor Air Quality in Commercial Buildings, American Society of Heating and Refrigeration Engineers
Environmental Solutions for Real Estate Transactions, Honolulu Board of Realtors
Storm Water Monitoring, Law Seminars International, Honolulu
Mold Remediation Boot Camp, Las Vegas
Mold University™, Honolulu and Houston
Indoor Air Quality for Property Managers, San Francisco, Honolulu, Las Vegas, Los Angeles
Mold Report™, San Francisco, Honolulu, Las Vegas, Los Angeles
Mold Awareness, International Executive Housekeepers Association
Advanced Conference on Real Estate, Law Seminars International
Hot Topics in the Mold Industry, American Indoor Air Quality Council, Hawaii
Mold Investigation Training, Pensacola, Fort Lauderdale, Orlando, Tampa, Florida
Environmental Investigation for Emergency Services, Burbank and Long Beach California
Multi-Family Residential Development, Lohrman Education Services, Honolulu
Environmental Law Seminar A to Z, NBI, Inc., Honolulu
Real Estate Development From Beginning to End, Lorman Educations Services, Honolulu

Heather Schauer

Environmental Technician

CAREER HISTORY

Experienced in conducting ASTM Standard Phase I Environmental Site Assessments (ESA)'s and site assessment work addressing PCBs, petroleum-related contaminants, pesticides, asbestos, metals, underground storage tanks (USTs), and non-point source contaminants and review of federal, state and county databases and regulatory files.

Experienced in conducting hazardous materials surveys and environmental site assessments for asbestos containing building materials, and lead containing paint

Experienced in conducting surveys for moisture intrusion, visible suspect mold and indoor air quality investigations.

Experienced in conducting post remediation verification (PRV) for mold and moisture intrusion remediation and hygienic indoor surfaces.

Experienced in environmental research and report preparation.

Experienced in ecological fieldwork.

EDUCATION

B.S. Microbiology – 2015 University of Hawaii, Manoa. Emphasis in virology and bacteriology.

SPECIALIZED TRAINING

AHERA Asbestos Building Inspector Certification No. HIASB-4032

Hawaii State Certified Lead Risk Assessor Certification No. PB-0816

Appendix C. Phase II Sampling and Analysis Plan

Caltech Submillimeter Observatory Soil Sampling and Analysis Plan Draft

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Caltech Submillimeter Observatory
Mauna Kea Summit
Mauna Kea, Hawaii

Prepared for:

California Institute of Technology
Pasadena, California

and

State of Hawaii Department of Health
Hazard Evaluation and Emergency Response (HEER) Office
2385 Waimano Home Road
Pearl City, Hawaii 96782

Prepared by:

ENPRO Environmental
151 Hekili Street, Suite 210
Kailua, Hawaii 96734

808.262.0909 (t)

ENPRO Project Number 2006-00249-PH2
September 25, 2020

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1.0 INTRODUCTION

The California Institute of Technology (Caltech) retained ENPRO Environmental (ENPRO) to prepare a Draft Sampling and Analysis Plan (SAP) to support the decommissioning of the Caltech Submillimeter Observatory (CSO) and associated pump shed and outbuilding located at the summit of Mauna Kea on Hawaii Island (the "Site," see Figures 1-3).

1.1 PURPOSE

The decommissioning of facilities within the CSO sublease include the observatory, pump house, single-story outbuilding, and cesspool. The project will include removing asphalt paving, slab-on-grade and below-grade foundations, utility demolition, earthwork, and the potential excavation and disposal of any soils with concentrations of target chemicals of potential concern (COPCs) exceeding the State of Hawaii Department of Health (DOH) Hazard Evaluation and Emergency Response (HEER) Office's most restrictive levels: the Tier I Environmental Action Levels (EALs) for unrestricted land use.

The purpose of this SAP is to assess whether COPCs are present in soils at the building footprints or that may have migrated beyond the footprints. The Site shall be evaluated based on a comparison of the analytical results to the DOH EALs for unrestricted land use of sites not within 150 meters of a surface water body and where groundwater is not a current or potential drinking water source (DOH, Fall 2017). Data shall also be used to adequately characterize the soil to meet the disposal acceptance requirements of the County of Hawaii West Hawaii Sanitary Landfill (WHSL) in the event that any COPCs are present at concentrations greater than the applicable EALs.

2.0 Background

2.1 Site Description

The Site is located near the summit of Mauna Kea, in the north central part of the island of Hawaii. The Site is further described by the County of Hawaii Real Property Tax Office as a 0.75-acre portion of Tax Map Key (3) 4-4-015: 009 (see Figure 2). It is located in an area zoned "Conservation."

For the purposes of this SAP, the Site is specifically defined as the following (see Figure 4):

- CSO footprint, approximately 6,000 square feet (sf)
- An 850-gallon cesspool, approximately 60 sf

Soil sampling at the Site will encompass an area of approximately 6,060 sf.

2.2 Climate

The summit of Mauna Kea is approximately 14,000 feet above sea level and has its own climate. Snow can occur year-round, with temperatures varying up to 30 ºF between noon and midnight. Daytime temperatures range from 60ºF in the summer to just above freezing in winter. Nighttime temperatures are usually 32ºF or below, regardless of the time of year. (Na Maka o ka Aina, 2020). The mean annual rainfall is approximately 8 inches (University of Hawaii, 2011).

The Site area is typically exposed to winds from the west/northwest during the day and from the east/northeast at night. Winds vary from about 10 to 15 miles per hour and can exceed 100 miles per hour during severe winter storms (Na Maka o ka Aina, 2020).

2.3 Soils/Geology

For detailed information regarding Site soils and geology, see the *Hydrogeological and Geological Evaluation: Decommissioning of the California Institute of Technology Submillimeter Observatory* (HGE) prepared by Intera Geoscience & Engineering Solutions (Intera) and dated September 18, 2019 (provided in the appendix).

2.4 SURFACE WATER

The Site region is moderately sloping in all directions. The nearest body of water is Lake Waiau located one mile to the south. Runoff from the Site does not flow into the lake. The Site is not within 150 meters of a surface water body.

2.5 GROUNDWATER

For detailed information regarding groundwater, see Intera's HGE dated September 18, 2019 (provided in the appendix).

2.6 HISTORIC LAND USE

Historical information provided in ENPRO's *Phase 1 Environmental Site Assessment: Caltech Submillimeter Observatory* (ESA) dated March 21, 2016, indicates that the Site was undeveloped land until 1983, since which the Site has been used for the construction and scientific operation of the CSO. CSO assembly was completed in 1987 and observations ceased in 2015.

2.7 CURRENT/FUTURE LAND USE

The Site is occupied by an out-of-use observatory that is in the process of being decommissioned. The surrounding area is conservation land developed with additional observatories. Future plans call for dismantling the CSO and returning the Site to its natural state.

3.0 PREVIOUS ENVIRONMENTAL REPORTS

One report regarding environmental conditions of the Site was provided for our review. A brief summary of each report is provided below:

Phase 1 Environmental Site Assessment: Caltech Submillimeter Observatory written by ENPRO and dated March 21, 2016.

This report noted a release of 22.7 gallons of hydraulic fluid beneath the CSO slab as reported in the Hazard Evaluation and Emergency Response (HEER) Office's Release Notification dated January 15, 2016. The release was reported to have occurred on May 27, 2009. Excavation and removal of contaminated soil was completed though there was remaining impacted soil under the slab, believed to be from previous releases. A no further action (NFA) designation is pending further testing of the soil under the slab to be conducted after the decommissioning of the observatory.

ENPRO recommended conducting multi-increment (MI) sampling of Site soil for COPCs associated with the hydraulic fluid release following dismantling of the CSO.

The following *de minimis* conditions were identified at the Site:

- Minor oil leak within the dome of the observatory
- Oil staining on the concrete slab at the base of the observatory

4.0 Site Investigation Objectives/Data Quality Objectives

4.1 Objectives and Chemicals of Potential Concern (COPCs)

The purpose of this SAP is to assess whether the following COPCs, potentially present in a hydraulic oil release, are present in soils beneath the CSO slab due to the history of the Site :

- Total petroleum hydrocarbons (TPH) as diesel range organics (DRO) and residual range organics (RRO)
- Polychlorinated biphenyls (PCBs)
- Lead

Stakeholders have indicated to Caltech a concern regarding the potential for the CSO cesspool to have adversely impacted the subsurface. Therefore, although the cesspool is not a REC and there is no regulatory requirement to investigate the cesspool, Caltech has incorporated an investigation of it into this SAP. As there is no specific cause for concern, the soil associated with the cesspool shall be sampled for the following wide suite of COPCs, including those to meet disposal requirements and those potentially present at film processing sites per the Client's request:

- Toxicity Characteristic Leaching Procedure (TCLP) cadmium, chromium, and lead (as needed)
- Total cadmium, chromium, silver, and lead
- TPH as gasoline range organics (GRO), DRO, and RRO
- Benzene, toluene, ethylbenzene, xylenes (BTEX)
- Polynuclear aromatic hydrocarbons (PAHs)
- PCBs
- Cyanide
- Halogenated volatile organic compounds (HVOCs)

ENPRO shall provide Caltech with information regarding COPCs at each location and advise Caltech regarding worker protection from exposure to identified contaminants.

Sampling and analysis shall also adequately characterize the soil to meet the disposal acceptance requirements of WHSL if COPCs are present in concentrations greater than the applicable EALs (see Section 4.2).

All soils excavated from the Site that are not determined to be acceptable for re-use on-site or within Tax Map Key (3) 4-4-015: 009 shall be disposed at a permitted on-island landfill.

4.2 DATA INFORMATION NEEDS

Data to be collected for this project shall support the evaluation as to whether the COPCs are present at the Site. The project site shall be evaluated based on a comparison of the analytical results to the EALs. Data shall also be used to adequately characterize the soil to meet the disposal acceptance requirements of WHSL if COPCs are identified in concentrations greater than the EALs.

To meet WHSL's acceptance criteria, the concentration of PCBs in the soil may not exceed 50 parts per million (ppm). WHSL's regulatory levels for TCLP metals are listed below:

Analyte	Regulatory Level (milligrams/liter)
Cadmium	1.0
Chromium	5.0
Lead	5.0
Silver	5.0

4.3 DECISION UNITS

Soil sampling will be conducted following initial asphalt and slab-on-grade foundation removal, but before the removal of foundation stem walls that extend deeper (the removal of which would disturb potentially impacted soil). See Sections 4.5 and 5.2 for details regarding the MI soil sampling approach.

The Site shall be divided into two lateral decision units (DUs), DUs 1 and 2 (Figure 4). The CSO lateral DU1 shall be further separated into two vertical DU layers (Layer A and B). The lateral DUs and corresponding DU layers are as follows:

- DU1: CSO, approximately 6,000 sf
    - Layer A: 0 – 6 inches beneath the below-grade slab, approximately 110 cubic yards (cy)
    - Layer B: 6 – 12 inches beneath the below-grade slab, approximately 110 cy

The cesspool soils shall be divided into the following DUs, as necessary:

- DU2: Soils removed from the exterior of the cesspool during removal and stockpiled on-site

- DU3 (if necessary): Soils beneath the cesspool if staining is observed following removal; soils shall be excavated until staining is no longer visible or until three additional feet of soil is excavated, whichever is less

4.4 DECISION STATEMENT

ENPRO shall provide Caltech with information regarding COPCs at each DU and advise Caltech regarding worker protection from exposure to identified contaminants.

Only material for which all COPCs are below the EALs may be re-used on-site at the contractor's discretion or elsewhere on TMK (3) 4-4-015: 009 at the University of Hawaii's discretion. All excess soils not re-used on-site shall be disposed at an appropriate landfill based on the results of the MI sampling and laboratory analysis.

If COPCs are detected at concentrations greater than the EALs in any DU, ENPRO will immediately consult with Caltech regarding appropriate responses, which may include additional remedial action and consultation with DOH.

If COPCs are detected at concentrations greater than the EALs, but within the WHSL acceptance criteria, the soil from that DU shall be transported to the WHSL. If COPCs detected in an MI soil sample exceed the EALs and do not meet the WHSL acceptance criteria, the soil shall be disposed of at a permitted landfill on the U.S. mainland.

4.5 SCOPE OF WORK

An MI sampling approach shall be employed to collect soil samples from each DU. A triplicate sample will be collected from the DU considered to be the most likely to contain COPCs at significant concentrations and analyzed to allow for calculation of the standard deviation of the analytical data. The triplicate sample shall be collected from DU1A to test field precision in accordance the DOH HEER Office Technical Guidance Manual (TGM), Section 4.2.8.2.

The scope of work for implementing this SAP involves coordinating and attending meetings with the client and the DOH, planning the environmental investigation, field identification of decision units and sampling locations, collection and packaging of soil samples in conformance with the SAP, transporting soil samples to the designated laboratory, evaluating site information and laboratory results, documenting results, and providing recommendations based on these results. See Section 5.0 for additional details.

5.0 Description of Sampling Activities

Caltech shall provide the following prior to the start of sampling activities:

- All appropriate permits
- Utility clearance of sampling areas
- Traffic control (to be continued for duration of sampling)

5.1 Groundwater

Groundwater sampling and disposal is not expected to occur during the project.

5.2 Soil Sampling Activities

To evaluate the presence of COPCs in the soils at the CSO footprint and cesspool location, an MI sampling approach will be employed. The sampling will be conducted prior to excavation of the soil at the Site. Utilities shall be marked prior to sampling commencement if utilities remain in place.

The MI sampling approach will be performed in conformance with the DOH HEER Office Technical Guidance Manual (TGM) (August 2016).

The Site is not a hazardous waste site and significant contamination is not expected to be encountered based on the results of previous sampling and analytical activities (see Section 3.0). Personnel shall use Level D personal protective equipment (PPE) unless contaminants are detected at concentrations greater than the EALs, at which point PPE shall be upgraded to Level C. See https://chemm.nlm.nih.gov/ppe.htm for a description of PPE requirements by level.

In addition, field monitoring will be performed with a photoionization detector (PID) as described in Section 5.3.

Based on the COPCs for each location, lateral DU 1 will be divided into 100 increments, and the cesspool DU(s) into 75 increments in a systematically random fashion representative of an equivalent volume of soil. Increment spacing shall be determined using the square root of the DU area divided by the targeted number of increments as described in TGM Section 4.2.4.1. Approximately 15 grams of soil will be collected approximately every 14.75 feet.

Sample increments for DU1 shall be collected at the depths specified in Section 4.3. For DU1, an excavator shall be used to scrape the top 12 inches of soil at each increment location. Increments from each DU layer will be collected using a stainless-steel sampling spoon and combined to form a single bulk MI sample. Each increment shall consist of approximately 15 grams of soil. Each bulk sample will have a mass of approximately 1.5 kilograms. Sampling spoons shall be decontaminated with Liquinox® and distilled water between DUs.

Stockpiled cesspool soils may be manipulated with an excavator or backhoe to allow for safe access. Soils shall be sampled from the DU2 stockpile in a systematically random fashion with a stainless-steel sampling spoon and combined to form a single bulk MI sample. Each increment shall consist of approximately 20 grams of soil for a bulk sample mass of 1.5 kilograms. Should a sample need to be collected from the bottom of the cesspool excavation (DU3) due to visible staining, 75 increments consisting of approximately 20 grams of soil each shall be collected directly from the excavator bucket using a stainless-steel sampling spoon and combined to form a single bulk sample.

Also, for each increment from cesspool DUs 2 and 3, approximately 5 grams of soil shall be collected with a disposable Terra-core (or similar) sampler and placed into a glass jar containing 25 mL of a methanol preservative (for volatile analysis), for a 1:1 ratio. Multiple jars shall be required for each MI sample as the methanol in each jar must cover the sample in its entirety while also not exceeding the volume which may be shipped in an individual container as allowed by the Department of Transportation (DOT).

All field personnel shall wear clean disposable nitrile gloves when collecting samples to avoid cross-contamination between DUs. Gloves shall be changed between DUs (e.g., if a hole extends from one DU layer to the next, based on depth, the field personnel will don a new pair of gloves prior to sampling each corresponding DU layer).

Samples will be labelled with a unique sample number, recorded on a chain-of-custody form, placed into an insulated sample chest with ice, and shipped overnight to OnSite Environmental, Inc. (OnSite) in Redmond, Washington for analysis.

Replicate samples shall be collected as described above.

5.3 PHOTOIONIZATION DETECTOR (PID) MONITORING

Environmental monitoring using a PID will be carried out to determine the potential presence of contamination in the soil. If the total VOC concentration in the workspace atmosphere exceeds an 8-hour, time weighted average (TWA) of 20 parts per million (ppm) or a 15-minute, short-term exposure limit (STEL) of 100 ppm, PPE requirements shall be upgraded to Level C.

PID monitoring will be conducted at each DU location using a MiniRAE 3000 as follows:

- The PID shall be calibrated in the field each day, prior to the start of monitoring
- Approximately 100 grams of soil from each DU will be placed in a clean bag
- The bag shall be sealed and allowed to equilibrate for approximately 10 minutes

- Following equilibration, the PID tip shall be inserted into the bag to collect a reading
- PID readings shall be logged for comparison to laboratory results

5.4 SOIL SUB-SAMPLING FOR LABORATORY ANALYSIS OF MI SAMPLES

Samples Intended for Non-Volatile Analyses:

The collection of each MI soil sample will result in approximately 1.5 kilograms of soil for analysis (the bulk sample). A sub-sampling technique will be used by the analytical laboratory to reduce the bulk sample to a laboratory analysis quantity (the analytical sample). The sub-sampling process is described below.

The bulk sample shall be dried and then passed through a 2-millimeter (No. 10) sieve to remove larger debris. The total soil sample shall be spread out on a clean flat surface, by slowly pouring the sample out and then spreading it to a thin (approximately ¼-inch) even layer. The spread-out soil shall be incrementally sampled using a stratified-random pattern by collecting approximately thirty small increments to make up a minimum 10-gram subsample for analysis. The goal is to represent the actual distribution of particle sizes in the sample. The minimum 10-gram subsample will then be analyzed.

All samples shall be destroyed and disposed of by the laboratory in accordance with their permit to receive soil (see appendix).

Samples Intended for Volatile Analyses:

Samples for VOC analysis will result in approximately 375 grams of soil preserved in methanol for analysis (the bulk sample). A sub-sampling technique will be used by the analytical laboratory to reduce the bulk sample to a laboratory analysis quantity (the analytical sample). The sub-sampling process is described below.

For samples requiring VOC analysis, sieving is not a viable option as this would lead to the significant loss of VOCs. If multiple jars are used for one MI sample, the weights of each sample will be recorded and equal volumes of methanol shall be extracted from each jar and combined in the laboratory to comprise the analytical sample.

All samples shall be destroyed and disposed of by the laboratory in accordance with their permit to receive soil (see appendix).

5.5 SAMPLE PRESERVATION PROCEDURES

MI soil samples for non-volatile analysis will be preserved in insulated sample chests with ice and/or frozen gel packs upon collection. MI soil samples for volatile analysis will be preserved in pre-weighed jars containing methanol and placed into insulated sample chests with ice and/or frozen gel packs upon collection.

5.6 LABORATORY ANALYTICAL PROCEDURES

The proposed laboratory analytical methods are listed in the following table.

Table 1

Summary of Compounds to be Analyzed, Laboratory Analytical Methods

Laboratory Analytical Group	Laboratory Method	Proposed Laboratory
Total Petroleum Hydrocarbons	EPA 8015M	OnSite
Heavy Metals – Soil	EPA 6010C/7471B	OnSite
Heavy Metals – TCLP	EPA 1311/1610D	OnSite
Benzene, Toluene, Ethylbenzene, and Xylenes	EPA 8260B	OnSite
Polychlorinated Biphenyls	EPA 8082A	OnSite
Polynuclear Aromatic Hydrocarbons	EPA 8270D	OnSite
Polynuclear Aromatic Hydrocarbons – Low Levels	EPA 8270D/SIM	OnSite
Halogenated Volatile Organic Compounds	EPA 8260C	OnSite
Organochlorine Pesticides	EPA 8081A	OnSite

5.7 CHAIN-OF-CUSTODY AND TRANSPORTATION

Chain-of-Custody record forms shall be used to document sample collection and shipment to the laboratory for analysis.

Each sample will be clearly labeled and logged on a chain-of-custody form. The sampler will retain a copy of the chain-of-custody forms. The original chain-of-custody form will be double-bagged in a Ziploc®-type plastic bag and placed into the cooler with the soil samples.

The chain-of-custody forms will include:

- The name, address, and telephone number of the sender
- The project number and name
- The sample identification numbers
- The type and number of sample containers
- The date and time of sampling
- The sample matrix

- The requested analytes and analytical methods
- The requested sample turnaround time
- Special instructions
- The authorized signatures of all persons who retain custody of the samples prior to receipt by the laboratory (Note: shippers such as FedEx typically do not sign off on chain of custody documentation)

5.8 SAMPLE IDENTIFICATION

All samples collected will be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory. The samples will have pre-assigned, identifiable, and unique numbers as described in Section 4.3.

Replicate samples will be preserved, packaged, and sealed in the same manner as other samples. Separate sample identification will be assigned to each replicate, and replicates will be submitted blind to the laboratory.

5.9 DECONTAMINATION PROCEDURES

Between decision units, the stainless-steel sampling spoon utilized to collect increments, excavator bucket, and the oil/water interface probe (if applicable) shall be decontaminated using a wash with Liquinox® and water followed by a double rinse with potable water. Following the wash and rinse, the stainless-steel sampling spoon shall be air dried prior to re-use.

5.10 INVESTIGATION DERIVED WASTE

In the process of collecting environmental samples the ENPRO sampling team will generate different types of potentially contaminated investigation derived waste (IDW) that may include the following:

- Used personal protective equipment (PPE)
- Disposable sampling equipment and related items
- Decontamination fluids

The EPA's National Contingency Plan (NCP) requires that management of IDW generated during sampling comply with all applicable or relevant and appropriate requirements (ARARs) to the extent practicable. The sampling plan will follow the *Office of Emergency and Remedial Response (OERR) Directive 9345.3-02* (May 1991) and the DOH HEER Office TGM (August 2016), which provides the guidance for the management of IDW. In addition, other legal and practical considerations that may affect the handling of IDW will be considered.

Used PPE and disposable equipment will be double bagged and placed in a municipal refuse dumpster. These wastes are not considered hazardous and can be sent to a municipal landfill.

Decontamination fluids that will be generated in the sampling event will consist of Liquinox® and water. The volume and concentration of the decontamination fluid will be sufficiently low to allow disposal at the site or sampling area. The water (and Liquinox®) will be poured onto a lined/bermed area (10-mil plastic sheeting with a filter sock berm or similar) and evaporated on-site.

5.11 LIST OF EQUIPMENT, CONTAINERS, AND SUPPLIES

The following equipment, containers and supplies may be used for obtaining MI soil samples and to support related activities:

- Stainless steel spoons
- Terra core (or similar) samplers
- Insulated sample chest
- Nitrile gloves
- Plastic bags
- Liquinox®
- Deionized water
- 10-mil plastic sheeting
- Filter sock berms (or equivalent)
- Teflon® sheeting
- Ziploc®-type bags
- Methanol
- Pre-weighed glass jars
- Oil/water interface probe

6.0 QUALITY ASSURANCE/QUALITY CONTROL PLAN

6.1 QUALITY ASSURANCE/QUALITY CONTROL DATA OBJECTIVES

Field and laboratory quality assurance/quality control (QA/QC) procedures will be implemented to ensure that the data gathered during the field investigation will meet the needs of the project objectives. Field activities will be performed as previously described. Analytical data generated will follow EPA methods and laboratory standard operating procedures (SOPs) and QA/QC guidelines for sample analysis. Adequate reporting levels of the chemicals of concern are dependent on the sample matrix, naturally occurring background concentrations, and laboratory instrumentation.

Quality assurance requirements shall be in accordance with the referenced analytical methods and laboratory tracking. The analyst generating the data and an experienced data reviewer will review the analytical data at the laboratory prior to its release. The analyst shall review the data to ensure that:

- Sample preparation information is correct and complete
- Analysis information is correct and complete
- The appropriate standard operating procedures were followed
- Analytical results are correct and complete
- Quality control samples were within established control limits
- Documentation, including the case narrative is complete

The data reviewer shall review the data package to verify that:

- Calibration data are scientifically sound and method compliant
- QC samples were within established guidelines
- Qualitative and quantitative results are correct
- Documentation and the case narrative are complete
- The data package is complete and ready for document archiving

The data for this project shall be collected and documented in such a manner that will allow the generation of data packages that can be used by an external data auditor to reconstruct the analytical process.

6.2 CALIBRATION PROCEDURES AND FREQUENCY

Calibration will be performed regularly on all laboratory instruments. Each piece of equipment will be calibrated according to manufacturer's procedures.

Laboratory instruments are calibrated before use with a 5-point curve. To verify the calibration, continuing calibration verification standards are used to ensure that the calibration curve has not drifted.

6.3 DATA REDUCTION AND VALIDATION

Most analytical data are documented in computer records or on printouts generated by the instrument data-handling computer and transferred to the centralized acquisition server or acquired directly to the centralized acquisition server. Standard logs are maintained to document preparation of standards. The identity and number of the parent material is recorded and each prepared standard is assigned a number that is traceable to the parent material. The analyst verifies instrument data, calculations, transfers, and documentation, and corrects errors, if detected. Technical department managers, quality control specialists, and project managers perform review of reports and supporting documentation.

6.4 FIELD QUALITY CONTROL CHECKS, SOIL SAMPLES

Field triplicate soil samples will be collected from one randomly selected DU. Field triplicate samples will be collected in the same manner as the original samples through the same DU as the original samples.

The triplicate samples allow for statistical calculation of several important values including the standard deviation, the relative standard deviation, and the 95 percent (%) upper confidence level (UCL) of the mean, as described below.

6.4.1 Standard Deviation

Standard deviation is a measure of the variation from the mean among a group of samples, and in this case it can be calculated for triplicate samples collected from a DU. The lower the standard deviation (the closer the replicate data are to the mean) the more precise the site data are as an estimate of average contaminant concentration in the DU under investigation.

Where replicate sampling is used to evaluate the variation from the mean of multiple DUs, the standard deviation of the contaminant(s) in the selected replicate DU is added to the contaminant levels of the other DUs in the batch for comparison to the relevant EALs. When a DU contaminant average concentration is close to the EALs, a lower standard deviation for the replicates provides a better chance to demonstrate that the contaminant concentration may be below the EALs. A low standard deviation for soil sampling data is achieved by reducing variation in sample results due to errors in field sampling/processing, lab sub-sampling/processing, or lab analysis, to the extent feasible.

6.4.2 95 Percent Upper Confidence Level

The 95% UCL is another statistical measure of the precision for a series of measurements. In this case, the normal and triplicate samples are used to calculate a mean (or average) value and a standard deviation. The mean and standard deviation are used to calculate, with 95% confidence, the mean value for the individual decision unit.

6.4.3 Relative Standard Deviation

The field replicate data collected for DUs are also used to demonstrate that the investigation error for each contaminant is within a reasonable range that supports a conclusion that average contaminant concentrations (e.g., mean plus standard deviation or 95% UCL of the mean) is below or above the relevant EALs. Typically, the relative standard deviation (RSD) of the field replicates (triplicates) is used for this evaluation. The RSD is expressed as a percentage and is calculated using the following formula:

$$\text{RSD\%} = \frac{100 \text{ X Standard Deviation}}{\text{Average}}$$

The lower the RSD% of the replicate data the better. Generally, an RSD% of approximately 35% or less indicates the amount of estimated total error is within a reasonable range for decision making. However, this evaluation will also depend on the data quality objective (DQO) established for the site investigation, as well as how close the contaminant concentrations are to the relevant EALs. In general, the closer the contaminant level is to the EAL, the more impact this statistical measure will have on site decisions. The higher the RSD%, the less confidence there is that the averages approximate a normal distribution, and that the average contaminant concentrations are adequately representative of the DU(s). As the RSD exceeds 50%, and if the average DU concentrations are near the EALs, there is increasing uncertainty that the data are adequately representative. As the RSD% approaches 100% there is very little confidence that the sampling data is useful for decision-making.

6.5 LABORATORY QUALITY CONTROL CHECKS, SOIL SAMPLES

Sample batch sizes will not exceed 20 samples. Batch QC will include method blanks, matrix spikes, matrix spike duplicates (laboratory control standard duplicate, if matrix spikes/matrix spike duplicates cannot be performed), surrogate analysis for organics, and second source reference standard analysis for metals. One method blank sample will be analyzed for every 20 samples (minimum of one per day, one per matrix).

6.5.1 Method Blank

Method blanks will be analyzed for each analytical batch submitted to the laboratory. An aliquot (extraction blank) equal in weight to the sample is used for the method blank analysis. The method blank is taken through the whole analytical process. The analytical results of the method blank are then reported to show that the blank is free of analytical interference.

6.5.2 Matrix Spike/Matrix Spike Duplicate

Matrix spike (MS) and matrix spike duplicate (MSD) are samples, to which known concentrations of analytes are added prior to sample preparation. The MS and MSD are taken through the whole analytical process. Following the analytical process, the recoveries of the spike analytes are calculated and reported for assessment of accuracy. When an MS duplicate is analyzed, the relative percent differences between the MS and the MSD results will also be calculated and reported. The percent recoveries and the relative percent difference are used to evaluate the effect of the sample matrix on the accuracy and precision of the analysis.

6.5.3 Surrogate Spike

Surrogate spike is a known concentration of a non-target analyte added prior to sample preparation. The surrogate is chemically similar to the target analyte and behaves similarly during extraction and analysis. The surrogate spike recovery must meet the established acceptance criteria, and measures the efficiency of the steps of the analytical method in recovering the non-target analytes.

6.5.4 Preventative Maintenance

To ensure that instruments are properly maintained and continue to operate properly, preventative maintenance activities are undertaken on a routine basis. An experienced analyst or a manufacturer's service representative performs maintenance. The types of preventative maintenance actions are dependent on the instrument. Any unusual conditions are investigated and resolved prior to beginning analysis of samples. Instrument maintenance records are maintained, and all non-routine maintenance activities are documented and stored in the department. A separate file is maintained for each instrument.

6.6 DATA QUALITY ASSESSMENT

The laboratory QA manual is designed to maintain the quality of its principal product, reliable and defensible analytical results. Staff members are trained in appropriate QA procedures to support the laboratory's QA plan. The laboratory applies acceptance criteria to all quality control data. When a sample analysis is complete, the quality control data are reviewed and evaluated by using acceptance criteria based on standard operating procedures or client specific data quality objectives. This evaluation is used to validate the corresponding data set. Evaluation is based on:

- Continuing Calibration Verification Standard

- Method Blank Evaluation
- Laboratory Control Evaluation
- MS and MSD Evaluation
- Surrogate Standard Evaluation

6.6.1 Accuracy

Accuracy will be calculated from analysis of matrix spike samples as follows:

$$\text{Accuracy} = \frac{(A - B) \times 100}{C}$$

Where "A" is the analyte determined experimentally from the spike sample; "B" is the background level by separate analysis of the unspiked sample; and "C" is the amount of spike added.

6.6.2 Precision

Precision is the degree of mutual agreement between individual measurements of the same material under similar conditions.

Precision will be determined through evaluation of percent difference in duplicate analysis of samples and by evaluating the standard deviation of multi-point calibrations.

Precision, as determined through percent difference in duplicate analysis of samples, standards and surrogates, is calculated as:

$$\text{Precision} = \frac{(A - B) \times 100}{(A + B)/2}$$

Where "A" is the larger value and "B" is the smaller value of duplicate analyses.

6.6.3 Completeness

Completeness will be evaluated by the percentage of valid analytical results compared to the total number of requested sample analytical results. The completeness objective for this project will be 90 percent or greater.

Percent completeness is calculated using the following equation:

$$\text{Completeness (\%C)} = \frac{(T - R) \times 100}{T}$$

Where “T” is the total number of sample results and “R” is the total number of rejected sample results.

6.7 CORRECTIVE ACTION

When a quality control problem is noted, the following steps will be taken to identify and correct the problem:

- The hard copies of the data will be re-examined.
- The analyst will re-analyze the standard or sample, as appropriate to meet criteria.
- If the problem is not resolved by standard re-analysis, the QA Manager or the Laboratory Director will be consulted to provide additional information about rectifying the problem.
- If the problem cannot be solved in-house, equipment repair contractors, manufacturer’s representatives, or outside consultants will be contacted as necessary to correct the problem.

7.0 Documentation and Reporting

7.1 Field Documentation

Field data will be entered into data entry sheets. All documentation in the data entry sheets shall be written in indelible ink. Changes made to the data entered in the data entry sheets will be crossed out with a single line and the change will be initialed by the person changing the data entry. All field documentation will become part of the project files. At a minimum, the following information will be provided in the field data entry sheets:

- ENPRO personnel conducting field activities
- Subcontractor personnel conducting field activities
- Brief description of project and planned field activities
- Date and time of all field activities (time will be recorded in 24-hour format)
- Weather information at the start of the field day, at the end of the field day, and during significant weather events
- Sample identification and time of sample collection
- Deviations from the proposed or approved sampling procedure
- Field conditions such as petroleum or chemical odor or soil staining

7.2 Investigation Report

Upon completion of the proposed scope of work, ENPRO will prepare and submit an Investigation Report that will contain all results obtained from soil sample analysis. The report will present a description of field procedures, observations and findings, photographic documentation, results of laboratory analyses, conclusions, and recommendations.

7.3 Schedule

Scheduling of soil investigation at the Site for the areas of concern will begin immediately following the authorization to proceed with this SAP by the client and the DOH. Soil sampling is estimated to require approximately one week to complete. Analytical laboratory turn-around-time will be approximately two weeks for all analytes. A report outlining the laboratory analytical results and the comparison to the regulatory limits is expected to require two weeks from the receipt of the final analytical results.

8.0 REFERENCES

Publications:

Name of Publication:	Aquifer Identification and Classification for Oahu: Groundwater Protection Strategy For Hawaii
Author of Publication:	Mink, J.F. and L.S. Lau
Published by:	Water Resources Research Center, University of Hawaii at Manoa, Honolulu, Hawaii
Date of Publication:	1990

Name of Publication:	Soil Survey for the Islands of Oahu, State of Hawaii
Author of Publication:	Foote, Donald E. et al.
Published by:	U.S. Department of Agriculture, Soil Conservation Service, in cooperation with the University of Hawaii Agricultural Experiment Station. Also available at http://websoilsurvey.nrcs.usda.gov/app/
Date of Publication:	1972

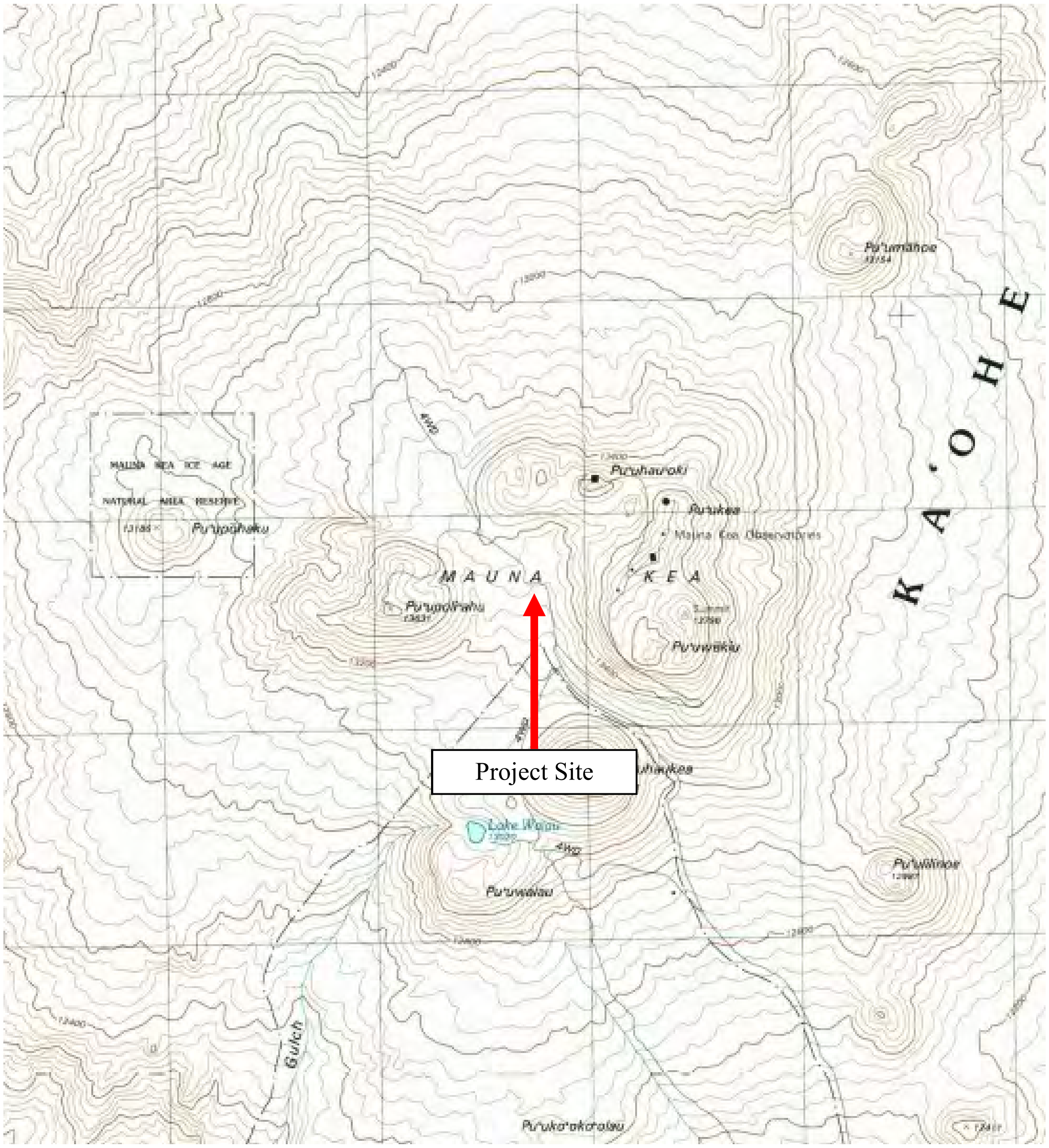
Name of Publication:	Hawaii *Department of Health (HDOH), Office of Hazard Evaluation and Emergency Response (*HEER*), Technical Guidance Manual (*TGM*), Interim Final, June 2009*
Author of Publication:	DOH, HEER
Published by:	DOH, HEER
Date of Publication:	2009

Name of Publication:	Tier 1 EAL Surfer
Author of Publication:	DOH HEER Office
Date of Publication:	2017

Name of Publication:	Geotechnical Investigation Report
Author of Publication:	Yogi Kwong Engineers, LLC
Date of Publication:	October 2017

9.0 APPENDICES

Site Figures
Laboratory Permit to Receive Soil
Hydrogeological and Geological Evaluation: Decommissioning of the California Institute of Technology Submillimeter Observatory

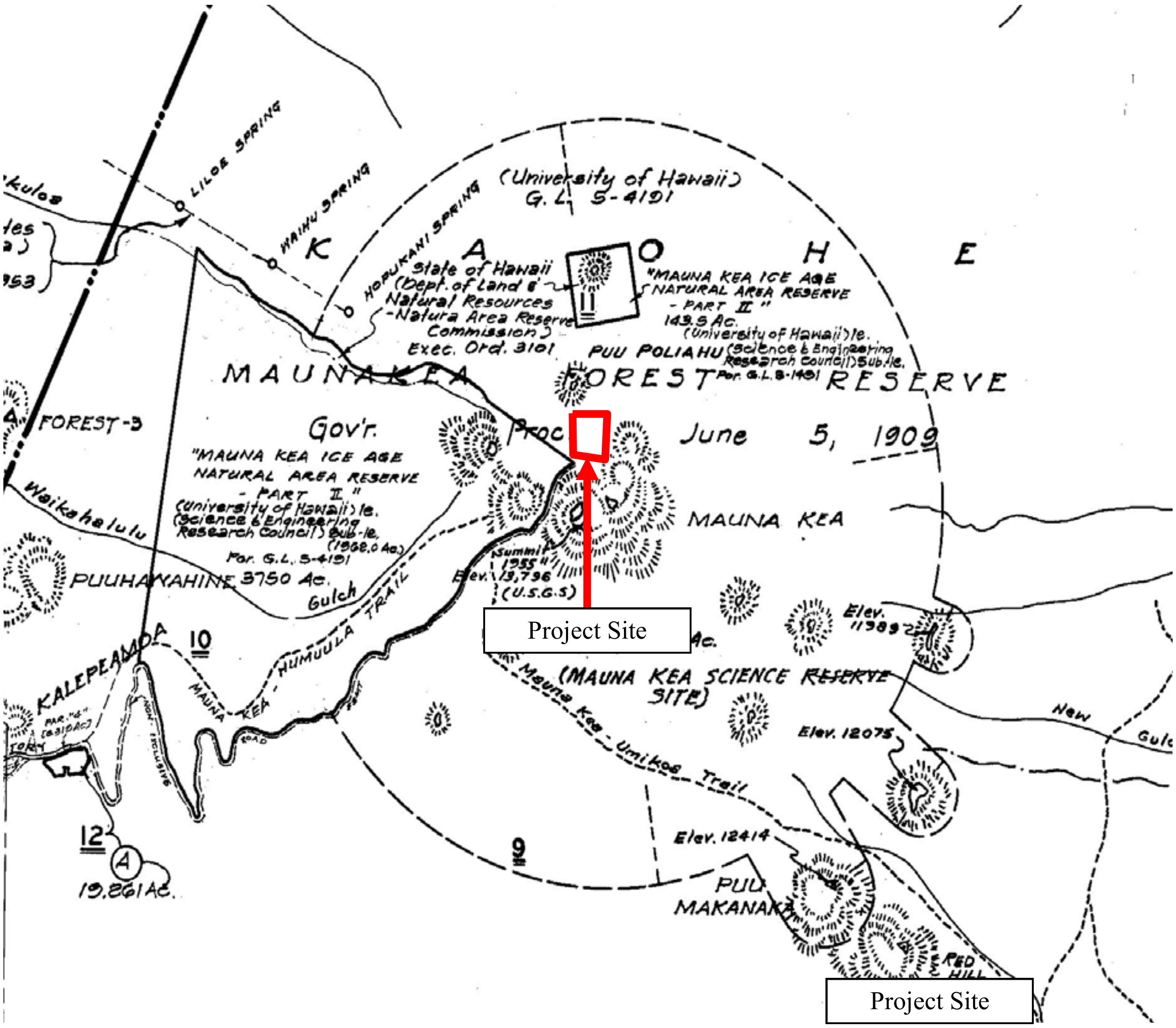


N

Source: U.S. Geological Survey, 1993

Figure 1
TOPOGRAPHIC MAP

Scale: 1 inch = 1, 320 feet



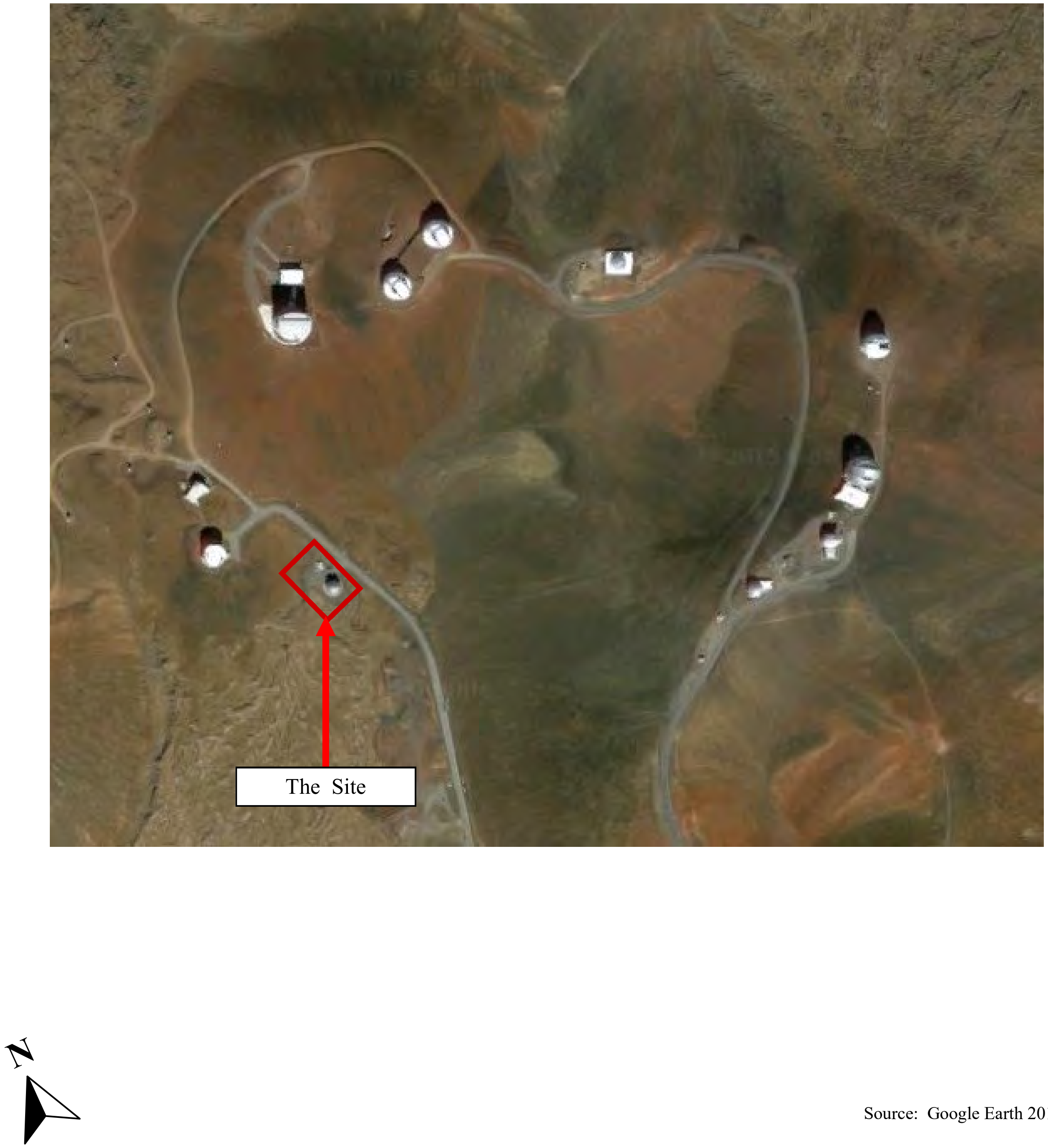
Source: Tax maps Bureau 1988

Figure 2
TAX MAP KEY (3) 4-4-015: 009

Scale: 1 inch = Approximately 1,500 feet

ENPRO environmental

Project Number 2006-00249-PH2
Caltech Submillimeter Observatory



Source: Google Earth 2016

Figure 3
AERIAL PHOTOGRAPH OF THE SITE

Scale: 1 inch = Approximately 750 feet

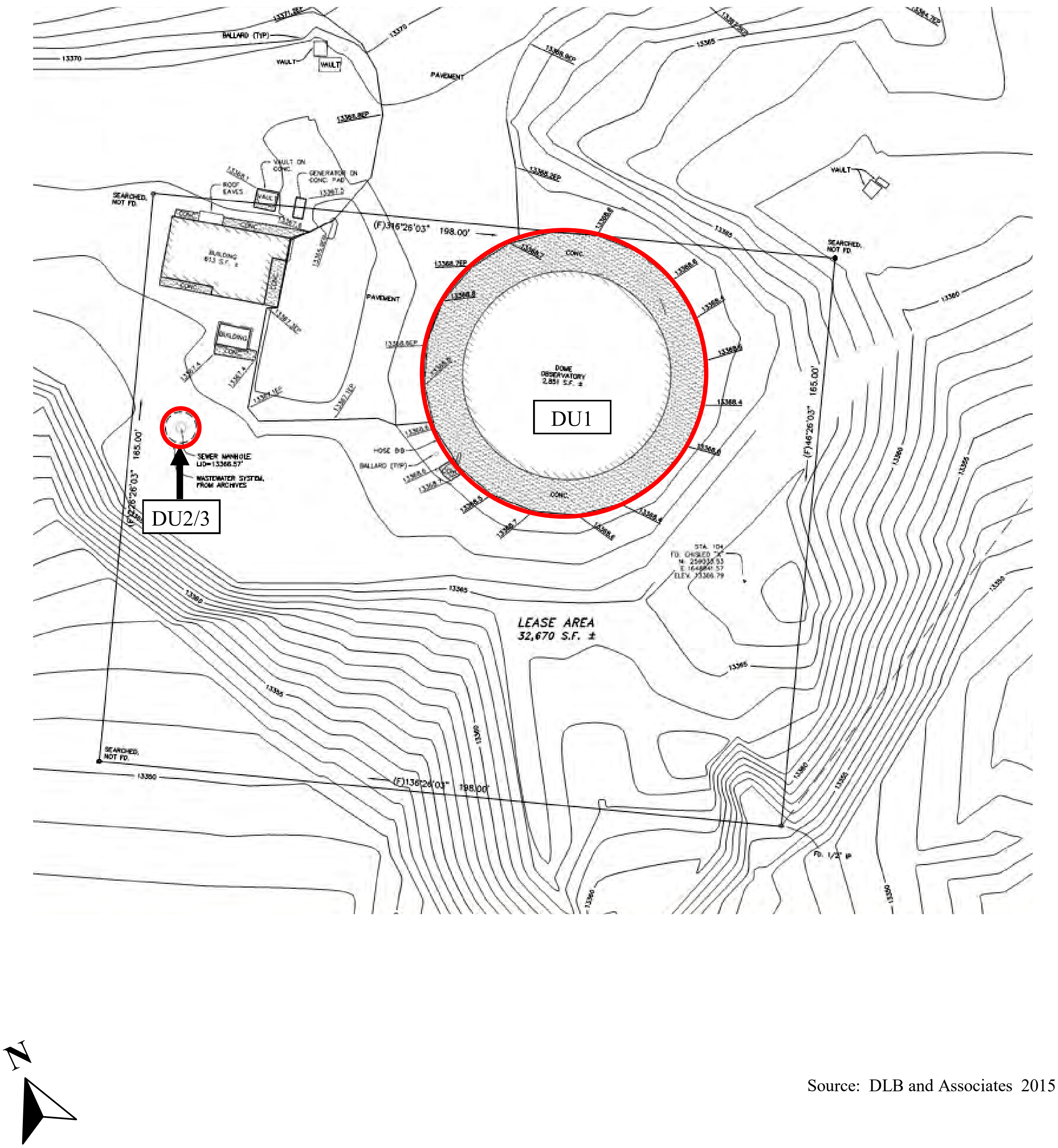


Figure 4
TOPOGRAPHIC MAP/DUs

Scale: 1 inch = 60 feet

Project Number 2006-00249-PH2
Caltech Submillimeter Observatory

United States Department of Agriculture

United States Department of Agriculture
Animal and Plant Health Inspection Service
Plant Protection & Quarantine
4700 River Road
Riverdale, MD 20737

Permit to Receive Soil

Regulated by 7 CFR 330

This permit was generated electronically via the ePermits system.

PERMITTEE NAME:	Mr. David Baumeister	**PERMIT NUMBER:**	P330-20-00217
COMPANY:	OnSite Environmental, Inc.	**APPLICATION NUMBER:**	P525-200922-004
ADDRESS:	14648 NE 95th Street Redmond, WA 98052	**DATE ISSUED:**	09/30/2020
		EXPIRES:	09/30/2023
MAILING ADDRESS:	14648 NE 95th Street Redmond, WA 98052	**HAND CARRY:**	No
PHONE:	(425) 883-3881	**FACILITY NUMBER:**	6114
ALT. PHONE:	206-550-2483	**FACILITY ACCOUNT:**	OnSite Environmental, Inc.
EMAIL:	dbaumeister@onsite-env.com	**RESEARCH CENTER:**	
FAX:	(425) 885-4603	**FACILITY NAME:**	
		FACILITY ADDRESS:	14648 NE 95th Street Redmond, Washington 98052
		FACILITY GPS:	
		MAIL ADDRESS:	14648 NE 95th Street Redmond, Washington 98052
		FACILITY CONTACT:	David Baumeister
		PHONE:	425-883-3881
		ALT. PHONE:	206-550-2483
		FAX:	425-885-4603
		EMAIL:	dbaumeister@onsite-env.com

PORTS OF ARRIVAL/PLANT INSPECTION STATIONS: AK, Anchorage; AL, Huntsville; AL, Mobile; AZ, Douglas; AZ, Lukeville; AZ, Naco; AZ, Nogales; AZ, Phoenix; AZ, San Luis; AZ, Tucson; CA, Calexico; CA, El Segundo; CA, Fresno; CA, Long Beach; CA, Oakland; CA, Ontario; CA, Otay Mesa; CA, Port Hueneme; CA, Sacramento; CA, San Diego; CA, San Jose; CA, San Ysidro; CA, South San Francisco; CA, Tecate; CO, Denver; CT, Hartford; CT, New Haven; DE, Dover; DE, Wilmington; FL, Ft. Lauderdale; FL, Ft. Myers; FL, Ft. Pierce; FL, Jacksonville; FL, Key West; FL, Miami; FL, Miami (Cargo, DHL, Fed Ex, UPS, etc); FL, Orlando; FL, Pensacola; FL, Port Canaveral; FL, Port Everglades; FL, Sanford; FL, Tampa; FL, West Palm Beach; GA, Atlanta; GA, Savannah; GU, Agana; HI, Hilo; HI, Honolulu; HI, Kahului; HI, Kailua-Kona; HI, Lihue; ID, Eastport; IL, Chicago; IN, Indianapolis; KY, Louisville; MA, South Boston; MD, Baltimore; MD, Laurel; ME, Bangor; ME, Calais; ME, Houlton; ME, Portland; MI, Detroit; MI, Port Huron; MI, Romulus; MI, Sault Saint Marie; MN, Duluth; MN, Grand Portage; MN, International Falls; MN, Minneapolis; MO, Kansas City; MO, St. Louis; MP, Commonwealth of the Northern Mariana Islands; MS, Gulfport; MS, Port Bienville; MT, Raymond; MT, Roosville; MT, Sweetgrass; NC, Raleigh; NC, Wilmington; ND, Dunseith; ND, Pembina; ND, Portal; NJ, Linden; NM, Albuquerque; NM, Columbus; NM, SantaTeresa; NV, Las Vegas; NY, Albany; NY, Alexandria Bay; NY, Brooklyn; NY, Buffalo; NY, Champlain, Rouses Point; NY, Jamaica; NY, Newburgh; OH, Ashtabula; OH, Cincinnati; OH, Cleveland; OH, Columbus; OH, Toledo; OH, Wilmington; OK, Oklahoma City; OR, Portland; PA, Allentown; PA, Harrisburg; PA, Philadelphia; PA, Pittsburgh; PA, Scranton; PR, Aguadilla; PR, Carolina; PR, Fajardo; PR, Mayaguez; PR, Ponce; RI, Warwick/Providence; SC, Charleston; TN, Memphis; TN, Nashville; TX, Austin; TX,

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Brownsville; TX, Corpus Christi; TX, Dallas; TX, Del Rio; TX, Eagle Pass; TX, El Paso; TX, Fabens; TX, Falcon; TX, Fort Hancock; TX, Freeport; TX, Galveston; TX, Hidalgo; TX, Humble; TX, Laredo; TX, Los Indios; TX, Pharr; TX, Port Arthur; TX, Presidio; TX, Progresso; TX, Rio Grande City; TX, Roma; TX, San Antonio; TX, Victoria; UT, Salt Lake City; VA, Dulles; VA, Norfolk; VI, St. Croix; VI, St. Thomas; VT, Berlin; WA, Blaine; WA, Oroville; WA, Port Angeles; WA, SeaTac; WA, Sumas; WI, Green Bay; WI, Milwaukee

Under the conditions specified, this permit authorizes the following:

Quantity of Soil per Shipment and Treatment

Sterilization will interfere with intended use - Your facility MUST be inspected and approved to receive this soil

SPECIAL INSTRUCTIONS TO INSPECTORS

See permit conditions below

INSTRUCTIONS TO DHS CBP INSPECTORS FOR IMPORTED SOIL SHIPMENTS ROUTED TO RECEIVING FACILITY:
For hand carry of soil, an official of CBP Agricultural Programs and Trade Liaison (APTL) would have been notified to document and facilitate the entry of the soil (See hand carry conditions below if stipulated).

Otherwise:
1) Confirm that the shipment under this USDA PPQ P330 permit is under bond to the point of entry.
2) Validate the permit in ePermits using the CBP search feature.
3) Confirm that the imported shipment has a valid USDA PPQ Form 550 Black/White label.
4) For questions or concerns, contact the USDA-APHIS-PPQ Permit Unit in Riverdale, MD, at 866-524-5421 and ask to speak with a compliance officer.

PERMIT GUIDANCE

1) Receipt or use of foreign isolates or samples from countries under sanctions requires specific permission from the U.S. Department of Treasury; please refer to https://www.treasury.gov/resource-center/sanctions/Programs/Pages/Programs.aspx
2) This permit does not authorize importation, interstate movement, possession, and/or use of strains of genetically engineered regulated materials/organisms (created by the use of recombinant DNA technology).
3) If an animal pathogen is identified in your shipment, to ensure appropriate safeguarding, please refer to http://www.aphis.usda.gov/import_export/animals/animal_import/animal_imports_anproducts.shtml
4) If a human pathogen is identified, please refer to the CDC Etiologic Agent Import Permit Program at http://www.cdc.gov/od/eaipp/
5) This permit does not fulfill the requirements of other federal or state regulatory authorities. Please contact the appropriate agencies, such as the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, the U.S. Food and Drug Administration, the Centers for Disease Control and Prevention, the APHIS Veterinary Services unit, the APHIS Biotechnology Regulatory Services, or your State's Department of Agriculture to ensure proper permitting.
6) If you are considering renewal of this permit, an application should be submitted at least 90 days prior to the expiration date of this permit to ensure continued coverage. Permits requiring containment

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facilities may take a longer period of time to process.

PERMIT CONDITIONS

CHEMICAL/PHYSICAL ANALYSIS IMPORTATION

USDA-APHIS issues this permit to Mr. David Baumeister with OnSite Environmental, Inc. in Redmond, Washington. The permit authorizes the importation of soil from all foreign sources (except countries with sanctions or embargoes by U.S. State Department) only for chemical/physical analysis in a controlled laboratory environment at the named facility on the permit.

1. This permit is issued by the United States Department of Agriculture's Animal and Plant Health Inspection Service (APHIS). It conveys APHIS regulations and requirements for the material(s) listed on this permit. It does not reduce or eliminate your legal duty and responsibility to comply with all other applicable Federal and State regulatory requirements.

• A copy of the permit or the permit number must accompany the shipment.
• You must be an individual at least 18 years old, or legal entity such as partnership, corporation, association, or joint venture.
• You are legally responsible for complying with all permit requirements and permit conditions.
• The regulated material and shipping container(s) are subject to inspection by officials of U.S. Customs and Border Protection (CBP) and APHIS. CBP or APHIS officials may require the shipment to be treated, seized, re-exported, or destroyed (in part or whole). You will be responsible for any associated expenses.
• If you violate any applicable laws associated with this permit, you may face substantial civil or criminal penalties. We may cancel all current permits and deny future permit applications.
• Without prior notice and during reasonable hours, authorized Federal and State Regulators must be allowed to inspect the conditions associated with the regulated materials/organisms authorized under this permit.

2. The Permit holder must comply with all the items listed below. In cases where notification is required, the notification must be made to the PPQ Pest Permit Staff at 866-524-5421 or pest.permits@usda.gov within one business day of the event triggering a notification. You must also notify the PPQ State Plant Health Director (SPHD) in your State. Access the list of SPHDs at https://www.aphis.usda.gov/aphis/ourfocus/planthealth/ppq-program-overview/ct_sphd.

• maintain a valid PPQ 330 permit as long as any portion of the regulated soil has not been treated or disposed of in accordance with these permit conditions,
• maintain an official permanent work assignment or affiliation at the address on this permit,
• notify PPQ of any change in the permit holder's work assignment, place of business, or affiliation,
• not assign or transfer this permit to other persons without prior PPQ authorization,
• notify PPQ of the receipt of an unauthorized and/or misdirected shipment of regulated soil and hold it until further instruction from PPQ,
• notify PPQ if the shipment includes any unusual/unexpected contents (including live insects and snails)

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and take all prudent measures to contain them until further instruction from PPQ,
• notify PPQ of any unauthorized or accidental release of the regulated soil and adequately mitigate the resulting environmental impacts,
• notify PPQ if the facility or equipment is damaged, destroyed, or otherwise compromised,
• notify PPQ if you intend to let your permit expire and you will no longer receive, handle, and/or dispose of regulated soil.

3. Prohibitions/Limitations:

Regulated soil must not be used:
• in field research or for other release into the environment before sterilization,
• for isolating, culturing, extracting, or concentrating live organisms,
• as a growing medium, unless specifically authorized in this permit.

4. Shipping/Movement

1) All shipments must consist of at least two inner packages and an outer shipping container securely sealed so that all prevent unauthorized loss of the regulated soil. The innermost packages (e.g. polythene super sacks, sealed drums, yard plastic-lined boxes, etc.) must be sealed and adequate to withstand pressure, temperature, and other climatic conditions incidental to shipment. The outer container must be rigid and durable enough to remain sealed and structurally intact to endure typical shipping conditions (dropping, stacking, impact from other freight, etc.). The conveyance must be secured by a lock, seal, or similar device. The permit holder is responsible for communicating these requirements to the shipper.

2) For soil that originates in Hawaii and Puerto Rico, a copy of this permit or permit number and the shipment must be presented to APHIS-Plant Protection and Quarantine (PPQ) for inspection and clearance prior to departure. For soil that originates in the U.S. Virgin Islands, a copy of this permit or the permit number and the shipment must be presented to APHIS-PPQ in Puerto Rico for inspection and clearance prior to arrival in mainland U.S. For more information on how to ship your package to APHIS-PPQ in Puerto Rico, visit our website at:
https://www.aphis.usda.gov/aphis/ourfocus/planthealth/import-information/permits/plant-pes ts/sa _soil/soil-shipping-requirements.
Following inspection, soil shipments from Hawaii, Puerto Rico, and the U.S. Virgin Islands are authorized to enter at any arrival point on the mainland U.S.

3) Unless the regulated soil is hand carried by an individual specifically authorized in this permit, it must be shipped by bonded carrier to the port of entry. Following release by CBP, further movement to the APHIS-PPQ approved facility must occur by means of a generally recognized commercial carrier.

4) The shipment must be free from foreign matter or debris, plants and plant parts, and other macro-organisms, such as insects, cyst nematodes, mollusks and acari. Regulated material commingled with unauthorized material will be treated, seized, re-exported, or destroyed (in part or whole).

5) All solid wood packing material (SWPM) accompanying the shipment must be in compliance with

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ISPM 15 treatment regulations and IPPC stamp requirements and enforcement. Noncompliant shipments will be treated, re-exported or destroyed at the consignee's expense.

6) Further distribution or movement of the regulated soil is not allowed without prior approval from the APHIS-PPQ SPHD in your State. Access the list of SPHDs at https://www.aphis.usda.gov/aphis/ourfocus/planthealth/ppq-program-overview/sphd. For such movements, you must follow the packaging standards described in these permit conditions, except that the use of black and white labels is not required.

7) Certain domestic mainland soil is regulated separately under 7 CFR 301. This permit does NOT authorize the movement of such soil. For further information on the movement of domestic mainland soil visit: https://www.aphis.usda.gov/aphis/ourfocus/planthealth/import-information/permits/regulated -orga nism-and-soil-permits/sa_soil/ct_domestic_soil.

5. Shipping Labels/Labeling

After issuance of this P330 permit and prior to importation, you will need to request PPQ Form 550 Black/White shipping label(s) at least 5 business days in advance of shipping date. If you applied online using ePermits, you may request the labels using the My Shipments/Labels feature. Otherwise, send your request to BlackWhiteGreenYellowlabelrequest@usda.gov. Specify the permit number and the total number of labels needed. All email requests must come from the permit holder or appointee and if requested by the appointee, they must Cc the permit holder on all requests. You may request additional labels the same way. We will send you the labels by email as a pdf.

A label must be attached with clear tape to the exterior of each package being imported under this permit. (It is NOT necessary to provide a shipping label for every sample contained within one package e.g. 5 bottles/bags/vials within one box needs only ONE label, not five). The labels have detailed instructions for use on the reverse side. You are responsible for instructing your shipper to carefully follow these instructions. You are responsible for each import shipping label issued under this permit. Failure to do so may result in refused entry or destruction of your package.

Enclose the following supplemental information in each shipment:
- Permittee Name
- Permit number
- Label number

Underlying packaging/wrapping must carry the address, billing, and any other information required to direct the shipment to its final destination (i.e., the permit holder's address; N.B., USDA APHIS does not defray any additional shipping costs incurred for transiting the shipment through an inspection station as the initial US destination).

NOTE: the PPQ Form 550 Black/White label is NOT required on shipments of soil that originate in Hawaii, Puerto Rico, and the U.S. Virgin Islands.

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6. Facility (Storage/Handling)

1) All regulated soil must be safeguarded at all times during movement, handling, and storage, until sterilized by one of the treatment method(s) specified in this permit. Upon arrival at the APHIS-PPQ approved facility, the regulated soil must be stored in two levels of secured containment until transferred or sterilized. As long as regulated soil is present, the containment and all other affected areas of the facility must be restricted to access by authorized personnel only.

2) All containers and storage areas will be labeled: “Regulated Soil – Sterilize before Disposal” (or an acceptable equivalent). The secured containment area must store only regulated material or, if the area also houses unregulated material, the regulated material must be clearly segregated from the unregulated material as well as being appropriately labeled.

3) The permit holder is responsible for the activities of those individuals working with the regulated soil. Everyone handling the regulated soil must read, agree to, and initial the permit conditions before working with or handling the regulated material. These initialed conditions do not need to be submitted to APHIS-PPQ but must be readily accessible in the event of an inspection and presented upon request.

4) Modifications to the facility or any procedural changes that affect the handling of the regulated soil must be approved by APHIS-PPQ prior to making changes. Please contact the PPQ Pest Permit Staff (email: pest.permits@usda.gov; phone: 866-524-5421; address: 4700 River Road, Unit 133, Riverdale, MD 20737; fax: 301-734-8700).

7. 1) Treatment/Disposal

All decontamination, sterilization, and disposal must comply with one of the methods authorized by the permit conditions. Prior to disposal, all regulated soil must be sterilized by one of the following methods:

Autoclave

a. Autoclave at 121 Celsius (250 Fahrenheit) for a minimum of 30 minutes at 15 psi.
b. Place autoclave tape or other indicators on each load prior to treatment. Check the autoclave tape or other indicator on each container to verify color change before disposal.
c. Calibrate annually according to the manufacturer’s instructions and maintain written records.
d. Use a commercially available biological indicator kit every 3 months, containing bacterial spores (e.g. Geobacillus stearothermophilus species) that are rendered unviable at 121 Celsius (250 Fahrenheit). Follow the manufacturer’s instructions. Service and retest the autoclave if any growth is observed.

Dry Heat

Use one of the following minimum temperature ranges and minimum exposure time combinations:
110 – 120.5 Celsius (230 – 249 Fahrenheit) for 16 hours
121 – 154 Celsius (250 – 309 Fahrenheit) for 2 hours

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154.4 – 192.5 Celsius (310 – 379 Fahrenheit) for 30 minutes
193 – 220 Celsius (380 – 429 Fahrenheit) for 4 minutes
221 – 232 Celsius (430 – 450 Fahrenheit) for 2 minutes

NOTE: Time starts when the entire sample reaches the required temperature and you must utilize a suitable temperature probe or currently calibrated thermometer for verification. The soil must be spread evenly throughout the chamber and not exceed 6 inches in depth.

Hydroclave

a. Hydroclave at a minimum of 121 Celsius (250 Fahrenheit) for a minimum of 30 minutes, or at a minimum of 132 Celsius (267 Fahrenheit) for a minimum of 15 minutes.
b. Observe the temperature sensor to ensure that the hydroclave maintains its required temperature.
c. Calibrate the hydroclave annually according to the manufacturer's instructions and maintain written records.

Incineration

With the exception of metal and glass containers, all regulated and associated material must be reduced completely to ash at the end of the incineration cycle.

As an alternative to the sterilization requirements listed above, disposal of regulated soil and any material contaminated with regulated soil may be conducted off site by a Disposal Facility holding a current PPQ Permit for Bulk Disposal or a Compliance Agreement for Bulk Disposal. Vendor may or may not be in the same state. SPHD approval is required prior to any movement of the regulated soil and approval is required in both the sending state and receiving state. Access the list of SPHDs at https://www.aphis.usda.gov/aphis/ourfocus/planthealth/ppq-program-overview/ct_sphd. All regulated soil and any material contaminated with regulated soil must be double contained during transport to the Disposal Facility to prevent any unauthorized dissemination of the regulated soil. For records maintenance requirements, refer to the record keeping permit condition.

No other sterilization methods are allowed without prior review and approval from PPQ Pest Permit Unit Staff. .

8. Decontamination of surfaces, tools, equipment, supplies and related materials

1) Unless other disposal arrangements have been approved in advance by PPQ Pest Permit Staff, all items coming in direct contact with, or exposed to, the regulated soil -- including but not limited to glassware, countertops, equipment, waste material, effluent, and shipping materials -- must be sterilized/sanitized/decontaminated prior to re-use or removal from the APHIS-PPQ approved facility, and prior to the expiration of this permit.

2) Use any of the following, either alone or in combination:

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a) immersed in minimum of .525 percent sodium hypochlorite (household bleach from the bottle is a minimum of 5 percent) for at least 20 minutes
b) immersed in 70 percent alcohol or ethanol for at least 30 minutes,
c) treated with quaternary ammonium compounds per manufacturer's specifications,
d) using one of the soil sterilization methods above.

3) Hydroclave or autoclave effluent as stipulated above.

9. Training requirements/Records/Record-Keeping

1) Standard Operating Procedures (SOPs) must be filed with, and approved by, the PPQ Pest Permit Staff at: email: pest.permits@usda.gov; phone: 866-524-5421; fax: 301-734-8700; address: River Road, Unit 133, Riverdale, MD 20737. All contact information must be kept current and the SOPs must be dated. If requirements in the permit conditions are more restrictive than the SOPs, the permit conditions take precedence. APHIS-PPQ must approve any changes to the SOPs before implementation. At a minimum, the SOP should describe how you will maintain compliance with APHIS-PPQ regulations. It must include how you plan to: transport, handle/process, store, safeguard, treat, and dispose of the regulated soil, effluent, and anything else coming into contact with the regulated soil. The SOP must also contain instructions regarding the cleanup of potential spillage of regulated soil and must be posted in areas where soil is stored and processed. A current copy of the SOP must be available at the time of facility inspection.

2) All employees working with the regulated soil must complete annual training. The training must cover the requirements on this permit and the Standard Operating Procedures submitted to APHIS-PPQ. Both a copy of the permit and the SOPs must be available at all times for the facility staff to consult.

Training records on each employee must be maintained for a period of three (3) years from the date the record was created and a list of all persons working with the soil in the APHIS-PPQ approved facility must be maintained.

3) The permit holder must keep records of all shipments received and samples processed under this permit. These records must be retained for a period of three (3) years after disposal of the soil, or (3) years after its transfer to another APHIS-PPQ approved facility. If soil is transferred between approved facilities, its identity must be maintained for traceability.

The records must include:
a. Date of arrival of each shipment.
b. Origin of the regulated soil.
c. Total weight of regulated soil in each shipment.
d. Date and weight of disposed or transferred amounts of regulated soil.
e. Method of disposal or location where the regulated soil was transferred to.

4) All records retained under this permit must be made available to Federal and State regulators upon

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request.

END OF PERMIT CONDITIONS

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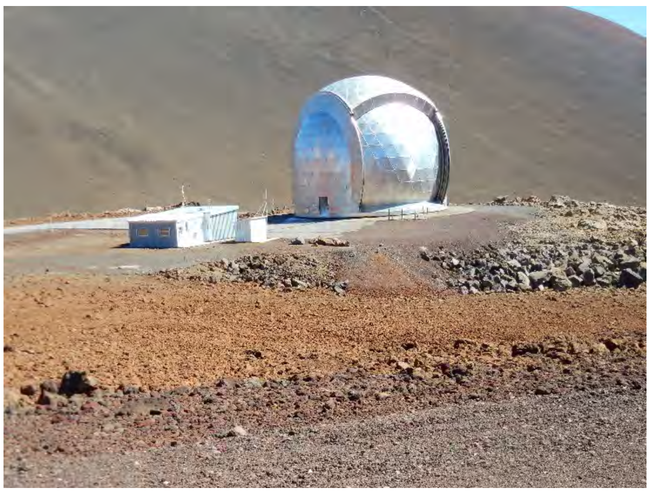
WARNING: Any alteration, forgery or unauthorized use of this Federal Form is subject to civil penalties of up to $250,000 (7 U.S.C.s 7734(b)) or punishable by a fine of not more than $10,000, or imprisonment of not more than 5 years, or both (18 U.S.C.s 1001)

HYDROGEOLOGICAL AND GEOLOGICAL EVALUATION

Decommissioning of the California Institute of Technology Submillimeter Observatory



Prepared for:

Caltech

California Institute of Technology
1200 E California Boulevard
Mail Code 103-6
Pasadena, California 91125

Prepared by:

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

INTERA Incorporated
74 Kihapai Street
Kailua, HI 96734

September 18, 2019

EXECUTIVE SUMMARY

The California Institute of Technology (Caltech) plans to decommission the Caltech Submillimeter Observatory (CSO), located near the summit of Maunakea, Hawai'i Island, Hawai'i. As part of the decommissioning process, Caltech is preparing an environmental assessment (EA). This report is intended to be part of the EA and provides a hydrogeological evaluation of Maunakea and a qualitative analysis of the potential impacts of wastewater from the CSO. This report also includes a geologic characterization of the rock fill material used in the CSO's foundation.

The regional groundwater body below the summit of Maunakea is probably a dike-impounded high-level aquifer (Figure 13; Izuka et al., 2018). The five aquifer systems that connect to the peak of Maunakea are Honokaa, Paʻauilo, Hakalau, Onomea and Waimea (Figure 17). There are also an unknown number of relatively small perched water bodies associated with buried glacial deposits and deposits of weathered ash or sediment. Lake Waiau is the surface expression of a shallow perched aquifer (Leopold et al., 2016).

One of the purposes of this report is to assess the potential for groundwater pollution from the onsite cesspool at the CSO. The cesspool is a minor source of pollution and will be closed and filled soon. Three general areas of potential concern were identified: 1) The public water systems in the regional aquifers surrounding Maunakea in Hilo, Waikoloa, Lālāmilo, Waikiʻi and Paʻauilo; 2) Potential impacts to the springs and water systems at Pōhakuloa; and 3) Lake Waiau.

Potential impacts to the regional aquifers were analyzed using published literature, by estimating travel times and attenuation, looking at nitrate data from water supply wells and by estimating dilution factors. Based on this analysis, there is virtually no possibility of impacts from wastewater on the surrounding regional aquifers.

Potential impacts to the springs and water sources of Pōhakuloa Gulch were analyzed by a literature search and by visual examination of the local topography. There is no indication that there is a direct groundwater connection between the CSO site and the springs of Pōhakuloa Gulch. It is highly unlikely that wastewater from the CSO would impact the springs. In addition, there is no indication of impacts in nitrate data from the springs.

Potential impacts to Lake Waiau were analyzed by reviewing scientific literature and through visual inspection of the area. Lake Waiau is not hydraulically connected to the CSO site via groundwater. There is also no surface water connection from the CSO site to Lake Waiau. There is no possibility that wastewater from the CSO is affecting Lake Waiau.

Approximately 2,335 cubic yards of fill were used to construct the CSO. Depending on the decommissioning alternative, Caltech may need to remove the fill. If the fill is removed, it may be considered necessary to return it to its source. INTERA conducted a geochemical analysis of samples from the fill and from a nearby lava flow. Based on the lithologic descriptions and geochemical analyses of the three fill samples and one sample from an adjacent a'a lava flow, the fill material at the CSO Site is determined to be sourced from Laupāhoehoe Volcanics which underlies Maunakea summit area. Much of the CSO Site fill was likely originally sourced from an excavation in a Laupāhoehoe lava flow during widening of the main road. Other components of the fill are probably tephra from one of the nearby Laupāhoehoe cinder cones.

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

DRAFT HYDROGEOLOGICAL AND GEOLOGICAL EVALUATION
Decommissioning of the California Institute of Technology Submillimeter Observatory

Report Date: September 18, 2019

Prepared for:
California Institute of Technology
1200 E California Boulevard
Mail Code 103-6
Pasadena, California 91125

Prepared by:
INTERA Incorporated
74 Kihapai Street
Kailua, HI 96734

This work was prepared by me or under my supervision

____ _____December 31, 2019__
Signature Expiration date

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ACROYNMS AND ABBREVIATIONS

bgs	below ground surface
Caltech	California Institute of Technology
CDUP	Conservation District Use Permit
COC	chain of custody
CSO	Caltech Submillimeter Observatory
CWRM	Commission on Water Resource Management
DLNR	(State of Hawai'i) Department of Land and Natural Resources
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ET	Evapotranspiration
ft	feet *or* foot
ft-msl	elevation in feet relative to mean sea level
gal/mo	gallons per month
gpd	gallons per day
GR	groundwater recharge
GW	groundwater use
HAR	Hawai'i Administrative Rules
HDOH	Hawai'i Department of Health
HDWS	Hawai'i Department of Water Supply
HI	human inputs
INTERA	INTERA Incorporated
kg/mo	kilograms per month
KP	Kahi Puka
LOI	loss on ignition
MCL	maximum contaminant level
mgd	million(s) of gallons per day
mg/L	milligrams per liter
NO_3	nitrate
NO_3-N	nitrate as nitrogen
OSDS	onsite sewage disposal system
PR	precipitation

PTA	Pōhakuloa Training Area
QA/QC	quality assurance and quality control
RO	runoff
RPD	relative percent difference
SAP	sample analysis plan
SWPP	Source Water Protection Plan
UH	University of Hawai'i
USGS	United States Geological Survey
WERF	Water Environment Research Foundation
WRPP	Water Resources Protection Plan
WSU	Washington State University
XRF	x-ray fluorescence

1.0 INTRODUCTION

The California Institute of Technology (Caltech) is moving forward with the decommissioning of the Caltech Submillimeter Observatory (CSO) per its “Notice of Intent to Decommission” submitted to the Office of Maunakea Management in November of 2015 (Stolper, 2015). Decommissioning involves removal of the structures and restoration of the site in accordance with its sublease and the 2010 Maunakea Decommissioning Plan (SRG, 2010). The CSO is located on a 0.75-acre site at 13,350 feet above mean sea level (ft-msl) altitude near the summit of Maunakea. The site is located within the Astronomy Precinct of the Maunakea Science Reserve (TMK: (3) 4-4-015:009) and is managed by the University of Hawaiʻi (UH, 2009). Since 1983, the subject site has been used exclusively for the construction and scientific operation of the CSO. The CSO was constructed between 1983 to 1986; since that time, Caltech has operated the CSO on Maunakea. The CSO facility includes the telescope, dome foundation, other underground structures, and support structures. The foundation is composed of rock fill. In addition, there is a cesspool to dispose of waste from two toilets and a few sinks.

The Maunakea summit is in the Conservation Land Use District, Resource subzone. Pursuant to Hawaiʻi Administrative Rules (§13-5-2 (4) (HAR)) ‘demolition’ of existing structures is an ‘identified land use’ in the Resource subzone of the Conservation Land Use District. A Conservation District Use Permit (CDUP) is required for certain land uses in the State Land Use Conservation District. State law (§343-5 (a) (2) (HRS)) requires that an Environmental Assessment (EA) be prepared “for any use within the land classified as a conservation district,” unless otherwise exempt. The EA addresses topics on the environmental effect of the project. One of the topics is the geological and hydrogeological setting. This report is intended to address this requirement.

INTERA Incorporated (INTERA) was selected to produce the report. INTERA was given the following tasks:

1. Prepare a general geological and hydrogeological assessment of Maunakea.
2. Prepare a qualitative analysis of the potential impacts of cesspool leachate flow.
3. Conduct a geologic characterization of the CSO fill material.

2.0 REGIONAL SETTING HAWAI'I

This chapter describes the regional climate, geology, and hydrology of Hawai'i and the Island of Hawai'i.

2.1 Climate

Hawai'i Island is in the tropics and the trade-wind belt of the North Pacific anticyclone. Hawai'i's climate varies seasonally and differs depending on the location (Giambelluca et al., 1986; 2013). The climate is diverse, including deserts, tropical rain forests and snow-capped mountains (Izuka et al., 2018). Hawai'i's diverse climate is attributed to the prevailing northeasterly trade winds that encounter the mountains, producing an orographic effect that forces moist air to rise, cool, condense and preferentially precipitate on the windward side and crests of mountain slopes rather than the leeward sides (**Figures 1** and **2**; Giambelluca et al., 2013; Izuka et al., 2018). Precipitation from orographic forcing is found at altitudes less than 7,000 ft-msl due to a thermal inversion at about 6,000 feet (ft), yielding desert conditions near the volcanic mountain summits (Giambelluca et al., 2013). Precipitation also varies spatially as a result of wind-mountain interactions, such as trade winds that wrap around the mountain slope and deposit precipitation on the southern side of Mauna Loa. Precipitation at the dry, leeward sides and mountain summits is largely sourced from storms, unrelated to orographic effect (Giambelluca et al., 2013). Strong diurnal heating and cooling in the summer produces convective rainfall precipitation at mid-altitudes in the afternoon (Giambelluca et al., 2013). Precipitation sourced from fog drip is associated with vegetated areas below 9,000 ft-msl and above 2,500 ft-msl (**Figure 3**; Engott, 2011). The effect climate and topography have on the distribution of vegetation on Hawai'i is shown on **Figure 4.**

2.2 Hawaiian Geology

The Hawaiian-Emperor Islands chain (archipelago) comprises basaltic shield volcanoes that formed over the last 75 to 80 million years as the Pacific Plate continues to migrate to the northwest over the Hawaiian Hotspot (Clague and Dalrymple, 1987). The hotspot is a conduit for magma flow from the Earth's mantle up through the oceanic crust (**Figure 5**). The main Hawaiian Islands formed in the last five million years, with the oldest (Kaua'i) found at the northwest, becoming younger towards the southeast, at which the youngest is the "Big Island" – Hawai'i. An idealized Hawaiian volcano evolves through four eruptive stages: pre-shield, shield, postshield and rejuvenated (**Figure 6**; Clague and Dalrymple, 1987; Clague and Sherrod, 2014). These stages are distinguished by lava composition, eruptive rate, style, and stage of development (Wolfe et al., 1997). An island can comprise more than one shield volcano. For example, Hawai'i Island is composed of five subaerial volcanos and two adjacent submarine volcanos: Loihi and Mahukona.

2.3 Hawai’i Island Geology

The land area of Hawai’i Island is composed of five subaerial shield volcanoes: Kohala, Hualālai, Mauna Loa, Maunakea and Kīlauea (**Figure 7**; **Table 1**; Izuka et al., 2018). Kohala, Maunakea and Hualālai volcanoes are in postshield stage, while Mauna Loa and Kīlauea are in the active shield stage (Clague and Dalrymple, 1987). Hawai’i Island volcanoes do not have known vents from the rejuvenated stage. Each volcano erupted contemporaneously (to some degree) with its neighboring volcanoes, resulting in complex interbedding (Wolfe and Morris, 1996; Wolfe et al., 1997). Wolfe et al. (1997) documented field evidence of interlayered strata from Mauna Loa, Maunakea and Hualālai at the saddle formed by the intersection of these volcanoes. **Figure 8** shows a simplified geologic map of Hawai’i Island with the major formations. The major formations of Hawai’i Island geology are summarized below, from youngest to oldest, from Izuka et al. (2018).

The subaerial volcanic and sedimentary rocks of Hawai’i Island can be divided into four main groups: lava flows (‘a‘ā and pāhoehoe), pyroclastic deposits and dikes (Wolfe et al., 1997). In addition, there are limited glacial and alluvial sedimentary deposits. The volume of sediments and tephra is small compared to the volume of lava flows in Hawai’i volcanos; however, part of the surficial geology on Maunakea is composed of tephra and glacial-related sediments **(Figure 8)**. ‘A‘ā flows contain a solid central core between gravelly clinker layers. Pāhoehoe flows are typically characterized by a smooth, ropy texture. Lava flows typically form highly permeable aquifers. Thick-ponded flows are less permeable and can be impediments to groundwater flow. Even more impermeable to groundwater flow are dikes, which are tabular, vertical, or sub-vertical lava intrusions that function as groundwater “dams.” Pyroclastic deposits originate from explosive volcanism and form tuff and ash beds (Wentworth and MacDonald, 1953). Ash deposits often rapidly weather and become less permeable.

Kohala Volcano is mostly formed by thin shield-stage basalt lava flows of the Pololū Volcanics from two rift zones trending northwest and southeast (**Figure 9**) that are now covered by younger, thicker rocks of the postshield stage Hāwī Volcanics. A summit caldera likely exists based on slightly curved faults near the summit and positive anomalies from gravity surveys. Dike swarms are exposed in the heads of large valleys on the northeast flank of the volcano. Subparallel faults formed a graben on the southeast flank, bordering Maunakea lavas.

Like Kohala, Maunakea is thought to be mostly composed of shield volcanics that are covered by the lower postshield Hāmākua Volcanics and upper postshield Laupāhoehoe Volcanics. The shield and lower postshield volcanics have similar hydrogeological properties; lower postshield volcanics differ mainly by geochemistry instead of structure. Laupāhoehoe Volcanics formed thicker flows than the Hāmākua Volcanics with many cinder cones. Discontinuous ash and soil layers are interbedded between some lava flows. Positive gravity anomalies indicate dense intrusive rocks, thousands of feet thick, exist beneath the summit (Kauahikaua et al., 2000; Flinders et al., 2013), interpreted by some as a buried caldera and associated dike complex (Stearns and Macdonald, 1946; Macdonald et al., 1983). Maunakea does not have clearly delineated rift zones, but rifts have been proposed by Stearns and Macdonald (1946), Fiske and Jackson (1972), and Macdonald et al. (1983), based on the distribution of cinder cones (**Figure 9**). Wolfe et al. (1997) suggested the distribution of cinder cones is unrelated to rift zones, which is consistent with nonconclusive interpretations from gravity surveys (Kauahikaua et al., 2000; Flinders et al., 2013). A few sedimentary (glacial till and glacial outwash) deposits exist on the summit and southern slope of Maunakea. Multiple cycles of glaciation between 280,000 and 9,080 years ago changed erosional and depositional patterns (Porter, 1979a,b) near the summit. No glaciers exist today, but permafrost was observed at the summit in 1969 (Woodcock, 1974) and persists in two locations (Schorghofer et al. 2017).

Hualālai is located on the west or Kona coast of Hawai'i Island. Hualālai is completely covered by postshield-stage volcanics of pāhoehoe and ʻaʻā flows (Moore et al., 1987). These deposits are collectively known as the Hualālai Volcanics. The postshield Hualālai Volcanics form a relatively thin veneer over the shield volcanics that ended 130,000 to 105,000 years ago (Moore and Clague, 1992). Hualālai Volcanics interbed with the Mauna Loa Volcanics to the north, east and south. The interpretation of rift zones associated with cinder cones are not conclusive based on gravity data. Hualālai is the only Hawai'i volcano without a positive gravity anomaly centered beneath the summit; instead, the anomaly is located several miles to the southwest (Kauahikaua et al., 2000).

Mauna Loa is the largest of Hawai'i's volcanoes, still in the shield stage, producing thin shield-stage, basalt lava flows. Rift zones are prominent to the northeast and southwest of the summit. Few dikes are exposed due to limited erosion, but many likely exist beneath the volcano based on gravity anomalies (Flinders et al., 2013). Kīlauea is an active volcano that has recently completed a near-continuous eruptive episode lasting more than 35 years and consists primarily of thin ʻaʻā and pāhoehoe flows with minor ash beds.

The Pāhala Ash is a loose term for pyroclastic deposits found throughout Hawai'i Island. They are primarily weathered and reworked ash layers (less than 55 ft thick). Ash is a glassy (no mineral structure) formation which can quickly weather into clayey soils. Radiometric dating has shown a wide range of ages: 3,000 to 39,000 years old (Sherrod et al., 2007). The Pāhala Ash is found on the slopes of Maunakea and southern slopes of Mauna Loa. The Pāhala Ash on Maunakea is likely derived from Laupāhoehoe or Hāmākua pyroclastic or hyaloclastic events.

Since Hawai'i is the youngest of the Hawaiian Islands, it has experienced the least amount of mass wasting and dissection by weathering. The limited erosion means that, even for the older volcanoes, the postshield volcanics obscures evidence of intrusive activity occurring over the constructional life of the volcano. The relative youth of the island also precludes formation of extensive reefs and caprock sequences found on the older islands due to its continuing rapid subsidence.

2.4 Groundwater

Historically, groundwater in Hawai'i Island has been considered in four general categories: (1) basal, (2) high-level or dike-impounded, (3) perched, and (4) sedimentary or caprock **(Figure 10)**. The hydrogeology of Hawai'i Island is unusual relative to the other islands due to active volcanoes, little weathering and absence of sedimentary caprock deposits. Drilling and research in the past 25 years has shown that this model may not be fully applicable to Hawai'i Island and possibly other islands (Thomas et al., 1996; Stolper et al., 2009; Thomas, 2016). Researchers have discovered deep freshwater aquifers in Hilo and Kona that do not fall into the four general categories. However, these four categories are still commonly used in Hawai'i hydrogeology. Hawai'i Island's hydrogeology is categorized by Izuka et al. (2018) into four principal settings **(Figures 10-12)**:

- Freshwater lens in highly permeable lava flows
- Dike-impounded groundwater associated with rift zones and calderas
- Perched groundwater associated with sediment or tephra deposited in between lava flows
- Stacked freshwater bodies located below sea level **(Figure 11)**.

Groundwater basal aquifers, also called freshwater lens systems, are an important source of drinking water in Hawai‘i. Hawai'i basal aquifers can occur in basalt and other igneous rocks as well as in sedimentary formations, locally known as caprock. In a basal aquifer, lower density (lighter) fresh water can be thought of as floating on higher density (heavier) saltwater. The fresh water and saltwater are separated by a mixing or transition zone where salinity gradually increases from near-fresh to seawater concentrations (i.e., brackish water, **Figure 12**). The behavior of basal groundwater is a function of the geologic properties of the rock, groundwater recharge, the dynamics of the transition zone and groundwater pumping. The water level in feet above sea level of basal aquifers is generally less than 50 ft-msl. Basal groundwater (that is not pumped out of the ground) ultimately discharges into the ocean as seeps and/or springs.

Some groundwater is retained behind dikes on the upper slopes of the volcanos or along rift zones. Dike-impounded water is also called high-level water because groundwater can be impounded several thousand feet above sea level. There are no mapped dikes in the study area, but this is not surprising because dikes are subsurface features that are exposed by mass wastage or fluvial erosion and Maunakea is only slightly eroded. It is probable that dikes occur in the subsurface. Dike-impounded groundwater discharges or "leaks" into the basal groundwater, deeper groundwater systems or, in many cases, into streams. Dike-impounded groundwater is also a drinking water source on Hawai'i Island.

Perched water in Hawai'i generally refers to relatively small aquifers situated on layers of weathered ash or soil above the basal or high-level aquifers. Perched aquifer systems either leak downward below the restrictive layers or discharge into streams and springs. Perched water is used for drinking water on Hawai'i Island.

The hydrogeologic framework of Hawai'i is not understood as well as the other islands due to the relatively large size of the island and the uneven distribution of lithological and hydrological data from wells that are generally clustered near the coastline (Mink and Lau, 1993; Whittier et al., 2004). Because of these data gaps, island-wide groundwater elevation contours cannot be made. A few scientific exploratory wells (i.e., PTA [Pōhakuloa Training Area], and the deep Hawaiian Scientific Drilling Project [HSDP] drill holes near Hilo, HSDP1 and HSDP2, see **Figure 8**) and geophysical studies (Zohdy and Jackson, 1969; Pierce and Thomas, 2009; Thomas, 2016) provide some subsurface information, but little or no subsurface hydrogeological data exists at the high-altitude interior, including beneath Maunakea.

The permeability or hydraulic conductivity of an aquifer are important parameters when considering contaminant transport or productivity. Permeability is a measure of how easily a subsurface material (i.e., different types of lava) transmits fluid. The parameter is used when variable density fluids are anticipated. Hydraulic conductivity, the common measure of fluid transmissivity in groundwater hydrology, accounts for fluid (i.e. density and salinity) and material properties (permeability of the rock).

Although permeability and hydraulic conductivity are technically different, the terms are commonly used interchangeably. The greater the hydraulic conductivity or permeability number, the easier water flows through the formation. Hydraulic conductivity is important in this study because, along with other aquifer parameters including porosity and gradient, it is used to estimate groundwater velocity. Velocity can be used to estimate groundwater travel time, which is a conservative measure for potential contaminant break though times. Groundwater velocity is a function of the hydraulic conductivity, groundwater gradient, and porosity. It is an expression of the speed at which groundwater flows through the geologic media or rock. Note that although hydraulic conductivity and velocity have the same units (distance/time), they denote different aquifer properties. Travel time is the elapsed time, in years, for water to travel from its place of origin, usually where it falls as rain, to its discharge point, the ocean or a water well.

Dike-impounded aquifers tend to have lower hydraulic conductivity because of the low-permeability intrusive dikes. Where lava flows are free of dikes, the shield and lower postshield-stage (i.e., Hāmākua Volcanics) are considered moderately to highly permeable, while the upper postshield stage volcanics (i.e., Laupāhoehoe Volcanics) are considered to have low to moderate permeability. Volcanic aquifers have a large range of hydraulic conductivity estimates in Hawai'i, from 270 to 34,000 ft/day. Field estimates of horizontal hydraulic conductivity have been determined based on pump testing in the following locales of Hawai'i Island:

- 2,885-6,670 ft/d in Kīlauea (Takasaki, 1993)
- 610-6,400 ft/d in Kohala (Underwood et al., 1995)
- 500-34,000 ft/d in the west coast of Hawai'i (Oki, 1999)
- 269-4,502 ft/d for the whole island (Rotzoll and El-Kadi, 2008)

Horizontal hydraulic conductivity estimates based on modeling include:

- 3,000-20,000 ft/d in Kīlauea (Gingerich, 1995)
- 918-3,116 ft/d about Maunakea (Whittier et al., 2004)

Lava intruded with dikes has lower hydraulic conductivity because dikes have very low permeability, and heat alteration of the rock reduces permeability. Dikes are vertical barriers which impede horizontal flow, causing high (i.e., impounded) groundwater levels (Stearns and Macdonald, 1946). Inland wells and springs with water levels greater than 1,000 ft-msl may represent groundwater impounded by dikes (Takasaki and Mink, 1985; Gingerich, 1995). Gingerich (1995) used model calibration based on tidal fluctuations to demonstrate that rift zone lava hydraulic conductivity is at least two orders of magnitude less than dike-free lava. Where rift zones are well delineated, dikes tend to parallel the trend (Takasaki and Mink, 1985; Whittier et al., 2004). Much uncertainty exists regarding the number of dikes and how thermal alteration varies spatially throughout rift zones (Izuka et al., 2018).

In dike-impounded groundwater, horizontal hydraulic conductivity estimates range as follows:

- <33 ft/day in the Kīlauea rift zone near the summit (Takasaki, 1993)
- 0.03-3.3 ft/day in Maunakea dike complexes (Whittier et al., 2004, based on numerical model calibration)
- 196-328 ft/day in Maunakea marginal dike complexes (Whittier et al., 2004)

Where sediment and tephra deposits exist, hydraulic properties are related to grain size and the degree of weathering. From a simple hydrogeological viewpoint, there are two types of tephra: coarse-grained and weathered fine-grained tephra. Coarse tephra (i.e., cinder) is highly permeable, but generally does not support aquifers (Stearns and Macdonald, 1946). Weathered fine tephra (i.e., ash) is associated with widespread perched aquifers on the Kohala and Maunakea windward-facing slopes where rainfall and recharge are abundant (**Figure 10**). The permeability of the weathered tephra is relatively low, and it tends to form a barrier to groundwater flow, creating a perched aquifer. Hydraulic conductivity values have not been quantified for tephra deposits.

Sedimentary deposits (i.e., glacial till) are considered to have low to moderate permeability, regardless of whether they are unconsolidated or consolidated (Stearns and Macdonald, 1946). Hydraulic conductivity values for sediments have been estimated on Maui at 0.38 ft/day in the vertical direction and 17 ft/day in the horizontal direction (Gingerich, 2008). Most deposits on Maunakea are poorly sorted gravel, sand, and silt deposited by fluvial, glacial, and landslide processes.

Recent research on the Island of Hawai'i indicates the presence of multiple stacked bodies of freshwater thousands of feet below sea level separated by seawater-saturated basalts (Thomas et al., 1996; Stolper et al., 2009). The deep HSDP drill holes near Hilo, HSDP1, and HSDP2 (**Figure 8**), revealed upper and lower freshwater-saturated aquifers **(Figure 11**, Thomas et al., 1996). They found a deep freshwater body about 400 ft thick, confined below a soil layer at 900 ft-bgs that marked the transition from Maunakea lavas below and younger overlying Mauna Loa lavas above in the HSDP1 borehole. The second, deeper HSDP2 borehole encountered this same deep freshwater aquifer at about 1,000 ft-bgs, as well as several, much deeper, freshwater-saturated aquifers extending from a depth of about 6,500 ft-bgs to more than 9,900 ft-bgs (Stolper et al., 2009).

Thomas et al. (1996) considered these stacked freshwater bodies as part of a deep groundwater system that receives water from approximately 7,000 ft elevation on the slopes of Maunakea, based on stable isotope and carbon-14 age dating. Stolper et al. (2009) estimated these fresh groundwater bodies account for as much as one third of the rainfall recharge from the windward, mid-altitude slopes of Maunakea. Scientists continue to investigate these systems.

Groundwater velocities are useful for estimating the time and distance contaminants can be transported. Groundwater velocities have been measured near the coast at Lahaina on Maui using fluorescein tracer, based on the time it took 50% of the dye mass to arrive (Craig et al., 2013). Groundwater velocity measurements varied from 1 to 31 ft/day and averaged 8.2 ft/day; however, these velocity values were probably higher than the natural velocity because the high injection rates during the study (3 mgd) increased the groundwater head gradient. Lau and Mink (2006) report a typical groundwater velocity of 1 ft/day for the Hawaiian Islands. Groundwater velocity parameters for the aquifers in Honolulu varied from 0.5 ft/day to 5.0 ft/day at Molokai (Liu, 2007). These values are representative of groundwater flow in the dike-free highly permeable lavas on Oahu.

2.5 Water Budget for Hawai'i Island

An understanding of the water budget provides information on groundwater availability and the potential for dilution of contaminants. A schematic of a water budget showing components for Hawai'i Island's hydrologic system, representative of recent conditions, is shown on **Figure 13**

(Izuka et al., 2018). A water budget is based on the concept that inputs must equal outputs plus changes in storage. For example, for natural conditions, precipitation should equal evapotranspiration plus runoff and groundwater recharge.

Precipitation includes rain, snow, and fog drip. Evapotranspiration is the water that is either evaporated directly into the atmosphere or that which is used by plants and transpired back into the atmosphere. Runoff is the component that contributes to streamflow. Groundwater recharge is the component of precipitation that percolates into the subsurface and is not lost to the atmosphere via evapotranspiration.

Estimates for each of Hawai'i Island's water budget components are provided in **Table 1**. Average precipitation for Hawai'i Island is 14,402 million gallons per day (mgd) from snow, rain, and fog drip. About 45% of the precipitation goes to groundwater recharge (6,595 mgd). A map of the fraction of precipitation that becomes recharge is shown on **Figure 14**, while actual recharge rates are shown on **Figure 15.** Recharge is highly variable throughout the island. Most of the groundwater recharge is modeled to naturally discharge to the ocean (6,492 mgd), with a relatively minor component extracted for human use (103 mgd). Most of the precipitation that does not recharge the groundwater system (approximately 55%) transfers back to the atmosphere as evapotranspiration (6,175 mgd), and the remaining 1,686 mgd is transported as runoff (RO) to the coast. A map view of the runoff zones and stream systems used in the Engott (2011) water budget is shown on **Figure 16.** A map of Hawai'i Island's aquifer systems and State of Hawai'i sustainable yield estimates are shown on **Figure 17** (CWRM, 2008).

Table 1. Water Budget Components for the Island of Hawai'i.

Inputs (mgd)			Outputs (mgd)			
Precipitation (PR)	Human Inputs (HI)	Groundwater Recharge (GR)	Evapo-transpiration (ET)	Runoff (RO)	Groundwater use (GW)	Discharge (ND)
14,402	57	6,595	6,175	1,686	103	6,492

Notes: **Source: Engott, 2011.**

HI: Human inputs (injection, irrigation, wastewater)

PR: precipitation, including rain, snow and fog.

GR: groundwater recharge

ET: evapotranspiration.

RO: runoff (i.e., streams and floods).

GW: groundwater withdrawals (i.e., pumping wells).

ND: net discharge. Submarine discharge, springs, seeps and stream baseflow.

3.0 MAUNAKEA

This chapter focuses on the climate, geology and hydrology of Maunakea. The CSO is located near the peak of Maunakea (**Figure 4**).

3.1 Climate

The climate of Maunakea is variable from sea level up to the summit at approximately 13,350 ft-msl. Orographic rainfall from the prevailing trade winds on the windward (northeast) side of the mountain causes abundant (greater than 100 inches/year) precipitation at the middle elevations, approximately 2,500 to 7,000 ft-msl. On the leeward side, where the trade winds are blocked, ocean-land temperature and pressure differences generate local diurnal variations in the wind. Surface heating causes upslope winds during the day that result in convective rainfall in the afternoon. Wind direction reverses at night, as cooled mountain air moves downslope. Higher temperatures during the summer cause more convective rainfall (Giambelluca et al., 2013). Above 9,000 ft-msl, near the summit of Maunakea, the climate is that of alpine desert where mean annual precipitation is less than 10 inches/year. The estimated mean annual rainfall at the CSO is 8.0 inches/year (Giambelluca et al., 2013).

3.2 Geology

Maunakea last erupted between 3,600 and 4,600 years ago (Porter et al., 1977; Lockwood, 2000). There are three known geologic formations in Maunakea. They are, from youngest (top) to oldest (bottom), the Laupāhoehoe, Hāmākua and shield-stage volcanics. The stratigraphy, or layering, of Maunakea Volcanics is shown in **Figure 18** (Wolfe et al., 1997). The Pāhala Ash, which is found intercalated with the Laupāhoehoe Volcanics, has been discussed previously.

Much of the surface of Maunakea is covered in Holocene-Pleistocene age Laupāhoehoe Volcanics which are composed of relatively thick flows of alkalic rocks (West et al., 1992), consisting of hawaiite, mugearite and benmoreite (Wolfe et al., 1997). The Laupāhoehoe Volcanics are composed of more viscous lavas that are often dense and thickly bedded with relatively low permeability.

The contact between Laupāhoehoe and Hāmākua Volcanics has been mapped and noted in boreholes like the PTA well at the saddle between Maunakea and Mauna Loa (**Figure 8**). Rock core from the PTA well drilled at 6,353 ft-msl elevation revealed Laupāhoehoe in the upper 425 ft below ground surface (bgs), which was distinguished from the underlying Hāmākua Volcanics based on a baked volcanic soil layer (Thomas and Haskins, 2013; Thomas, 2018).

The Pleistocene-age Hāmākua Volcanics, emplaced as relatively thin lava flows with tholeiitic basalt composition (low silica), are found stratigraphically below the Laupāhoehoe. Shield-stage lavas are stratigraphically below the Hāmākua and have similar lithology but are not exposed at land surface. The Hāmākua Volcanics are exposed in deep erosional canyons (Porter et al., 1977). Ash and soil layers in the Hāmākua and shield-stage volcanics form low permeability layers which impede vertical groundwater flow. These layers may also form small perched aquifers. There is no clear boundary between the shield and postshield lavas, due to intercalated tholeiitic and alkalic lava flows (Frey et al., 1991). Both the Hāmākua and underlying shield-stage lavas are composed of relatively thin-bedded ʻaʻā and pāhoehoe lava flows and are highly permeable.

Dikes, with magma sourced from the shield or postshield volcanics, extend through the Hāmākua Volcanics and very likely the Laupāhoehoe Volcanics, in a zone that is approximately 3 miles wide at the summit of Maunakea (Don Thomas, 2018). The dike-intruded lavas are significantly less permeable, due to the dikes themselves and heat alteration of the surrounding lavas.

The volcanic formations, ash layers, and glacial/alluvial deposits comprising the surficial geology of Maunakea are shown on **Figure 19.** The glacial deposits shown on **Figure 19** coincide with an ice cap that was approximately 27 square miles in area, extending down to 12,000 ft-msl elevation, 13,000 to 40,000 years ago (Lockwood, 2009).

3.3 Groundwater

The regional groundwater body below the summit of Maunakea is probably a dike-impounded high-level aquifer (**Figure 13**; Izuka et al., 2018). It is “probable” because there is no direct confirmation of high-level water from drilling. Ground water hydrologic units have been established by the Commission on Water Resource Management to provide a consistent basis for managing ground water resources (CWRM, 2008). The five aquifer systems that connect to the peak of Maunakea are Honokaa, Paʻauilo, Hakalau, Onomea and Waimea **(Figure 17)**. There are also an unknown number of relatively small perched water bodies associated with buried glacial deposits and deposits of weathered ash or sediment. Lake Waiau is the surface expression of a shallow perched aquifer (Leopold et al., 2016).

There are several factors affecting the vulnerability of an aquifer. They include potential flow pathways of groundwater recharge, the occurrence of potential contaminating activities, and physical and geochemical conditions in the vadose zone that may affect contaminant transport (Whittier et al., 2010; Eberts et al., 2013). Contaminant transport is affected by attenuation factors. These include adsorption, biological action, chemical action (cation and anion exchange or precipitation), filtration, and dilution. These natural geochemical and physical conditions also influence the viability and transport of bacteria. For example, slightly elevated temperatures may increase biological activity and accelerate alteration of organic contaminants and nutrients. Other important factors in the phreatic zone include travel time and dilution. Dilution of contaminants will be greater in areas with high groundwater recharge. Travel time is a function of groundwater velocity and distance between recharge areas and discharge areas. There is more potential for attenuation during longer travel times. Multiple groundwater flow pathways are a function of the geology, recharge and hydrogeology of the region. Travel time and attenuation is affected by longer or shorter flow paths.

One of the purposes of this report is to assess the potential for groundwater pollution from the onsite cesspool at the CSO (Section 4.1). The cesspool is a minor source of pollution and will be closed and filled. INTERA has formulated a conceptual groundwater model of the region. A conceptual model is a simplified graphical representation of the relevant geology and hydrogeology of a site.

The depth to groundwater is important in determining possible recharge flow pathways. There is no direct information on the regional groundwater table below the summit of Maunakea, but data exist at the PTA in the saddle between Maunakea and Mauna Loa from the scientific boring at PTA Test Well 1 (**Figure 20**) (Thomas and Haskins, 2013). Perched groundwater was encountered at two depth intervals in the PTA Test Well 1: 500-540 and 700-1,181 ft bgs. The regional water table was encountered at 1,806 ft bgs, or at about 4,500 ft-msl.

Geophysical surveys have also indicated elevated groundwater levels at the lower slopes of the eastern flank of Maunakea (Pierce and Thomas, 2009; Thomas, 2016). Zones of low resistivity observed in magnetotelluric surveys collected about the eastern flank of Maunakea suggest the frequency and extent of perched or high-level groundwater bodies is higher than previously anticipated (Thomas, 2016).

This information indicates that the regional groundwater level below Maunakea is at the deepest 9000 ft bgs (4,500 ft-msl). If known water levels in other Hawai'i summit areas are extrapolated, the regional water level below the summit is probably significantly higher. We have assumed an average depth to groundwater below the summit area of 3,000 ft bgs (10,000 ft-msl). The regional groundwater below the summit is probably dike impounded, so water levels will vary significantly in different dike compartments.

Groundwater travel time is also a factor in assessing aquifer vulnerability. Another scientific boring of the HSDP, Kahi Puka 1 (KP-1), in Hilo revealed important age-dating information on groundwater encountered at 1050 ft bgs (Thomas et al., 1996). Freshwater sampled in this interval was determined to have an age of approximately 2,200 years (elapsed time since it originated as rainfall), based on carbon dating of dissolved bicarbonate. Stable isotopic data suggested that the water originated at about the 7000 ft-msl elevation, about 18.5 miles away from Hilo. This indicated an average groundwater velocity in this deep flow system of at least 44 ft/year. This velocity was derived from data on the deep groundwater flow system at about 1000 ft below sea level, and it provides an indication of flow velocity. It is likely that groundwater originating from the peak of Maunakea enters the deep flow system. These findings suggest it would take at least 3,000 years for groundwater to travel from the summit of Maunakea to the shoreline of Hilo (Thomas, 2018b).

Based on these and other data, the Maunakea groundwater system is represented by Cross Section A-A' on **Figure 21**. Cross Section A-A' depicts the groundwater system for approximately 24 miles between the CSO (Maunakea peak) and Hilo. The Laupāhoehoe Volcanics are assumed to extend approximately 1,000 ft bgs in the summit area and become a thinner veneer downslope. The Hāmākua Volcanics are lumped with the shield volcanics because they have similar hydrogeological properties (i.e., relatively high hydraulic conductivity), while the Laupāhoehoe Volcanics have distinctly lower hydraulic conductivity. Groundwater levels in the dike-impounded zone beneath the CSO are thought to vary around an average of 10,000 ft-msl in the 3-mile wide rift zone (**Figure 21**).

We depict two major flow paths for regional groundwater flow originating in the summit area. The upper arrow depicts overflow or spill from the dike compartments. This water would flow through other high-level aquifers in areas that are potentially not fully saturated. The lower arrow shows a flow path for water discharging at or below sea level from the dike compartments and flowing as basal or deep groundwater towards the ocean. Recharge at higher elevations will be pushed to deeper levels in the saturated zone by recharge occurring at lower elevations. This will result in deeper groundwater flow paths for higher elevation recharge. Contaminants transported in groundwater from higher elevations will also tend to be pushed deeper in the aquifer. The flow paths will be discussed in more detail in Section 4.3.

The dike-impounded groundwater beneath the summit of Maunakea is a leaky system that flows radially in all directions away from the summit and CSO. This distribution of flow directions means a contaminant that is introduced to the dike-impounded groundwater system could be transported radially, in several directions from the Maunakea summit area.

The "may not be fully saturated" labeled zone between 20,000 and 100,000 ft (horizontal) on **Figure 21** is in a zone where extensive perching likely exists with alternating saturated and unsaturated zones (Thomas, 2018). If high level water discharges into this zone the flow would be both saturated and unsaturated.

Dilution is another factor in assessing the vulnerability of an aquifer to contamination. The rate of groundwater recharge and the surface area over which the recharge occurs affects dilution. The recharge above 9,000 ft elevation is less than 10 inches/year. The recharge at the mid-elevation trade wind high rainfall zone between 2,000 and 6,000 ft elevation is greater than 100 inches/year (**Figure 21**). As groundwater moves radially downslope from the summit area, the surface area that is receiving recharge from rainfall increases and the total volume of recharge also increases. Consequently, groundwater recharge from the summit is diluted many times as it flows seaward.

Groundwater levels are high in the dike-impounded zone despite the lower recharge due to the low average hydraulic conductivity of the dike intruded rock that limits outflows **(Figure 21)**. The groundwater gradient (slope) between the dike impounded water of the summit and the basal water beneath Kaūmana and Hilo is considered to be relatively uniform due to the very high recharge rates (>100 in/yr) that help maintain high water levels in this area. This distribution of groundwater levels is supported by geophysical surveys of Thomas (2016) and water tables observed in the following wells (**Figure 20):**

- PTA Test Well 1, 8-4532-002, at an elevation of approximately 6,500 ft-msl, has a water table of around 4,500 ft-msl.
- Saddle Road well, 8-4110-001, at an elevation of approximately 2000 ft-msl and 7 miles from shoreline, has a water table of around 950 ft-msl.
- The Kaūmana test well, 8-4010-001, at an elevation of approximately 1800 ft-msl and 6.5 miles from shoreline, has a reported water table of 997 ft-msl.
- The Pi'ihonua Deepwell C, 8-4208-001, at an elevation of approximately 975ft-msl and 3.7 miles from shoreline, has a reported head of 26 ft-msl.

3.4 Surface Water and Lake Waiau

Other hydrologic systems to consider are perched groundwater and surface water. A map showing the watersheds, surface water and aquifer systems near the summit of Maunakea is shown in **Figure 22.** The Pōhakuloa and Waikahalulu Gulches are the most highly developed gulches on the upper mountain slopes **(Figure 22)**. There are three known major springs near Pōhakuloa gulch: the Hopukani, Waihū, and Liloe springs (collectively "Pōhakuloa Springs").

Pōhakuloa Gulch originates on the southwest side of Maunakea. The watershed includes the CSO and Lake Waiau. The surficial geology in the higher elevations is comprised of lava flows, pyroclastic deposits and glacial deposits. There is little or no soil and vegetation. The gulch likely formed due to scouring from melting glaciers (Macdonald et al., 1983; Lockwood, 2000; Porter, 2005). These melt waters are thought to have contributed to the initial filling of Lake Waiau (Sherrod et al., 2007).

INTERA visited Lake Waiau and walked the upper portion of the Pōhakuloa Gulch watershed on November 9, 2018. The lake was filled and overflowing into the gulch (**Figures 23** and **24**). The watershed around the lake is mostly rock rubble, red weathered lava rock, and slightly weathered lava flows. Occasional tufts of grass grew in the weathered material. The lake was pigmented green from algae, and the perimeter of the lake was surrounded by grass. Although the lake was overflowing, the soil was dry and there was no indication of recent precipitation or surface water inflows, indicating that the lake is an expression of perched groundwater.

INTERA noted that there are green algae in the lake. This implies the presence of nutrients. Nutrients and algae have been documented in Lake Waiau in 1977 to 1978 before the CSO was constructed (Laws and Woodcock, 1982). Laws and Woodcock (1982) noted that there were hypereutrophic conditions in the lake and found elevated levels of chlorophyll a in the lake during a drought. Patrick and Kauahikaua (2015) also noted that the lake was green during a period of low water levels in September 2013.

Lake Waiau is a culturally significant feature of Hawai'i, named after one of the snow goddesses of Maunakea, located approximately 4,000 ft south of the CSO (**Figure 22**). Lake Waiau is a perched alpine lake that fluctuates in size with precipitation and has recently been shrinking in overall size (Patrick and Delparte, 2014); although it was at full volume in November 2018. It is a perennial body of water in the crater of a cinder cone that was occupied by ice during past glaciations. Water remains in the lake despite being situated atop porous volcanics, due a fine-grained ash or glacial till layer that perches groundwater (Leopold et al., 2016).

Woodcock (1980) suggested that Lake Waiau water levels are related to rainfall and suggested that winter storms play an important role in the lake water budget, meaning that winter storms help recharge the lake. Woodcock (1980) also conducted a comparative study of tritium concentrations in lake, groundwater, and spring water. The results indicated that Lake Waiau water discharges into the Pōhakuloa Springs. Woodcock (1980) also suggested that relict ice may be blocking groundwater flow and that when the ice melts the lake may not be sustainable. Woodcock (1974) discovered permafrost near the summit crater, but there is no direct evidence of permafrost near Waiau. Leopold et al. (2016) also found no indication of ice through geophysical analysis. In addition, Woodcock (1974) did not show permafrost below Lake Waiau.

Ehlmann et al. (2005) analyzed hydrologic and isotopic data over a three-year period. They concluded that winter storms are the primary source of water for Lake Waiau. They also derived watershed and drainage channels from field and topographic data. The watershed and drainage calculations indicate the land surrounding the CSO does not drain into Lake Waiau. Runoff from the CSO area would flow into Pōhakuloa Gulch below Lake Waiau (**Figure 25**, Plate 1 from Ehlmann et al., 2005). This is corroborated from field observations by INTERA. **Figure 26** shows a view looking southwest towards Pōhakuloa Gulch (C), Lake Waiau (B) and the CSO (A). Surface water flow appears to go west and then south around the lake.

Ehlmann et al. (2005) concluded that Lake Waiau is fed by a small 135,000 square meter circular basin and is isolated from the surface drainage of the telescopes. They concluded that precipitation is sufficient to fill and sustain the lake. There is no indication that the small aquifer and watershed that feeds Lake Waiau are hydraulically connected to the CSO site via surface water or groundwater.

Based on published studies and INTERA's field visit, a conceptual model of the area under the CSO and Lake Waiau was constructed, as shown on Cross-Section B-B' (**Figure 27**). Dike-impounded groundwater is depicted in the 10,000 ft-msl range, about 3,000 ft bgs. The perched Lake Waiau water is depicted in a cinder cone of the Laupāhoehoe Volcanics. The CSO, Lake Waiau and the dike-impounded groundwater are hydraulically disconnected. There is no potential for surface or groundwater to reach Lake Waiau.

3.5 Water Budget

As mentioned in Section 2, the distribution of groundwater recharge varies significantly along the eastern flank of Maunakea (**Figures 15** and **21**). The recharge at the peak, near the CSO, is less than 10 inches/year, while the recharge at the 2,000 to 6,000 ft elevation is greater than 100 inches/year. The average precipitation at the CSO is 8.0 inches/year (Giambelluca et al., 2013), indicating that the recharge is less than 8 inches/year. The State of Hawai'i, Commission on Water Resource Management (CWRM) calculated water budgets as part of the Water Resource Protection Plan (WRPP) (CWRM, 2008). The United States Geological Survey (USGS) have calculated water budgets for the Onomea Aquifer System (Engott, 2011). The Onomea Aquifer System is the hydrologic unit of interest in this study because it is between the CSO and Hilo (**Figure 15**). Similar water budget components as those presented in **Table 1** for the Island of Hawai'i are presented for the Onomea Aquifer System in **Table 2:**

Table 2. Water Budget Components for the Onomea Aquifer System (Engott, 2011).

Inputs (mgd)	Outputs (mgd)					Sustainable Yield (mgd)
Precipitation (PR)	Groundwater Recharge (GR)	Evapo-transpiration (ET)	Runoff (RO)	WRRP Recharge	Water Use 2005	WRRP Sustainable Yield
1,310	417	412	481	335	0.372	147

Notes:

Precipitation is calculated as sum of rainfall and fog from Table 7 of Engott, 2011.
Evapotranspiration is sum of ET and CEvap from Table 7 of Engott, 2011.

WRRP = CWRM (2008)

The State of Hawai'i has calculated a baseline recharge rate of 335 mgd for the Onomea aquifer (CWRM, 2008; **Figure 17**), while the USGS (Engott, 2011) calculated 417 mgd (24% higher). **Figures 14** and **15** illustrate the spatial distribution of groundwater recharge values used in the USGS estimate for the Onomea aquifer.

4.0 WASTEWATER LEACHATE

The public has voiced concern over the potential for the wastewater leachate from the onsite wastewater disposal system (OSDS) to contaminate aquifers. This section describes the CSO facility, leachate associated with the facility's cesspool, a conceptual model for transport in the subsurface, as well as a comparative study of cesspools and water quality in the downhill community of Kaūmana in Hilo. A map of the CSO cesspool in the context of the others on Hawai'i Island is presented on **Figure 28.**

4.1 CSO Facility

The site has been used exclusively for construction and scientific operation of the CSO since 1983 (Stolper, 2015). The CSO telescope was constructed between 1983 and 1986, on a 0.75-acre site at 13,350 ft-msl, 200 ft below the summit of Maunakea (**Figure 29**). The CSO is located within the Astronomy Precinct of the Maunakea Science Reserve. The CSO site has been subleased to Caltech by the University of Hawai'i (UH) and the State of Hawai'i Department of Land and Natural Resources (DLNR) and has been operated since 1986, subject to a CDUP, issued by the DLNR, and an Operating Agreement between Caltech and UH.

The CSO facility includes a small wastewater system to dispose of waste from two toilets and a few sinks. The initial application for the CDUP (application submitted June 10, 1982) notes: "It is estimated that when the telescope becomes operational an average of five to seven persons will be present on the mountain at one time, operating in two shifts per day at the telescope site. The additional personnel are expected to generate an additional 1,100 to 1,500 gallons per month (gal/mo) of liquid sewage." Consistent with these prior estimates and review of a sampling of water delivery to the CSO over the years, it appears that the average monthly water delivery to CSO was 1,250 gal/mo. An as-built figure of the cesspool in the context of the CSO is shown on **Figure 30**, with a cesspool-specific drawing on **Figure 31** (Stolper, 2015). The cesspool is seven (7) ft in diameter, ten (10) ft tall and the discharge occurs through the bottom and side perforations.

The 1982 Environmental Impact Statement (EIS), prepared prior to the construction of CSO, notes that, "disposal of 1,100-1,500 gal/mo of liquid sewage into an 850-gallon septic tank is not expected to impact the hydrology of the area or pollute Lake Waiau." The EIS further noted, "The combined factors of relatively low effluent flow, evaporation losses from the cesspool tank, storage within the underlying lava rock or permafrost, probable downward dispersion (in event of a deep permafrost layer) and estimated negligible flow rate combined with significant purification within a few hundred feet of the source−lead to the conclusion of no impact on Lake Waiau."

The intent of Section 4.3 is to discuss and test the conclusions of the original assessment of the potential impact of the cesspool on the ground and surface water resources of Maunakea.

4.2 Leachate

Cesspool leachate contain nutrients (i.e., nitrogen) and potentially pathogens. Nitrogen compounds are commonly used to determine if leachate has contaminated surface water and/or groundwater. Nitrogen content is often used in wastewater quality assessments because it is a limited nutrient and because it can be harmful to humans. The federal maximum contaminant level (MCL) for nitrate (NO_3) is 10 mg/L (NO_3 as N or NO_3-N). Nitrogen and other nutrients can also cause eutrophication in streams, other freshwater bodies and coastal waters (Cummings and Babcock, 2012). The typical background nitrate level in Hawai'i groundwater is less than 3 milligrams per liter (mg/L) NO_3-N (Hawai'i Department of Health [HDOH], 2018).

Figure 32 shows the typical sequence of transformations that nitrogen undergoes after being introduced to the environment as wastewater (organic nitrogen). Organic nitrogen is first transformed into ammonium by microbes in the soil. If sufficient oxygen is present, ammonium will convert to nitrate. Most of the aquifers used for potable water supply in Hawai'i contain enough oxygen to allow nitrate to be the stable form of nitrogen (HDOH, 2018). Thereafter, in the absence of oxygen, microbes can consume nitrate and release nitrogen back to the atmosphere as nitrous oxide. It is important to note that nitrate and ammonium can transform back and forth repeatedly, depending on oxygen content at various zones of an aquifer. Typically, there is less oxygen with increasing depth in an aquifer.

Cesspools at public facilities generally have higher nitrogen concentrations (about 110 mg/L) than those at residential properties (about 80 mg/L), probably because of less dilution associated with the washing machines, showers, and numerous sinks found at residences (Figure 4-2 from Cummings and Babcock, 2012). An average nitrogen concentration of 87 mg/L in cesspool effluent was determined based on sampling and an assumed average effluent discharge rate of 9,580 gal/mo in Maui (Whittier and El-Kadi, 2014; HDOH 2017b, 2018; Delevaux et al., 2018). The CSO did not have as many visitors as a typical public facility, therefore the 87 mg/L nitrogen concentration from Delevaux et al. (2018) is most likely present in the CSO cesspool effluent because the facility lacked washing machines, and other facilities etc. that contribute to lower concentrations at residence cesspools.

The estimated cesspool leachate discharge rate, based on water delivery records, is 1,250 gal/mo. We calculate an average nitrogen loading rate of 0.41 kg/month for the CSO cesspool, based on the 87 mg/L N concentration. In Kaūmana, the average effluent and nitrate loading rate for a single cesspool is 20,100 gal/mo and 4.5 kg/mo, respectively. The nitrogen loading rate at the CSO is significantly lower than a typical cesspool because of the low total effluent discharge.

4.3 Potential Transport Pathways

INTERA developed Cross Sections A-A' and B'B' (**Figure 20**) to illustrate possible flow and transport pathways from the CSO to areas where there might be impacts to humans or the coastal environment. INTERA analyzed two potential transport pathways at regional and local scales. The larger scale flow pathway is via the regional groundwater flow system (**Figure 21**). The three components of the regional flow system are labeled A, B and C on **Figure 21.**

For example, if the leachate were to impact the regional groundwater system in Hilo, it must first percolate through the 3,000 ft thick vadose (unsaturated) zone beneath the summit of Maunakea (A) and then travel 120,000 ft (about 23 miles, the first 20 miles of which have no monitoring wells) of straight-line (horizontal) distance towards Hilo through the basal or shallower flow system (B) and/or the deep aquifer (C).

It has been suggested that there might be a smaller scale surface-groundwater flow system that connects the CSO to surface water features near the summit of Maunakea (i.e., Lake Waiau) or Pōhakuloa Gulch (**Figure 22**). There is no indication that Lake Waiau is connected via surface water or groundwater. The approximate straight-line horizontal travel distance from the CSO to the springs in Pōhakuloa Gulch is 12,000 ft. This local scale flow path is limited to the shallow depths of the vadose zone (Component A from **Figure 21,** depicted with larger scale in **Figure 27**) and areal extent shown on **Figure 22.** Hopukani, Waihū, and Liloe Springs are located between three and four miles downhill from the CSO, along Pōhakuloa Gulch. Surface water runoff from the CSO and Lake Waiau flows through Pōhakuloa Gulch, near these springs.

4.3.1 Regional Scale (CSO to Hilo)

Figure 21 shows a diagram the conceptual flow system from the CSO to Hilo. The regional dike-impounded groundwater is about 3,000 ft below ground surface. Groundwater recharge, along with the leachate, must percolate through this unsaturated zone to reach the regional flow system. The unsaturated zone includes the vertical extent of the Laupāhoehoe formation and some of the Hāmākua or shield-stage volcanics.

INTERA used the graphical software package VS2DI to model the vertical flow of leachate through the unsaturated zone. VS2DI simulates fluid flow and solute or energy transport through variably saturated porous media (USGS, 2000). INTERA constructed a conservative model that does not account for low permeability zones that would slow groundwater flow. The model did not simulate any saturated zones, although they may be present. Additionally, the model did not simulate dispersion.

Aquifer parameters are required to model groundwater flow. In this case saturated hydraulic conductivity, porosity, residual moisture content, and van Genuchten parameters: alpha and beta (van Genuchten, 1980) were included in the simulation, while dispersion, , which would reduce leachate concentrations as the plume travels more distance, was not.

A porosity of 0.1 was assumed (within the published range of 0.05-0.5 for volcanic rocks). The model is very sensitive to porosity. Porosity is a measurement of the open space in the rock that can contain water. The higher the porosity, the more water that can be contained in the formation. Higher porosity results in slower downward groundwater velocity. We used a relatively low estimate of porosity because we assume only a fraction of all the pore spaces are interconnected to transmit fluid. This is a conservative estimate and could result in an overestimate of the vadose zone groundwater velocity.

We assume 0.15 ft/day hydraulic conductivity in the vertical and horizontal directions. We used this hydraulic conductivity value for two reasons: (1) It is in the range of horizontal hydraulic conductivity values (0.03-3.3 ft/day) typical for dike complex basalts (Whittier et al., 2004), and (2) it is equal to the CSO leachate loading rate. This is the rate at which the subsurface must transmit leachate flow to prevent ponding of waste in the cesspool. The hydraulic conductivity must be greater than the leachate loading rate or there would have been evidence of overflow from the cesspool. The 0.15 ft/day leachate loading rate is calculated by converting the 1,250 gal/mo loading rate to cubic feet, dividing by the cross-sectional area of the cesspool (38 ft^2) and converting to day units. It is probable that the actual hydraulic conductivity of the various formations (Laupāhoehoe, Hāmākua, shield stage) is much more variable, but there is no direct information on the hydraulic characteristics of the geologic features in these formations, except for observational evidence indicating that the Laupāhoehoe Volcanics are likely less permeable than the Hāmākua and shield volcanics.

The residual moisture content and van Genuchten parameters were chosen based on assumptions of how much of the pore space contains water when drained and how rapidly the pore spaces saturate. 5% residual moisture content was assumed, based on the conceptual model of the geology in which the fraction of pore spaces that are interconnected are considered relatively large in diameter. Larger diameter pore spaces have less capillary suction to resist groundwater flow. The alpha and beta parameters were specified as 1.3 and 3.1, respectively. The alpha and beta van Genuchten parameters represent pore spaces that fill and drain relatively rapidly, consistent with the nature of fractured basalt.

No attenuation factors were considered in this simple model solution to be conservative. The leachate would have been subject to several attenuation factors. These include adsorption, biological action, chemical action (cation and anion exchange or precipitation), filtration, and dilution. There is simply not enough information to adequately model these parameters. But it is probable that that these parameters act on the leachate and reduce the concentrations of pathogens and nutrients. In particular, dilution and biodegradation are significant components not considered in this conceptual model that would reduce the concentrations of leachate material (i.e., pathogens and nitrate). The predicted concentrations are likely to be higher (conservative) than actual concentrations since the model does not account for these attenuation factors.

The model simulated 35 years of CSO operation. The model domain consisted of a grid 3,000 ft tall and 100 ft by 100 ft wide with 0.1 foot vertical and 1-foot horizontal resolution. For the top boundary condition, we represented cesspool discharge as pure leachate (i.e., concentration = 1) and the surrounding ground surface as recharging at 0.00014 ft/day of pure water (i.e., leachate concentration = 0), based on the <8 inches/year recharge rate at the summit of Maunakea.

The results indicate the leachate plume would travel downward to the dike-impounded groundwater level 3,000 ft below ground surface in 34 years (**Figure 33**). This travel time was determined based on the time it took for the unit concentration (i.e., the red color of **Figure 33**) to reach the bottom of the model boundary, representing the groundwater table depth. This equates to a vertical velocity of about 88 ft/year. Any leachate that percolated to the dike impounded groundwater table(s) would become part of the regional aquifer system between the CSO and Hilo (**Figure 21**).

Estimation of the travel time through the unsaturated zone is the first step. Next, we need to show the travel time though the saturated or phreatic zone. **Figure 21** illustrates two flow paths through the saturated zone. The range of estimated velocities and travel times for the vadose zone, the saturated or phreatic zone basal aquifer (Lau and Mink, 2006; Liu, 2007, Thomas et al., 1996), are shown in **Table 3.**

The estimated travel time for leachate from the CSO cesspool to the basal aquifer beneath the Hilo-Kaūmana area is estimated to range between 72 years to 412 years, based on the sum of travel times through Components A and B from **Figure 21** and **Table 3.** Regarding the deep aquifer flow path (Component C from **Figure 21** and **Table 3**), the groundwater travel time is estimated about 3,000 years from the peak of Maunakea to Hilo based on the age dating of groundwater from Thomas et al. (1996). The mean velocity of 50 ft/year for groundwater transport through Component C (**Table 3**) is a conservative estimate based on findings from Thomas et al. (1996). The earliest estimated arrival time for effluent from the Maunakea Summit in Hilo is 72 years. In other words, no effluent from the cesspool, even in miniscule amounts, has reached Hilo.

Table 3. Groundwater Velocity and Travel Time Estimates for Components of Regional Groundwater System Between the CSO and Hilo.

Component	Groundwater Velocity (feet/year)			Travel Distance (feet)	Travel Time (years)		
	Mean	Minimum	Maximum		Mean	Minimum	Maximum
A -Vadose zone	88	--	--	3,000	34	--	--
B - Basal aquifer	1,747	318	3,176	120,000	208	38	378
C - Deep aquifer	50	--	--	120,000	3,000	--	--

Notes:

Source for vadose zone: this report.

Sources for basal aquifer: Lau and Mink, 2006; Liu, 2007; Whittier, 2018b.

Source for deep aquifer: Thomas et al., 2016.

Groundwater recharge in the Onomea Aquifer System is very high when compared to the potential human-induced recharge of the cesspool at the CSO facility. The CSO cesspool may contribute up to 1,250 gal/mo or 0.0000417 mgd. The input from the CSO represents about 0.0000100% of the total recharge in the aquifer. Based on the groundwater recharge, hypothetical inflow from the CSO cesspool would be too diluted to measure when it reaches drinking water wells in the Hilo area.

4.3.2 Regional Scale Aquifers Surrounding CSO

We must also consider potential impacts to the environment and other drinking water sources around Maunakea. Groundwater flow emanates radially from the Maunakea peak. The regional flow path between the CSO and Hilo is analogous to other flow paths emanating radially outward from the CSO to the northwest and northeast (**Figure 34**).

For example, the Waimea Aquifer System is northwest of the Maunakea peak. The sustainable yield of the Waimea Aquifer System is 24 mgd (CWRM 2008). Engott (2011) estimated that the groundwater recharge is 35.62 mgd. Public water supply wells owned by the Waikoloa Water Company (PWS 135) and the Hawai'i Department of Water Supply (PWS 160) currently exist in the Aquifer. These wells are approximately 120,000 ft from the CSO (the wells are widely separated so this represents an average). The wells are potentially downgradient from the CSO and are in the Waimea aquifer system. Based on the basal groundwater velocities presented in **Table 3**, we estimate the minimum groundwater travel times from the CSO to these public water supply wells to be in the range of 70 to 400 years (similar to the Hilo travel times). Nitrate data from wells sampled from public water systems (PWS) #135, 160 are shown on **Tables 4** and **5,** respectively. Nitrate (as nitrogen) concentrations are consistently between 1 and 2 mg/L, still well below the MCL of 10 mg/L. Nitrate levels are also lower than the Hawai'i natural background level of 3 mg/L. Based on this information, there is no indication of impacts from the CSO cesspool. There are also no discernable impacts from other cesspools and OSDS in the Waimea Aquifer System.

Table 4. Nitrate results from municipal water supply wells in PWS 135 of Waikoloa Village, 1997-2013.

	PWS 135					
	8-5745-002	8-5745-003	8-5546-001	8-5546-002	8-5545-001	8-5745-004
	Parker 4	Waikoloa 1	Waikoloa 2	Waikoloa 3	Waikoloa 6	Waikoloa 7
Date Sampled	Nitrate as Nitrogen (mg/L)					
11/18/1997	--	1.3	1.3	1.3	--	--
7/28/1998	--	1.2	1.2	1.3	--	--
12/9/1998	--	--	--	1.3	--	--
5/11/1999	--	--	--	1.3	--	--
8/9/1999	--	1.2	1.2	1.3	--	--
10/4/1999	--	--	--	< 0.3	--	--
3/1/2000	--	--	1.2	1.3	--	--
3/8/2000	--	1.2	--	--	--	--
3/27/2001	--	1.2	1.3	1.4	--	--
4/15/2002	--	1.2	1.2	1.3	--	--
6/18/2003	--	1.2	< 0.3	1.3	--	--
6/15/2004	--	--	1.3	1.4	--	--
10/11/2004	--	1.2	--	--	--	--
5/24/2005	--	1.3	1.2	1.4	--	--
7/12/2006	--	1.3	1.2	1.3	--	--
3/28/2007	--	1.2	1.2	1.3	--	--
8/18/2008	--	--	--	--	1.1	--
2/10/2009	--	--	--	--	1.0	--
10/18/2010	1.4	--	--	--	--	--
1/18/2011	1.5	--	--	--	--	--
7/15/2013	--	--	--	--	--	1.4

Table 5. Nitrate Results from Municipal Water Supply Wells in PWS 160 Owned by the Hawai'i Department of Water Supply, 1998-2007.

	PWS 160						
	8-5946-001	8-5946-002	8-5946-003	8-5946-004	8-5846-001	8-5846-002	8-5846-003
	Lālāmilo A	Lālāmilo B	Lālāmilo C	Lālāmilo D	Parker 1	Parker 2	Parker 3
Date Sampled	**Nitrate as Nitrogen (mg/L)**						
7/28/1998	1.2	1.2	1.2	1.2	--	--	--
8/16/1999	1.2	1.2	1.2	--	--	--	--
10/20/1999	--	--	--	--	--	1.2	--
12/13/1999	--	--	--	--	--	1.2	--
2/23/2000	1.2	1.2	1.2	--	--	1.2	--
8/15/2000	--	--	--	--	1.2	--	--
4/17/2001	0.8	1.2	1.2	1.1	--	--	--
3/19/2002	1.3	1.3	1.3	1.2	--	1.3	--
9/17/2002	--	--	--	--	1.2	--	--
11/5/2003	1.2	1.2	1.2	--	1.2	1.2	--
12/9/2003	--	--	--	--	1.3	--	--
4/20/2004	1.2	1.2	1.2	--	1.2	1.2	--
6/15/2005	--	1.2	1.2	--	--	1.2	--
6/29/2005	--	--	--	--	1.2	--	--
12/5/2005	1.2	--	--	--	--	--	--
11/14/2006	1.2	1.2	--	1.2	--	1.2	--
3/21/2007	1.2	--	1.2	1.2	--	1.2	--
9/26/2007	--	1.3	--	--	--	--	--
4/21/2008	--	--	--	--	--	1.2	--
5/19/2008	--	--	--	--	1.2	--	--
1/26/2009	--	--	--	--	1.2	--	--
10/26/2010	--	--	--	--	--	--	1.3
1/18/2011	--	--	--	--	--	--	1.4

Waiki'i Ranch is located about 12 miles (66,000 ft) from the Maunakea peak. Based on the basal groundwater velocities presented in **Table 3,** we estimate the minimum groundwater travel times from the CSO to these public water supply wells to be in the range of 55 to 240 years. Nitrate levels (**Table 6**) in the Waiki'i Ranch wells are less than 2 mg/L NO_3-N. There is no indication of elevated nitrate levels.

Table 6. Nitrate Results from Municipal Water Supply Wells in PWS 162 of Waikoloa Village, 1998-2007.

	PWS 162	
	8-5239-001	8-5239-002
	Waiki'i 1	Waiki'i 2
Date Sampled	Nitrate as Nitrogen (mg/L)	
11/4/1997	1.5	--
7/27/1998	1.6	--
8/17/1998	1.6	1.7
11/24/1998	1.1	1.7
12/8/1998	1.1	1.7
8/11/1999	1.7	1.7
8/17/1999	1.7	1.6
3/8/2000	1.5	1.7
4/10/2001	1.6	1.8
4/8/2002	1.4	1.7
7/16/2003	1.4	1.7
6/28/2004	1.5	1.7
4/11/2005	1.4	1.7
8/2/2006	1.7	1.7
3/28/2007	1.4	1.6

To the northeast, Pa‘auilo is about 85,000 ft downgradient from the CSO. The sustainable yield of the Pa'auilo Aquifer System is 60 mgd (CWRM 2008) and the estimated recharge is 120.86 mgd (Engott 2011). The estimated groundwater travel times from the CSO to Pa'auilo are between 60 and 300 years based on the maximum and minimum groundwater velocities from Table 3 and 85,000 ft straight-line distance between the two locations. Nitrate data from the municipal Pa'auilo supply well are consistently 1.4 mg/L (**Table 7**), indicating no impact from the CSO cesspool.

Table 7. Nitrate Results from Municipal Water Supply Wells in PWS 134 of Waikoloa Village, 1998-2007.

	PWS-134
	8-6223-001
	Pa'auilo
Date Sampled	Nitrate as Nitrogen (mg/L)
5/5/2004	1.4
4/13/2005	1.4
10/23/2006	1.4
2/28/2007	1.4

It is extremely unlikely that leachate from the CSO will impact the regional aquifer beneath Hilo and the other regional aquifers near the communities of Waikoloa Village and Pa'auilo (**Figure 34**). The dike-impounded groundwater beneath the summit of Maunakea is a leaky system that flows radially in all directions away from the summit and CSO. This distribution of flow directions means a contaminant that is introduced to the dike-impounded groundwater system could be transported radially, in several directions from the Maunakea summit area. Abundant groundwater recharge would dilute the contaminants introduced in the summit area. Additionally, biodegradation processes would result in some uptake of nitrogen.

It is unlikely that any pathogens from the CSO will reach the regional aquifer system. Pathogens from wastewater have been known to degrade by 10^{-5} (five orders of magnitude) within 92 days of travel time (Crockett, 2007). This means that the unit concentration of pathogens would be 0.00001 after 92 days. During this time, the attenuation factors mentioned above would reduce the mass of the leachate. Any leachate flowing through the regional aquifer system would be subject to dispersion with more travel distance. Below approximately 7,000 ft-msl elevation, groundwater recharge is substantial (~100 inches/year) and would dilute any leachate (i.e., nitrate) that manages to travel that far. It is extremely unlikely that leachate from the CSO would affect drinking water sources in Hilo. This report discusses cesspools and drinking water quality data from the Kaūmana study in Section 4.4.

4.3.3 Local Scale (CSO to Lake Waiau and Springs)

There is concern that leachate from the CSO may impact the culturally significant Lake Waiau or impact Hopukani, Waihū and Liloe springs (collectively the "Pōhakuloa Springs"; (**Figure 22**), which is adjacent to the Pōhakuloa Gulch There is a concern that during large rainfall, surface water from the CSO site may discharge into Pōhakuloa Gulch. Ehlmann et al. (2006) found, based on topographic watershed analysis, that the CSO is not in the Waiau drainage basin, but in the Pōhakuloa Gulch watershed. There is no direct evidence of a saturated groundwater connection between the CSO site and Pōhakuloa Gulch, but the surface water connection indicates that there may be a hydraulic connection during heavy rainfall and runoff periods. Note that there is no documentation that surface water runoff from the CSO reaches the gulch, but it is theoretically possible as ascertained from analysis of topographic data.

The potential for groundwater hydraulic connection between Lake Waiau and the downslope springs (i.e., Waihū) was first proposed by Woodcock (1980). In addition, Woodcock found a correlation between Lake Waiau water levels and flow from the springs. INTERA observed overflow from Lake Waiau into the gulch on November 9, 2018.

There is a possibility that there is a surface water connection between the CSO and the Pōhakuloa Springs. If this is the case, then there is a possibility that leachate from the cesspool may reach the groundwater supplying the springs. If leachate is significantly affecting water quality in the springs, then there should be indications in spring water quality. INTERA obtained nitrate data from the HDOH. Nitrate water quality data sampled from the springs six times between 2009 and 2013 range between 0.3 and 0.58 mg/L (**Table 8**). Natural background nitrate in Hawai'i is probably about 0.5 mg/L, although in some places it may be as high as 4 mg/L (HDOH, 2018). Nitrate levels in the springs are at background level and do not show influence from contamination.

Table 8. Nitrate in the Pōhakuloa Springs.

	Nitrate as Nitrogen	Nitrate + Nitrite
Date Sampled	(mg/L)	
4/29/2009	0.48	--
9/9/2009	0.30	0.30
2/22/2010	0.49	0.49
5/23/2011	0.56	0.56
3/6/2012	0.57	0.57
6/4/2013	0.58	0.58

Source: Rob Whittier of the State of Hawai'i Department of Health Safe Drinking Water Branch (email October 12, 2018)

4.4 Kaūmana OSDS Comparison

The influence of potential contaminant flux from the single CSO cesspool on the regional aquifer is small compared to the total contaminant flux from cesspools and other OSDSs. The following section includes calculations of the contaminant flux from cesspools in the Kaūmana area of Hilo. In addition, we look at nitrate data in neighboring wells. It is important to note that the CSO cesspool is not currently in use and is slated for closure and filling, but the cesspools in Kaūmana and adjacent regions are still in operation. There are nearly 88,000 known cesspools in the State of Hawai'i. The total effluent discharge from these cesspools is about 53 mgd. About 49,300 cesspools serve 82,000 housing units on Hawai'i Island (HDOH, 2017). Cesspool effluent can be a significant threat to human health and to sensitive ecosystems. Cesspool effluent has not been formally treated in an engineered system and contains pathogens and nutrients such as nitrogen and phosphorus. Cesspool effluent may percolate into the groundwater system and enter water supplies or discharge via groundwater to streams and coastal waters. The Hawai'i legislature has begun to address the challenge of upgrading cesspools by prioritizing the hazard from cesspools and initiating methods to help encourage people to upgrade their cesspools to safer ODSDs.

In order to constrain our comparison of the discontinued CSO cesspool with the cesspool challenge on Hawai'i Island we have limited our study area to the cesspools in the potential impact area of four public water supply wells (**Figure 20**). These wells belong to the Hawai'i Department of Water Supply (HDWS) and include Saddle Road Deepwell (8-4110-001), Pi'ihonua #1 C (8-4208-001), and Pi'ihonua #3 A&B (8-4306-001 and 002). The Saddle Road Deepwell and Pi'ihonua #1 are the furthest inland and are less subject to contamination from cesspools. Pi'ihonua #3 A & B are downgradient of numerous cesspools, indicating that these are more vulnerable to contamination, if there is any measurable impact. **Figure 35** shows the area used for our comparison in Kaūmana and neighboring communities.

We created a polygon encompassing the cesspools that may influence the HDWS wells introduced in the previous paragraph (**Figure 35**). There are about 1,000 cesspools (class IV OSDS) in this part of Kaūmana. We did not consider other types of OSDS, only cesspools. The HDOH has calculated the effluent loading rates from these cesspools. The effluent (leachate) loading rates vary from 200 to 1,400 gallons per day (gpd) (6,000 to 42,000 gal/mo) from each cesspool. The average nitrogen loading rate from a single cesspool varies from 0.05-0.32 kg/day. The total discharge from the cesspools in our Kaūmana study area is 680,000 gallons/day of effluent (**Figure 35**). This discharge includes 155 kg/day of nitrogen (**Figure 36**). For comparison, the assumed cesspool leachate discharge rate at the CSO was 42 gpd, with a range of nitrogen loading rates of 0.01 kg/day to 0.017 kg/day (0.014 kg/day on average). The discharge rate of the CSO was de minimis compared to the total discharge in the Kaūmana area.

Despite the large effluent and nutrient flux from the cesspools in the Kaūmana area, there is no discernable impact to nitrate concentrations in the HDWS wells. **Table 9** shows recent nitrate levels in our study area wells. The nitrate levels in wells were all under 0.5 mg/L, which is at the lower end of nitrate background (i.e., natural) levels in Hawai'i groundwater (HDOH, 2018). Nitrate background levels in Hawai'i are less than 3 mg/L NO_3-N. The state and federal maximum contaminant level (MCL) for nitrate in drinking water is 10 mg/L (as nitrogen). The maximum nitrate concentrations from the wells in our study area were between 1997 - 2017 were 0.42 mg/L, with mostly non-detect results (<0.05 mg/L) (**Table 9**). These low concentrations are most likely the consequence of the enormous amount of recharge in the Onomea Aquifer System. Engott (2011) estimated the baseline recharge at 417 mgd. The lower nitrate concentrations observed in Kaūmana water supply wells suggests that dilution from high groundwater flows is an important factor in mitigating the impact of cesspools. Whittier and El Kadi (2014) also concluded that dilution is an important factor in determining risk from cesspools.

Table 9. Nitrate Results from Municipal Water Supply Wells in Kaūmana, 1998-2007.

	State Well ID / Name			
	8-4110-001	8-4306-001	8-4306-002	8-4208-001
	Saddle Road	Pihonua #3 A	Pihonua #3 B	Pihonua #1 C
Date Sampled	Nitrate as Nitrogen (mg/L)			
5/19/1998	--	--	--	0.30
7/15/1998	--	< 0.30	0.38	0.31
6/22/1999	--	0.39	0.38	0.31
10/11/1999	--	--	< 0.30	--
2/22/2000	--	0.38	0.38	0.30
3/28/2001	--	0.38	0.38	< 0.30
6/18/2003	0.40	0.38	0.40	0.32
4/19/2004	0.40	0.37	0.38	< 0.30
11/8/2004	< 0.30	< 0.30	0.38	< 0.30
3/30/2005	0.41	0.38	< 0.30	0.30
6/19/2006	0.42	0.38	0.38	0.31
2/27/2007	0.42	0.38	0.38	0.31

Source: Rob Whittier of the State of Hawai'i Department of Health Safe Drinking Water Branch (email October 12, 2018)

4.5 Leachate Conclusions

There is concern that regional and local water supplies may be affected by the CSO cesspool. Potentially affected wells include water supply wells located around Maunakea, including drinking water wells in Hilo. Closer to the CSO, there is also concern that local surface water and shallow groundwater of nearby Lake Waiau and the Pōhakuloa Springs may be affected by the cesspool.

There is virtually no potential for leachate impact to drinking water supplies of Hilo or other communities around Maunakea, based on the long groundwater travel times, and the substantial amount of groundwater recharge and dilution. Despite the more than 1,000 cesspools located in Kaūmana **(Figures 35** and **36**), water supply wells in the area have nitrate (as nitrogen) concentrations less than 0.5 mg/L, which is lower than both the general Hawai'i background level of less than 3 mg/L, and the Federal MCL of 10 mg/L.

In addition, nitrate data from water supply wells in the communities surrounding Maunakea show no sign of impact. Leachate transport through the 3,000 ft of unsaturated volcanics separating the CSO from the dike-impounded groundwater is calculated to take a minimum of 34 years. This calculation does not consider perching layers, dispersion, adsorption, chemical attenuation, or biodegradation factors. Thereafter, if any leachate were to enter the dike-impounded groundwater, contaminants would have to travel 12 to 24 miles to drinking water wells while getting significantly diluted from recharge and groundwater underflow. For example, the estimated travel times to Hilo vary from 72 to 3000 years. Slower groundwater velocities have been calculated for the deep groundwater flow systems system of Maunakea that were discovered below Hilo. Groundwater flowing between the CSO and Hilo is subject to substantial amounts of recharge, which would dilute potential contamination.

There is virtually no potential for leachate impact to Lake Waiau or the Pōhakuloa Springs based on the lack of hydraulic connection between these water bodies and the CSO and the low nitrate levels from the springs.

5.0 FILL ANALYSIS

5.1 Introduction

Approximately 2,335 cubic yards of fill were used to construct the CSO, and the maximum depth of the fill is about 10 ft deep on the downhill side of the facility. The origin of the fill was not documented and, depending on the decommissioning alterative implemented, the CSO permit conditions may require the fill to be removed from the CSO site. It is possible that the fill used was from the summit area (Laupāhoehoe Volcanics), but it is also possible that the fill came from further down the mountain in the Hāmākua Volcanics or from a quarry in Mauna Loa lavas. The problem is that the fill may have to be returned to the volcano from where it originated. The generally accepted hypothesis is that the fill came from the Laupāhoehoe Volcanics of Maunakea, near the summit.

A total of four (4) samples were obtained for geochemical analysis (**Figure 37**). Three (3) samples were obtained from the underlying fill. These provide information to characterize the geochemical composition of the fill. One (1) sample was obtained from a lava flow that was immediately adjacent to the CSO site to provide compositional data on the Laupāhoehoe Volcanics. The four (4) samples were collected and analyzed in accordance with the Sampling and Analysis Plan (SAP) (INTERA, 2018).

5.2 Methods

5.2.1 Field Sampling and Descriptions

Field sampling occurred on November 9, 2018 by a Professional Geologist, Kevin Gooding of INTERA, using the "Judgmental Sampling" methodology (EPA, 2002). Sample selection was made based on knowledge of the geology and fill under investigation. Four (4) samples were collected: three (3) from the fill (CSO-F-1, CSO-F-2, and CSO-F-3) and one (1) from an adjacent native lava flow (CSO-N-1) (**Figure 37** and **Table 10**). The fill samples were located around the CSO property and all samples were collected from hand dug holes, one (1) foot bgs on average. The native lava flow sample location was chosen based on recommendation from Mr. Fritz Klasner. Mr. Klasner noted that a portion of the lava flow adjacent to the CSO Site had been removed in order to widen the access road at about the same time the CSO was constructed.

Table 10. Sample Types and Locations.

Sample	Location	Type	Location Description
CSO-F-1	19.822490° - 155.475771°	Fill	Approximately 70 feet west of the CSO
CSO-F-2	19.822693° - 155.475739°	Fill	Approximately 90 feet north northwest of the CSO; 28 feet north of the cesspool manhole.
CSO-F-3	19.822366° - 155.475380°	Fill	Approximately 18 feet southeast of the CSO.
CSO-N-1	19.822440° - 155.474727°	Lava flow	North side of the Maunakea Road, 250 feet downhill (east) of the centerline of the CSO driveway.

The general lithology of the fill material was determined with observations from six (6) randomly located holes dug to various depths, ranging from 0.8 to 1.5 ft below the top of the fill surface. Fill-clast lithology was described using terminology consistent with Compton (1985) and Wentworth and MacDonald (1953). Lithology of the native lava flow sample (CSO-N-1) was also described. Lithologic descriptions of the four (4) samples are presented in Section 1.3.1. These three (3) fill and one (1) native rock samples were stored in double-bagged Ziploc® packaging and labeled for shipment for geochemistry analyses. Duplicate field samples were not necessary.

5.2.2 Geochemical Analyses

The four (4) samples were shipped to the Washington State University (WSU) GeoAnalytical Lab in Pullman, Washington, via overnight freight (FedEx) with a chain-of-custody (COC) form for major and minor oxide and trace element geochemical analysis using x-ray fluorescence (XRF). Samples were dried prior to submittal to the WSU GeoAnalytical Lab. XRF analysis was conducted using a low (2:1) lithium-tetraborate fused bead technique developed in-house at the WSU GeoAnalytical Lab (Johnson et al., 1999) to get percent composition (by weight) for 29 elements: silicon, aluminum, titanium, iron, manganese, calcium, magnesium, potassium, sodium, phosphorus scandium, vanadium, nickel, chromium, barium, strontium, zirconium, yttrium, rubidium, niobium, gallium, copper, zinc, lead, lanthanum, cesium, thorium, neodymium, and uranium. These elements are reported in oxide (mineral) form because this is a byproduct of the ignition process used to get percent composition. A duplicate lab analysis was made on fill sample CSO-F-2 for quality assurance and quality control (QA/QC).

5.3 Results

Sample lithology descriptions and geochemical compositions for the four (4) samples collected at the CSO Site (**Figure 37)** are presented in this section.

5.3.1 Field Descriptions

Lithological descriptions of the fill material from CSO-F-1 through CSO-F-3 rock samples are as follows.

5.3.1.1 CSO-F-1

This sample was collected from 0.5 ft below the top of the fill surface (**Figures 38** and **39**). The fill was composed of crushed compacted cinders with occasional fragments of dense lava. Three (3) approximately 4-inch diameter rocks were encountered. The sample submitted to the WSU GeoAnalytical Lab was an aphanitic piece of vesicular basalt, with very small glassy, green phenocrysts that appear to be olivine.

5.3.1.2 CSO-F-2

This sample was collected from approximately 1 foot below the top of the fill surface (**Figure 340**). The fill was composed of compacted cinders and dense lava fragments with fragments up to five (5) inches in diameter. Three (3) pieces of dense, aphanitic black dense lava that were 2 to 4 inches in diameter were collected.

5.3.1.3 CSO-F-3

This sample was collected from 1.3 ft below the top of the fill surface (**Figures 41** and **42**). The fill was composed of compacted dense lava fragments and cinders. Two (2) boulder-sized fragments were encountered in the hole, with the larger fragment being greater than 1-ft diameter.

5.3.1.4 CSO-N-1

This sample was collected from an a'a lava flow exposed approximately 250 ft east of the CSO Site (**Figures 43** through **45**). A portion of this lava flow was excavated (removed) to widen the existing road about the same time as the CSO facility was built. The central portion of this a'a lava flow consists of dense, aphanitic, fine-grained lava with very small plagioclase phenocrysts, which impart a silvery sheen to fresh hand samples. This a'a lava flow has ice polishing on its undisturbed upper surfaces. The top of this flow consists of flow-generated clinker (a'a lava) that is very porous and could be mistaken for cinders (air-fall tephra). The sample was collected in-situ, and jointed lava immediately below the clinker flow top. The texture of the selected sample was vesicular and aphanitic.

5.3.2 Geochemistry

The unnormalized percent composition (by weight) of major oxides are listed in **Table 11** along with the sum of percentages and loss-on-ignition (LOI) percentages. The ten (10) major oxides listed in descending order of abundance are: silicon (Si), aluminum (Al), iron (Fe), titanium (Ti), manganese (Mn), magnesium (Mg), calcium (Ca), sodium (Na), potassium (K), and phosphorus (P). Selected major oxides proved to be diagnostic for the purposes of this investigation (see below).

Table 11. Unnormalized Percent Composition of Major Elements for Each of the CSO Rock Samples.

	Sample			
	CSO-F-1	CSO-F-2	CSO-F-3	CSO-N-1
Major Oxide	Unnormalized Percent Composition (by weight)			
SiO2	52.27	52.06	49.23	50.97
TiO2	2.36	2.33	2.86	2.44
Al2O3	17.36	17.20	17.55	17.34
FeO*	9.61	9.63	11.05	10.08
MnO	0.22	0.22	0.21	0.22
MgO	3.02	3.40	3.96	3.39
CaO	6.34	6.19	6.78	6.23
Na2O	4.97	4.79	4.10	4.87
K2O	2.09	2.11	1.65	2.06
P2O5	0.95	0.96	0.87	0.99
Sum	99.22	98.89	98.26	98.59
LOI	0.28	0.32	1.01	0.79

The LOI values indicate how much mass was lost during analyses. Typically, LOI values greater than 1.5% suggest the sample may have experienced significant alteration. All four (4) samples were considered acceptable. As a QA/QC check for laboratory analyses, we compare the relative percent difference (RPD) in percent composition for each major oxide in the CSO-F-2 sample versus a duplicate analysis. The unnormalized baseline and duplicate percent compositions and RPDs for CSO-F-2 are provided in **Table 12.** The ® denotes that a duplicate bead made from the same rock powder and analyzed.

Table 12. Baseline and Duplicate (®) CSO-F-2 Unnormalized Percent Compositions for Each Major Oxide with Corresponding Relative Percent Differences. (RPD)

	Sample		
	CSO-F-2	CSO-F-2®	RPD
Major Oxide	Percent (%)		
SiO2	52.06	52.01	0.10
TiO2	2.33	2.34	0.43
Al2O3	17.20	17.17	0.17
FeO	9.63	9.58	0.52
MnO	0.22	0.22	0.00
MgO	3.40	3.38	0.59
CaO	6.19	6.20	0.16
Na2O	4.79	4.79	0.00
K2O	2.11	2.11	0.00
P2O5	0.96	0.96	0.00
Sum	98.89	98.76	0.13
LOI	0.32	0.32	0.00

RPDs for all major oxides are well below 1%, indicating the laboratory analytical approach meets the QA/QC criteria. Since the data meet field and lab QA/QC requirements, we can normalize percent compositions relative to the mass remaining after analysis, as shown on **Table 13.**

Table 13. Normalized Percent Composition of Major Oxides for Each of the CSO Rock Samples.

	Sample			
	CSO-F-1	CSO-F-2	CSO-F-3	CSO-N-1
Major Oxide	Normalized Percent Composition (by weight)			
SiO2	52.69	52.65	50.11	51.69
TiO2	2.38	2.36	2.92	2.47
Al2O3	17.50	17.39	17.86	17.58
FeO	9.69	9.74	11.25	10.23
MnO	0.22	0.22	0.21	0.23
MgO	3.05	3.43	4.03	3.44
CaO	6.39	6.26	6.90	6.32
Na2O	5.01	4.84	4.17	0.94
K2O	2.11	2.13	1.68	2.09
P2O5	0.96	0.97	0.88	1.01
Total	100.00	100.00	100.00	100.00

Normalized percent compositions are most suitable for comparison of samples. CSO-F-3 has the lowest amount of SiO_2 and highest amount of FeO. The comparison of subtle differences between each sample's elemental composition is most intuitively done with a plot, presented and discussed in the following section.

5.4 Discussion

5.4.1 Geochemistry

Wolfe et al. (1997) used the classification scheme of Le Bas et al. (1986) to define Maunakea lava flow types. This classification system plots total alkali (Na_2O + K_2O) versus silica ($Si0_2$). We plotted total alkali (Na_2O + K_2O) versus silica ($Si0_2$) for the four (4) samples collected in this study on the diagram used by Wolfe et al. (1997; Figure 5 on p. 17) to distinguish Hāmākua and Laupāhoehoe Volcanics. We also added the "general field extents" of the Hāmākua and Laupāhoehoe Volcanics defined by Wolfe et al. (1997) to our **Figure 46.** All four (4) analyzed CSO samples plot within the Laupāhoehoe Volcanics field defined by Wolfe et al. (1997). Samples CSO-F-1, CSO-F-2, and CSO-N-1 are fairly closely clustered, suggesting that they are very likely "related", possibly even produced by the same eruptive event. Sample CSO-F-3 doesn't cluster with the other three (3) samples and is compositionally different enough to suggest that it isn't related to the other three (3) samples. For example, CSO-F-3 (**Table 11**) has much higher TiO_2, FeO, MgO, & CaO and lower SiO_2, Na_2O, K_2O, & P_2O_5 than the other three (3) samples – which makes it a Hawaiite, while the other three (3) samples are mugearite. This Hawaiite sample may represent a piece of tephra from one of the adjacent cinder cones. All four (4) samples likely came from the area around the CSO facility, since two (2) of the three (3) fill samples are compositionally similar to the nearby Laupāhoehoe lava flows. Lastly, we compare these findings via geochemical analyses with rock descriptions from the field campaign.

5.4.2 Field Descriptions

The determination that all three (3) fill samples and the native lava flow sample belong to the Laupāhoehoe Volcanics (hawaiite and mugearite) using geochemical analyses is consistent with the general field lithologic descriptions of the samples. The road-cut through the Laupāhoehoe lava flow is likely the main source of the fill. This supports the interpretation that fill material is sourced from local, native volcanics adjacent to the CSO Site near the summit of Maunakea.

5.5 Conclusion

Based on the lithologic descriptions and geochemical analyses of the three (3) fill samples and one (1) sample from an adjacent a'a lava flow, the fill material at the CSO Site is determined to be sourced from Laupāhoehoe Volcanics which underlies Maunakea summit area. Much of the CSO Site fill was likely originally sourced from an excavation in a Laupāhoehoe lava flow during widening of the main road. Other components of the fill are probably tephra from one of the nearby Laupāhoehoe cinder cones.

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7.0 FIGURES

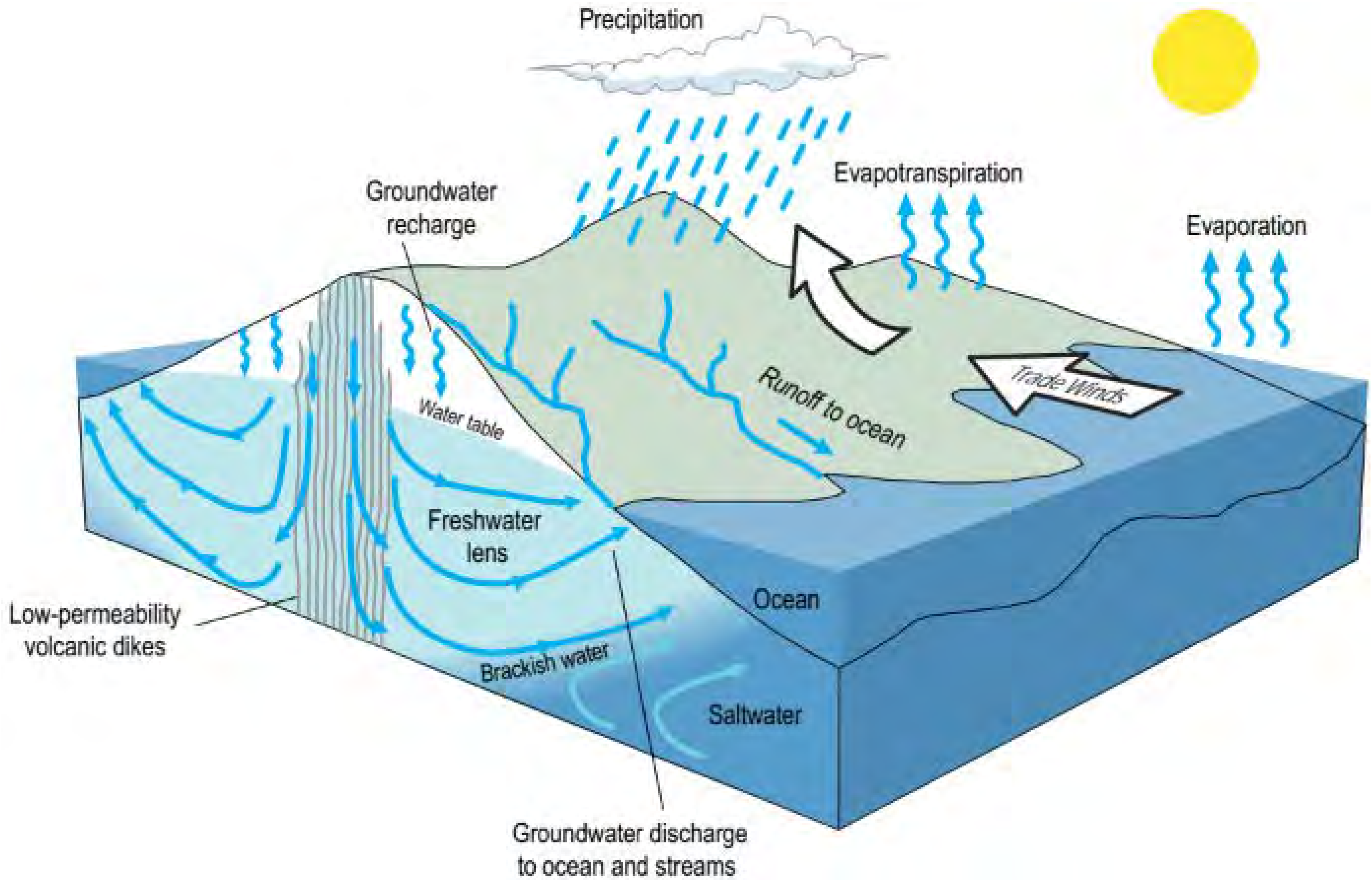

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Figure 1. Conceptual Model of Hawaiian Island Hydrologic Cycle (Izuka et al., 2018).

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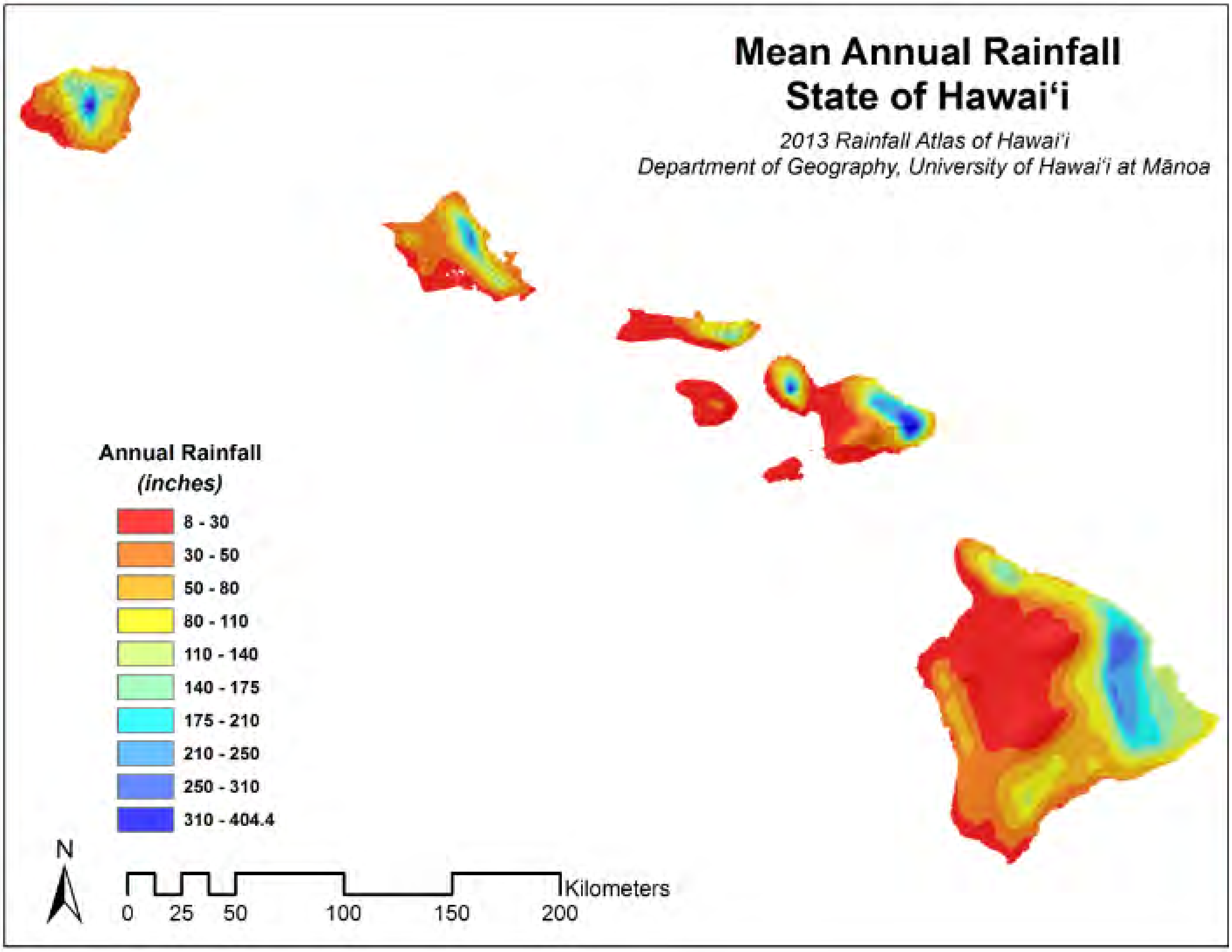

Figure 2. Distribution of Rainfall Throughout the Hawaiian Islands (Giambelluca, et al. 2013).

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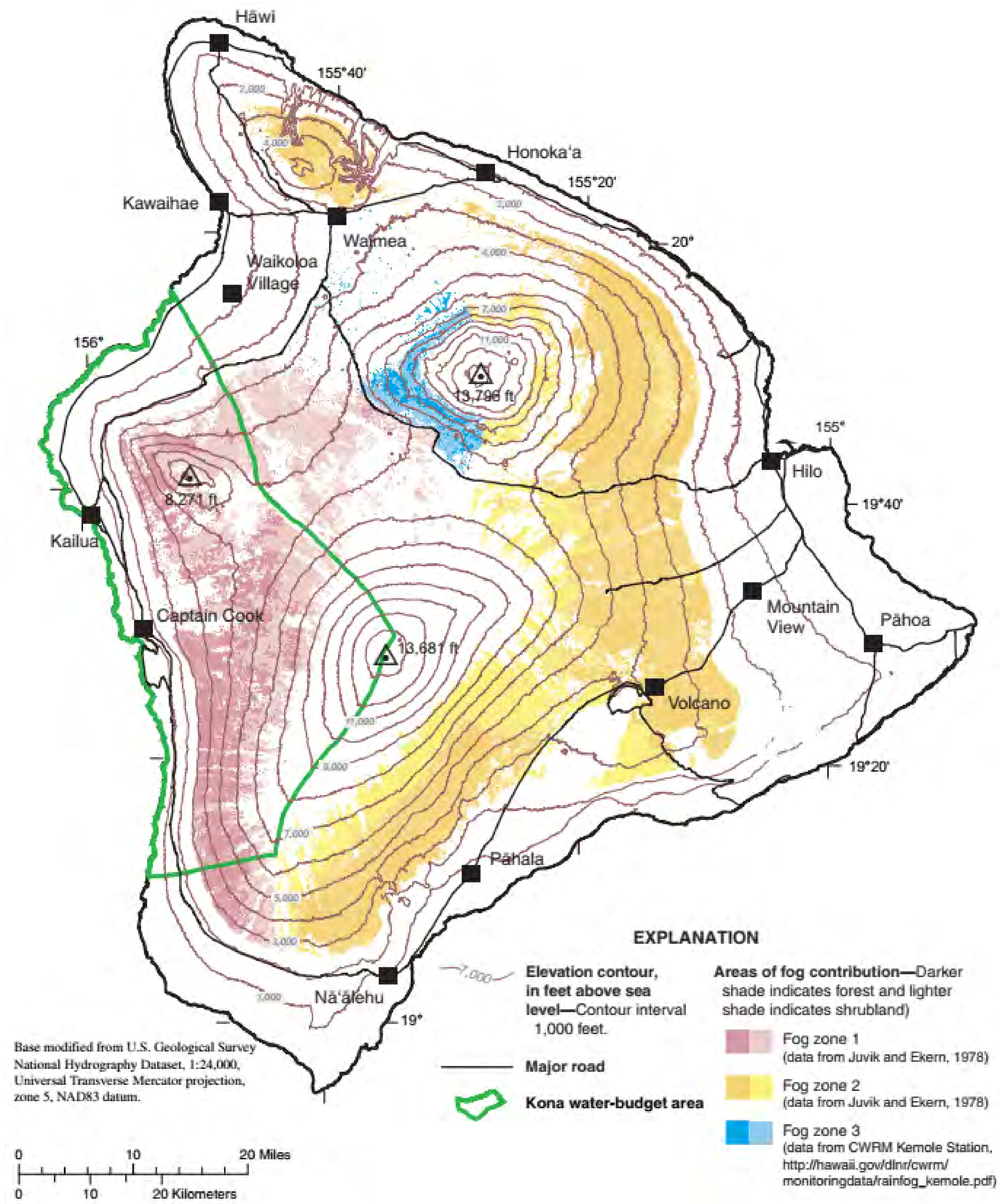

Figure 3. The Distribution of Fog Zones on Hawai'i Island (Engott, 2011).

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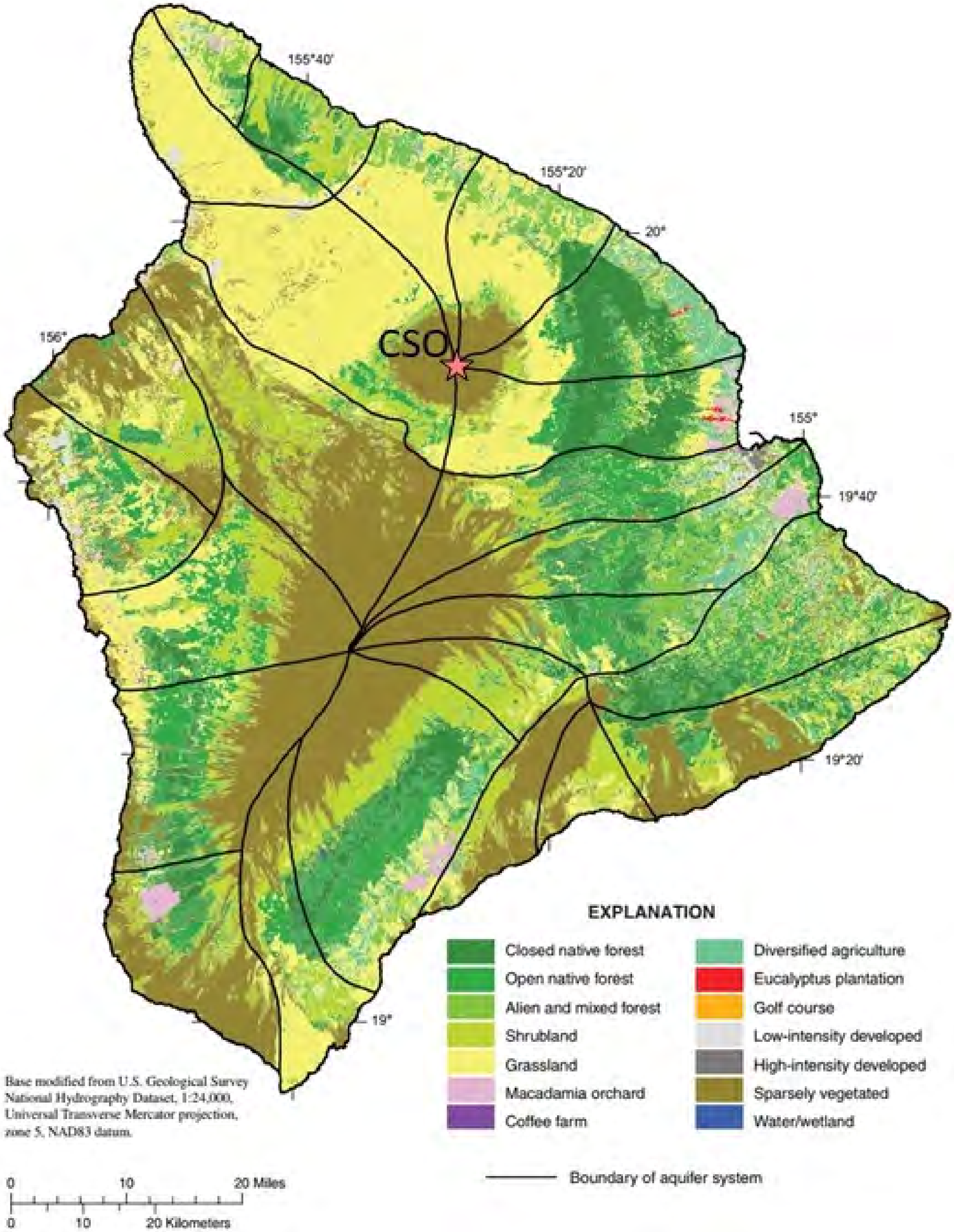

Figure 4. The Distribution of Vegetation on the Island of Hawai'i (Engott, 2011).

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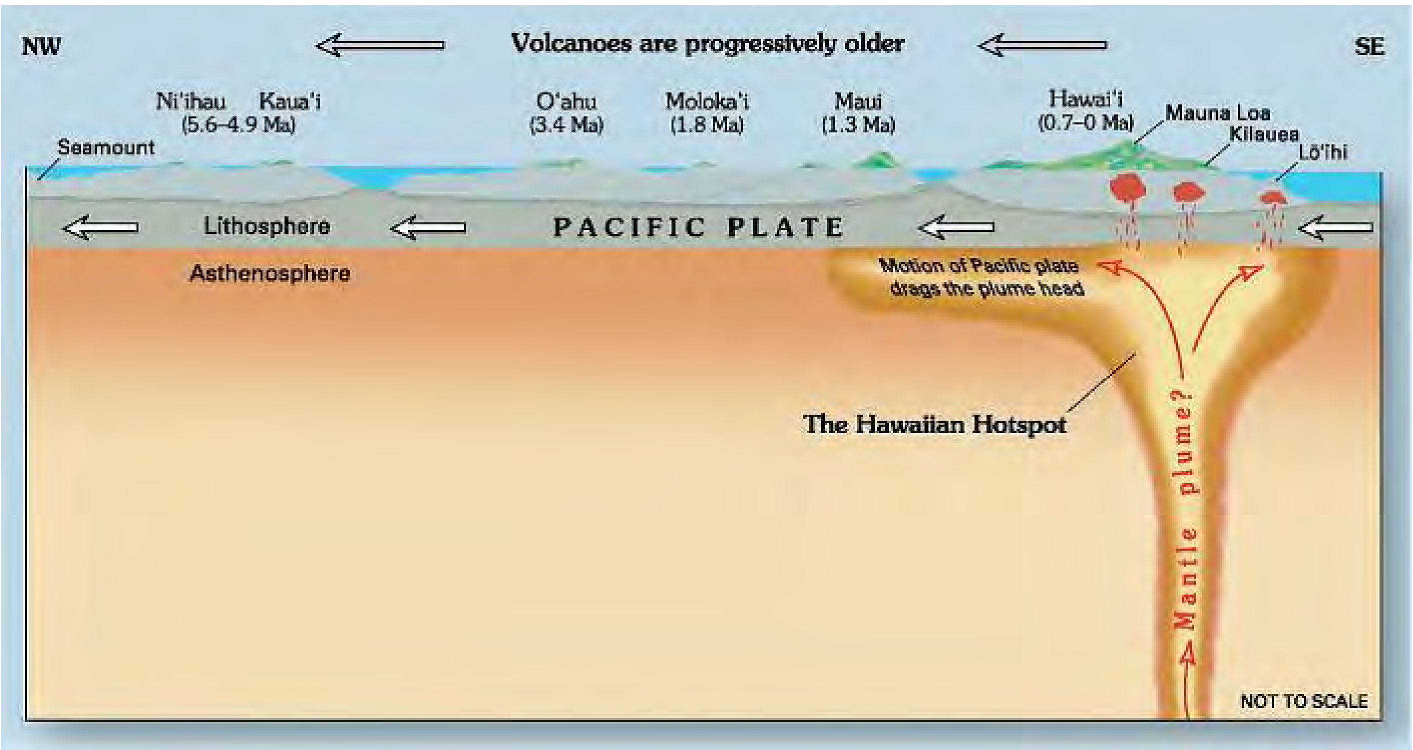

Figure 5. Conceptual Model for the Hawaiian Hot Spot (Thomas 2018a)

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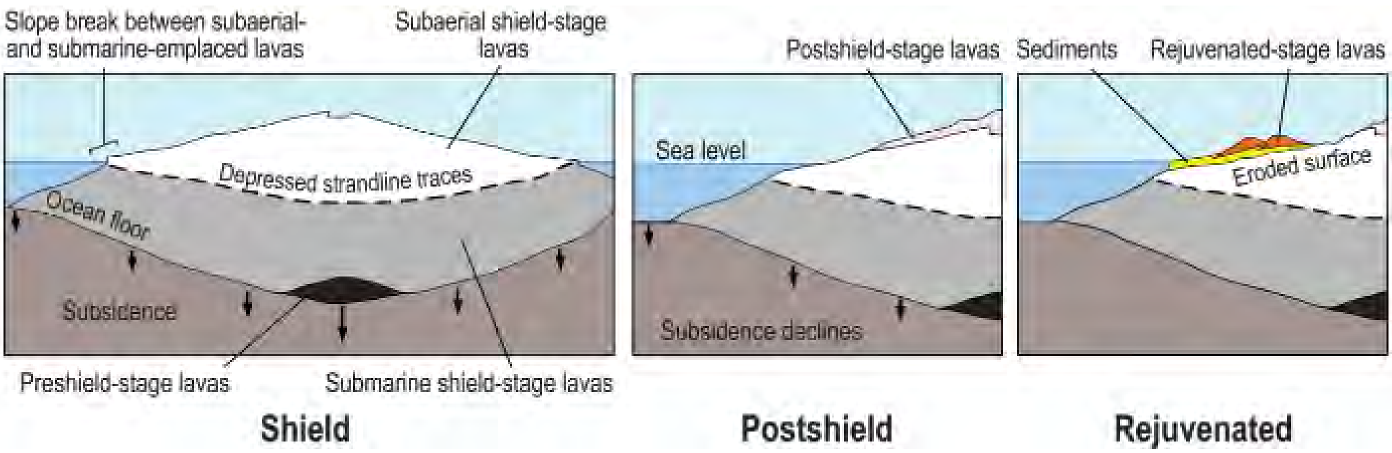

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Figure 6. Conceptual Model for Stages of Hawaiian Volcanism (Izuka et al., 2018).

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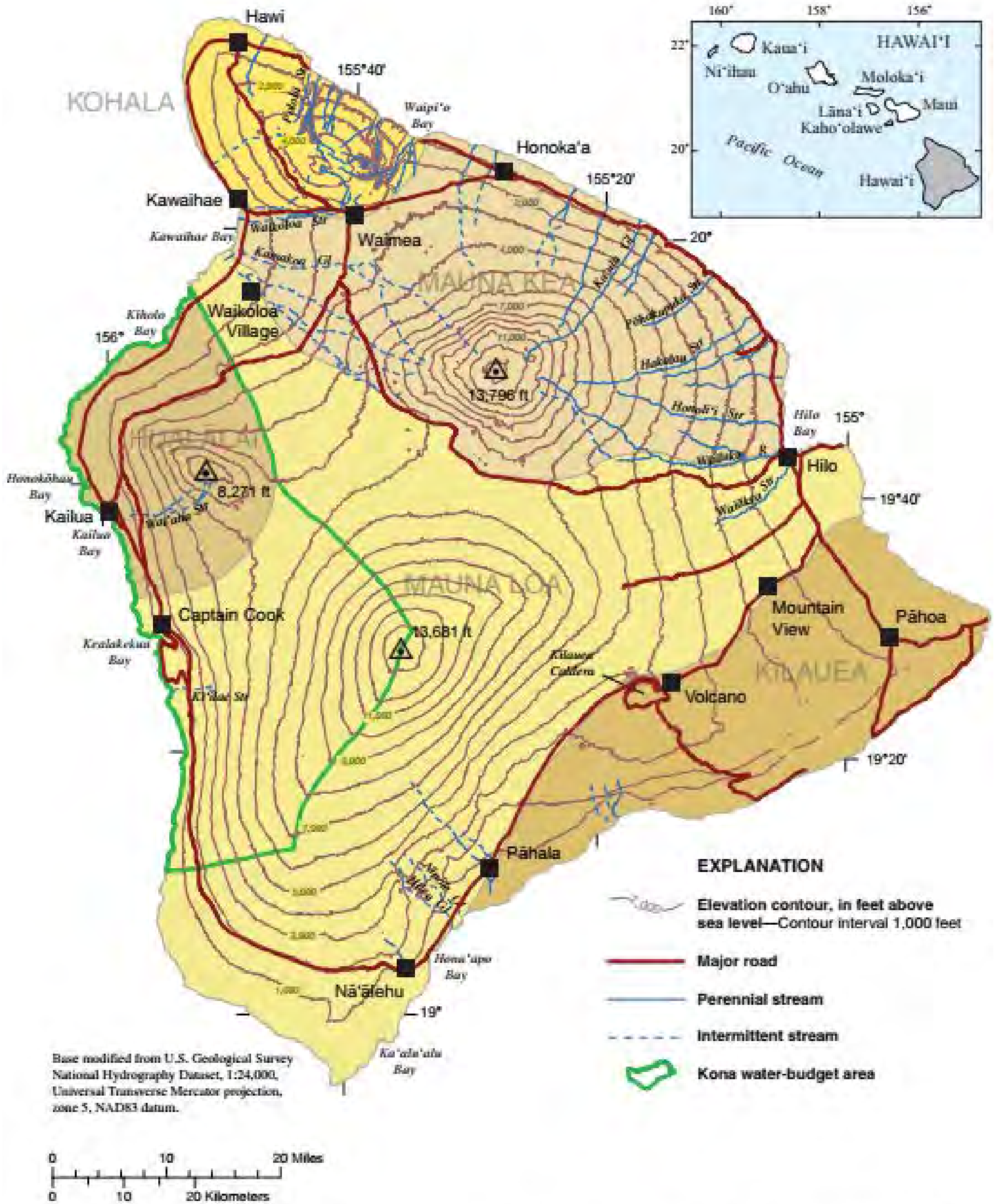

Figure 1. Major geographical features and the generalized extent of the surface rocks of the five volcanoes (colors) that form the Island of Hawai'i. (Modified from State of Hawai'i, 2008).

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Figure 7. Physiologic Map with Streams for Island of Hawai'i (Engott, 2011).

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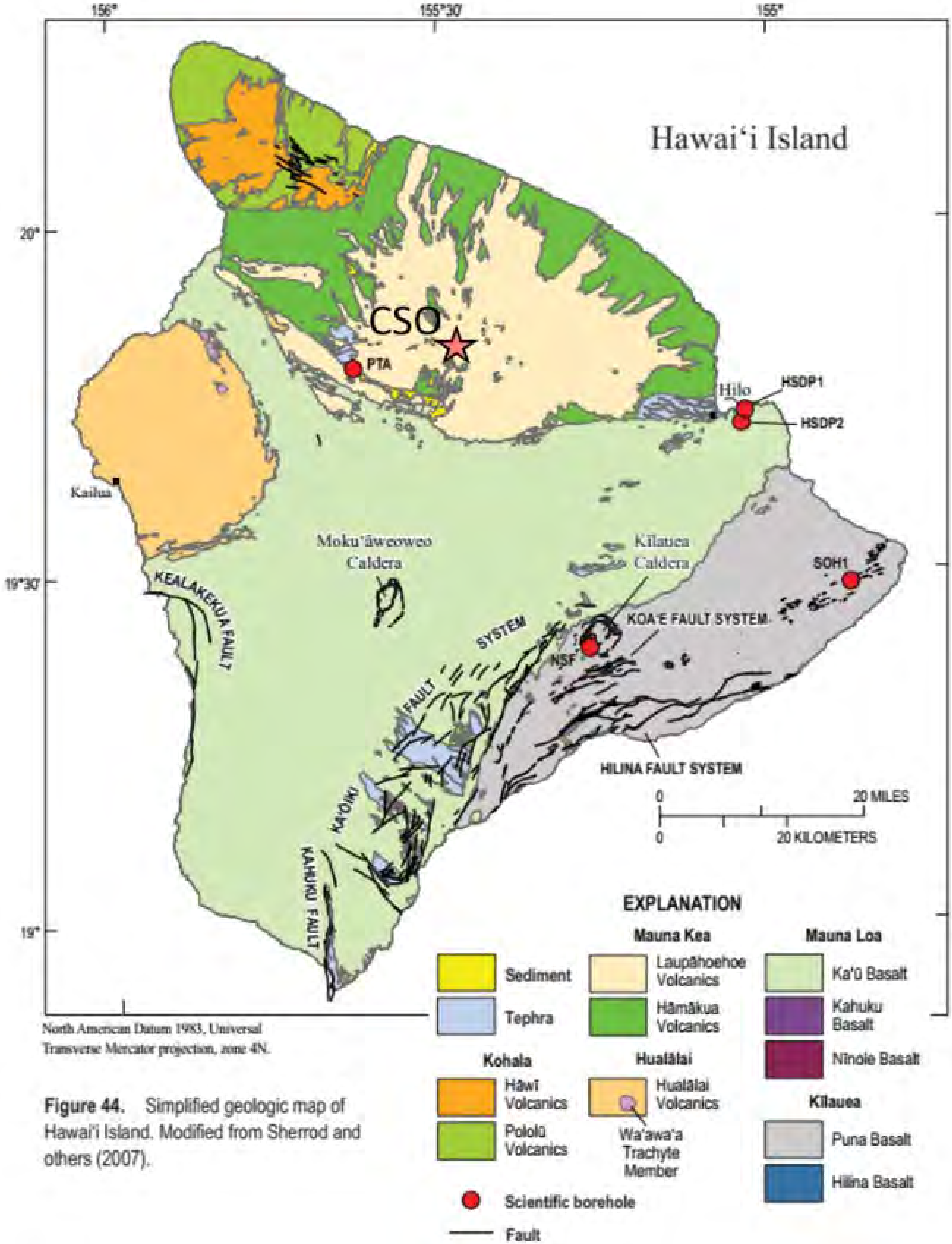

Figure 44. Simplified geologic map of Hawai'i Island. Modified from Sherrod and others (2007).

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Figure 8. Simplified Geology Map with Locations of Scientific Borings (Izuka et al. 2018).

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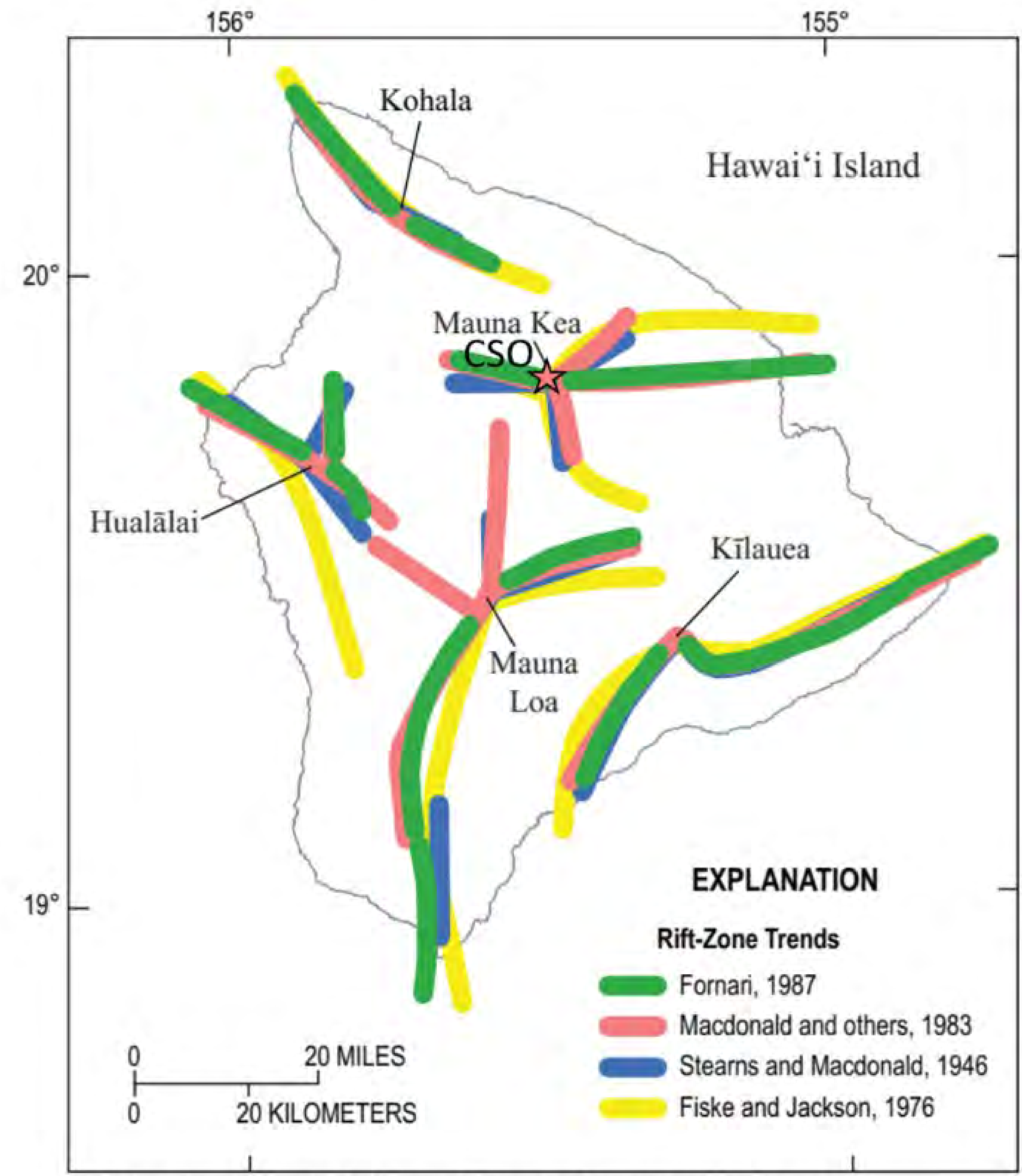

North American Datum 1983, Universal Transverse Mercator projection, zone 4N.

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Figure 9. Island of Hawai'i Rift Zones (Izuka et al., 2018).
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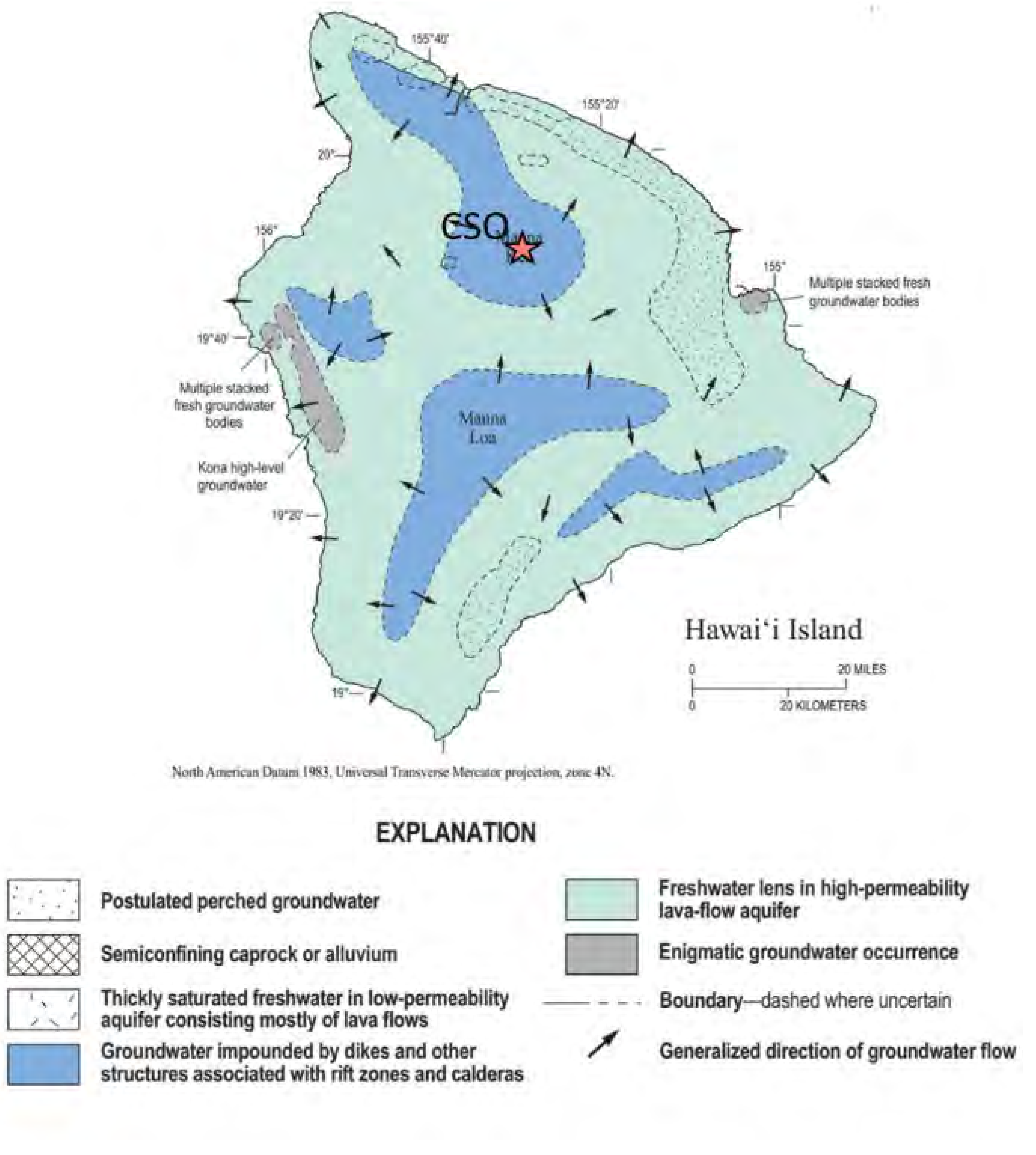

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Figure 10. Conceptual Model of Groundwater Systems Throughout the Island of Hawai'i (Izuka et al., 2018).

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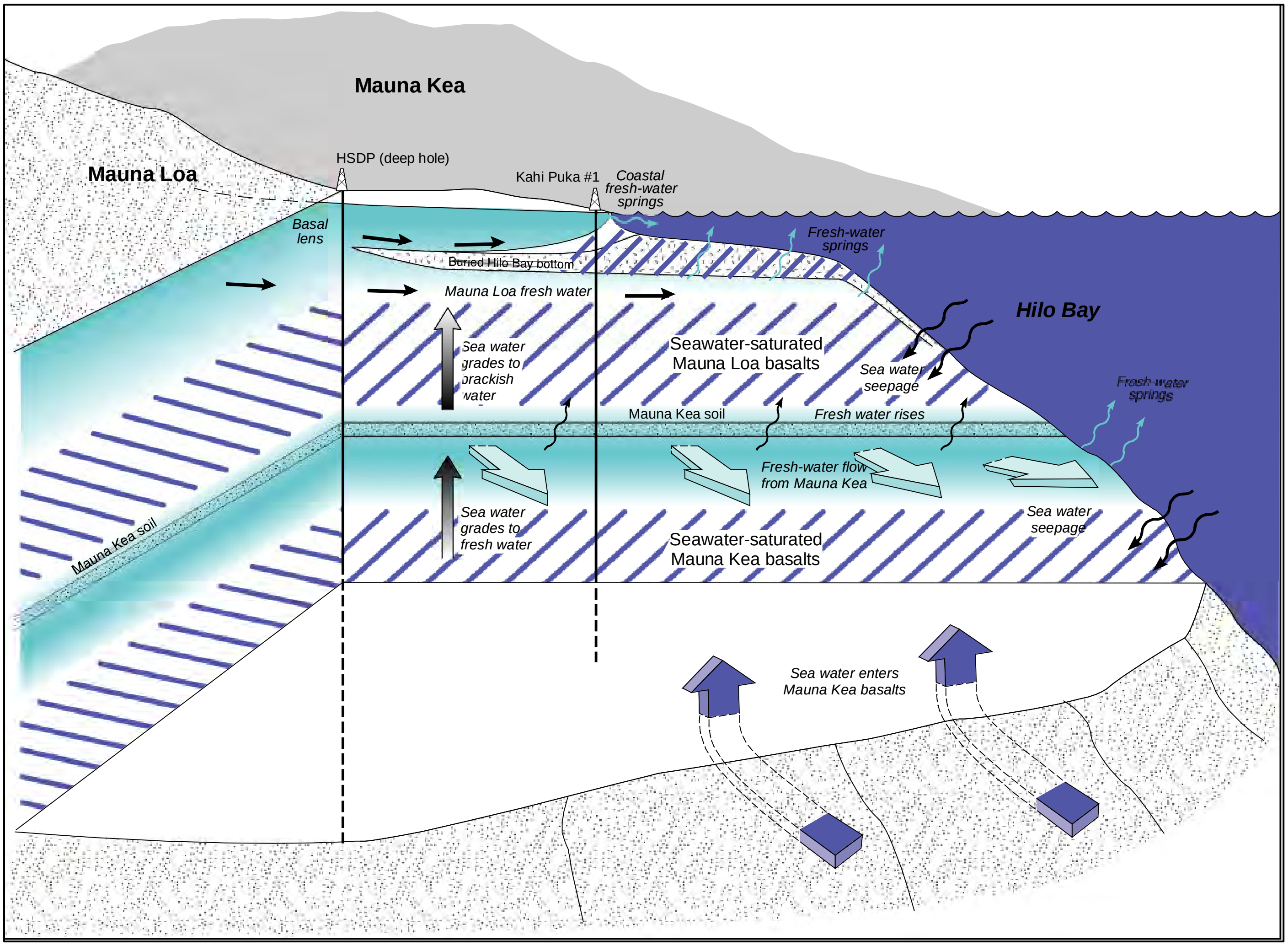

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Figure 11. Conceptual Model of Stacked Freshwater Bodies (Thomas 2018a).

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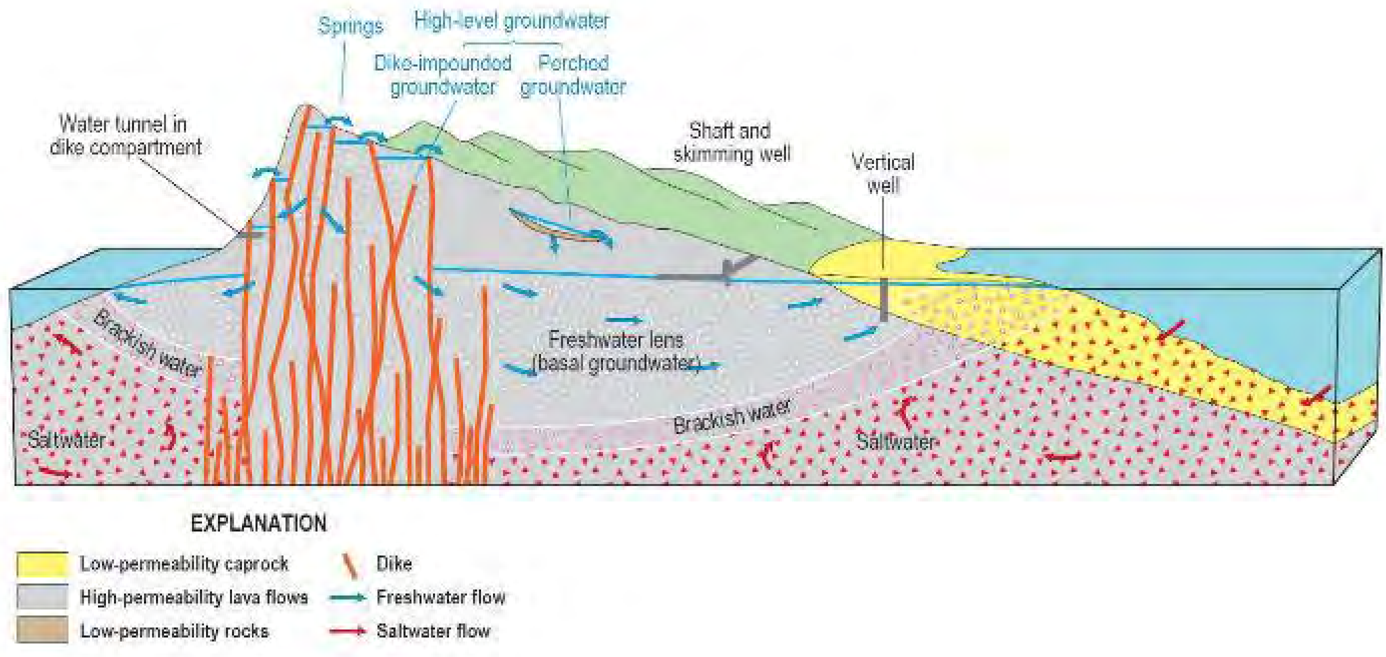

Figure 12. Conceptual Model of Groundwater Occurrence and Flow in Hawai'i Developed in the Middle 20th Century (Izuka et al., 2018).

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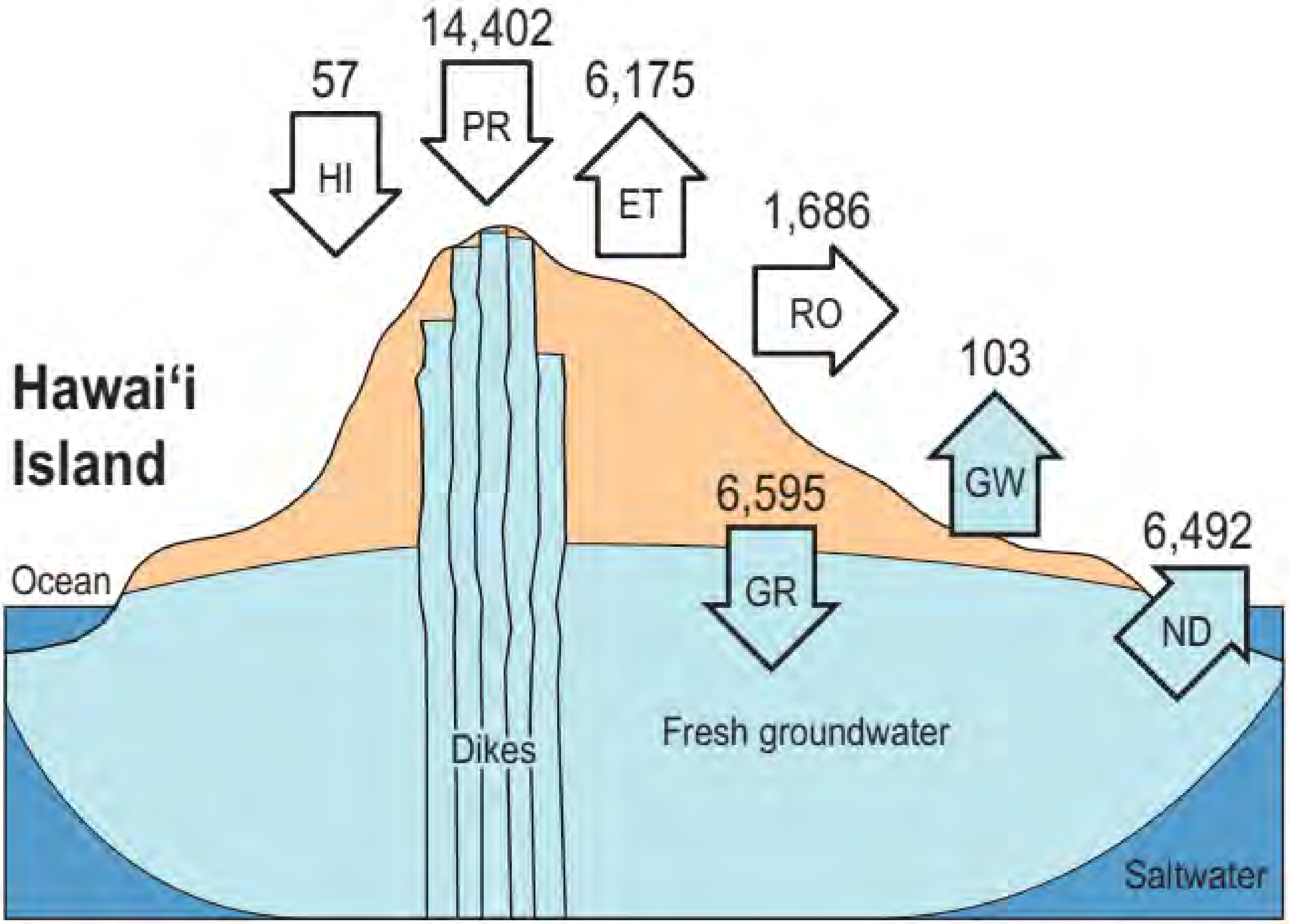

Figure 13. Water Budget Schematic for Hawai'i Island (Izuka et al., 2018).

Hydrogeological and Geological Evaluation
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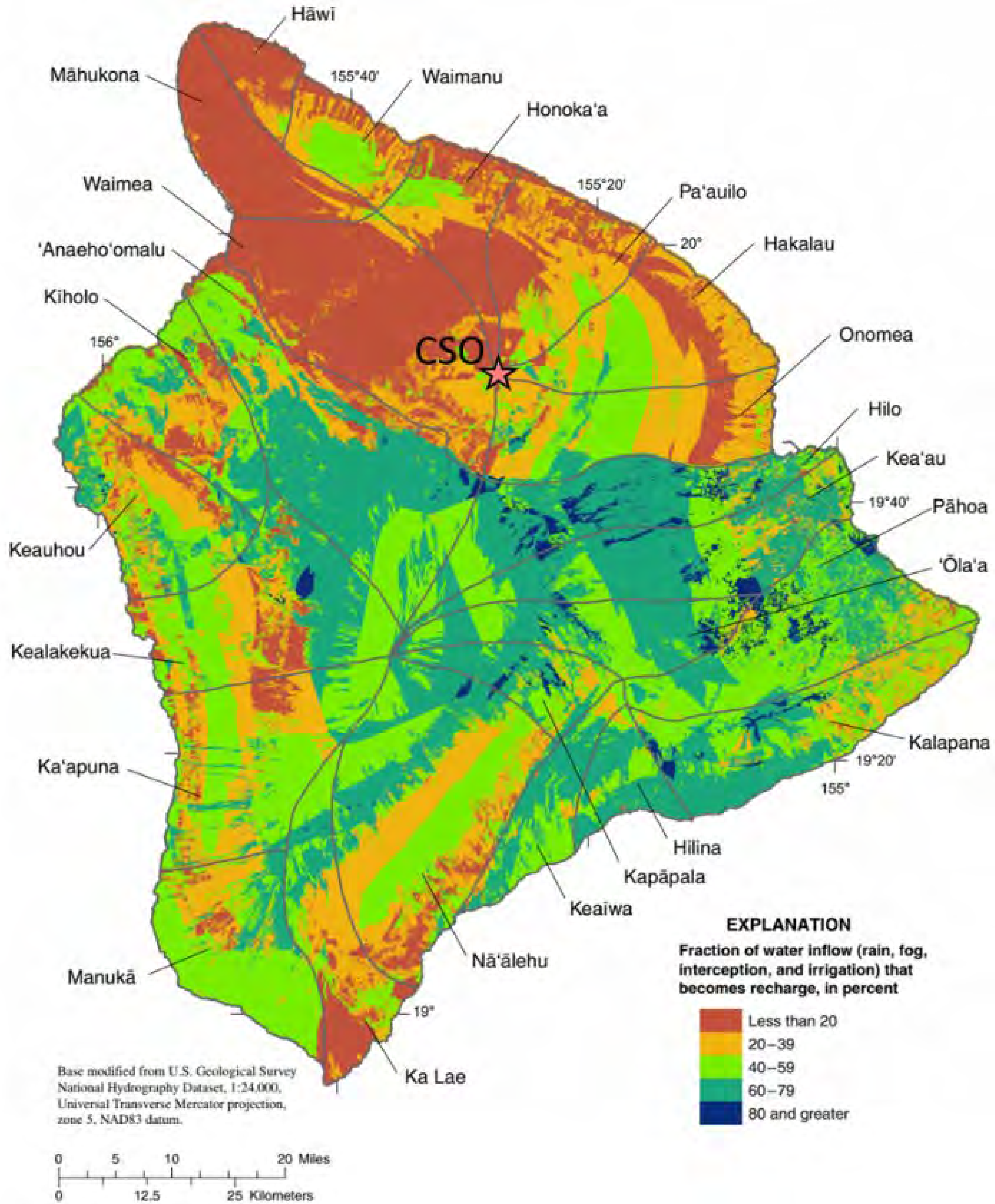

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Figure 14. Fraction of Precipitation that Becomes Recharge on Hawai'i Island (Engott, 2011).

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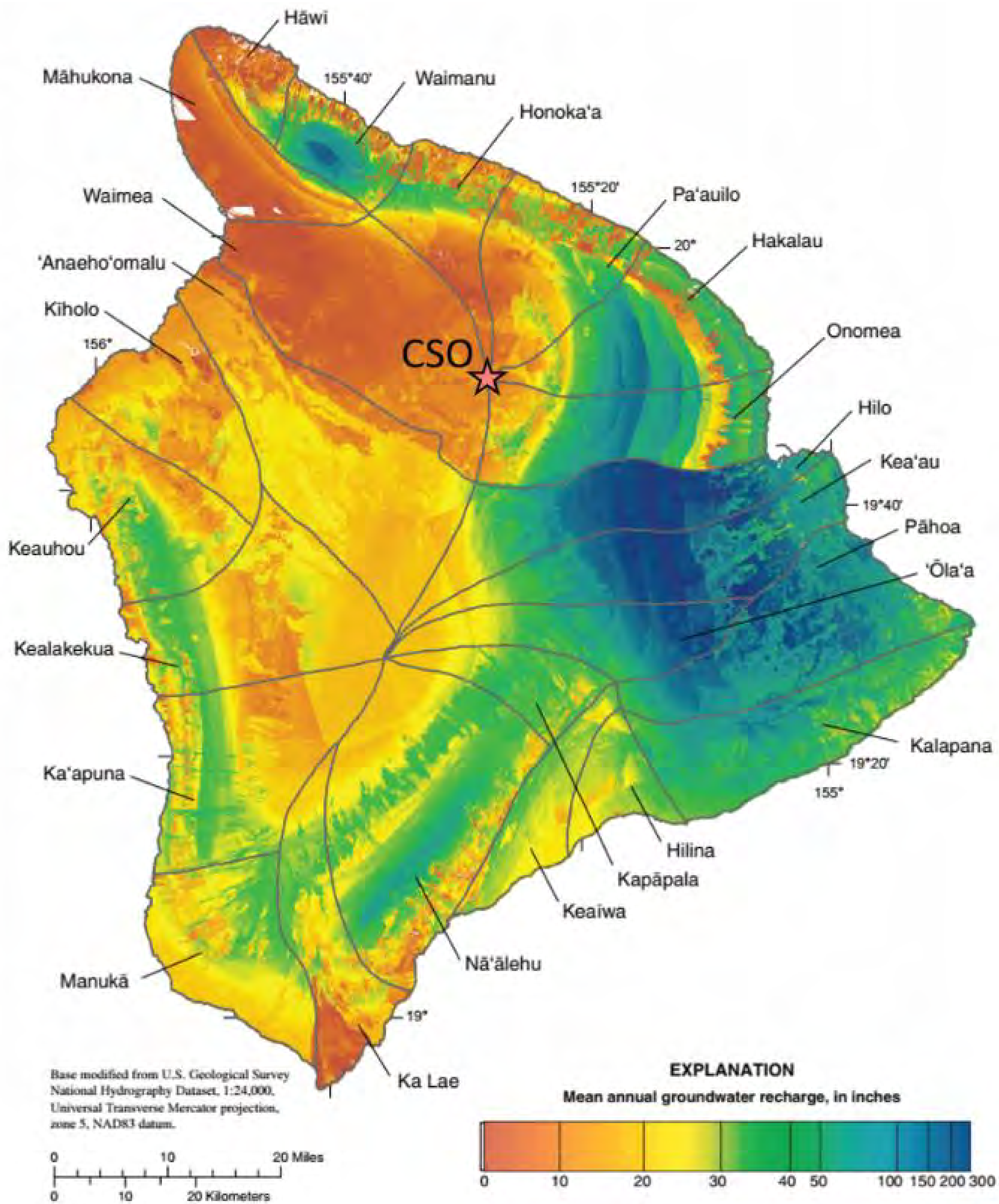

Figure 15. Distribution of Recharge through Hawai'i Island (Engott, 2011).

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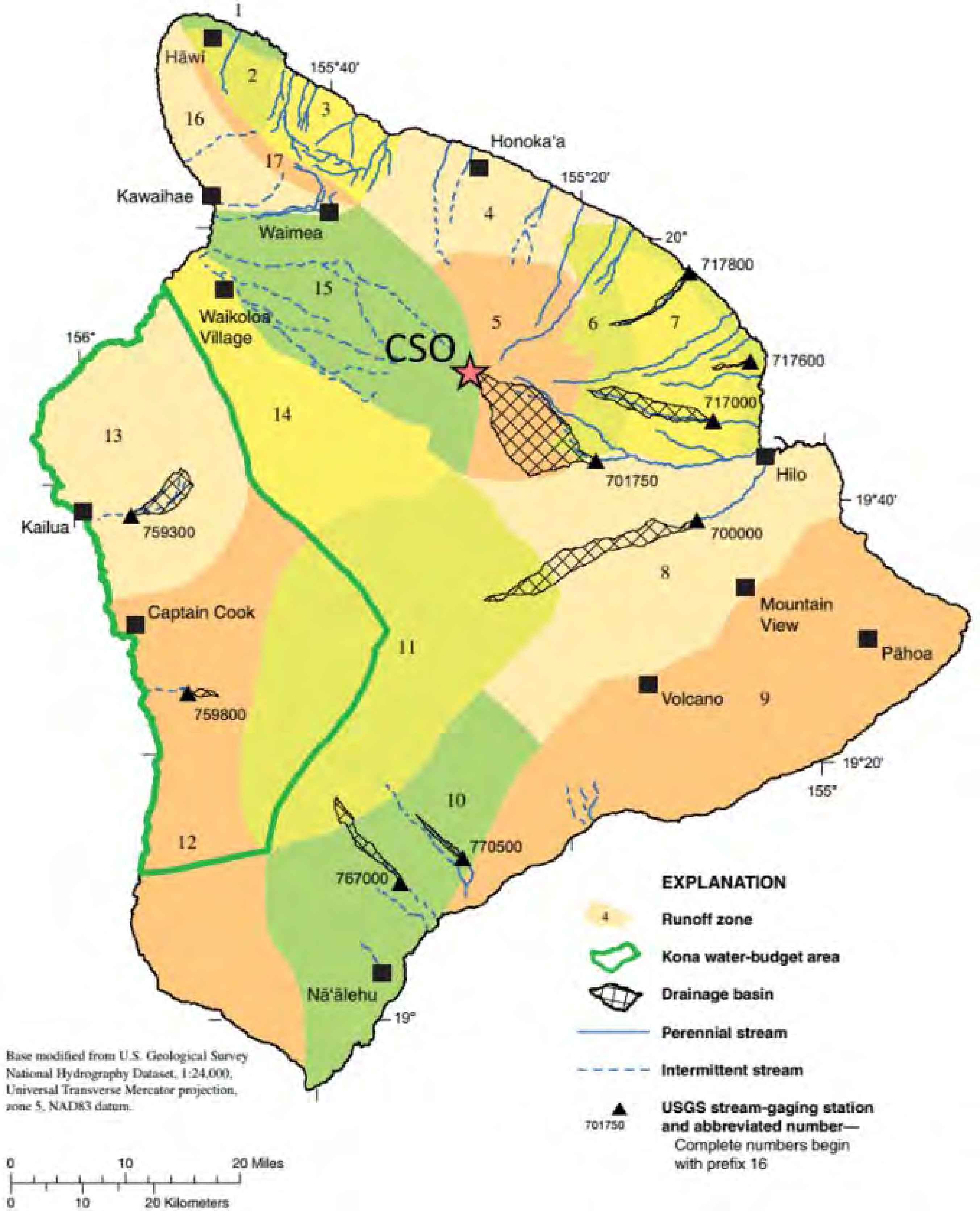

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Figure 16. Zonation Used for Hawai'i Island Water Budget by the U.S. Geological Survey (Engott, 2011).

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Decommissioning of the Caltech Submillimeter Observatory

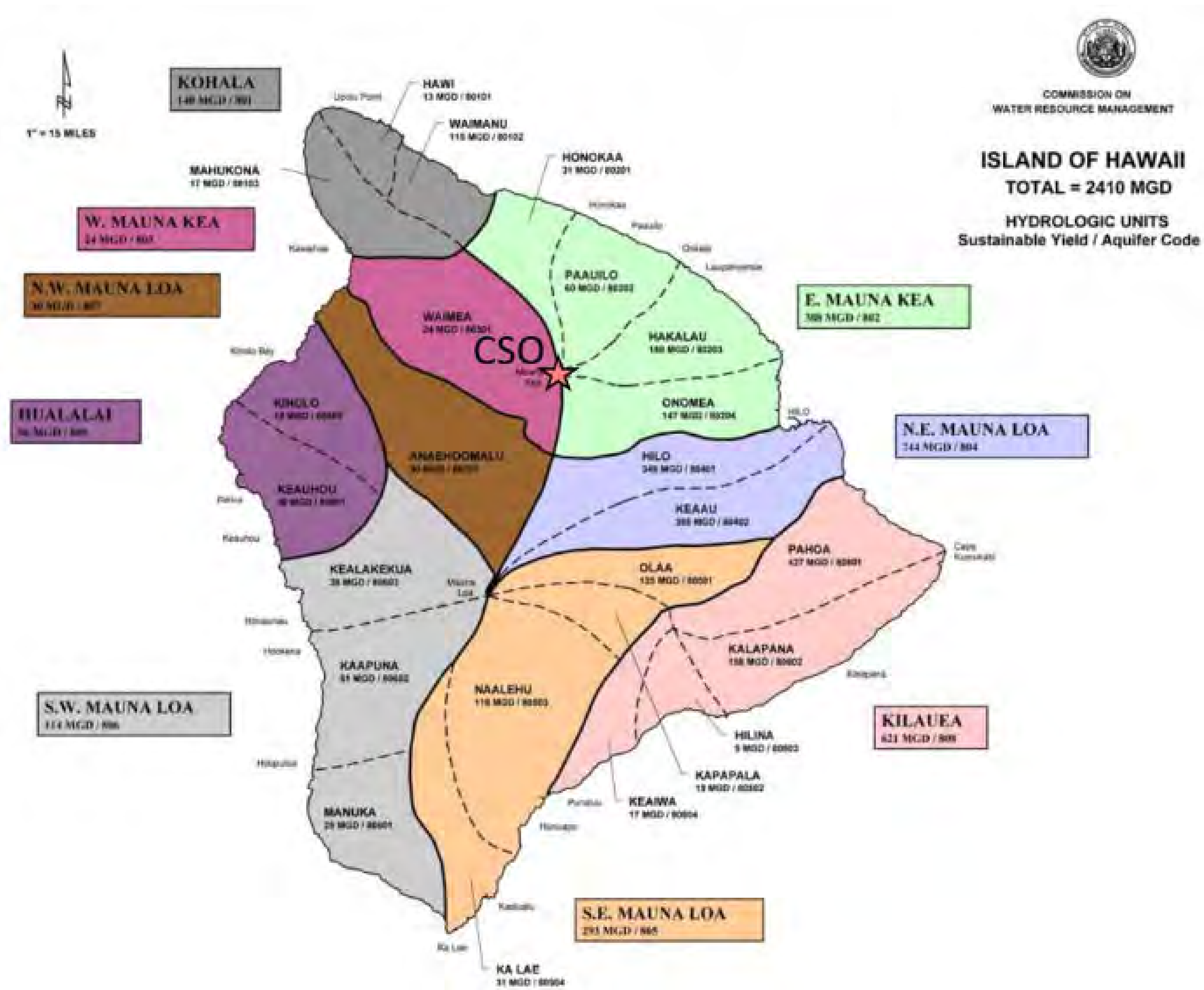

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Figure 17. Island of Hawai'i Hydrologic Units and Sustainable Yield (CWRM, 2008).

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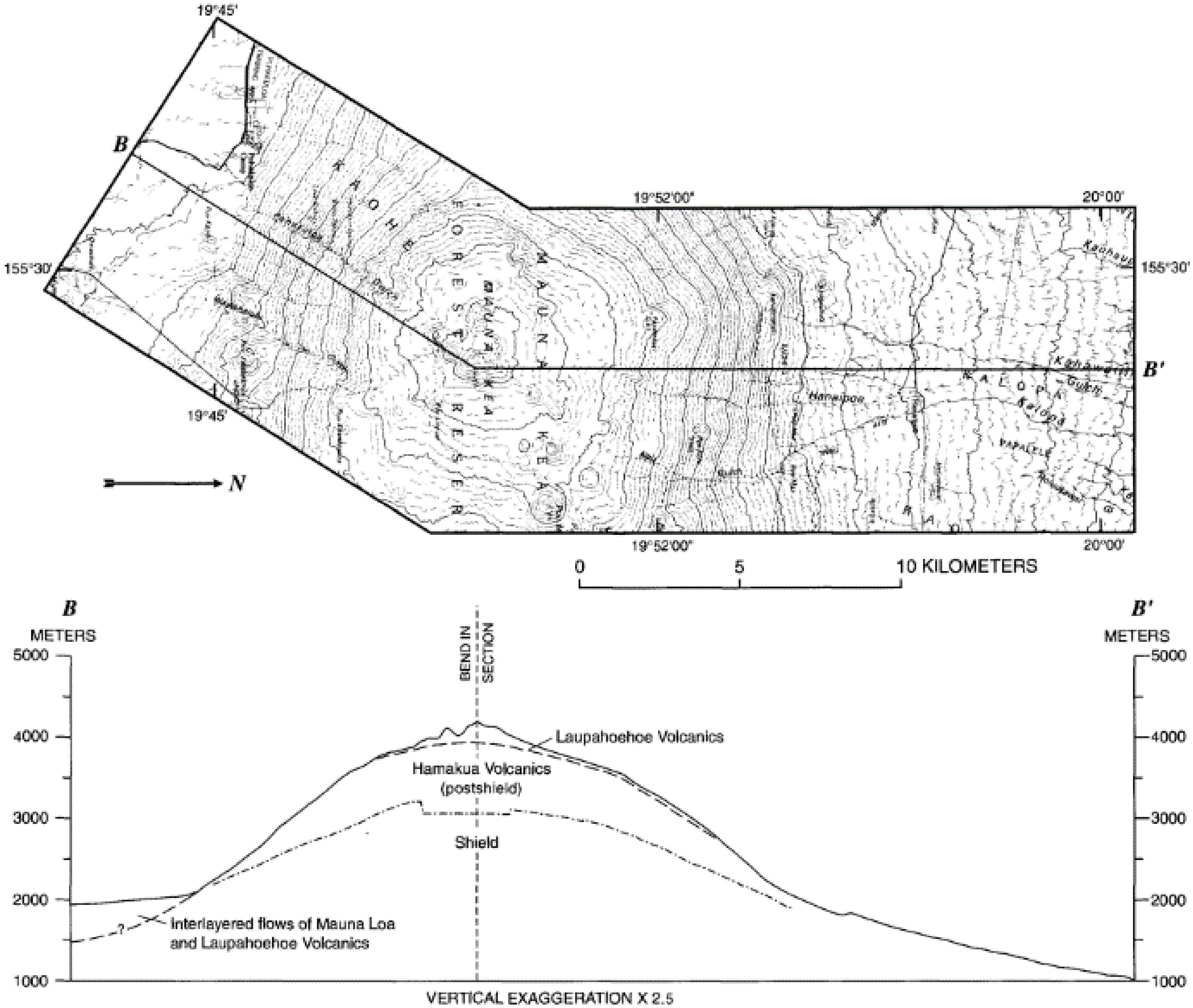

Figure 18. Cross-Section and Location Map of Maunakea (Wolfe et al., 1997).

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Decommissioning of the Caltech Submillimeter Observatory

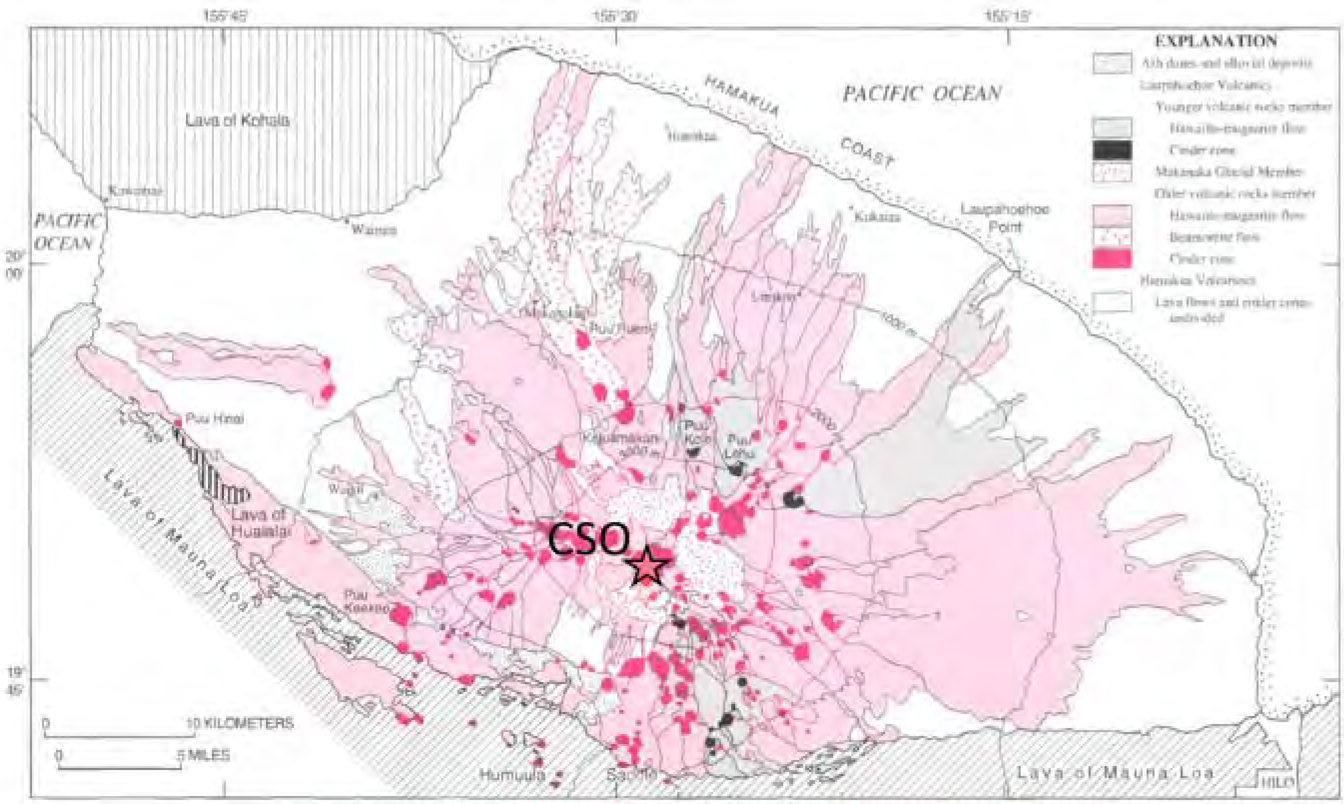

Figure 19. The Distribution of Maunakea Lava Flows, Cinder Cones and Makanaka Glacial Deposits (modified from Wolfe et al., 1997).

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Decommissioning of the Caltech Submillimeter Observatory

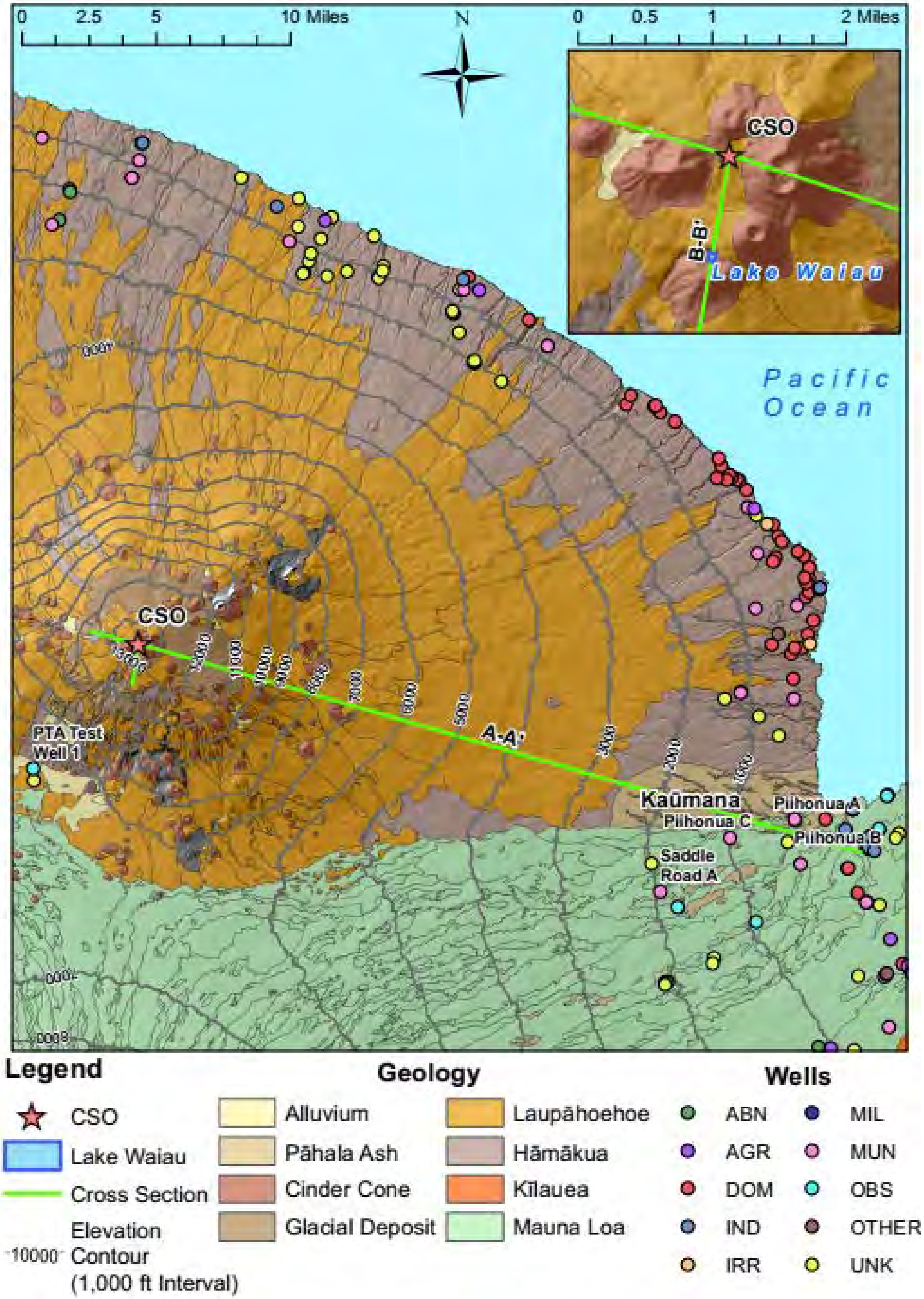
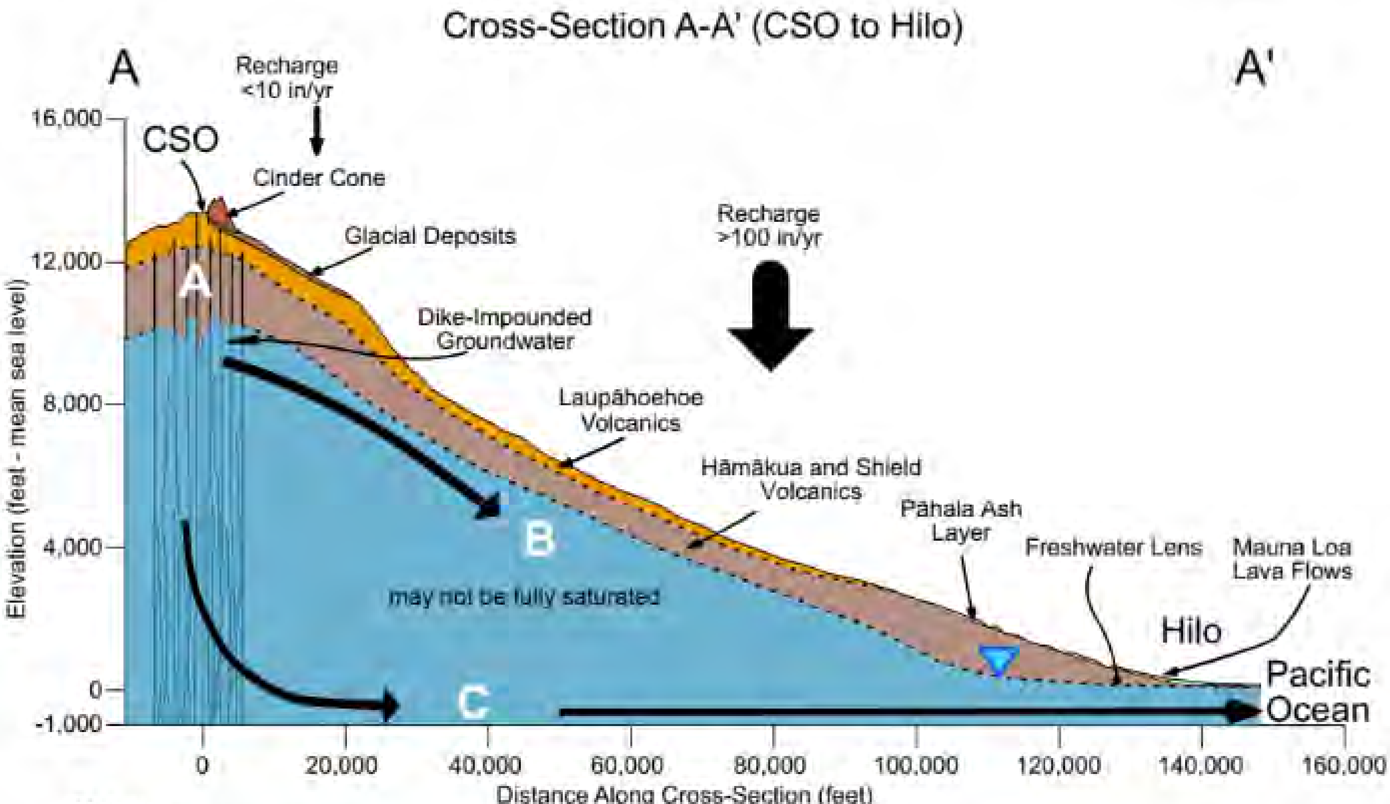


Figure 20. Geologic Map with Cross-Section A-A' and Locations.

Hydrogeological and Geological Evaluation
Decommissioning of the Caltech Submillimeter Observatory



Notes:

1) 5x vertical exaggeration.
2) Subsurface contacts are approximate based on Maunakea cross-sections from:
   Wolfe et al., 1997. The Geology and Petrology of Maunakea Volcano, Hawaii--A Study of Postshield Volcanism. *U.S. Geological Survey Professional Paper 1557*.
3) Surface geology is from Trusdell, Wolfe and Morris, 2005. Digital Database of the Geologic map of the island of Hawaii.
4) Topography is from 10-m spatial resolution USGS digital elevation model.

Figure 21. Cross Section A-A.
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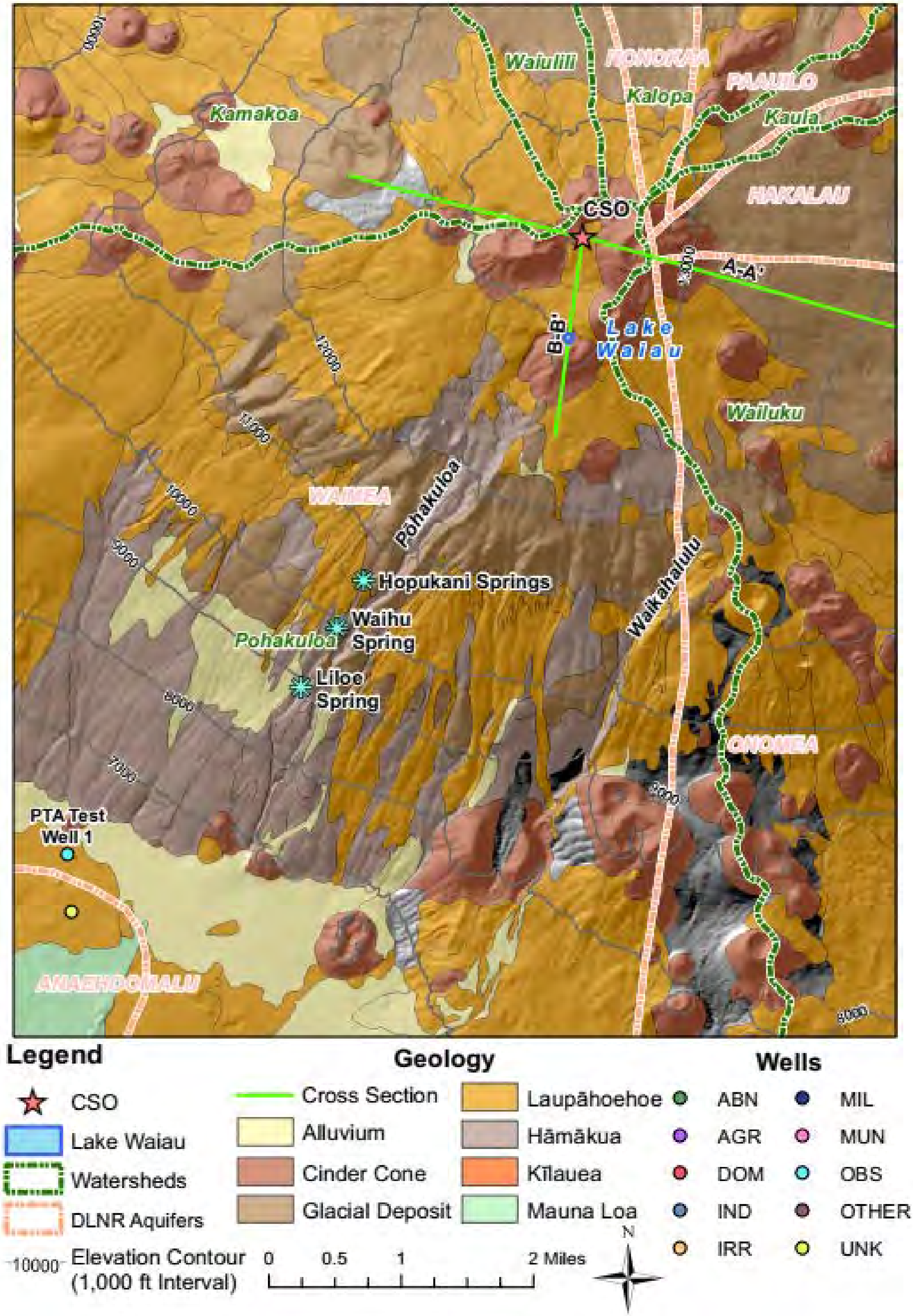

Figure 22. Geologic Map showing the Department of Land and Natural Resources aquifer systems, watersheds, PTA Test Well 1 and the Springs in relation to the CSO and Lake Waiau.

Hydrogeological and Geological Evaluation
Decommissioning of the Caltech Submillimeter Observatory

Figure 23. Photo of Lake Waiau Taken on November 9, 2018 Looking Southeast.

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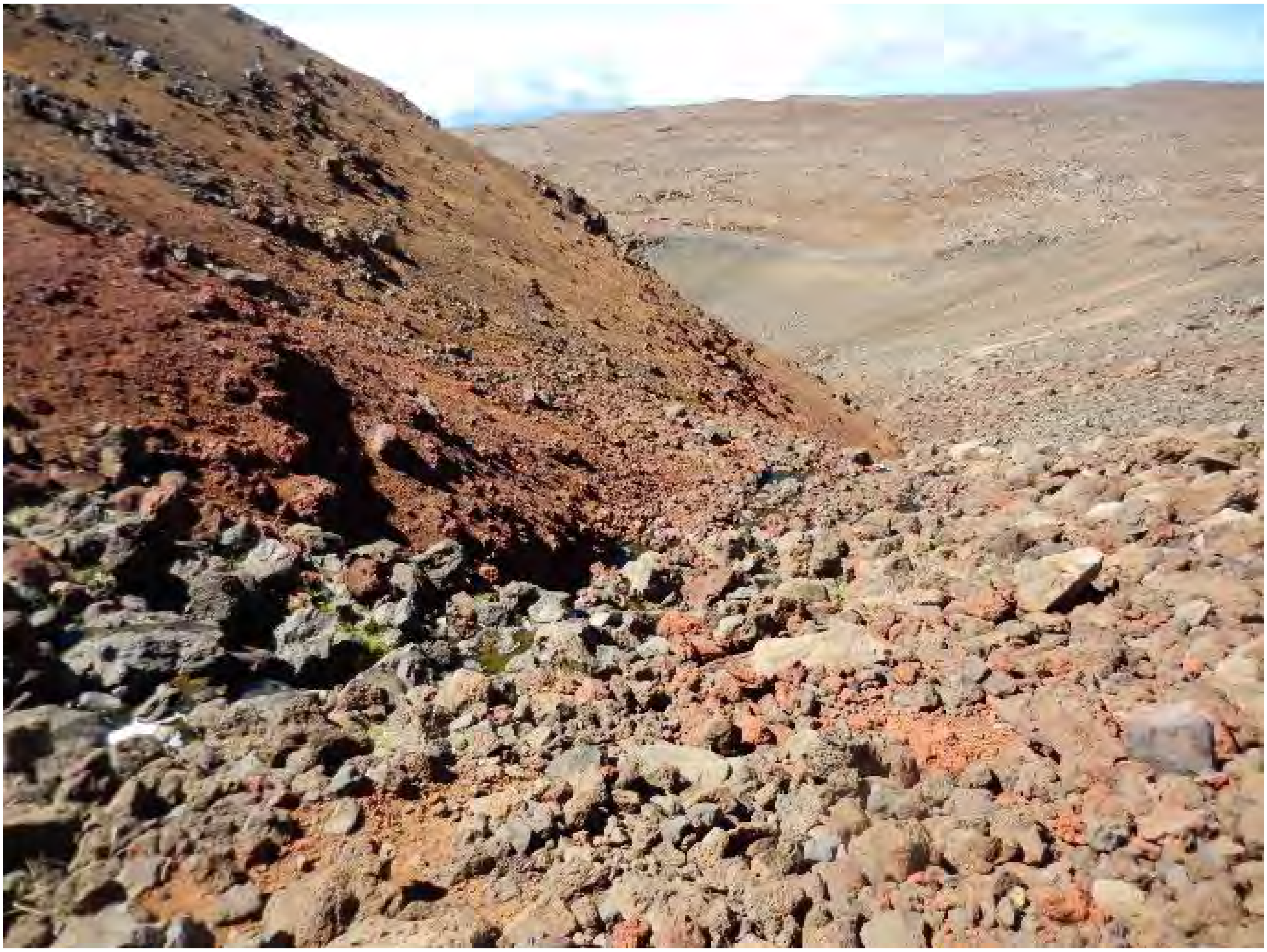

Figure 24. Water Cascading from Lake Waiau Towards Pōhakuloa Gulch (11/9/18).

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Decommissioning of the Caltech Submillimeter Observatory

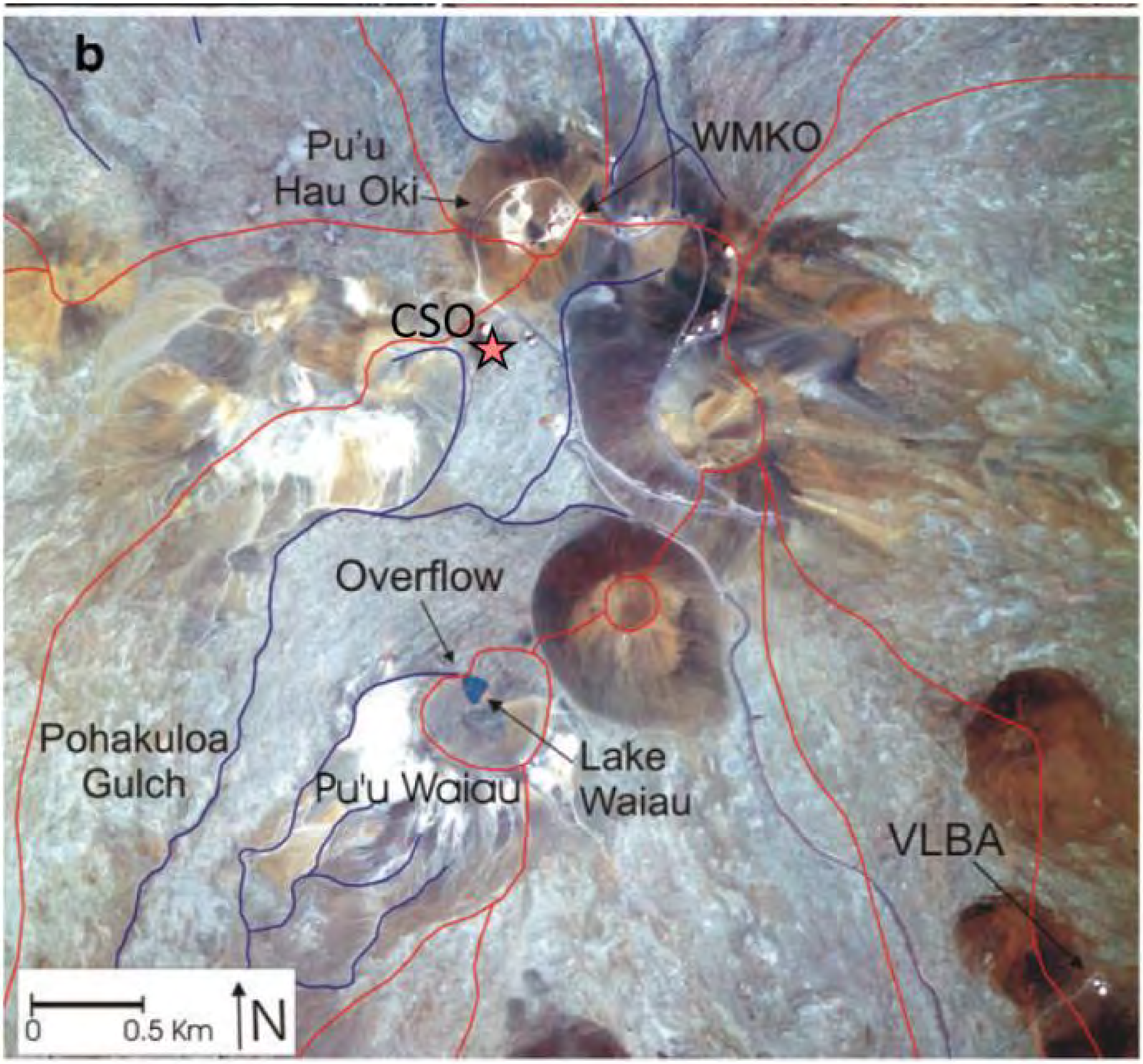
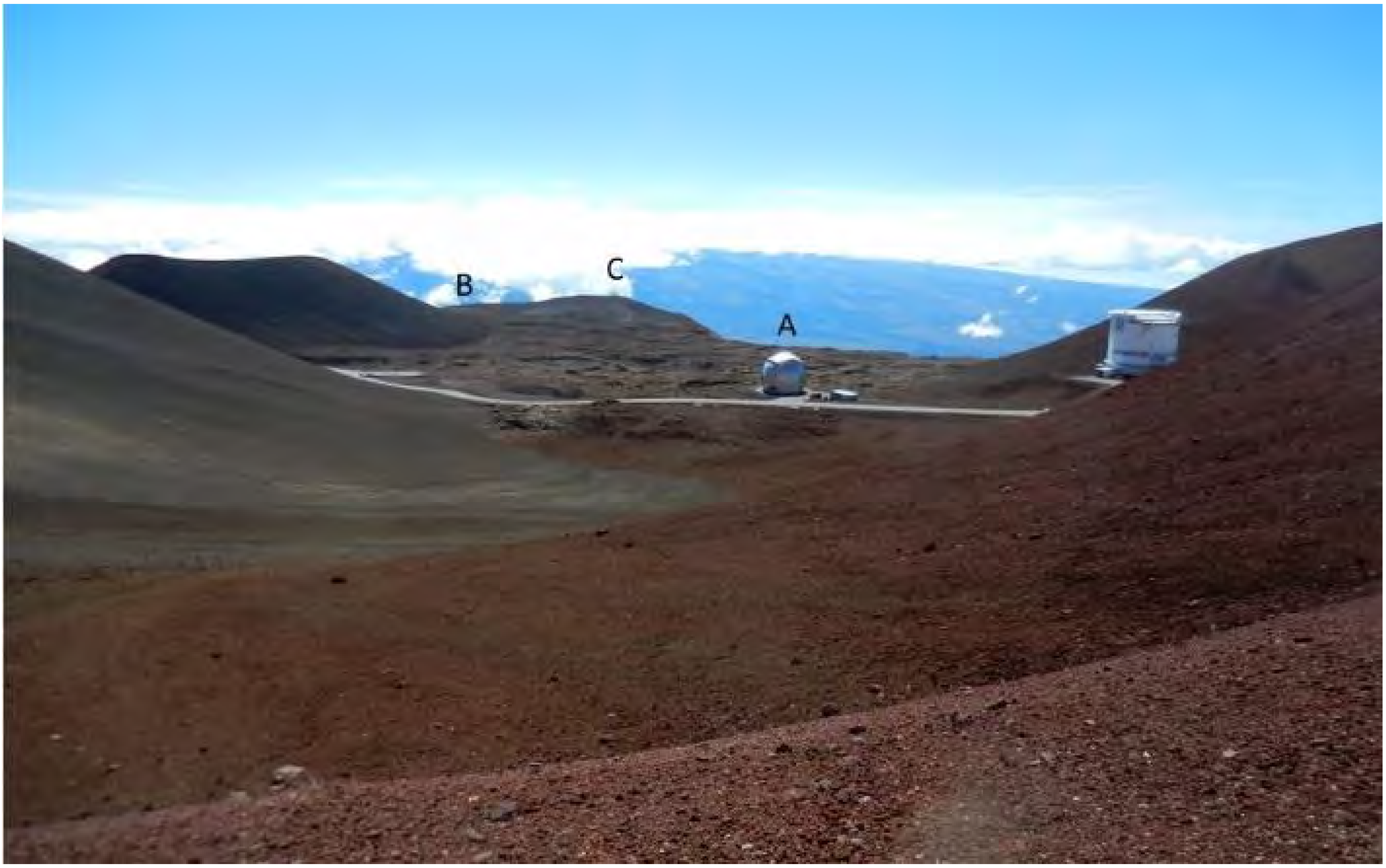


Figure 25. Figure showing flow lines (blue) and watershed boundaries (red) (Ehlmann et al., 2006).
Hydrogeological and Geological Evaluation
Decommissioning of the Caltech Submillimeter Observatory



“A” is the CSO. “B” is the approximate location of Lake Waiau. The flow from the CSO goes behind “C” and flows into Pōhakuloa Gulch.

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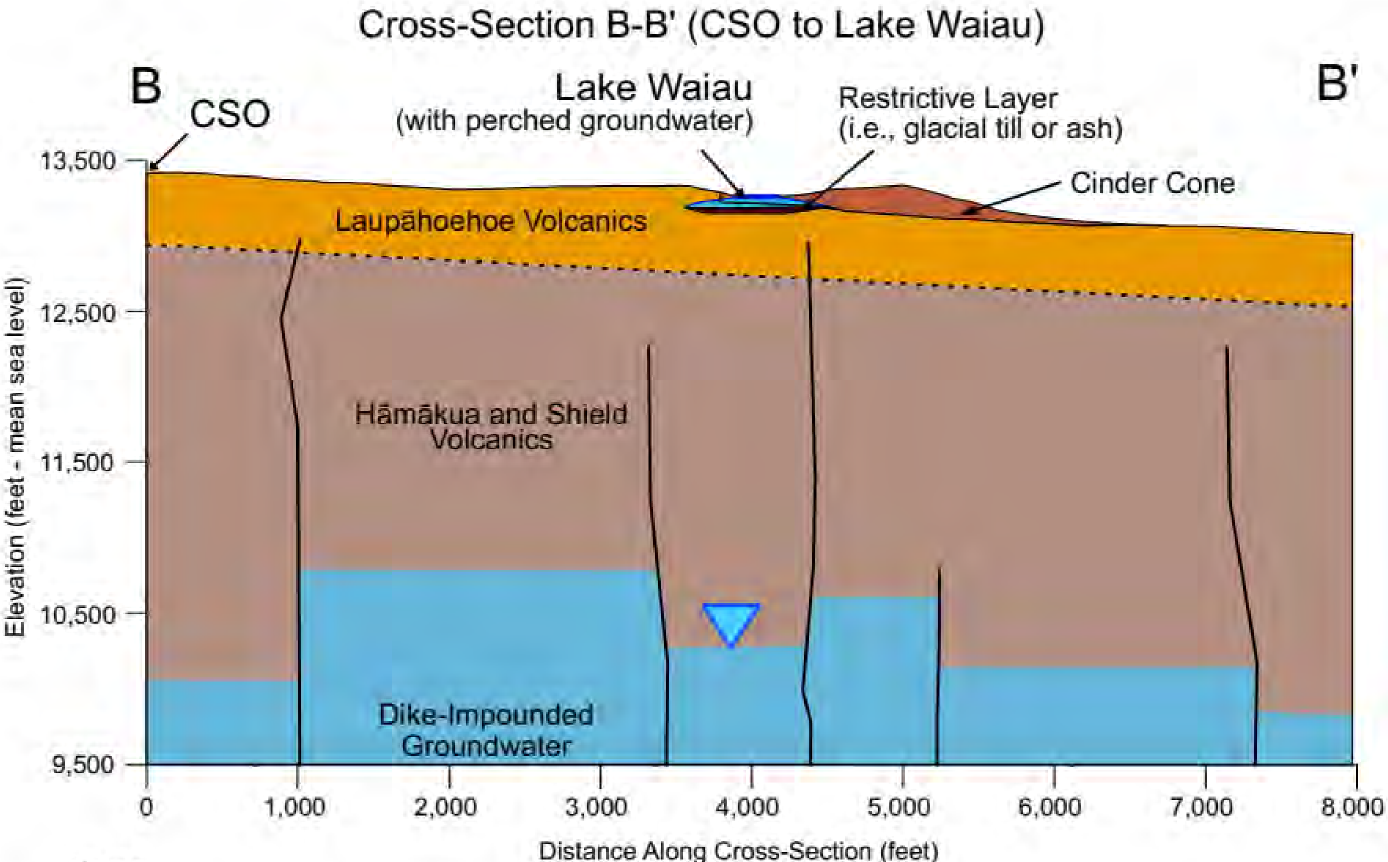
Figure 26. Looking Southwest Towards the CSO and Mauna Loa.
Hydrogeological and Geological Evaluation
Decommissioning of the Caltech Submillimeter Observatory



Notes:
1) No vertical exaggeration.
2) Subsurface contacts are approximate based on Maunakea cross-sections from:
Wolfe et al., 1997. The Geology and Petrology of Maunakea Volcano, Hawaii--A Study of Postshield Volcanism. *U.S. Geological Survey Professional Paper 1557*.
3) Surface geology is from Trusdell, Wolfe and Morris, 2005. Digital Database of the Geologic map of the island of Hawaii.
4) Topography is from 10-m spatial resolution USGS digital elevation model.

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Figure 27. Cross-Section B-B.
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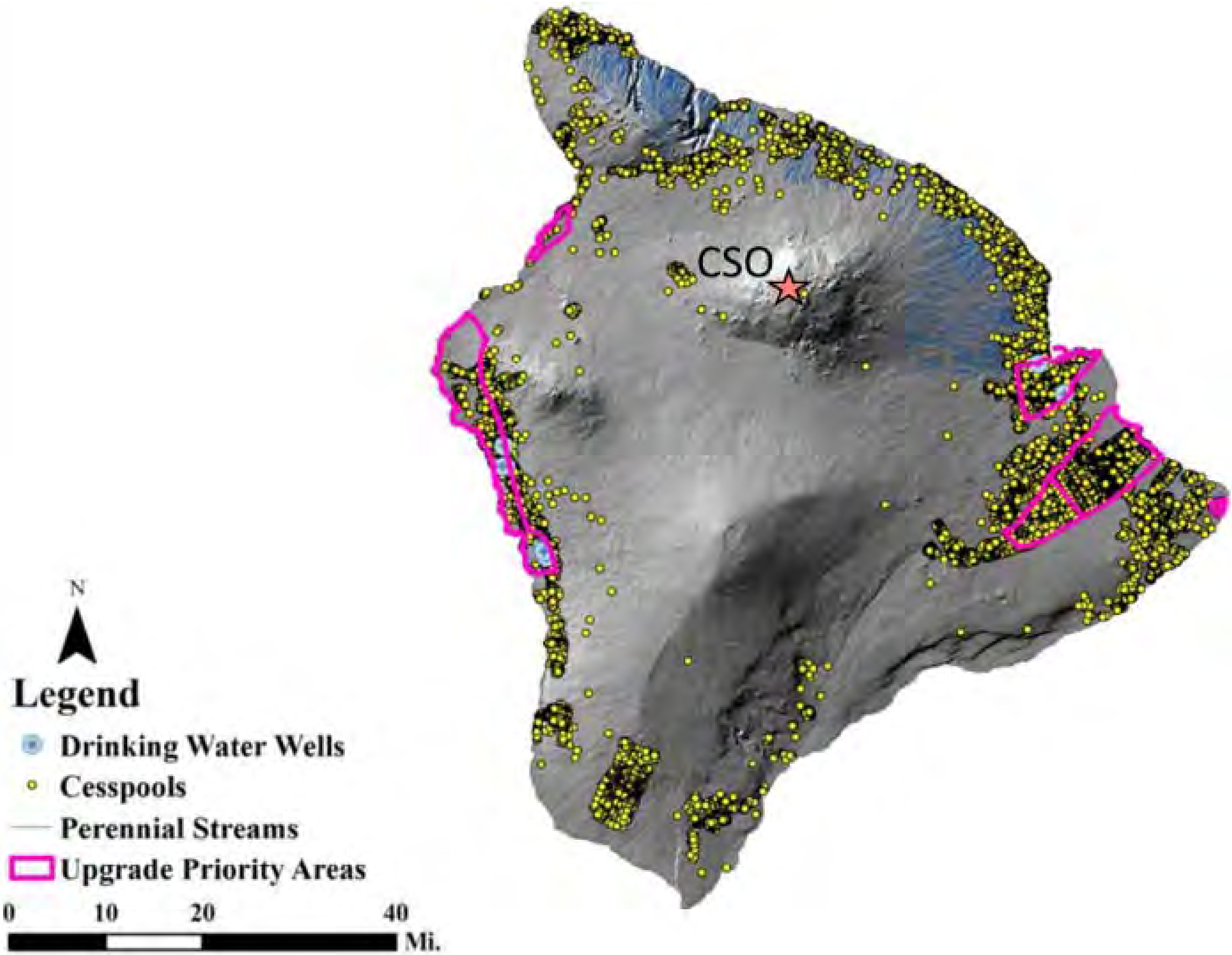

Figure 28. Map of Cesspools Throughout Hawai'i Island (Act 125 Legislature Cesspool Report).

Hydrogeological and Geological Evaluation
Decommissioning of the Caltech Submillimeter Observatory

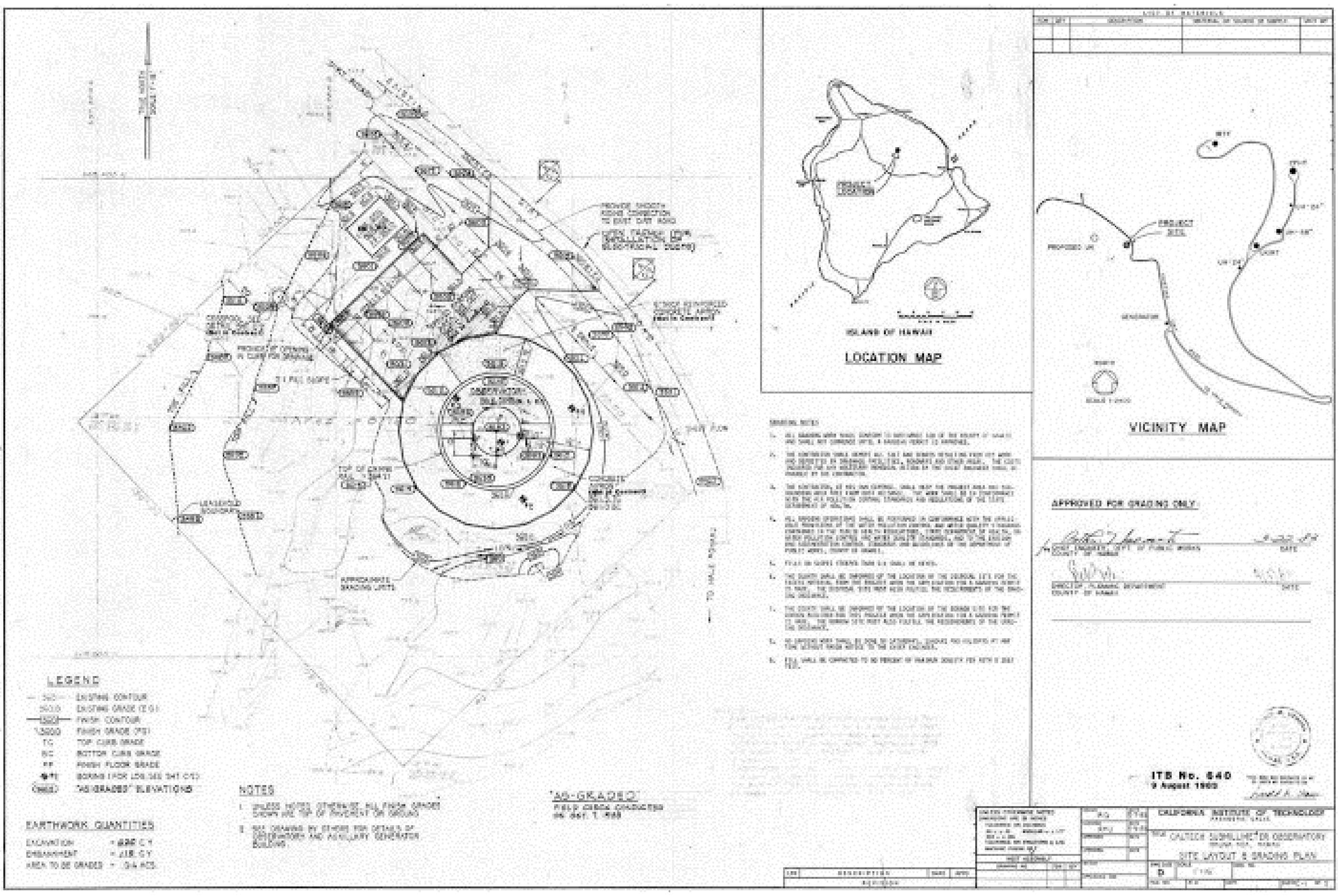

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Figure 29. Facility Map 1
(2015 CSO Decommissioning Report).
Hydrogeological and Geological Evaluation
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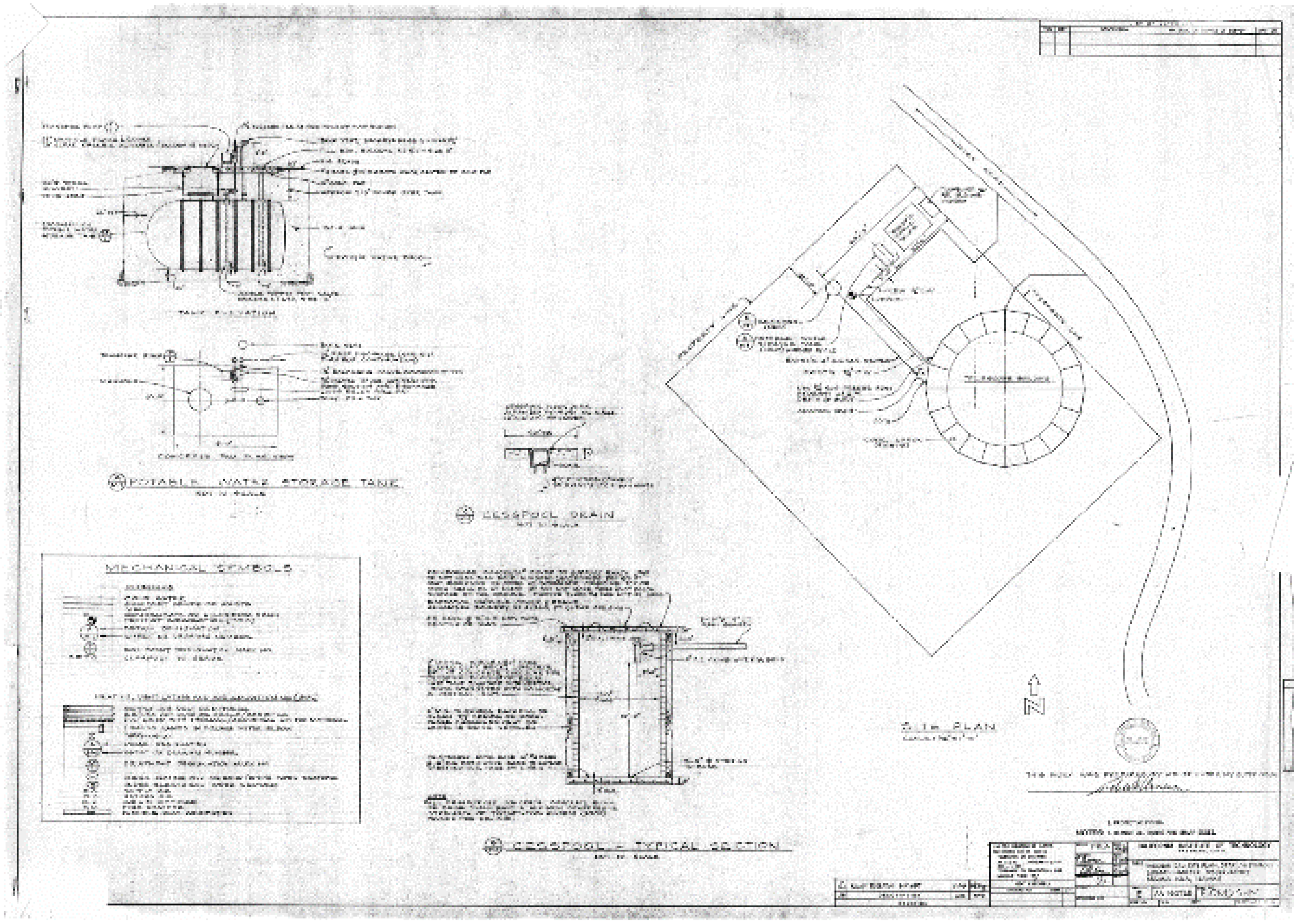


Figure 30. Facility Map Showing Cesspool in Relation to CSO (2015 Decommissioning Report).

Hydrogeological and Geological Evaluation

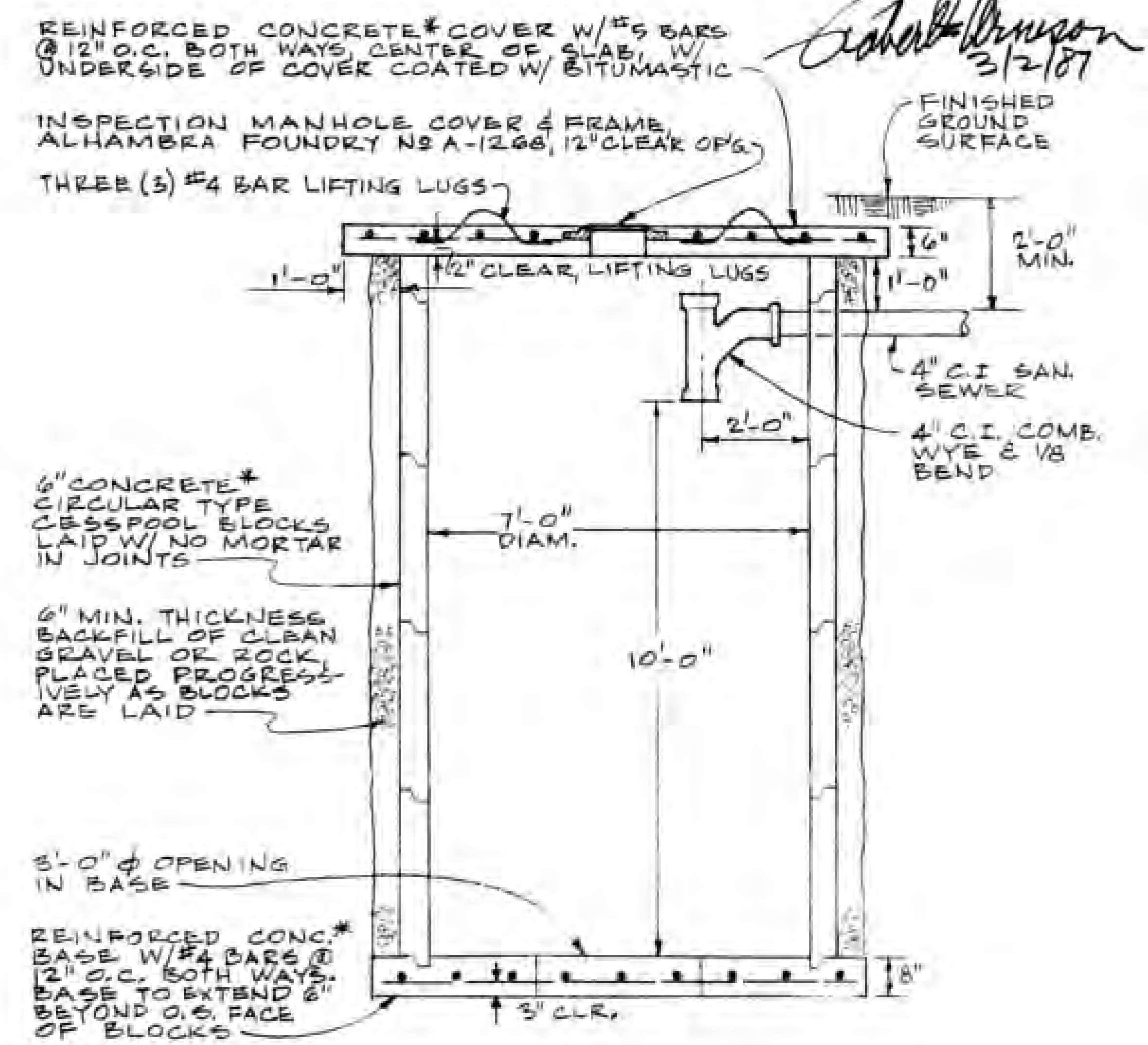
Decommissioning of the Caltech Submillimeter Observatory

REPORT ON INDIVIDUAL WASTEWATER SYSTEM

PROPERTY OWNER: California Institute of Technology
Address: Mauna Kea, Hawaii
Lot Size: 198.00' X 165.00'
CONTRACTOR: Constructors Hawaii Inc.
OWNER'S AGENT: Robert E. Arneson, P.E.
Mailing Address: 1116 Donna Beth Avenue
West Covina, CA 91791
Telephone: (818) 9193304
(213) 8252853

ROBERT E. ARNESON
REGISTERED PROFESSIONAL ENGINEER
No. 5592
MECHANICAL
HAWAII, U.S.A.

Robert Arneson
3/2/87



*NOTE:
ALL REINFORCED CONCRETE & CESSPOOL BLOCKS SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF TWENTY-FIVE HUNDRED (2500) POUNDS PER SQ. INCH.

CESSPOOL - CROSS SECTION

NOT TO SCALE

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Figure 31. Cesspool Schematic (2015 CSO Decommissioning Report).

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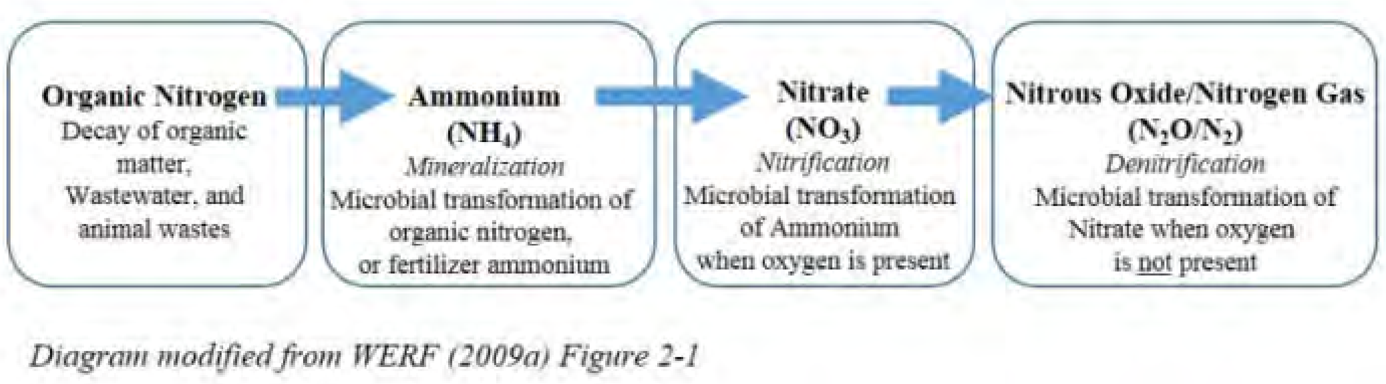

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Figure 32. A Typical Nitrogen Cycle for Waste Effluent (Organic Nitrogen). Source: WERF (2009); HDOH (2018).

Hydrogeological and Geological Evaluation
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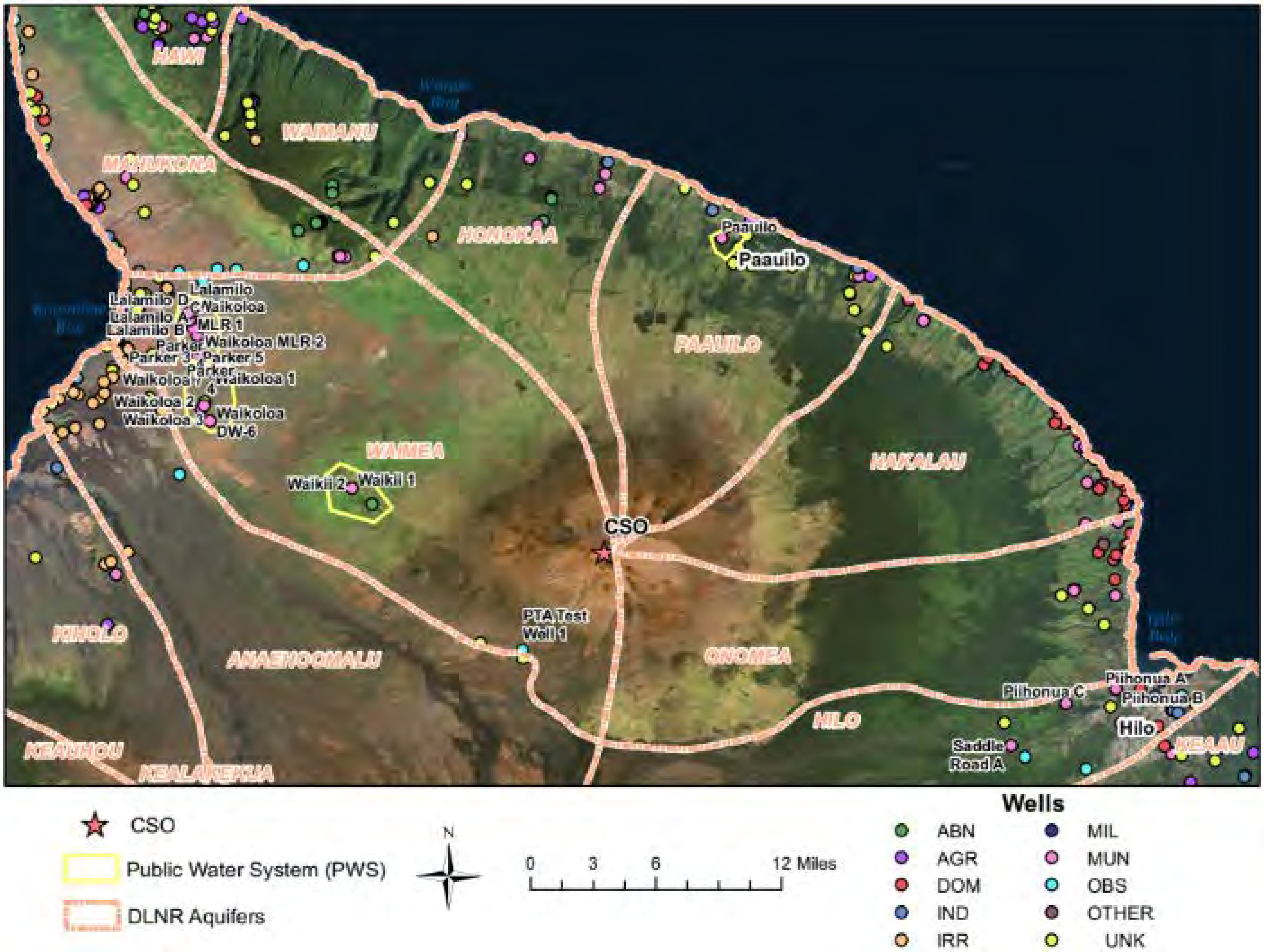
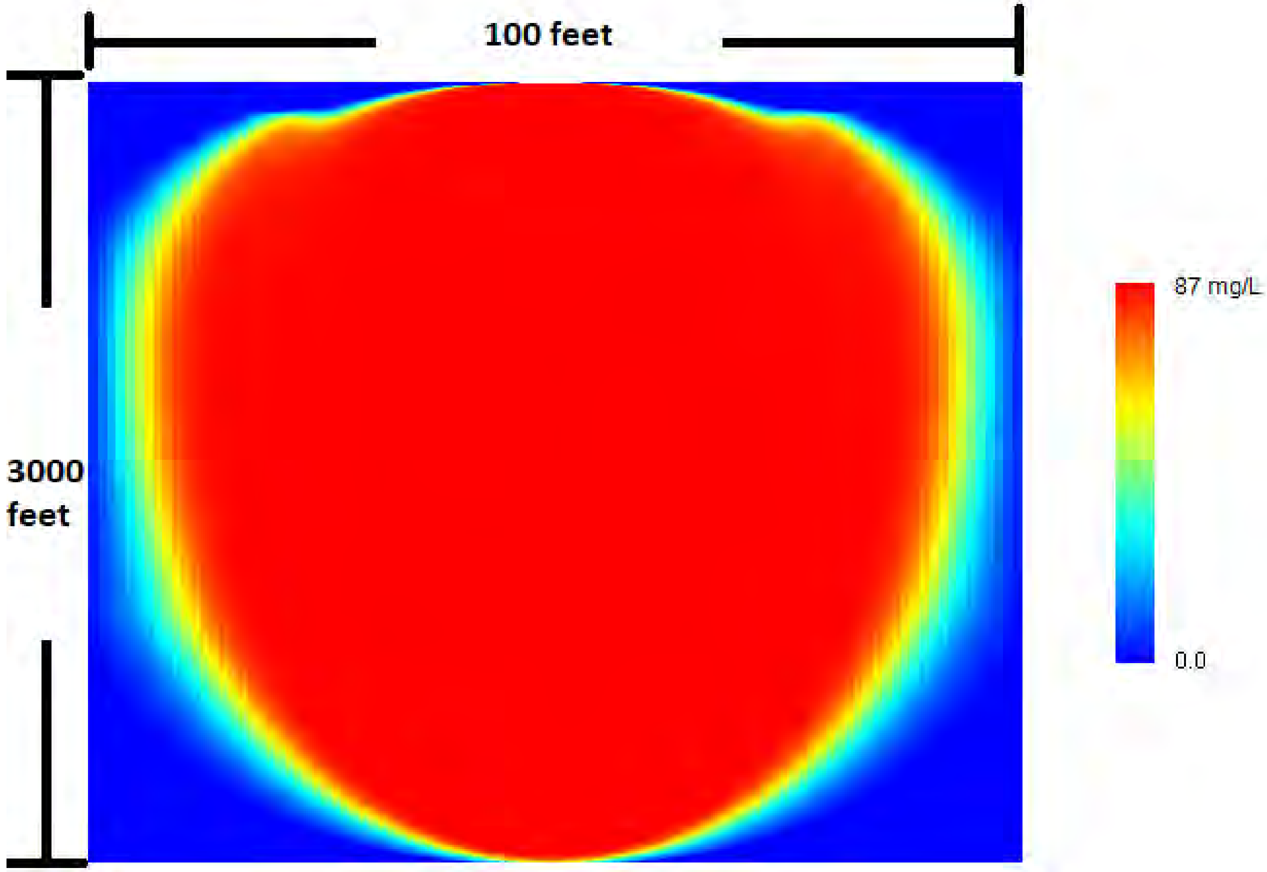


Figure 33. Wells from Waikoloa Village and Paauilo Public Water Systems (PWS) with Nitrate Sample Data from the State of Hawai'i (see tables 4-7).

Hydrogeological and Geological Evaluation
Decommissioning of the Caltech Submillimeter Observatory



Time = 12594.921

Mass Balance Error	Total for Simulation	Rate for this step
Fluid	0.00%	7.90%
Solute	0.03%	8.43%

The colorbar represents relative concentration and time is in days. Mass balance error is attributed to the fluid and solute leaving the model domain.

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Figure 34. VS2DI Transport Model of the Subsurface below the CSO.

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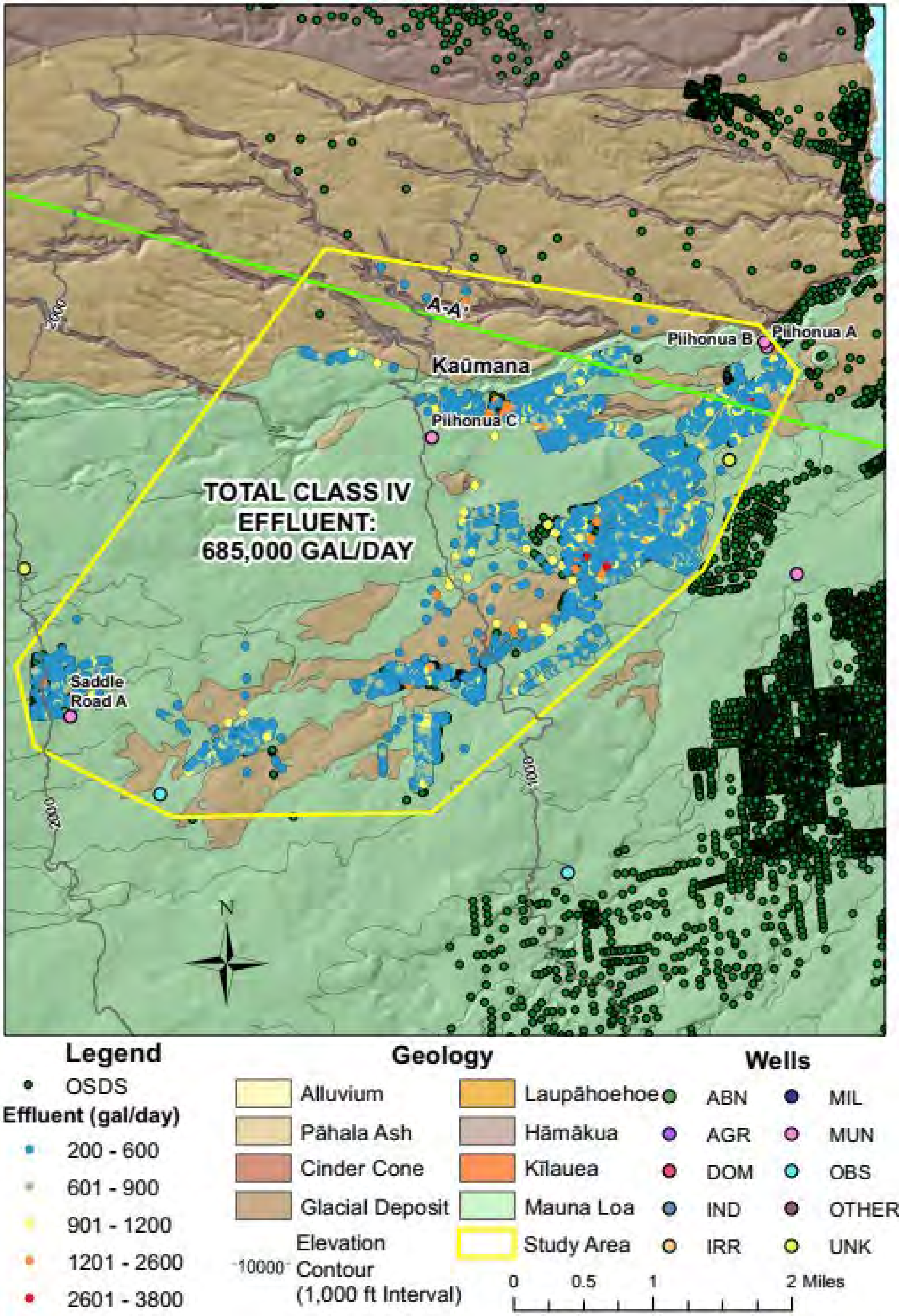
Decommissioning of the Caltech Submillimeter Observatory



Dark green dots represent on-site disposal systems (OSDS) that are outside the study area or non-cesspool OSDS for those located within the study area.

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Figure 35. Kaūmana Total Nitrogen Loading Rate Map.

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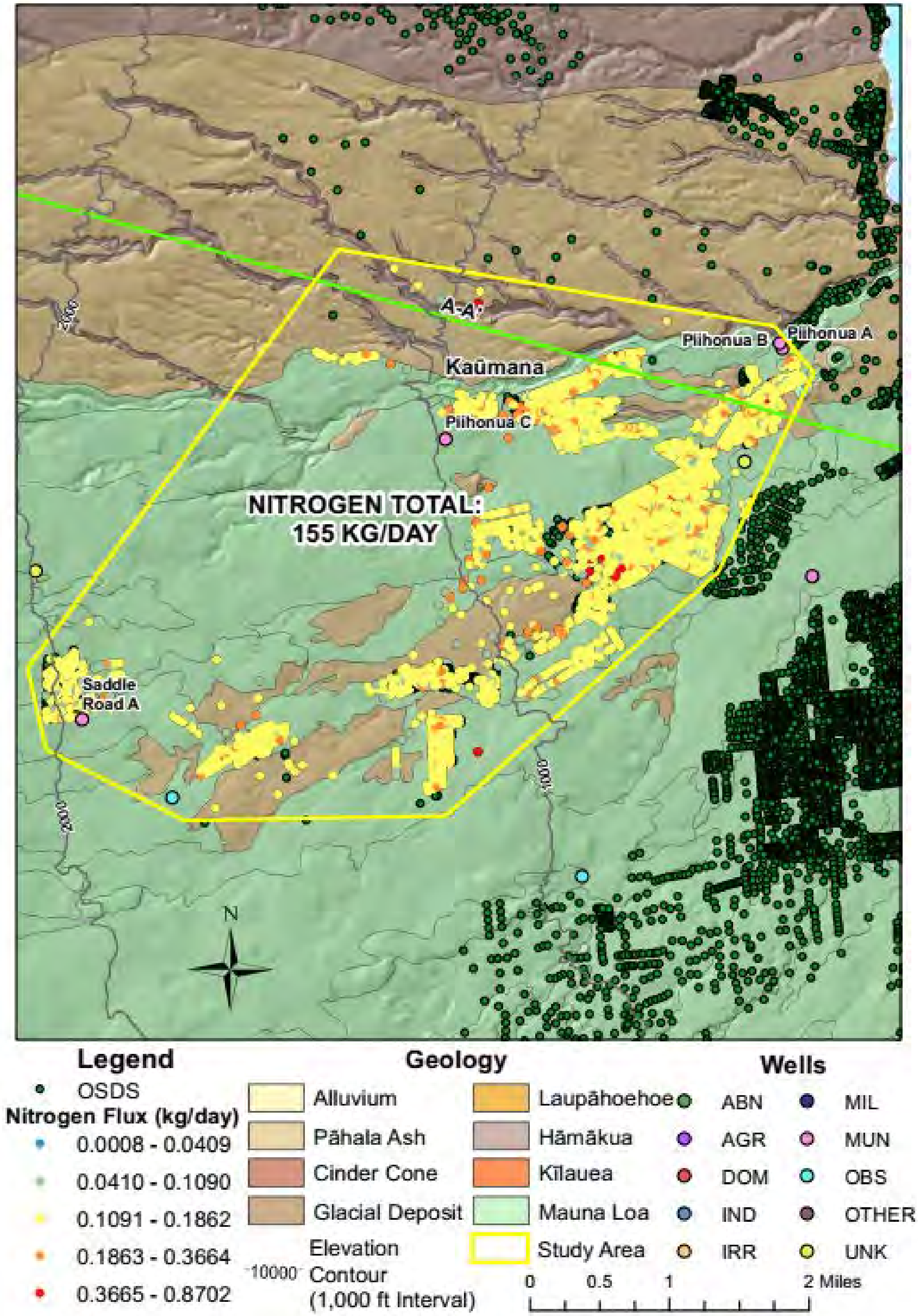

Dark green dots represent on-site disposal systems (OSDS) that are outside the study area or non-cesspool OSDS for those located within the study area.

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Figure 36. Kaūmana Total Nitrogen Loading Rate Map.

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Figure 37. CSO Fill and Native Rock Sample Locations.
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Decommissioning of the Caltech Submillimeter Observatory

Figure 38. CSO-F-1 Sampling Hole.
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Figure 39. CSO-F-1 Sample Location.
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Figure 40. CSO-F-2 Sample Hole.
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Decommissioning of the Caltech Submillimeter Observatory

Figure 41. CSO-F-3 Sample Hole.
Hydrogeological and Geological Evaluation
Decommissioning of the Caltech Submillimeter Observatory

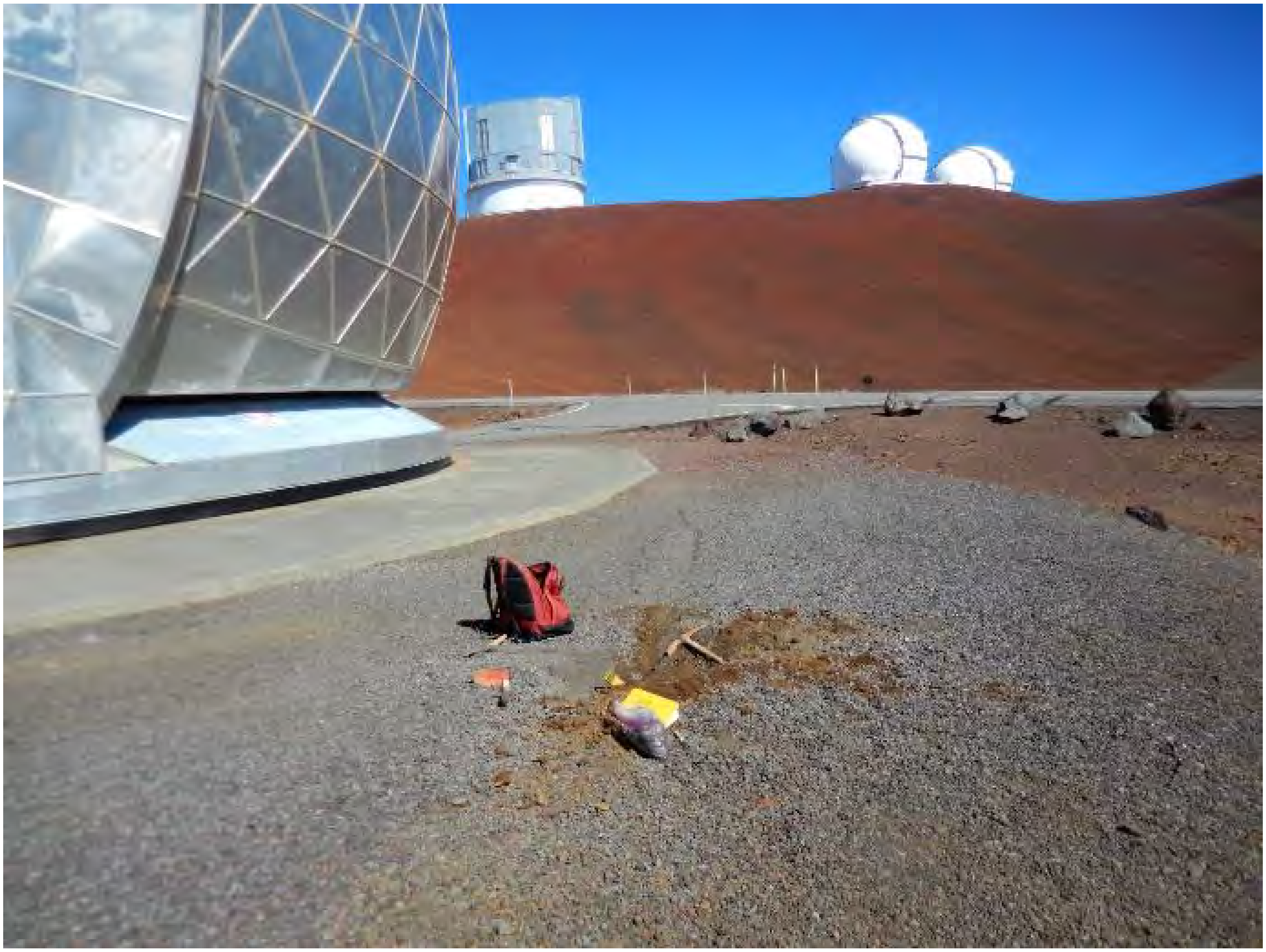

Figure 42. CSO-F-3 Sample Location.
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Decommissioning of the Caltech Submillimeter Observatory

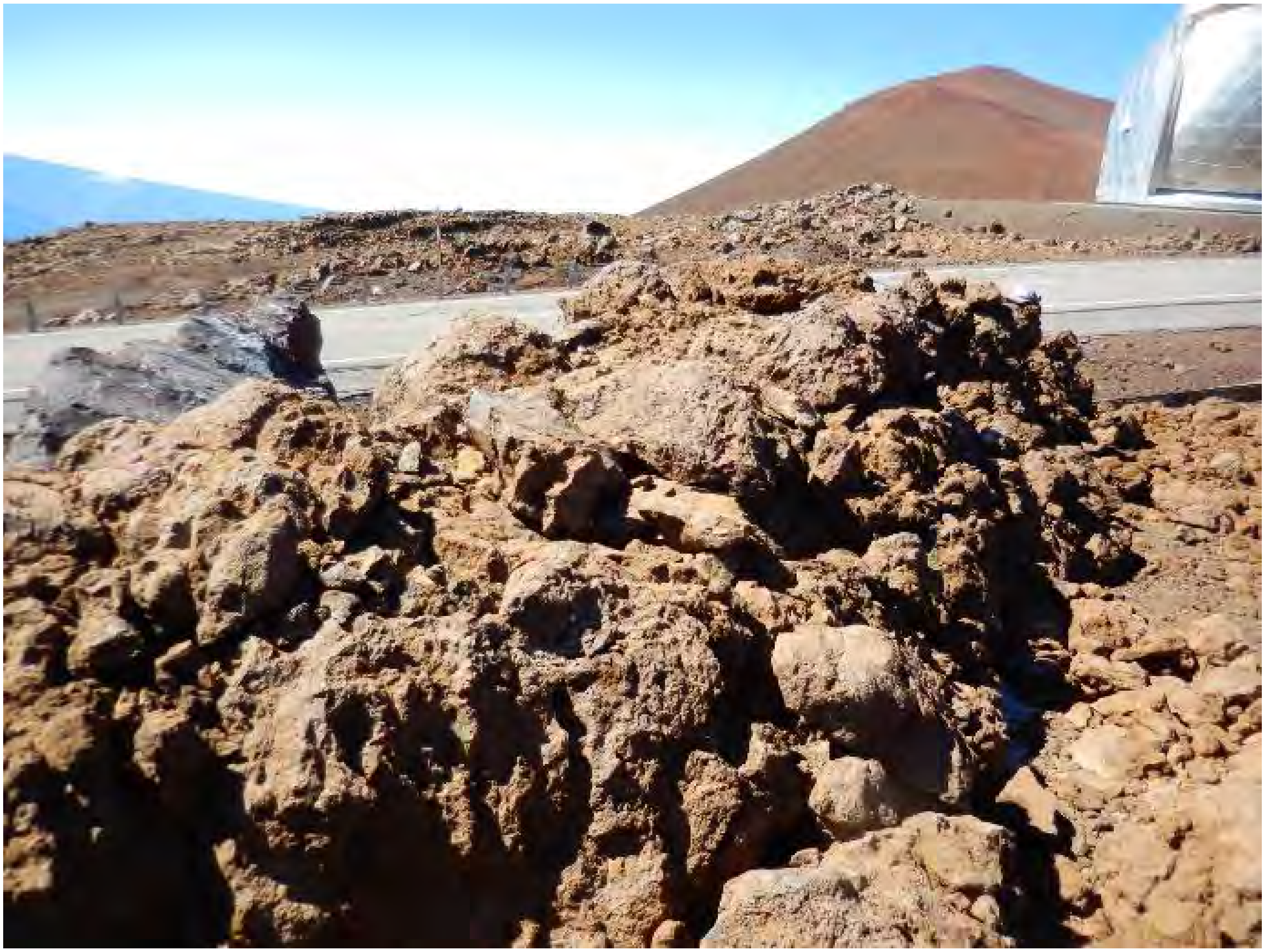

Figure 43. Volcanic Flow in Relationship to CSO from which CSO-N-1 Sample was Collected from the Left-Back Area Shown in this Photo.

Hydrogeological and Geological Evaluation
Decommissioning of the Caltech Submillimeter Observatory

Figure 44. CSO-N-1 Sample.
Hydrogeological and Geological Evaluation
Decommissioning of the Caltech Submillimeter Observatory

Figure 45. CSO-N-1 Sample Area.
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Decommissioning of the Caltech Submillimeter Observatory

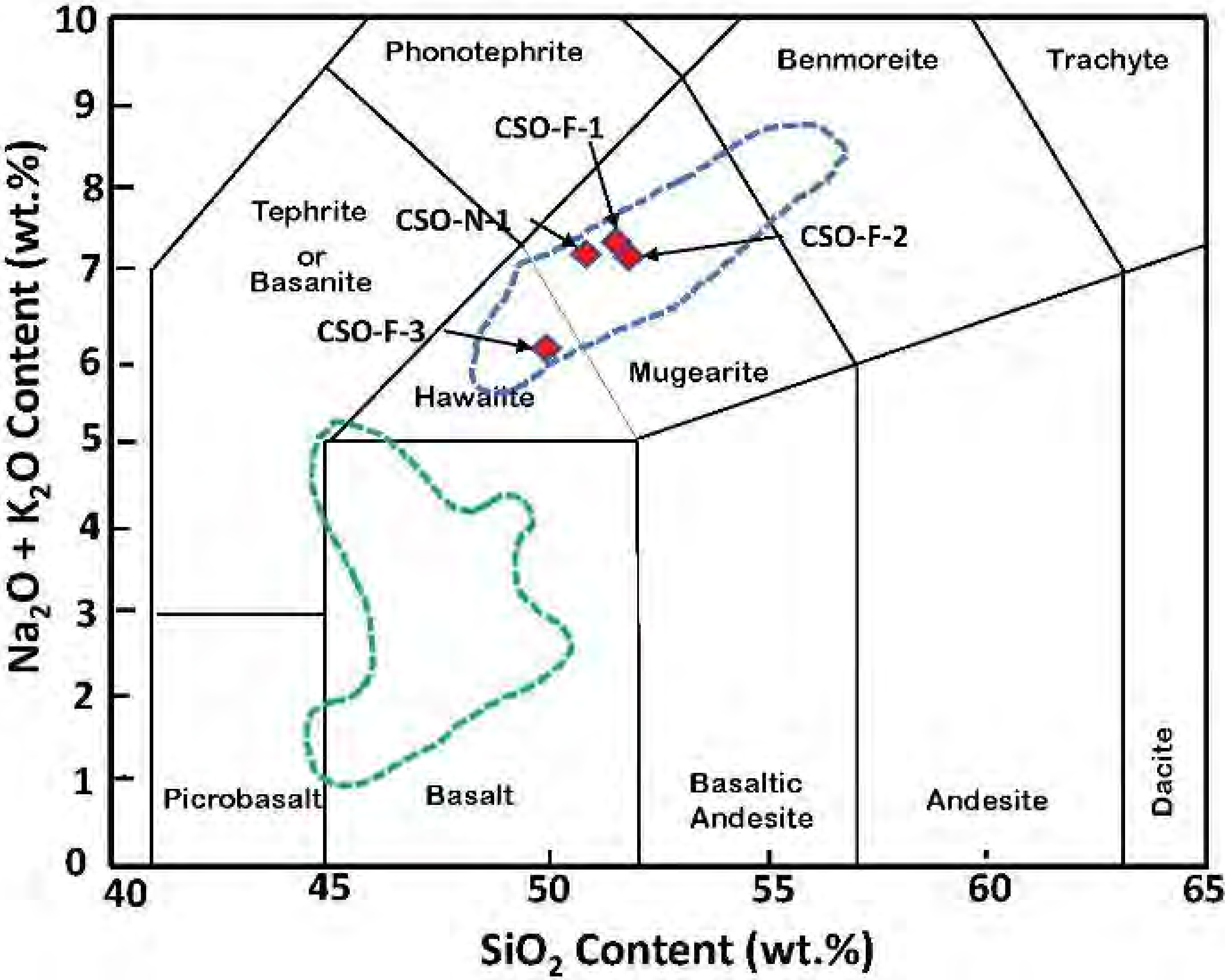

Diagram was used by Wolfe et al. (1997) to compositionally classify Mauna Kea lavas. The green dashed line denotes the approximately extent and range of geochemically analyzed older Hāmākua Volcanics and the blue dashed line denotes the approximately extent and range of geochemically analyzed younger Laupāhoehoe Volcanics as reported by Wolfe et al. (1997, p. 17, Figure 5). The 4 samples collected and analyzed for this investigation (red diamonds) all fall within the Laupāhoehoe Volcanics extent.

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Figure 46. Total Alkali Versus Silica Contents Diagram (Le Bas et al., 1986).

Hydrogeological and Geological Evaluation
Decommissioning of the Caltech Submillimeter Observatory

Appendix D. Asbestos, Lead Paint and Mold Survey Report – Caltech Submillimeter Observatory

ASBESTOS, LEAD PAINT AND MOLD SURVEY REPORT

CALTECH SUBMILLIMETER OBSERVATORY
MAUNA KEA, BIG ISLAND, HAWAII

Prepared for:
CALIFORNIA INSTITUTE OF TECHNOLOGY (CALTECH)
1200 E. California Blvd.
Pasadena, CA 91125

Prepared by:

LEHUA ENVIRONMENTAL INC.
P.O. Box 1018
Kamuela, Hawaii 96743
tel: (808) 494-0365

February 5, 2019

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LEAD LABORATORY ANALYTICAL RESULTS AND CHAIN-OF-CUSTODY FORMS
MOLD LABORATORY ANALYTICAL RESULTS AND CHAIN-OF-CUSTODY FORMS

1.0 CERTIFICATIONS AND LIMITATIONS

Lehua Environmental Inc. has completed this asbestos, lead paint and mold survey for the Caltech Submillimeter Observatory located on Mauna Kea, Big Island, Hawaii. LEI's findings and recommendations contained herein are based on research, site observations, government regulations and laboratory data, which were gathered at the time and location of the study. Opinions stated in this report do not apply to changes that may have occurred after the services were performed.

LEI has performed specified services for this project with the degree of care, skill and diligence ordinarily exercised by professional consultants performing the same or similar services. No other warranty, guarantee, or representation, expressed or implied, is included or intended; unless otherwise specifically agreed to in writing by both LEI and LEI's Client.

This report is intended for the sole use of LEI's Client exclusively for the Subject Site. LEI's Client may use and release this report, including making and retaining copies, provided such use is limited to the particular site and project for which this report is provided. However, the services performed may not be appropriate for satisfying the needs of other users. Release of this report to third-parties will be at the sole risk of LEI's Client and/or said user, and LEI shall not be liable for any claims or damages resulting from or connected with such release or any third party's use or reuse of this report.

Prepared By: ______________________

Kamalana Kobayashi
State of Hawaii Certified Asbestos Inspector
Certification #: HIASB-0613 Expires: 6/18/19
State of Hawaii Certified Lead Risk Assessor
Certification #: PB-0132 Expires: 5/16/19

Date: February 5, 2019

2.0 EXECUTIVE SUMMARY

Lehua Environmental Inc. (LEI) has completed this asbestos, lead paint and mold survey for the Caltech Submillimeter Observatory located on Mauna Kea, Big Island, Hawaii (Subject Site). From January 22-23, 2019, LEI personnel performed site reconnaissance to identify and inventory asbestos-containing material (ACM), lead-containing paint (LCP), lead-based paint (LBP) and mold impacted areas of the Subject Site. This survey included interior and exterior surfaces of the Subject Site in preparation for the scheduled decommissioning of the Subject Site's structures.

During LEI's survey, LCP, LBP and mold impacted surfaces were identified at the Subject Site. The following summarizes the hazardous materials identified during LEI's survey:

Summary of ACM Survey

None of the sampled suspect ACM at the Subject Site were identified to contain detectable concentrations of asbestos by laboratory analysis. Table 1 located in Appendix I summarizes all the samples collected during the asbestos survey at the Subject Site. Photograph Log 1 in Appendix II includes photographs of the sampled suspect ACM. Finally, Appendix III includes the laboratory results for the sampled suspect ACM.

Summary of Lead Paint Survey

Paint chip laboratory results indicated that six (6) of the sampled painted surfaces contained lead in excess of the EPA/HUD guideline of 5,000 mg/kg and are considered to be Lead-Based Paint (LBP). Additionally, seven (7) sampled painted surfaces contained detectable levels of lead at levels less than 5,000 mg/kg and are considered to be Lead-Containing Paint (LCP). Table 2 located in Appendix I summarizes the lead paint survey results. Photograph Log 2 in Appendix II identifies the sampled paints at the Subject Site. Finally, Appendix III includes the laboratory results for the sampled paints at the Subject Site.

The following table lists the identified LBP and LCP surfaces at the Subject Site.

Identified Lead-Based Paint (LBP) and Lead-Containing Paint (LCP)
Caltech Submillimeter Observatory
Mauna Kea, Big Island, Hawaii

Bldg.	*Interior/ Exterior*	*Room*	*Description*	*Color*	*Substrate*	*Cond.*	*LCP or LBP?*
Main	Exterior	Throughout	Pole	Red	Metal	Poor	LBP
Main	Exterior	Throughout	Pole Cap	Yellow	Metal	Poor	LBP
Main	Interior	Entry	Hand Rails	Red	Metal	Poor	LCP
Main	Interior	Throughout	Stairs	White	Metal	Fair	LBP
Main	Exterior	Throughout	Frame	White	Metal	Poor	LCP
Main	Exterior	Throughout	Various	Yellow	Metal	Poor	LBP
Main	Exterior	Throughout	Door Jamb	White	Wood	Fair	LCP
Water Pump Shed	Exterior	Throughout	Shed	White	Metal	Fair	LBP
Water Pump Shed	Exterior	Throughout	Door Jamb and Roof	Beige	Metal	Fair	LBP
Water Pump Shed	Interior	Throughout	Frame	Red	Metal	Poor	LCP
Large Storage Shed	Interior	Throughout	Frame	Red	Metal	Poor	LCP
Pump House	Interior	Throughout	Shelf	White	Metal	Poor	LCP
Main	Exterior	Throughout	Shutter Frame	Silver	Metal	Poor	LCP

Summary of Mold Survey

The types and relative percentages of fungi identified in the indoor and outdoor air samples collected at the Subject Site were generally similar (the presence or absence of genera in small numbers should not be considered abnormal). Therefore, LEI did not identify indoor mold concentrations to be elevated at the Subject Site.

Various moisture damaged ceiling tiles were observed throughout the Subject Site. LEI did identify an elevated concentration of mold on the surface tape lift sample collected on the ceiling tiles in Rooms 105 and 204 of the Subject Site. The following table summarizes this finding.

Identified Mold Present
Caltech Submillimeter Observatory
Mauna Kea, Big Island, Hawaii

Room	Sample Location	Mold and Fungi Identification	General Impression
105 (Galley)	Surface of ceiling tile with visible signs of water damage	Low volume of *Cladosporium sp.* observed	Minimal mold growth present
204	Surface of ceiling tile with visible signs of water damage	High volume of *Alternaria sp.* observed	Mold growth present

In summary, LBP, LCP and mold were observed at the Subject Site. Based on LEI's visual survey of the site, inventory of identified potentially hazardous materials, and laboratory data, LEI recommends the following:

- Manage and/or remove and dispose of hazardous and regulated materials in accordance with applicable local, state, and federal regulations, prior to renovation and/or demolition activities that may disturb these materials.
- Remove and dispose of all loose and flaking (poor condition) LCP and LBP that may be disturbed during renovation/demolition activities in accordance with applicable local, state, and federal regulations.
- Spot remove and dispose of LCP and LBP in areas that have the potential to become airborne or otherwise create dust (i.e. from sanding, drilling, friction, etc.) during renovation/demolition activities.
- Any remediation and demolition contractor(s) must take appropriate measures to comply with applicable EPA, OSHA and HIOSH regulations pertaining to the handling of lead containing materials and worker protection. Note that OSHA and HIOSH regulate activities that disturb paint which contain any detectable concentration of lead. Note that detectable levels of lead in the paint were found throughout the Subject Site.
- Have air monitoring conducted for airborne lead by qualified personnel during any lead paint disturbance and general renovation activities of areas that were determined to contain this contaminant.
- Previously water damaged ceiling tiles located throughout the Subject Site should be removed and replaced. These tiles may be identified by water staining and/or discoloration.

3.0 INTRODUCTION/PURPOSE

The purpose of this survey was to investigate the Subject Site for the presence of various hazardous materials. Specifically, LEI completed the following tasks:

- Performed site reconnaissance at the Subject Site;
- Collected one-hundred and two (102) samples of suspect asbestos-containing material (ACM) from the Subject Site;
- Submitted the one-hundred and two (102) samples of suspected ACM to Hawaii Analytical Laboratories, LLC for analysis of asbestos via Polarized Light Microscopy (PLM) in accordance with the AHERA protocol and NIOSH Method 600/R-93/116;
- Collected twenty-two (22) paint chip samples from the Subject Site;
- Submitted the twenty-two (22) paint chip samples to Hawaii Analytical Laboratories, LLC for analysis via EPA Method 7420 for total lead content;
- Visually inspected the Subject Site for signs of water damage and/or visible mold growth;
- Collected a total of four (4) non-culturable air samples from within and outside the Subject Site;
- Analyzed the four (4) non-culturable air samples collected via spore trap analysis for total fungal structures;
- Collected a total of four (4) tape-lift mold samples from the Subject Site;
- Analyzed the four (4) tape-lift mold samples via direct microscopic analysis; and
- Prepared this report documenting the field activities and the results of the investigation including analytical results, conclusions, and recommendations.

4.0 METHODOLOGY

4.1 Asbestos

LEI personnel collected a total of one-hundred and two (102) samples of suspect building materials for asbestos analysis. All of the suspect ACM samples were collected from the Subject Site in general accordance with EPA guidelines and recommendations.

The suspect ACM were wetted with amended water before sample collection. A small piece was then carefully cut out and placed into a labeled re-sealable plastic bag. The sampling equipment was cleaned between each sample collection to avoid cross-contamination between samples. The approximate quantity of each suspect ACM was noted. Sample locations were randomly selected in accordance with EPA protocols and recommendations.

All samples were properly logged and recorded following strict chain of custody procedure and submitted to Hawaii Analytical Laboratories, LLC in Honolulu, Hawaii for analysis by polarized light microscopy in accordance with EPA Method 600/R-93/116. Hawaii Analytical Laboratories, LLC is accredited for bulk asbestos analysis through successful participation in the National Voluntary Lab Accreditation Program (NVLAP).

4.2 Lead Paint

LEI personnel collected and analyzed twenty-two (22) paint chip samples from the Subject Site in accordance with the EPA guidelines and recommendations.

The suspect lead-containing paints were wetted with amended water before sample collection. Paint was carefully scraped and placed into a labeled re-sealable plastic bag. The sampling equipment was cleaned between each sample collection to avoid cross-contamination between samples. All samples were properly logged and recorded following strict chain of custody procedure and submitted to Hawaii Analytical Laboratories, LLC for analysis in accordance with EPA method 7420.

4.3 Mold

Air Samples

Three (3) air samples were collected from various interior areas of the Subject Site and one (1) air sample was collected from an upwind exterior location directly adjacent to the Subject Site. All air samples were collected using a high-volume pump calibrated for a flow rate of 15 liters per minute equipped with a Zefon Air-O-Cell spore-trap sampling cassette. The non-culturable air samples were placed into individual sealable plastic bags and submitted to Hawaii Analytical Laboratories, LLC located in Honolulu, Hawaii for spore trap analysis. All samples were properly labeled and delivered to the testing laboratories with a complete chain-of-custody form.

Tape Lift

A total of four (4) tape-lift samples were collected from various interior surfaces of the Subject Site. Samples were placed into individual sealed tape-lift media and submitted to Hawaii Analytical Laboratories, LLC located in Honolulu, Hawaii for direct microscopic examination. All samples were properly labeled and shipped to the testing laboratories with a complete chain-of-custody form.

5.0 RESULTS

5.1 Asbestos Survey

LEI's State of Hawaii certified asbestos inspector, Mr. Kama Kobayashi identified thirty-four (34) suspect materials for sample collection. None of the sampled suspect materials were identified to be ACM by laboratory analysis. Table 1 found in Appendix I lists the results of all samples collected during LEI's survey. Photograph Log 1 found in Appendix II contains photographs of the sampled suspect ACM at the Subject Site. Appendix III contains the laboratory results for the asbestos analysis.

5.2 Lead Paint Survey

LEI's State of Hawaii certified lead paint risk assessor, Mr. Kama Kobayashi collected a total of twenty-two (22) paint samples from the Subject Site. Paint chip laboratory results indicated that six (6) of the sampled painted surfaces contained lead in excess of the EPA/HUD guideline of 5,000 mg/kg and are considered to be LBP. Additionally, seven (7) sampled painted surfaces contained detectable levels of lead at levels less than 5,000 mg/kg and are considered to be LCP. Table 2 located in Appendix I summarizes the lead paint survey results. Photograph Log 2 in Appendix II identifies the sampled paints at the Subject Site. Finally, Appendix III includes the laboratory results for the sampled paints at the Subject Site.

5.3 Mold Survey

In interpreting air-sampling and surface tape lift sample results, it should be noted that national and international numerical guidelines have not been established by standards-setting agencies or associations for "safe" exposure limits to fungi. There is international consensus, however, that in non-problem naturally cooled buildings, indoor airborne fungal concentrations will be comparable or lower than outdoor concentrations.

In addition, the types and relative percentages of fungi will be generally similar (the presence or absence of genera in small numbers should not be considered abnormal). Indoor air sample results that are not comparable to outdoor air sample results suggest that indoor growth sites and/or reservoirs may be present.

LEI bases their conclusions of the air sampling and surface tape lift sample results on the overall comparison of fungal concentrations and biodiversity in each area sampled, which are compared to the concentrations of the outdoors.

The results of LEI's mold investigation activities are summarized in Tables A and B below:

TABLE A
DIRECT MICROSCOPIC EXAMINATION REPORT: NON-CULTURABLE AIR SAMPLES
CALTECH SUBMILLIMETER OBSERVATORY, MAUNA KEA, HAWAII

Room	Sample Location	Summary of Laboratory Results	General Impression	Sample #
105 (Galley)	Floor level	General spore count of 48 spores/m^3. The percent and type of fungal constituents included approx. 100% *Cladosporium sp.* as listed on the laboratory report (Attachment III).	Common spores found in soils, plant litter, leaf surfaces or decayed plants, easily dispersed by wind.	012319-M1
205 (Control Room)	Floor level	General spore count of 48 spores/m^3. The percent and type of fungal constituents included approx. 100% *Aspergillus/Penicillium sp.* as listed on the laboratory report (Attachment III).	Common spores found in soils or decayed plants, easily dispersed by wind.	012319-M2
204	Floor level	General spore count of 96 spores/m^3. The percent and type of fungal constituents included approx. 50% *Aspergillus/Penicillium sp.* and 50% *Cladosporium sp.* as listed on the laboratory report (Attachment III).	Common spores found in soils, plant litter, leaf surfaces or decayed plants, easily dispersed by wind.	012319-M3
Exterior	Ground level	General spore count of 140 spores/m^3. The percent and type of fungal constituents included approx. 33% *Basidiospore sp.* and 66.6% *Cladosporium sp.* as listed on the laboratory report (Attachment III).	Common spores found in gardens, forests, woodlands, soils or decayed plants, easily dispersed by wind.	012319-M4

TABLE B
DIRECT MICROSCOPIC EXAMINATION REPORT: TAPE-LIFT SAMPLES
CALTECH SUBMILLIMETER OBSERVATORY, MAUNA KEA, HAWAII

Room	Sample Location	Mold and Fungi Identification	General Impression	Sample #
105 (Galley)	Surface of ceiling tile with visible signs of water damage	Low volume of *Cladosporium sp.* observed	Minimal mold growth present	012319-T1
205 (Control Room)	Surface of ceiling tile with visible signs of water damage	Sparse volume of *Cladosporium sp.* observed	Normal trapping	012319-T2
204	Surface of ceiling tile with visible signs of water damage	High volume of *Alternaria sp.* observed	Mold growth present	012319-T3
204	Surface of sheetrock walls	Sparse volume of *Cladosporium sp.* observed	Normal trapping	012319-T4

Normal trapping means indicative of normal conditions that are seen on surfaces everywhere. It is the distribution of spores usually seen outdoors.

The dominant fungal constituents identified in the indoor and outdoor air samples and tape lift samples were *Cladosporium sp., Alternaria sp., Basidiospores sp*. and *Penicillium/Aspergillus sp*.

Cladosporium sp. are found on soils, plant litter, leaf surfaces and old or decayed plants. They are easily dispersed in wind. They are widespread indoors on many substrates, including textiles and wood.

Alternaria sp. are found on soils, dead organic debris, on food stuffs and textiles. They are easily dispersed in wind. They are widespread indoors on a variety of substrates.

Basidiospores are found on decaying plant matter and in gardens, forests and woodlands. Indoors they are the cause of "dry rot".

The *Penicillium/Aspergillus* species are commonly found in soil, decaying plant debris and compost piles and can disseminate due to wind. Indoors it is commonly found in house dust and grows in areas with excess moisture and/or water damaged areas such as wallpaper, wallpaper glue, decaying fabrics and moist chipboards. Colonies are usually shades of blue, green and white.

6.0 RECOMMENDATIONS AND CONCLUSIONS

In summary, LBP, LCP and mold were observed at the Subject Site. Based on LEI's visual survey of the site, inventory of identified potentially hazardous materials, and laboratory data, LEI recommends the following:

- Manage and/or remove and dispose of hazardous and regulated materials in accordance with applicable local, state, and federal regulations, prior to renovation and/or demolition activities that may disturb these materials.
- Remove and dispose of all loose and flaking (poor condition) LCP and LBP that may be disturbed during renovation/demolition activities in accordance with applicable local, state, and federal regulations.
- Spot remove and dispose of LCP and LBP in areas that have the potential to become airborne or otherwise create dust (i.e. from sanding, drilling, friction, etc.) during renovation/demolition activities.
- Any remediation and demolition contractor(s) must take appropriate measures to comply with applicable EPA, OSHA and HIOSH regulations pertaining to the handling of lead containing materials and worker protection. Note that OSHA and HIOSH regulate activities that disturb paint which contain any detectable concentration of lead. Note that detectable levels of lead in the paint were found throughout the Subject Site.
- Have air monitoring conducted for airborne lead by qualified personnel during any lead paint disturbance and general renovation activities of areas that were determined to contain this contaminant.
- Previously water damaged ceiling tiles located throughout the Subject Site should be removed and replaced. These tiles may be identified by water staining and/or discoloration.

7.0 REFERENCES

- Code of Federal Regulations. Occupational Safety and Health Standards. Title 29, Part 1910 (1910.1000 TO END). Washington DC. US Government Printing Office, 2001.
- Code of Federal Regulations. Occupational Safety and Health Standards. Title 29, Part 1926.62. Washington DC. US Government Printing Office, 2001.
- Code of Federal Regulations. National Emission Standard for Hazardous Air Pollutants (NESHAP), Asbestos Regulations. Title 40, Part 61, Subpart M. Washington DC. US Government Printing Office, June 19, 1995.
- US Department of Housing and Urban Development. Guidance for the Evaluation and Control of Lead Paint Hazards in Housing, 2001.
- University of Wisconsin-Milwaukee, Department of Environmental Health, Safety and Risk Management website, http://www.uwm.edu/Dept/EHSRM/HAZEXCEPTIONS/a.html, 2000.

Appendix I

TABLES OF RESULTS

Table 1. Asbestos Inspection Results
Caltech Submillimeter Observatory
Mauna Kea, Big Island, Hawaii

Bldg.	***Floor***	***Room/ Area***	***Homogeneous Areas***	***Material***	***Color/ Description***	***Friable***	***Type***	***Cond.***	***Est. Amt. of Material (ft^2)***	***Asbestos Content***
Main	1	Exterior	Observatory Slab	Cement	Gray	No	Misc.	Fair	2,500	None Detected None Detected None Detected
Main	1	Exterior & Interior	ALL ROOMS	Caulking	Gray	No	Misc.	Fair	450 linear feet	None Detected None Detected None Detected
Main	1	Exterior/Entry	Entry/Exit 1 & 2	Sheetrock & Joint Compund	Beige	Yes	Surface	Fair	400	None Detected None Detected None Detected
Main	1	Interior	RM 105, 106, 107, 108, Halls, RR	12" x 12 " VFT & Mastic	Blue	No	Misc.	Fair	800	None Detected None Detected None Detected
Main	1	Interior	Pedestal Platform	Floor Surfacing	Gray	No	Misc.	Poor	400	None Detected None Detected None Detected
Pumphouse	1	Exterior	Pumphouse Slab	Cement	Gray	No	Misc.	Fair	100	None Detected Not Deteceted Not Deteceted
Main	1	Interior	RM 105	Caulking	White	No	Misc.	Fair	50 linear ft.	None Detected None Detected None Detected
Main	1	Interior	ALL ROOMS	Base Cove & Mastic	Gray	No	Misc.	Fair	500 linear ft.	None Detected None Detected None Detected
Main	1	Interior	RM 105	2' x 4' Ceiling Tile #1	White	Yes	Misc.	Fair	125	None Detected None Detected None Detected
Main	1	Interior	RM 105	2' x 4' Ceiling Tile #2	White	Yes	Misc.	Fair	125	None Detected None Detected None Detected
Main	2	Interior	RM 204, 206, Halls, RR	12" x 12" VFT & Mastic	Blue	No	Misc.	Fair	600	None Detected None Detected None Detected
Main	2	Interior	RM 205, 206, Den	Base Cove & Mastic	Gray	No	Misc.	Fair	500 linear ft.	None Detected None Detected None Detected

Table 1. Asbestos Inspection Results
Caltech Submillimeter Observatory
Mauna Kea, Big Island, Hawaii

Bldg.	*Floor*	*Room/ Area*	*Homogeneous Areas*	*Material*	*Color/ Description*	*Friable*	*Type*	*Cond.*	*Est. Amt. of Material (ft^2)*	*Asbestos Content*
Main	2	Interior	Den	Carpet & Mastic	Gray	No	Misc.	Fair	300	None Detected None Detected None Detected
Main	2	Interior	RM 204, 205, 206, Den	2' x 4' Ceiling Tile #1	White	Yes	Misc.	Poor	300	None Detected None Detected None Detected
Main	2	Interior	RM 204, 205, 206, Den	2' x 4' Ceiling Tile #2	White	Yes	Misc.	Poor	300	None Detected None Detected None Detected
Main	2	Interior	RM 204, 205, 206, Den	2' x 4' Ceiling Tile #3	White	Yes	Misc.	Poor	300	None Detected None Detected None Detected
Main	2	Interior	Den	12" x 12" VFT & Mastic	Gray	No	Misc.	Fair	100	None Detected None Detected None Detected
Main	2	Interior	RM 204, 205, 206, Den	Insulation	Yellow	Yes	TSI	Fair	900	None Detected None Detected None Detected

Table 1. Asbestos Inspection Results
Caltech Submillimeter Observatory
Mauna Kea, Big Island, Hawaii

Sample ID
A-1
A-2
A-3
A-4
A-5
A-6
A-7
A-8
A-9
A-10
A-11
A-12
A-13
A-14
A-15
A-16
A-17
A-18
A-19
A-20
A-21
A-22
A-23
A-24
A-25
A-26
A-27
A-28
A-29
A-30
A-31
A-32
A-33
A-34
A-35
A-36

Table 1. Asbestos Inspection Results
Caltech Submillimeter Observatory
Mauna Kea, Big Island, Hawaii

Sample ID
A-37
A-38
A-39
A-40
A-41
A-42
A-43
A-44
A-45
A-46
A-47
A-48
A-49
A-50
A-51
A-52
A-53
A-54

Table 2. Lead Paint Inspection Results
Caltech Submillimeter Observatory
Mauna Kea, Big Island, Hawaii

Bldg.	***Interior/ Exterior***	***Room***	***Description***	***Color***	***Substrate***	***Cond.***	***Lead Conc. (mg/kg)***	***LCP or LBP?***	***Sample ID***
Main	Exterior	N/A	Pole	Red	Metal	Poor	150,000	LBP	L-1
Main	Exterior	N/A	Pole Cap	Yellow	Metal	Poor	140,000	LBP	L-2
Main	Exterior	N/A	Floor	Gray	Wood	Poor	<40[1]	None	L-3
Main	Interior	Entry	Hand Rails	Red	Metal	Poor	77	LCP	L-4
Main	Interior	All	Stairs	White	Metal	Fair	5,200	LBP	L-5
Main	Exterior	Entry	Walls	Beige	Sheetrock	Fair	<40[1]	None	L-6
Main	Interior	All	Door Jamb	Red	Metal	Fair	<40[1]	None	L-7
Main	Interior	All	Door	Beige	Wood	Fair	<40[1]	None	L-8
Main	Interior	All	Wall	Beige	Sheetrock	Fair	<40[1]	None	L-9
Main	Interior	Galley (105)	Cabinets	White	Wood	Fair	<40[1]	None	L-10
Main	Exterior	N/A	Frame	White	Metal	Poor	200	LCP	L-11
Main	Exterior	N/A	Various	Yellow	Metal	Poor	56,000	LBP	L-12
Main	Exterior	N/A	Cage	White	Metal	Fair	65	LCP	L-13
Main	Interior	Pedestal Platform	Ceiling	White	Metal	Poor	<40[1]	None	L-14
Water Pump Shed	Exterior	N/A	Shed	White	Metal	Fair	69,000	LBP	L-15
Water Pump Shed	Exterior	N/A	Door Jamb and Roof	Beige	Metal	Fair	11,000	LBP	L-16
Water Pump Shed	Interior	N/A	Frame	Red	Metal	Poor	250	LCP	L-17

[1] *Below the laboratory detection limit. May be considered non-lead containing paint.*

Table 2. Lead Paint Inspection Results
Caltech Submillimeter Observatory
Mauna Kea, Big Island, Hawaii

Bldg.	***Interior/ Exterior***	***Room***	***Description***	***Color***	***Substrate***	***Cond.***	***Lead Conc. (mg/kg)***	***LCP or LBP?***	***Sample ID***
Large Storage Shed	Interior	N/A	Frame	Red	Metal	Poor	63	LCP	L-18
Pump House	Interior	N/A	Shelf	White	Metal	Poor	1,600	LCP	L-19
US Navy Research Shed	Exterior	N/A	Door	White	Metal	Fair	<40[1]	None	L-20
US Navy Research Shed	Interior	N/A	Wall	White	Sheetrock	Fair	<40[1]	None	L-21
Main	Exterior	N/A	Shutter Frame	Silver	Metal	Poor	380	LCP	L-22

[1] *Below the laboratory detection limit. May be considered non-lead containing paint.*

Appendix II

PHOTOGRAPH LOG 1 – ASBESTOS SURVEY PHOTOGRAPH LOG
PHOTOGRAPH LOG 2 – LEAD PAINT SURVEY PHOTOGRAPH LOG

Photograph Log 1. Asbestos Photograph Log
Caltech Submillimeter Observatory, Mauna Kea, Hawaii

A-1: None Detected
A-2: None Detected
A-3: None Detected

Gray concrete slab beneath observatory.

A-4: None Detected
A-5: None Detected
A-6: None Detected

Gray caulking throughout observatory.

A-7: None Detected
A-8: None Detected
A-9: None Detected

Beige sheetrock and joint compound at observatory entry.

Photograph Log 1. Asbestos Photograph Log
Caltech Submillimeter Observatory, Mauna Kea, Hawaii

A-10: None Detected
A-11: None Detected
A-12: None Detected

Blue 12” X 12” vinyl floor tile and associated black mastic.

A-13: None Detected
A-14: None Detected
A-15: None Detected

Gray floor surfacing on pedestal platform.

A-16: None Detected
A-17: None Detected
A-18: None Detected

Gray concrete slab beneath pumphouse.

Photograph Log 1. Asbestos Photograph Log
Caltech Submillimeter Observatory, Mauna Kea, Hawaii

A-19: None Detected
A-20: None Detected
A-21: None Detected

White caulking on cabinets in Room 105.

A-22: None Detected
A-23: None Detected
A-24: None Detected

Gray base cove and associated brown mastic.

A-25: None Detected
A-26: None Detected
A-27: None Detected

White rough textured 2' X 4' ceiling tile.

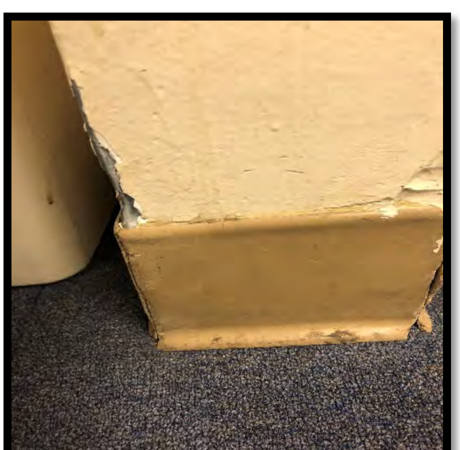
Photograph Log 1. Asbestos Photograph Log
Caltech Submillimeter Observatory, Mauna Kea, Hawaii

A-28: None Detected
A-29: None Detected
A-30: None Detected

White pinhole 2’ X 4’ ceiling tile.

A-31: None Detected
A-32: None Detected
A-33: None Detected

Blue 12” X 12” vinyl floor tile and associated black mastic.



A-34: None Detected
A-35: None Detected
A-36: None Detected

Gray base cove and associated brown mastic.

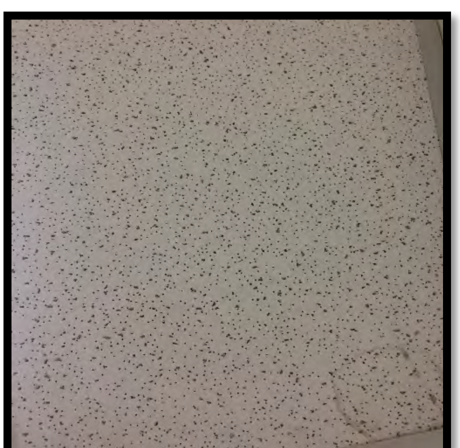
Photograph Log 1. Asbestos Photograph Log
Caltech Submillimeter Observatory, Mauna Kea, Hawaii

A-37: None Detected
A-38: None Detected
A-39: None Detected

Gray carpet and associated brown mastic.

A-40: None Detected
A-41: None Detected
A-42: None Detected

White 2’ X 4’ ceiling tile #1.



A-43: None Detected
A-44: None Detected
A-45: None Detected

White 2’ X 4’ ceiling tile #2.

Photograph Log 1. Asbestos Photograph Log
Caltech Submillimeter Observatory, Mauna Kea, Hawaii

A-46: None Detected
A-47: None Detected
A-48: None Detected

White pinhole 2' X 4' ceiling tile.

A-49: None Detected
A-50: None Detected
A-51: None Detected

Gray 12" x 12" vinyl floor tile and associated black mastic.

A-52: None Detected
A-53: None Detected
A-54: None Detected

Yellow foam ceiling insulation.

Photograph Log 1. Asbestos Photograph Log
Caltech Submillimeter Observatory, Mauna Kea, Hawaii

A-55: None Detected
A-56: None Detected
A-57: None Detected

Silver foil lined foam insulation.

A-58: None Detected
A-59: None Detected
A-60: None Detected

Beige sheetrock and joint compound throughout interior of observatory.

A-61: None Detected
A-62: None Detected
A-63: None Detected

Black sealant in parking lot.

Photograph Log 1. Asbestos Photograph Log
Caltech Submillimeter Observatory, Mauna Kea, Hawaii

A-64: None Detected
A-65: None Detected
A-66: None Detected

Gray caulking in restroom.

A-67: None Detected
A-68: None Detected
A-69: None Detected

Concrete slab beneath US Navy Research Slab.

A-70: None Detected
A-71: None Detected
A-72: None Detected

Blue 12” X 12’ vinyl floor tile and associated black mastic.

Photograph Log 1. Asbestos Photograph Log
Caltech Submillimeter Observatory, Mauna Kea, Hawaii

A-73: None Detected
A-74: None Detected
A-75: None Detected

White 4” pipe insulation.

A-76: None Detected
A-77: None Detected
A-78: None Detected

White sheetrock and associated joint compound.

A-79: None Detected
A-80: None Detected
A-81: None Detected

Silver paint on shutter frame exterior..

Photograph Log 1. Asbestos Photograph Log
Caltech Submillimeter Observatory, Mauna Kea, Hawaii

A-82: None Detected
A-83: None Detected
A-84: None Detected

White ceiling texture in Electronics Lab.

A-85: None Detected
A-86: None Detected
A-87: None Detected

White water tank insulation.

A-88: None Detected
A-89: None Detected
A-90: None Detected

Gray floor surfacing.

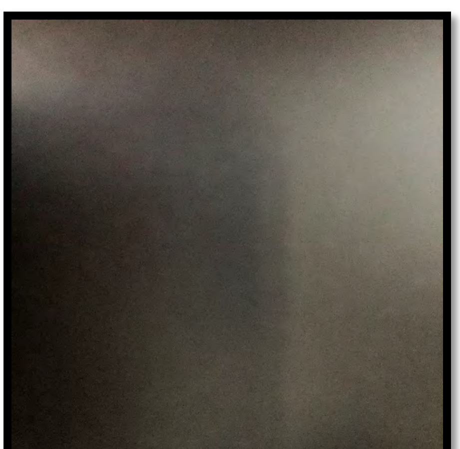
Photograph Log 1. Asbestos Photograph Log
Caltech Submillimeter Observatory, Mauna Kea, Hawaii

A-94: None Detected
A-95: None Detected
A-96: None Detected

White sheetrock wall and associated joint compound in US Navy Research Shed.

A-97: None Detected
A-98: None Detected
A-99: None Detected

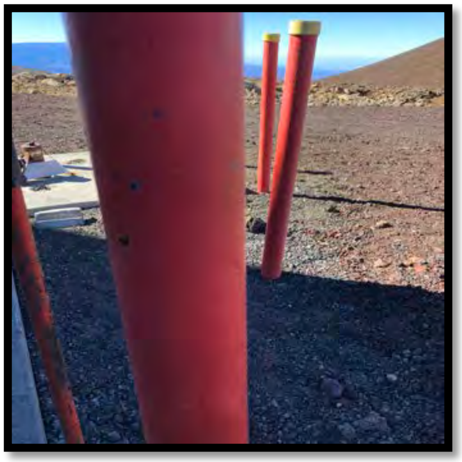
Gray door and window caulking in US Navy Research Shed.



A-52: None Detected
A-53: None Detected
A-54: None Detected

Black vibration cloth in room 105.

Photograph Log 2. Lead Paint Photograph Log
Caltech Submillimeter Observatory, Mauna Kea, Hawaii



L-1: (150,000 mg/kg) Lead-Based Paint

Red metal poles outside of observatory.

L-2: (140,000 mg/kg) Lead-Based Paint

Yellow metal pole caps outside of observatory.

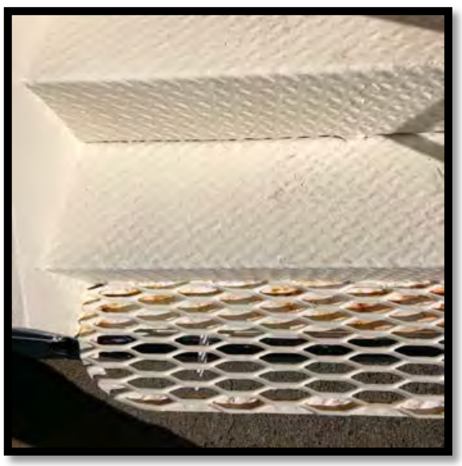
L-3: (< 40 mg/kg) Below Laboratory Detection Limit

Gray wooden floor on exterior of observatory.

Photograph Log 2. Lead Paint Photograph Log
Caltech Submillimeter Observatory, Mauna Kea, Hawaii

L-4: (77 mg/kg) Lead-Containing Paint

Red metal hand rails throughout observatory.



L-5: (5,200 mg/kg) Lead-Based Paint

White metal stairs throughout observatory.

L-6: (< 40 mg/kg) Below Laboratory Detection Limit

Beige sheetrock walls at observatory entries.

Photograph Log 2. Lead Paint Photograph Log
Caltech Submillimeter Observatory, Mauna Kea, Hawaii

L-7: (< 40 mg/kg) Below Laboratory Detection Limit

Red metal door jambs throughout observatory.

L-8: (< 40 mg/kg) Below Laboratory Detection Limit

Beige wooden doors throughout observatory.

L-9: (< 40 mg/kg) Below Laboratory Detection Limit

Beige sheetrock walls throughout interior of observatory.

Photograph Log 2. Lead Paint Photograph Log
Caltech Submillimeter Observatory, Mauna Kea, Hawaii

L-10:(< 40 mg/kg) Below Laboratory Detection Limit

White wooden cabinets in Room 105.

L-11: (200 mg/kg) Lead-Containing Paint

White metal beams throughout observatory.

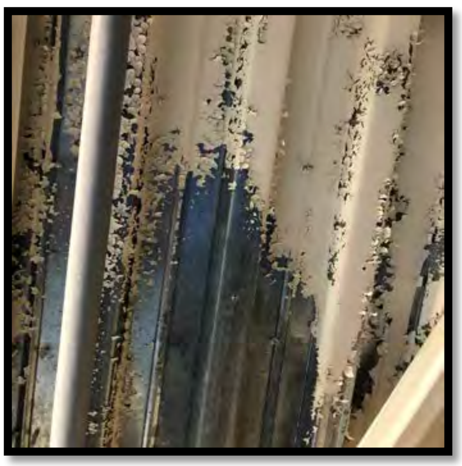
L-12: (58,000 mg/kg) Lead-Based Paint

Various yellow painted metal throughout observatory.

Photograph Log 2. Lead Paint Photograph Log
Caltech Submillimeter Observatory, Mauna Kea, Hawaii

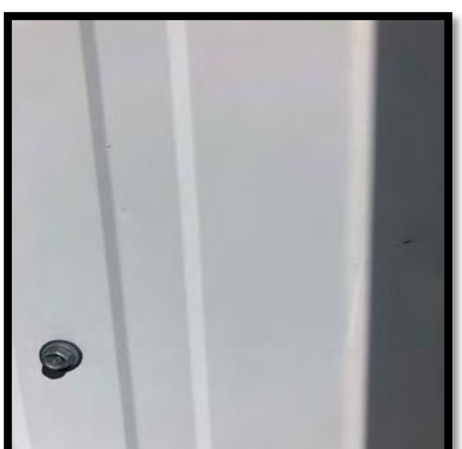
L-13: (65 mg/kg) Lead-Containing Paint

White metal caging throughout observatory.



L-14: (< 40 mg/kg) Below Laboratory Detection Limit

White metal corrugated ceiling.



L-15: (69,000 mg/kg) Lead-Based Paint

White metal exterior of water pump shed.

Photograph Log 2. Lead Paint Photograph Log
Caltech Submillimeter Observatory, Mauna Kea, Hawaii

L-16: (11,000 mg/kg) Lead-Based Paint

White metal door jamb and roof of water pump shed.

L-17: (250 mg/kg) Lead-Containing Paint

Red metal frame inside water pump shed.

L-18: (63 mg/kg) Lead-Containing Paint

Red metal frame inside large storage shed.

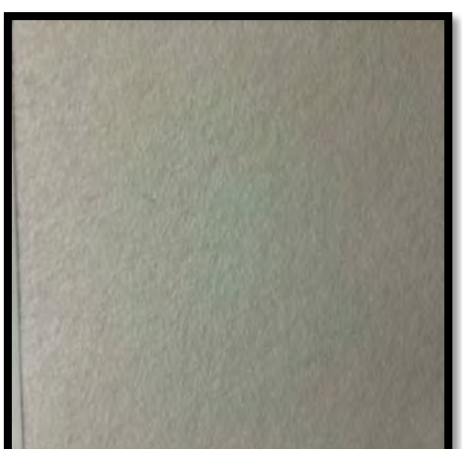
Photograph Log 2. Lead Paint Photograph Log
Caltech Submillimeter Observatory, Mauna Kea, Hawaii

L-19: (1,600 mg/kg) Lead-Containing Paint

White metal shelf inside pump house.

L-20: (< 40 mg/kg) Below Laboratory Detection Limit

White metal door on US Navy Research Shed.



L-21: (< 40 mg/kg) Below Laboratory Detection Limit

White sheetrock wall inside US Navy Research Shed.

Photograph Log 2. Lead Paint Photograph Log
Caltech Submillimeter Observatory, Mauna Kea, Hawaii

L-22: (380 mg/kg) Lead-Containing Paint

Silver paint on observatory dome and shutter.

Appendix III

ASBESTOS LABORATORY ANALYTICAL RESULTS AND CHAIN-OF-CUSTODY FORMS
LEAD LABORATORY ANALYTICAL RESULTS AND CHAIN-OF-CUSTODY FORMS
MOLD LABORATORY ANALYTICAL RESULTS AND CHAIN-OF-CUSTODY FORMS

Hawaii Analytical Laboratory
ANALYTICAL REPORT

Friday, February 01, 2019

Mr. Kama Kobayashi
Lehua Environmental Inc.
P.O. Box 1018
Kamuela HI 96743

Phone Number: (808) 494-0365
Facsimile:
Email: lehuaenvironmental@gmail.com

Lab Job No: 201900696
Date Submitted: 1/25/2019
Your Project: Caltech Observatory, 1/22/19

Bulk Asbestos Determination

Sample No.	Your Sample Description	Asbestos Present?	Type	%v/v	Other Fibrous	%v/v	Matrix	Date Analyzed
201903858	**A-1**		NONE DETECTED		None detected		Cementitious + other	1/30/2019
Layer	Grey concrete material							
Comments								
201903859	**A-2**		NONE DETECTED		None detected		Cementitious + other	1/30/2019
Layer	Grey concrete material							
Comments								
201903860	**A-3**		NONE DETECTED		None detected		Cementitious + other	1/30/2019
Layer	Grey concrete material							
Comments								
201903861	**A-4**		NONE DETECTED		None detected		Binder + other	1/30/2019
Layer	Clear caulk							
Comments								
201903862	**A-5**		NONE DETECTED		None detected		Binder + other	1/30/2019
Layer	Clear caulk							
Comments								
201903863	**A-6**		NONE DETECTED		None detected		Binder + other	1/30/2019
Layer	Clear caulk							
Comments								

Hawaii Analytical Laboratory is a NIST NVLAP accredited laboratory (NVLAP Lab Code 200655-0) and is accredited in accordance with the recognized ISO/ IEC 17025:2005. Controlled doc.: Asbestos Report, rev. 1 - 20160830

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Lehua Environmental Inc.
P.O. Box 1018
Kamuela HI 96743

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201903864	**A-7**		NONE DETECTED		None detected		Calcite + binder	1/30/2019
Layer	White compound material							
Comments								
201903865	**A-8**		NONE DETECTED		None detected		Calcite + binder	1/30/2019
Layer	White compound material							
Comments								
201903866	**A-9**		NONE DETECTED		None detected		Calcite + binder	1/30/2019
Layer	White compound material							
Comments								
201903867	**A-10**		NONE DETECTED		None detected		Vinyl	1/30/2019
Layer	Blue vinyl floor tile							
Comments								
201903867	**A-10**		NONE DETECTED		None detected		Binder + other	1/30/2019
Layer	Tan/yellow mastic							
Comments								
201903868	**A-11**		NONE DETECTED		None detected		Vinyl	1/30/2019
Layer	Blue vinyl floor tile							
Comments								
201903868	**A-11**		NONE DETECTED		None detected		Binder + other	1/30/2019
Layer	Tan/yellow mastic							
Comments								
201903869	**A-12**		NONE DETECTED		None detected		Vinyl	1/30/2019
Layer	Blue vinyl floor tile							
Comments								

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201903869	**A-12**		NONE DETECTED		None detected		Binder + other	1/30/2019
Layer	Tan/yellow mastic							
Comments								
201903870	**A-13**		NONE DETECTED		None detected		Calcite + binder + glass + paint	1/30/2019
Layer	Blue/grey flooring material							
Comments								
201903871	**A-14**		NONE DETECTED		None detected		Calcite + binder + glass + paint	1/30/2019
Layer	Blue/grey flooring material							
Comments								
201903872	**A-15**		NONE DETECTED		None detected		Calcite + binder + glass + paint	1/30/2019
Layer	Blue/grey flooring material							
Comments								
201903873	**A-16**		NONE DETECTED		None detected		Cementitious + other	1/30/2019
Layer	Grey concrete material							
Comments								
201903874	**A-17**		NONE DETECTED		None detected		Cementitious + other	1/30/2019
Layer	Grey concrete material							
Comments								
201903875	**A-18**		NONE DETECTED		None detected		Cementitious + other	1/30/2019
Layer	Grey concrete material							
Comments								
201903876	**A-19**		NONE DETECTED		Wollastonite (+/- optical sign)	**10**	Binder + other	1/30/2019
Layer	White caulk							
Comments								

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201903877	**A-20**		NONE DETECTED		Wollastonite (+/- optical sign)	**10**	Binder + other	1/30/2019
Layer	White caulk							
Comments								
201903878	**A-21**		NONE DETECTED		Wollastonite (+/- optical sign)	**10**	Binder + other	1/30/2019
Layer	White caulk							
Comments								
201903879	**A-22**		NONE DETECTED		None detected		Vinyl + other	1/30/2019
Layer	Beige covebase							
Comments								
201903879	**A-22**		NONE DETECTED		Wollastonite (+/- optical sign)	**5**	Binder + other	1/30/2019
Layer	Brown mastic							
Comments								
201903880	**A-23**		NONE DETECTED		None detected		Vinyl + other	1/30/2019
Layer	Beige covebase							
Comments								
201903880	**A-23**		NONE DETECTED		Wollastonite (+/- optical sign)	**5**	Binder + other	1/30/2019
Layer	Brown mastic							
Comments								
201903881	**A-24**		NONE DETECTED		None detected		Vinyl + other	1/30/2019
Layer	Beige covebase							
Comments								
201903881	**A-24**		NONE DETECTED		Wollastonite (+/- optical sign)	**5**	Binder + other	1/30/2019
Layer	Brown mastic							
Comments								

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201903882	**A-25**		NONE DETECTED		Mineral wool (amorphous) + cellulose (undulose)	**35**	Perlite + binder + glass bead	1/30/2019
Layer	White acoustic tile							
Comments								
201903883	**A-26**		NONE DETECTED		Mineral wool (amorphous) + cellulose (undulose)	**35**	Perlite + binder + glass bead	1/30/2019
Layer	White acoustic tile							
Comments								
201903884	**A-27**		NONE DETECTED		Mineral wool (amorphous) + cellulose (undulose)	**35**	Perlite + binder + glass bead	1/30/2019
Layer	White acoustic tile							
Comments								
201903885	**A-28**		NONE DETECTED		Mineral wool (amorphous) + cellulose (undulose)	**35**	Perlite + binder + glass bead	1/30/2019
Layer	White acoustic tile							
Comments								
201903886	**A-29**		NONE DETECTED		Mineral wool (amorphous) + cellulose (undulose)	**35**	Perlite + binder + glass bead	1/30/2019
Layer	White acoustic tile							
Comments								
201903887	**A-30**		NONE DETECTED		Mineral wool (amorphous) + cellulose (undulose)	**35**	Perlite + binder + glass bead	1/30/2019
Layer	White acoustic tile							
Comments								
201903888	**A-31**		NONE DETECTED		None detected		Vinyl	1/30/2019
Layer	Blue vinyl floor tile							
Comments								

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Bulk Asbestos Determination

Sample No.	Your Sample Description	Asbestos Present?	Type	%v/v	Other Fibrous	%v/v	Matrix	Date Analyzed
201903888	**A-31**		NONE DETECTED		Wood fiber (undulose)	**10**	Binder + other	1/30/2019
Layer	Tan mastic (limited) / wood							
Comments								
201903889	**A-32**		NONE DETECTED		None detected		Vinyl	1/30/2019
Layer	Blue vinyl floor tile							
Comments								
201903889	**A-32**		NONE DETECTED		Wood fiber (undulose)	**10**	Binder + other	1/30/2019
Layer	Tan mastic (limited) / wood							
Comments								
201903890	**A-33**		NONE DETECTED		None detected		Vinyl	1/30/2019
Layer	Blue vinyl floor tile							
Comments								
201903890	**A-33**		NONE DETECTED		Wood fiber (undulose)	**10**	Binder + other	1/30/2019
Layer	Tan mastic (limited) / wood							
Comments								
201903891	**A-34**		NONE DETECTED		None detected		Vinyl + other	1/30/2019
Layer	Beige covebase							
Comments								
201903891	**A-34**		NONE DETECTED		Wollastonite (+/- optical sign)	**5**	Binder + other	1/30/2019
Layer	Brown mastic							
Comments								
201903892	**A-35**		NONE DETECTED		None detected		Vinyl + other	1/30/2019
Layer	Beige covebase							
Comments								

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201903892	**A-35**		NONE DETECTED		Wollastonite (+/- optical sign)	**5**	Binder + other	1/30/2019
Layer	Brown mastic							
Comments								
201903893	**A-36**		NONE DETECTED		None detected		Vinyl + other	1/30/2019
Layer	Beige covebase							
Comments								
201903893	**A-36**		NONE DETECTED		Wollastonite (+/- optical sign)	**5**	Binder + other	1/30/2019
Layer	Brown mastic							
Comments								
201903894	**A-37**		NONE DETECTED		Synthetic fiber (undulose) + cellulose (undulose)	**45**	Binder + other	1/30/2019
Layer	Black glue / brown paper board							
Comments								
201903894	**A-37**		NONE DETECTED		Synthetic fiber (undulose)	**85**	Calcite + binder + other	1/30/2019
Layer	Blue carpet							
Comments								
201903895	**A-38**		NONE DETECTED		Synthetic fiber (undulose)	**85**	Calcite + binder + other	1/30/2019
Layer	Blue carpet							
Comments								
201903896	**A-39**		NONE DETECTED		Synthetic fiber (undulose)	**85**	Calcite + binder + other	1/30/2019
Layer	Blue carpet							
Comments								
201903897	**A-40**		NONE DETECTED		Mineral wool (amorphous) + cellulose (undulose)	**35**	Perlite + binder + glass bead	1/30/2019
Layer	White acoustic tile							
Comments								

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Sample No.	Your Sample Description	Asbestos Present?	Type	%v/v	Other Fibrous	%v/v	Matrix	Date Analyzed
201903898	**A-41**		NONE DETECTED		Mineral wool (amorphous) + cellulose (undulose)	**35**	Perlite + binder + glass bead	1/30/2019
Layer	White acoustic tile							
Comments								
201903899	**A-42**		NONE DETECTED		Mineral wool (amorphous) + cellulose (undulose)	**35**	Perlite + binder + glass bead	1/30/2019
Layer	White acoustic tile							
Comments								
201903900	**A-43**		NONE DETECTED		Mineral wool (amorphous) + cellulose (undulose)	**35**	Perlite + binder + glass bead	1/30/2019
Layer	White acoustic tile							
Comments								
201903901	**A-44**		NONE DETECTED		Mineral wool (amorphous) + cellulose (undulose)	**35**	Perlite + binder + glass bead	1/30/2019
Layer	White acoustic tile							
Comments								
201903902	**A-45**		NONE DETECTED		Mineral wool (amorphous) + cellulose (undulose)	**35**	Perlite + binder + glass bead	1/30/2019
Layer	White acoustic tile							
Comments								
201903903	**A-46**		NONE DETECTED		Mineral wool (amorphous) + cellulose (undulose)	**35**	Perlite + binder + glass bead	1/30/2019
Layer	White acoustic tile							
Comments								
201903904	**A-47**		NONE DETECTED		Mineral wool (amorphous) + cellulose (undulose)	**35**	Perlite + binder + glass bead	1/30/2019
Layer	White acoustic tile							
Comments								

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201903905	**A-48**		NONE DETECTED		Mineral wool (amorphous) + cellulose (undulose)	**35**	Perlite + binder + glass bead	1/30/2019
Layer	White acoustic tile							
Comments								
201903906	**A-49**		NONE DETECTED		Cellulose / wood fiber (undulose)	**40**	Binder + other	1/30/2019
Layer	Black mastic / wood paper							
Comments								
201903906	**A-49**		NONE DETECTED		None detected		Vinyl + other	1/30/2019
Layer	Blue tile							
Comments								
201903907	**A-50**		NONE DETECTED		Cellulose / wood fiber (undulose)	**40**	Binder + other	1/30/2019
Layer	Black mastic / wood paper							
Comments								
201903907	**A-50**		NONE DETECTED		None detected		Vinyl + other	1/30/2019
Layer	Blue tile							
Comments								
201903908	**A-51**		NONE DETECTED		Cellulose / wood fiber (undulose)	**40**	Binder + other	1/30/2019
Layer	Black mastic / wood paper							
Comments								
201903908	**A-51**		NONE DETECTED		None detected		Vinyl + other	1/30/2019
Layer	Blue tile							
Comments								
201903909	**A-52**		NONE DETECTED		Mineral wool (amorphous)	**95**	Other	1/30/2019
Layer	Yellow insulation							
Comments								

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201903910	**A-53**		NONE DETECTED		Mineral wool (amorphous)	**95**	Other	1/30/2019
Layer	Yellow insulation							
Comments								
201903911	**A-54**		NONE DETECTED		Mineral wool (amorphous)	**95**	Other	1/30/2019
Layer	Yellow insulation							
Comments								
201903912	**A-55**		NONE DETECTED		Fibrous glass (amorphous)	**15**	Aluminum + other	1/30/2019
Layer	Silver wrap							
Comments								
201903912	**A-55**		NONE DETECTED		None detected		Foam	1/30/2019
Layer	Yellow foam insulation							
Comments								
201903913	**A-56**		NONE DETECTED		Fibrous glass (amorphous)	**15**	Aluminum + other	1/30/2019
Layer	Silver wrap							
Comments								
201903913	**A-56**		NONE DETECTED		None detected		Foam	1/30/2019
Layer	Yellow foam insulation							
Comments								
201903914	**A-57**		NONE DETECTED		Fibrous glass (amorphous)	**15**	Aluminum + other	1/30/2019
Layer	Silver wrap							
Comments								
201903914	**A-57**		NONE DETECTED		None detected		Foam	1/30/2019
Layer	Yellow foam insulation							
Comments								

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201903915	**A-58**		NONE DETECTED		Cellulose (undulose)	**15**	Gypsum	1/30/2019
Layer	White drywall							
Comments								
201903916	**A-59**		NONE DETECTED		Cellulose (undulose)	**15**	Gypsum	1/30/2019
Layer	White drywall							
Comments								
201903917	**A-60**		NONE DETECTED		Cellulose (undulose)	**15**	Gypsum	1/30/2019
Layer	White drywall							
Comments								
201903918	**A-61**		NONE DETECTED		None detected		Tar + other	1/30/2019
Layer	Black tar material							
Comments								
201903919	**A-62**		NONE DETECTED		None detected		Tar + other	1/30/2019
Layer	Black tar material							
Comments								
201903920	**A-63**		NONE DETECTED		None detected		Tar + other	1/30/2019
Layer	Black tar material							
Comments								
201903921	**A-64**		NONE DETECTED		None detected		Binder	1/30/2019
Layer	Clear caulk							
Comments								
201903921	**A-64**		NONE DETECTED		None detected		Calcite + binder + paint	1/30/2019
Layer	White compound material / paint							
Comments								

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201903922	**A-65**		NONE DETECTED		None detected		Binder	1/30/2019
Layer	Clear caulk							
Comments								
201903923	**A-66**		NONE DETECTED		None detected		Binder	1/30/2019
Layer	Clear caulk							
Comments								
201903923	**A-66**		NONE DETECTED		None detected		Calcite + binder + paint	1/30/2019
Layer	White compound material / paint							
Comments								
201903924	**A-67**		NONE DETECTED		None detected		Cementitious + other	1/30/2019
Layer	Grey concrete material							
Comments								
201903925	**A-68**		NONE DETECTED		None detected		Cementitious + other	1/30/2019
Layer	Grey concrete material							
Comments								
201903926	**A-69**		NONE DETECTED		None detected		Cementitious + other	1/30/2019
Layer	Grey concrete material							
Comments								
201903927	**A-70**		NONE DETECTED		None detected		Vinyl	1/30/2019
Layer	Blue vinyl floor tile							
Comments								
201903927	**A-70**		NONE DETECTED		Wood fiber (undulose)	**10**	Binder + other	1/30/2019
Layer	Yellow mastic / wood							
Comments								

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201903928	**A-71**		NONE DETECTED		None detected		Vinyl	1/30/2019
Layer	Blue vinyl floor tile							
Comments								
201903928	**A-71**		NONE DETECTED		None detected		Binder + calcite + other	1/30/2019
Layer	Yellow mastic / white compound material							
Comments								
201903929	**A-72**		NONE DETECTED		None detected		Vinyl	1/30/2019
Layer	Blue vinyl floor tile							
Comments								
201903929	**A-72**		NONE DETECTED		None detected		Binder + other	1/30/2019
Layer	Yellow mastic							
Comments								
201903930	**A-73**		NONE DETECTED		Fibrous glass (amorphous) + cellulose (undulose)	**35**	Aluminum + binder	1/30/2019
Layer	Silver wrap							
Comments								
201903930	**A-73**		NONE DETECTED		Mineral wool (amorphous)	**95**	Other	1/30/2019
Layer	Yellow insulation							
Comments								
201903931	**A-74**		NONE DETECTED		Fibrous glass (amorphous) + cellulose (undulose)	**35**	Aluminum + binder	1/30/2019
Layer	Silver wrap							
Comments								
201903931	**A-74**		NONE DETECTED		Mineral wool (amorphous)	**95**	Other	1/30/2019
Layer	Yellow insulation							
Comments								

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201903932	**A-75**		NONE DETECTED		Fibrous glass (amorphous) + cellulose (undulose)	**35**	Aluminum + binder	1/30/2019
Layer	Silver wrap							
Comments								
201903932	**A-75**		NONE DETECTED		Mineral wool (amorphous)	**95**	Other	1/30/2019
Layer	Yellow insulation							
Comments								
201903933	**A-76**		NONE DETECTED		Cellulose (undulose)	**15**	Gypsum	1/30/2019
Layer	Tan drywall							
Comments								
201903933	**A-76**		NONE DETECTED		None detected		Calcite + binder + paint	1/30/2019
Layer	White joint compound (1) / beige paint							
Comments								
201903933	**A-76**		NONE DETECTED		Cellulose (undulose)	**30**	Calcite + binder	1/30/2019
Layer	White joint compound (2) / paper							
Comments								
201903934	**A-77**		NONE DETECTED		None detected		Calcite + binder + paint	1/30/2019
Layer	White joint compound (1) / beige paint							
Comments								
201903934	**A-77**		NONE DETECTED		Cellulose (undulose)	**30**	Calcite + binder	1/30/2019
Layer	White joint compound (2) / paper							
Comments								
201903935	**A-78**		NONE DETECTED		Cellulose (undulose)	**15**	Gypsum	1/30/2019
Layer	Tan drywall							
Comments								

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201903935	**A-78**		NONE DETECTED		None detected		Calcite + binder + paint	1/30/2019
Layer	White joint compound (1) / beige paint							
Comments								
201903935	**A-78**		NONE DETECTED		Cellulose (undulose)	**30**	Calcite + binder	1/30/2019
Layer	White joint compound (2) / paper							
Comments								
201903936	**A-79**		NONE DETECTED		None detected		Paint + other	1/30/2019
Layer	Silver paint							
Comments								
201903937	**A-80**		NONE DETECTED		None detected		Paint + other	1/30/2019
Layer	Silver paint							
Comments								
201903938	**A-81**		NONE DETECTED		None detected		Paint + other	1/30/2019
Layer	Silver paint							
Comments								
201903939	**A-82**		NONE DETECTED		None detected		Calcite + binder + paint	1/30/2019
Layer	White joint compound / beige paint							
Comments								
201903940	**A-83**		NONE DETECTED		None detected		Calcite + binder + paint	1/30/2019
Layer	White joint compound / beige paint							
Comments								
201903941	**A-84**		NONE DETECTED		None detected		Calcite + binder + paint	1/30/2019
Layer	White joint compound / beige paint							
Comments								

Mr. Kama Kobayashi
Lehua Environmental Inc.
P.O. Box 1018
Kamuela HI 96743

Phone Number: (808) 494-0365
Facsimile:
Email: lehuaenvironmental@gmail.com

Lab Job No: 201900696
Date Submitted: 1/25/2019
Your Project: Caltech Observatory, 1/22/19

Bulk Asbestos Determination

Sample No.	Your Sample Description	Asbestos Present?	Type	%v/v	Other Fibrous	%v/v	Matrix	Date Analyzed
201903942	**A-85**		NONE DETECTED		Fibrous glass (amorphous) + cellulose (undulose)	**35**	Aluminum + binder + other	1/30/2019
Layer	Silver wrap / tan coat							
Comments								
201903942	**A-85**		NONE DETECTED		Mineral wool (amorphous)	**95**	Other	1/30/2019
Layer	Yellow insulation							
Comments								
201903943	**A-86**		NONE DETECTED		Fibrous glass (amorphous) + cellulose (undulose)	**35**	Aluminum + binder + other	1/30/2019
Layer	Silver wrap / tan coat							
Comments								
201903943	**A-86**		NONE DETECTED		Mineral wool (amorphous)	**95**	Other	1/30/2019
Layer	Yellow insulation							
Comments								
201903944	**A-87**		NONE DETECTED		Fibrous glass (amorphous) + cellulose (undulose)	**35**	Aluminum + binder	1/30/2019
Layer	Silver wrap							
Comments								
201903944	**A-87**		NONE DETECTED		Mineral wool (amorphous)	**95**	Other	1/30/2019
Layer	Yellow insulation							
Comments								
201903945	**A-88**		NONE DETECTED		None detected		Calcite + binder + glass + paint	1/30/2019
Layer	Blue/grey flooring material							
Comments								
201903946	**A-89**		NONE DETECTED		None detected		Calcite + binder + glass + paint	1/30/2019
Layer	Blue/grey flooring material							
Comments								

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Date Submitted: 1/25/2019
Your Project: Caltech Observatory, 1/22/19

Bulk Asbestos Determination

Sample No.	Your Sample Description	Asbestos Present?	Type	%v/v	Other Fibrous	%v/v	Matrix	Date Analyzed
201903947	**A-90**		NONE DETECTED		None detected		Calcite + binder + glass + paint	1/30/2019
Layer	Blue/grey flooring material							
Comments								
201903951	**A-94**		NONE DETECTED		Cellulose (undulose)	**15**	Gypsum	1/30/2019
Layer	White drywall							
Comments								
201903951	**A-94**		NONE DETECTED		None detected		Calcite + binder + paint	1/30/2019
Layer	White joint compound / paint							
Comments								
201903952	**A-95**		NONE DETECTED		Cellulose (undulose)	**15**	Gypsum	1/30/2019
Layer	White drywall							
Comments								
201903952	**A-95**		NONE DETECTED		None detected		Calcite + binder + paint	1/30/2019
Layer	White joint compound / paint							
Comments								
201903953	**A-96**		NONE DETECTED		Cellulose (undulose)	**15**	Gypsum	1/30/2019
Layer	White drywall							
Comments								
201903953	**A-96**		NONE DETECTED		None detected		Calcite + binder + paint	1/30/2019
Layer	White joint compound (1) / paint							
Comments								
201903953	**A-96**		NONE DETECTED		Cellulose (undulose)	**30**	Calcite + binder	1/30/2019
Layer	White joint compound (2) / paper							
Comments								

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Lab Job No: 201900696
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Bulk Asbestos Determination

Sample No.	Your Sample Description	Asbestos Present?	Type	%v/v	Other Fibrous	%v/v	Matrix	Date Analyzed
201903954	**A-97**		NONE DETECTED		None detected		Binder + other	1/30/2019
Layer	Grey caulk							
Comments								
201903955	**A-98**		NONE DETECTED		None detected		Binder + other	1/30/2019
Layer	Grey caulk							
Comments								
201903956	**A-99**		NONE DETECTED		None detected		Binder + other	1/30/2019
Layer	Grey caulk							
Comments								
201903957	**A-100**		NONE DETECTED		Fibrous glass (amorphous)	**50**	Binder + other	1/30/2019
Layer	Black membrane material							
Comments								
201903958	**A-101**		NONE DETECTED		Fibrous glass (amorphous)	**50**	Binder + other	1/30/2019
Layer	Black membrane material							
Comments								
201903959	**A-102**		NONE DETECTED		Fibrous glass (amorphous)	**50**	Binder + other	1/30/2019
Layer	Black membrane material							
Comments								

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P.O. Box 1018
Kamuela HI 96743

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Facsimile:
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Lab Job No: 201900696
Date Submitted: 1/25/2019
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General Comments
The bulk sample[s] analysis subject of this analytical report were conducted in general accordance with the procedures outlined in the United States Environmental Protection Agency's "Interim Method for the Determination of Asbestos in Bulk Insulation Samples" (EPA-600/M4-82-020, Dec. 1982) and / or "Method for Determination of Asbestos in bulk Building Materials" (EPA-600/R-93-116, July 1993). The analysis of each bulk sample relates only to the material examined, and may or may not represent the overall composition of its original source. Floor tile and other resinously bound materials, when analyzed by the EPA methods referenced above may yield false negative results because of limitations in separating closely bound fibers and in detecting fibers of small length and diameter. Alternative methods of identification, including Transmission Electron Microscopy (TEM) may or may not be applicable. We utilize calibrated visual area estimation on a routine basis and do not conduct point counting unless specifically requested to do so. Estimated error for the visual determinations presented are 50% relative (1 to 5%); 25% relative (6 to 25%) and 20% (>26% v/v). We will not separate layers which in our opinion are not readily discernable. This report is not to be duplicated except in full without the expressed written permission of Hawaii Analytical Laboratory. This report must not be used by the client to claim product certification, approval or endorsement by NVLAP, NIST or any agency of Federal Governement. Unless otherwise indicated, the sample condition at the time of receipt was acceptable.

Results and Symbols Definitions
> This testing result is greater than the numerical value listed.
< This testing result is less than the numerical value listed.
None Detected = asbestos was not observed in the sample. If trace amount of asbestos was detected below our quantifiable limits of 1.0%, <1% (trace) would be indicated and the asbestos type listed. Point counting, where applicable, are recommended to improve accuracy.

Eva Skogsberg

Eva Skogsberg
Laboratory Supervisor

HAWAII ANALYTICAL LABORATORY, LLC
3615 Harding Avenue, Suite 308
Honolulu, HI 96816
Ph: 808-735-0422 - Fax: 808-735-0047
www.analyzehawaii.com

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Report To*	Kama Kobayashi
Company	Lehua Environmental Inc.
Address*	PO BOX 1018
	Kamuela, Hawaii 96743
Phone / Cell No.*	808-494-0365
Report results to	K. Kobayashi
via email or fax	Jkline.geo@gmail.com, lehuaenvironmental@gmail.com

Invoice To*	Kamalana Kobayashi
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Address*	PO BOX 1018
	Kamuela, Hawaii 96743
Phone / Cell No.*	
Purchase Order No.	
Email Invoice To	lehuaenvironmental@gmail.com

Need Results By*:

- ☑ 5 Working Days (WD)
- ☐ 4 WD
- ☐ 3 WD
- ☐ 2 WD
- ☐ 24 hours
- ☐ 6 hours or less
- ☐ 4 hours or less
- ☐ 1-2 hours

Site/Project Name: Caltech Observatory

Client Project No.:

Sampled By: Jason Kline

Comments / Special Instructions: ☐ verbal results needed?

* Notified client of missing samples A-91, A-92, A-93 1/25 SI

PLM POSITIVE STOP Instructions:
☐ Positive stop per SAMPLE
☐ Positive stop per LAYER

LAB USE ONLY: 201900696

	Sample Identification / Description* (Maxmium of 30 Characters)	Date Sampled* (mm/dd/yy)	Collection Medium	Sample Area / Air Volume	Analysis Requested*	Method Reference	Lab ID
1	L-1	1/22/2019	Bulk		Lead %		201903836
2	L-2	1/22/2019	Bulk		Lead %		201903837
3	L-3	1/22/2019	Bulk		Lead %		201903838
4	L-4	1/22/2019	Bulk		Lead %		201903839
5	L-5	1/22/2019	Bulk		Lead %		201903840
6	L-6	1/22/2019	Bulk		Lead %		201903841
7	L-7	1/22/2019	Bulk		Lead %		201903842
8	L-8	1/22/2019	Bulk		Lead %		201903843
9	L-9	1/22/2019	Bulk		Lead %		201903844
10	L-10	1/22/2019	Bulk		Lead %		201903845
11	L-11	1/22/2019	Bulk		Lead %		201903846
12	L-12	1/22/2019	Bulk		Lead %		201903847
13	L-13	1/22/2019	Bulk		Lead %		201903848
14	L-14	1/22/2019	Bulk		Lead %		201903849
15	L-15	1/22/2019	Bulk		Lead %		201903850
16	L-16	1/22/2019	Bulk		Lead %		201903851
17	L-17	1/22/2019	Bulk		Lead %		201903852

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Address*	:	PO BOX 1018
		Kamuela, Hawaii 96743
Phone / Cell No.*	:	808-494-0365
Report results to	:	K. Kobayashi
via email or fax	:	Jkline.geo@gmail.com, lehuaenvironmental@gmail.com

Invoice To*	:	Kamalana Kobayashi
Company	:	Lehua Environmental Inc.
Address*	:	PO BOX 1018
		Kamuela, Hawaii 96743
Phone / Cell No.*	:	
Purchase Order No.	:	
Email Invoice To	:	lehuaenvironmental@gmail.com

Need Results By*:

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- ☐ 4 WD
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- ☐ 2 WD
- ☐ 24 hours
- ☐ 6 hours or less
- ☐ 4 hours or less
- ☐ 1-2 hours

Site/Project Name: Caltech Observatory

Client Project No.:

Sampled By: Jason Kline

Comments / Special Instructions: ☐ verbal results needed?

PLM POSITIVE STOP Instructions:
☐ Positive stop per SAMPLE
☐ Positive stop per LAYER

LAB USE ONLY
201900696

	Sample Identification / Description* (Maxmium of 30 Characters)	Date Sampled* (mm/dd/yy)	Collection Medium	Sample Area / Air Volume	Analysis Requested*	Method Reference	*Lab ID*
18	L-18	1/22/2019	Bulk		Lead %		201903853
19	L-19	1/22/2019	Bulk		Lead %		201903854
20	L-20	1/22/2019	Bulk		Lead %		201903855
21	L-21	1/22/2019	Bulk		Lead %		201903856
22	L-22	1/22/2019	Bulk		Lead %		201903857
23	A-1	1/22/2019	Bulk		Asbestos %		201903858
24	A-2	1/22/2019	Bulk		Asbestos %		201903859
25	A-3	1/22/2019	Bulk		Asbestos %		201903860
26	A-4	1/22/2019	Bulk		Asbestos %		201903861
27	A-5	1/22/2019	Bulk		Asbestos %		201903862
28	A-6	1/22/2019	Bulk		Asbestos %		201903863
29	A-7	1/22/2019	Bulk		Asbestos %		201903864
30	A-8	1/22/2019	Bulk		Asbestos %		201903865
31	A-9	1/22/2019	Bulk		Asbestos %		201903866
32	A-10	1/22/2019	Bulk		Asbestos %		201903867
33	A-11	1/22/2019	Bulk		Asbestos %		201903868
34	A-12	1/22/2019	Bulk		Asbestos %		201903869

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Company	:	Lehua Environmental Inc.
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Phone / Cell No.*	:	808-494-0365
Report results to	:	K. Kobayashi
via email or fax	:	Jkline.geo@gmail.com, lehuaenvironmental@gmail.com

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Address*	:	PO BOX 1018
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Phone / Cell No.*	:	
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Site/Project Name: Caltech Observatory

Client Project No.:

Sampled By: Jason Kline

Comments / Special Instructions: ☐ verbal results needed?

PLM POSITIVE STOP Instructions:
☐ Positive stop per SAMPLE
☐ Positive stop per LAYER

LAB USE ONLY
201900696

	Sample Identification / Description* (Maxmium of 30 Characters)	Date Sampled* (mm/dd/yy)	Collection Medium	Sample Area / Air Volume	Analysis Requested*	Method Reference	*Lab ID*
35	A-13	1/22/2019	Bulk		Asbestos %		201903870
36	A-14	1/22/2019	Bulk		Asbestos %		201903871
37	A-15	1/22/2019	Bulk		Asbestos %		201903872
38	A-16	1/22/2019	Bulk		Asbestos %		201903873
39	A-17	1/22/2019	Bulk		Asbestos %		201903874
40	A-18	1/22/2019	Bulk		Asbestos %		201903875
41	A-19	1/22/2019	Bulk		Asbestos %		201903876
42	A-20	1/22/2019	Bulk		Asbestos %		201903877
43	A-21	1/22/2019	Bulk		Asbestos %		201903878
44	A-22	1/22/2019	Bulk		Asbestos %		201903879
45	A-23	1/22/2019	Bulk		Asbestos %		201903880

Relinquished By (Print and Sign)	Date/Time	Received By (Print and Sign)	Date/Time
Jason Kline	1/24/2019 5:00		

*Sample description can be paint chips, concrete, specific sample collection location, etc…
If matrix is 'soil', please specify if it is a FOREIGN SOIL SAMPLE (outside Hawaii) in the comment section.
All samples submitted are subject to Hawaii Analytical Laboratory terms and conditions.
*Required fields, failure to complete these fields may result in a delay in your samples being processed.

☐ via HAC ☐ via USPS ☐ via drop box ☐ via FedEx ☐ via pick up
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3 of 9

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via email or fax	: Jkline.geo@gmail.com, lehuaenvironmental@gmail.com

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Site/Project Name: Caltech Observatory

Client Project No.:

Sampled By: Jason Kline

Comments / Special Instructions: ☐ verbal results needed?

PLM POSITIVE STOP Instructions:
☐ Positive stop per SAMPLE
☐ Positive stop per LAYER

LAB USE ONLY
201900696

	Sample Identification / Description* (Maxmium of 30 Characters)	Date Sampled* (mm/dd/yy)	Collection Medium	Sample Area / Air Volume	Analysis Requested*	Method Reference	*Lab ID*
1	A-24	1/22/2019	Bulk		Asbestos %		201903881
2	A-25	1/22/2019	Bulk		Asbestos %		201903882
3	A-26	1/22/2019	Bulk		Asbestos %		201903883
4	A-27	1/22/2019	Bulk		Asbestos %		201903884
5	A-28	1/22/2019	Bulk		Asbestos %		201903885
6	A-29	1/22/2019	Bulk		Asbestos %		201903886
7	A-30	1/22/2019	Bulk		Asbestos %		201903887
8	A-31	1/22/2019	Bulk		Asbestos %		201903888
9	A-32	1/22/2019	Bulk		Asbestos %		201903889
10	A-33	1/22/2019	Bulk		Asbestos %		201903890
11	A-34	1/22/2019	Bulk		Asbestos %		201903891
12	A-35	1/22/2019	Bulk		Asbestos %		201903892
13	A-36	1/22/2019	Bulk		Asbestos %		201903893
14	A-37	1/22/2019	Bulk		Asbestos %		201903894
15	A-38	1/22/2019	Bulk		Asbestos %		201903895
16	A-39	1/22/2019	Bulk		Asbestos %		201903896
17	A-40	1/22/2019	Bulk		Asbestos %		201903897

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Site/Project Name:	Client Project No.:	Sampled By:
Caltech Observatory		Jason Kline

Comments / Special Instructions:

☐ verbal results needed?

PLM POSITIVE STOP Instructions:
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LAB USE ONLY: 201900696

	Sample Identification / Description* (Maxmium of 30 Characters)	Date Sampled* (mm/dd/yy)	Collection Medium	Sample Area / Air Volume	Analysis Requested*	Method Reference	*Lab ID*
18	A-41	1/22/2019	Bulk		Asbestos %		201903898
19	A-42	1/22/2019	Bulk		Asbestos %		201903899
20	A-43	1/22/2019	Bulk		Asbestos %		201903900
21	A-44	1/22/2019	Bulk		Asbestos %		201903901
22	A-45	1/22/2019	Bulk		Asbestos %		201903902
23	A-46	1/22/2019	Bulk		Asbestos %		201903903
24	A-47	1/22/2019	Bulk		Asbestos %		201903904
25	A-48	1/22/2019	Bulk		Asbestos %		201903905
26	A-49	1/22/2019	Bulk		Asbestos %		201903906
27	A-50	1/22/2019	Bulk		Asbestos %		201903907
28	A-51	1/22/2019	Bulk		Asbestos %		201903908
29	A-52	1/22/2019	Bulk		Asbestos %		201903909
30	A-53	1/22/2019	Bulk		Asbestos %		201903910
31	A-54	1/22/2019	Bulk		Asbestos %		201903911
32	A-55	1/22/2019	Bulk		Asbestos %		201903912
33	A-56	1/22/2019	Bulk		Asbestos %		201903913
34	A-57	1/22/2019	Bulk		Asbestos %		201903914

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- ☐ 24 hours
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Site/Project Name: Caltech Observatory

Client Project No.:

Sampled By: Jason Kline

Comments / Special Instructions: ☐ verbal results needed?

PLM POSITIVE STOP Instructions:
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LAB USE ONLY: 201900696

	Sample Identification / Description* (Maxmium of 30 Characters)	Date Sampled* (mm/dd/yy)	Collection Medium	Sample Area / Air Volume	Analysis Requested*	Method Reference	*Lab ID*
35	A-58	1/22/2019	Bulk		Asbestos %		201903915
36	A-59	1/22/2019	Bulk		Asbestos %		201903916
37	A-60	1/22/2019	Bulk		Asbestos %		201903917
38	A-61	1/22/2019	Bulk		Asbestos %		201903918
39	A-62	1/22/2019	Bulk		Asbestos %		201903919
40	A-63	1/22/2019	Bulk		Asbestos %		201903920
41	A-64	1/22/2019	Bulk		Asbestos %		201903921
42	A-65	1/22/2019	Bulk		Asbestos %		201903922
43	A-66	1/22/2019	Bulk		Asbestos %		201903923
44	A-67	1/22/2019	Bulk		Asbestos %		201903924
45	A-68	1/22/2019	Bulk		Asbestos %		201903925

Relinquished By (Print and Sign)	Date/Time	Received By (Print and Sign)	Date/Time
Jason Kline	1/24/2019 5:00		

*Sample description can be paint chips, concrete, specific sample collection location, etc...
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awb#: 173-.................

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Company	Lehua Environmental Inc.		Company	Lehua Environmental Inc.
Address*	PO BOX 1018 Kamuela, Hawaii 96743		Address*	PO BOX 1018 Kamuela, Hawaii 96743
Phone / Cell No.*	808-494-0365		Phone / Cell No.*	
Report results to	K. Kobayashi		Purchase Order No.	
via email or fax	Jkline.geo@gmail.com, lehuaenvironmental@gmail.com		Email Invoice To	lehuaenvironmental@gmail.com

Need Results By*:

- ☑ 5 Working Days (WD)
- ☐ 4 WD
- ☐ 3 WD
- ☐ 2 WD
- ☐ 24 hours
- ☐ 6 hours or less
- ☐ 4 hours or less
- ☐ 1-2 hours

Site/Project Name: Caltech Observatory

Client Project No.:

Sampled By: Jason Kline

Comments / Special Instructions:

☐ verbal results needed?

PLM POSITIVE STOP Instructions:

☐ Positive stop per SAMPLE

☐ Positive stop per LAYER

LAB USE ONLY: 201900696

	Sample Identification / Description* (Maxmium of 30 Characters)	Date Sampled* (mm/dd/yy)	Collection Medium	Sample Area / Air Volume	Analysis Requested*	Method Reference	Lab ID
1	A-69	1/22/2019	Bulk		Asbestos %		201903926
2	A-70	1/22/2019	Bulk		Asbestos %		201903927
3	A-71	1/22/2019	Bulk		Asbestos %		201903928
4	A-72	1/22/2019	Bulk		Asbestos %		201903929
5	A-73	1/22/2019	Bulk		Asbestos %		201903930
6	A-74	1/22/2019	Bulk		Asbestos %		201903931
7	A-75	1/22/2019	Bulk		Asbestos %		201903932
8	A-76	1/22/2019	Bulk		Asbestos %		201903933
9	A-77	1/22/2019	Bulk		Asbestos %		201903934
10	A-78	1/22/2019	Bulk		Asbestos %		201903935
11	A-79	1/22/2019	Bulk		Asbestos %		201903936
12	A-80	1/22/2019	Bulk		Asbestos %		201903937
13	A-81	1/22/2019	Bulk		Asbestos %		201903938
14	A-82	1/22/2019	Bulk		Asbestos %		201903939
15	A-83	1/22/2019	Bulk		Asbestos %		201903940
16	A-84	1/22/2019	Bulk		Asbestos %		201903941
17	A-85	1/22/2019	Bulk		Asbestos %		201903942

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3615 Harding Avenue, Suite 308
Honolulu, HI 96816
Ph: 808-735-0422 - Fax: 808-735-0047
www.analyzehawaii.com

☐ New Client?

Report To*	:	Kama Kobayashi
Company	:	Lehua Environmental Inc.
Address*	:	PO BOX 1018
		Kamuela, Hawaii 96743
Phone / Cell No.*	:	808-494-0365
Report results to	:	K. Kobayashi
via email or fax	:	Jkline.geo@gmail.com, lehuaenvironmental@gmail.com

Invoice To*	:	Kamalana Kobayashi
Company	:	Lehua Environmental Inc.
Address*	:	PO BOX 1018
		Kamuela, Hawaii 96743
Phone / Cell No.*	:	
Purchase Order No.	:	
Email Invoice To	:	lehuaenvironmental@gmail.com

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- ☐ 3 WD
- ☐ 2 WD
- ☐ 24 hours
- ☐ 6 hours or less
- ☐ 4 hours or less
- ☐ 1-2 hours

Site/Project Name: Caltech Observatory

Client Project No.:

Sampled By: Jason Kline

Comments / Special Instructions: ☐ verbal results needed?

PLM POSITIVE STOP Instructions:
☐ Positive stop per SAMPLE
☐ Positive stop per LAYER

LAB USE ONLY
201900696

	Sample Identification / Description* (Maxmium of 30 Characters)	Date Sampled* (mm/dd/yy)	Collection Medium	Sample Area / Air Volume	Analysis Requested*	Method Reference	*Lab ID*
18	A-86	1/22/2019	Bulk		Asbestos %		201903943
19	A-87	1/22/2019	Bulk		Asbestos %		201903944
20	A-88	1/22/2019	Bulk		Asbestos %		201903945
21	A-89	1/22/2019	Bulk		Asbestos %		201903946
22	A-90	1/22/2019	Bulk		Asbestos %		201903947
23	* A-91	1/22/2019	Bulk		Asbestos %		201903948
24	* A-92	1/22/2019	Bulk		Asbestos %		201903949
25	* A-93	1/22/2019	Bulk		Asbestos %		201903950
26	A-94	1/22/2019	Bulk		Asbestos %		201903951
27	A-95	1/22/2019	Bulk		Asbestos %		201903952
28	A-96	1/22/2019	Bulk		Asbestos %		201903953
29	A-97	1/22/2019	Bulk		Asbestos %		201903954
30	A-98	1/22/2019	Bulk		Asbestos %		201903955
31	A-99	1/22/2019	Bulk		Asbestos %		201903956
32	A-100	1/22/2019	Bulk		Asbestos %		201903957
33	A-101	1/22/2019	Bulk		Asbestos %		201903958
34	A-102	1/22/2019	Bulk		Asbestos %		201903959

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☐ New Client?

Report To*	:	Kama Kobayashi
Company	:	Lehua Environmental Inc.
Address*	:	PO BOX 1018
		Kamuela, Hawaii 96743
Phone / Cell No.*	:	808-494-0365
Report results to	:	K. Kobayashi
via email or fax	:	Jkline.geo@gmail.com, lehuaenvironmental@gmail.com

Invoice To*	:	Kamalana Kobayashi
Company	:	Lehua Environmental Inc.
Address*	:	PO BOX 1018
		Kamuela, Hawaii 96743
Phone / Cell No.*	:	
Purchase Order No.	:	
Email Invoice To	:	lehuaenvironmental@gmail.com

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- ☑ 5 Working Days (WD)
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- ☐ 3 WD
- ☐ 2 WD
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- ☐ 4 hours or less
- ☐ 1-2 hours

Site/Project Name: Caltech Observatory

Client Project No.:

Sampled By: Jason Kline

Comments / Special Instructions: ☐ verbal results needed?

PLM POSITIVE STOP Instructions:
☐ Positive stop per SAMPLE
☐ Positive stop per LAYER

LAB USE ONLY
201900696

	Sample Identification / Description* (Maxmium of 30 Characters)	Date Sampled* (mm/dd/yy)	Collection Medium	Sample Area / Air Volume	Analysis Requested*	Method Reference	*Lab ID*
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							

Relinquished By (Print and Sign)	Date/Time	Received By (Print and Sign)	Date/Time
Jason Kline	1/24/2019 5:00	Stephanie Iha [signature]	01-25-19P02:23 RCVD

*Sample description can be paint chips, concrete, specific sample collection location, etc...
If matrix is 'soil', please specify if it is a FOREIGN SOIL SAMPLE (outside Hawaii) in the comment section.
All samples submitted are subject to Hawaii Analytical Laboratory terms and conditions.
*Required fields, failure to complete these fields may result in a delay in your samples being processed.

☒ via HAC ☐ via USPS ☐ via drop box ☐ via FedEx ☐ via pick up
awb#: 173-32451230

Page: 3 of 3

Hawaii Analytical Laboratory
ANALYTICAL REPORT

Thursday, January 31, 2019

Mr. Kama Kobayashi
Lehua Environmental Inc.
P.O. Box 1018
Kamuela HI 96743

Phone Number: (808) 494-0365
Facsimile:
Email: lehuaenvironmental@gmail.com

Lab Job No: 201900696
Date Submitted: 1/25/2019
Your Project: Caltech Observatory, 1/22/19

Lead, total (paint chips)

NIOSH Method: 7082m LEAD by FAAS

Sample No.	Your Sample Description	Results	Units	Date Analyzed
201903836	**L-1**	150000	mg/kg	1/28/2019
Comments				
201903837	**L-2**	140000	mg/kg	1/28/2019
Comments				
201903838	**L-3**	< 40	mg/kg	1/28/2019
Comments				
201903839	**L-4**	77	mg/kg	1/28/2019
Comments				
201903840	**L-5**	5200	mg/kg	1/31/2019
Comments				
201903841	**L-6**	< 40	mg/kg	1/31/2019
Comments				
201903842	**L-7**	< 40	mg/kg	1/31/2019
Comments				
201903843	**L-8**	< 40	mg/kg	1/31/2019
Comments				

Mr. Kama Kobayashi
Lehua Environmental Inc.
P.O. Box 1018
Kamuela HI 96743

Phone Number: (808) 494-0365
Facsimile:
Email: lehuaenvironmental@gmail.com

Lab Job No: 201900696
Date Submitted: 1/25/2019
Your Project: Caltech Observatory, 1/22/19

Lead, total (paint chips)

NIOSH Method: 7082m LEAD by FAAS

Sample No.	Your Sample Description	Results	Units	Date Analyzed
201903844	**L-9**	< 40	mg/kg	1/31/2019
Comments				
201903845	**L-10**	< 40	mg/kg	1/31/2019
Comments				
201903846	**L-11**	200	mg/kg	1/31/2019
Comments				
201903847	**L-12**	56000	mg/kg	1/31/2019
Comments				
201903848	**L-13**	65	mg/kg	1/31/2019
Comments				
201903849	**L-14**	< 40	mg/kg	1/31/2019
Comments				
201903850	**L-15**	69000	mg/kg	1/31/2019
Comments				
201903851	**L-16**	11000	mg/kg	1/31/2019
Comments				
201903852	**L-17**	250	mg/kg	1/31/2019
Comments				
201903853	**L-18**	63	mg/kg	1/31/2019
Comments				
201903854	**L-19**	1600	mg/kg	1/31/2019
Comments				

Mr. Kama Kobayashi
Lehua Environmental Inc.
P.O. Box 1018
Kamuela HI 96743

Phone Number: (808) 494-0365
Facsimile:
Email: lehuaenvironmental@gmail.com

Lab Job No: 201900696
Date Submitted: 1/25/2019
Your Project: Caltech Observatory, 1/22/19

Lead, total (paint chips)

NIOSH Method: 7082m LEAD by FAAS

Sample No.	Your Sample Description	Results	Units	Date Analyzed
201903855	**L-20**	< 40	mg/kg	1/31/2019
Comments				
201903856	**L-21**	< 40	mg/kg	1/31/2019
Comments				
201903857	**L-22**	380	mg/kg	1/31/2019
Comments				

All Quality Control data are acceptable unless otherwise noted.
MRL for lead air is 5ug.
MRL for lead wipe is 10ug.
MRL for lead paint or soil is 40 mg/kg for a 0.25g sample.

General Comments
The sample[s] analysis subject of this analytical report were conducted in general accordance with the procedures associated with the "analytical method" referenced above. Modifications to this methodology may have been made based upon the analyst's professional judgment and / or sample matrix effects encountered. The analysis of sample relates only to the sample analyzed, and may or may not be representative of the original source of the material submitted for our analysis. All analysts participate in interlaboratory quality control testing to continuously document profiency. This report is not to be duplicated except in full without the expressed written permission of Hawaii Analytical Laboratory. This report should not be construed as an endorsement for a product or a service by the AIHA LAP, LLC or any affiliated organizations. Sample and associated sampling / collection data is reported as provided by client. TWA values have been calculated based on information supplied by the client that the laboratory has not independently verified. Results have not been corrected for blank determinations unless noted in remarks. Unless otherwise indicated the sample condition at the time of receipt was acceptable.

Results and Symbols Definitions
> This testing result is greater than the numerical value listed.
< This testing result is less than the numerical value listed.
# = Analytical methods marked with an "#" are not within our AIHA LAP, LLC Scope of Accreditation.
MRL = Method Reporting Limit.

Jennifer Hsu Liao

Jennifer Hsu Liao
Laboratory Manager

HAWAII ANALYTICAL LABORATORY, LLC
3615 Harding Avenue, Suite 308
Honolulu, HI 96816
Ph: 808-735-0422 - Fax: 808-735-0047
www.analyzehawaii.com

☐ New Client?

Report To*	Kama Kobayashi	Invoice To*	Kamalana Kobayashi
Company	Lehua Environmental Inc.	Company	Lehua Environmental Inc.
Address*	PO BOX 1018 Kamuela, Hawaii 96743	Address*	PO BOX 1018 Kamuela, Hawaii 96743
Phone / Cell No.*	808-494-0365	Phone / Cell No.*	
Report results to	K. Kobayashi	Purchase Order No.	
via email or fax	Jkline.geo@gmail.com, lehuaenvironmental@gmail.com	Email Invoice To	lehuaenvironmental@gmail.com

Need Results By*:

- ☑ 5 Working Days (WD)
- ☐ 4 WD
- ☐ 3 WD
- ☐ 2 WD
- ☐ 24 hours
- ☐ 6 hours or less
- ☐ 4 hours or less
- ☐ 1-2 hours

Site/Project Name: Caltech Observatory

Client Project No.:

Sampled By: Jason Kline

Comments / Special Instructions: ☐ verbal results needed?

* Notified client of missing samples A-91, A-92, A-93 1/25 SI

PLM POSITIVE STOP Instructions:
☐ Positive stop per SAMPLE
☐ Positive stop per LAYER

LAB USE ONLY: 201900696

	Sample Identification / Description* (Maxmium of 30 Characters)	Date Sampled* (mm/dd/yy)	Collection Medium	Sample Area / Air Volume	Analysis Requested*	Method Reference	Lab ID
1	L-1	1/22/2019	Bulk		Lead %		201903836
2	L-2	1/22/2019	Bulk		Lead %		201903837
3	L-3	1/22/2019	Bulk		Lead %		201903838
4	L-4	1/22/2019	Bulk		Lead %		201903839
5	L-5	1/22/2019	Bulk		Lead %		201903840
6	L-6	1/22/2019	Bulk		Lead %		201903841
7	L-7	1/22/2019	Bulk		Lead %		201903842
8	L-8	1/22/2019	Bulk		Lead %		201903843
9	L-9	1/22/2019	Bulk		Lead %		201903844
10	L-10	1/22/2019	Bulk		Lead %		201903845
11	L-11	1/22/2019	Bulk		Lead %		201903846
12	L-12	1/22/2019	Bulk		Lead %		201903847
13	L-13	1/22/2019	Bulk		Lead %		201903848
14	L-14	1/22/2019	Bulk		Lead %		201903849
15	L-15	1/22/2019	Bulk		Lead %		201903850
16	L-16	1/22/2019	Bulk		Lead %		201903851
17	L-17	1/22/2019	Bulk		Lead %		201903852

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☐ New Client?

Report To*	Kama Kobayashi	Invoice To*	Kamalana Kobayashi
Company	Lehua Environmental Inc.	Company	Lehua Environmental Inc.
Address*	PO BOX 1018 Kamuela, Hawaii 96743	Address*	PO BOX 1018 Kamuela, Hawaii 96743
Phone / Cell No.*	808-494-0365	Phone / Cell No.*	
Report results to	K. Kobayashi	Purchase Order No.	
via email or fax	Jkline.geo@gmail.com, lehuaenvironmental@gmail.com	Email Invoice To	lehuaenvironmental@gmail.com

Need Results By*:

- ☑ 5 Working Days (WD)
- ☐ 4 WD
- ☐ 3 WD
- ☐ 2 WD
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- ☐ 6 hours or less
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- ☐ 1-2 hours

Site/Project Name: Caltech Observatory

Client Project No.:

Sampled By: Jason Kline

Comments / Special Instructions:

☐ verbal results needed?

PLM POSITIVE STOP Instructions:

☐ Positive stop per SAMPLE

☐ Positive stop per LAYER

LAB USE ONLY

201900696

	Sample Identification / Description* (Maxmium of 30 Characters)	Date Sampled* (mm/dd/yy)	Collection Medium	Sample Area / Air Volume	Analysis Requested*	Method Reference	*Lab ID*
18	L-18	1/22/2019	Bulk		Lead %		201903853
19	L-19	1/22/2019	Bulk		Lead %		201903854
20	L-20	1/22/2019	Bulk		Lead %		201903855
21	L-21	1/22/2019	Bulk		Lead %		201903856
22	L-22	1/22/2019	Bulk		Lead %		201903857
23	A-1	1/22/2019	Bulk		Asbestos %		201903858
24	A-2	1/22/2019	Bulk		Asbestos %		201903859
25	A-3	1/22/2019	Bulk		Asbestos %		201903860
26	A-4	1/22/2019	Bulk		Asbestos %		201903861
27	A-5	1/22/2019	Bulk		Asbestos %		201903862
28	A-6	1/22/2019	Bulk		Asbestos %		201903863
29	A-7	1/22/2019	Bulk		Asbestos %		201903864
30	A-8	1/22/2019	Bulk		Asbestos %		201903865
31	A-9	1/22/2019	Bulk		Asbestos %		201903866
32	A-10	1/22/2019	Bulk		Asbestos %		201903867
33	A-11	1/22/2019	Bulk		Asbestos %		201903868
34	A-12	1/22/2019	Bulk		Asbestos %		201903869

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Report To*	Kama Kobayashi
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Site/Project Name: Caltech Observatory

Client Project No.:

Sampled By: Jason Kline

Comments / Special Instructions: ☐ verbal results needed?

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LAB USE ONLY 201900696

	Sample Identification / Description* (Maxmium of 30 Characters)	Date Sampled* (mm/dd/yy)	Collection Medium	Sample Area / Air Volume	Analysis Requested*	Method Reference	*Lab ID*
35	A-13	1/22/2019	Bulk		Asbestos %		201903870
36	A-14	1/22/2019	Bulk		Asbestos %		201903871
37	A-15	1/22/2019	Bulk		Asbestos %		201903872
38	A-16	1/22/2019	Bulk		Asbestos %		201903873
39	A-17	1/22/2019	Bulk		Asbestos %		201903874
40	A-18	1/22/2019	Bulk		Asbestos %		201903875
41	A-19	1/22/2019	Bulk		Asbestos %		201903876
42	A-20	1/22/2019	Bulk		Asbestos %		201903877
43	A-21	1/22/2019	Bulk		Asbestos %		201903878
44	A-22	1/22/2019	Bulk		Asbestos %		201903879
45	A-23	1/22/2019	Bulk		Asbestos %		201903880

Relinquished By (Print and Sign)	Date/Time	Received By (Print and Sign)	Date/Time
Jason Kline	1/24/2019 5:00		

***Sample description can be paint chips, concrete, specific sample collection location, etc…**
If matrix is 'soil', please specify if it is a FOREIGN SOIL SAMPLE (outside Hawaii) in the comment section.
All samples submitted are subject to Hawaii Analytical Laboratory terms and conditions.
***Required fields, failure to complete these fields may result in a delay in your samples being processed.**

☐ via HAC ☐ via USPS ☐ via drop box ☐ via FedEx ☐ via pick up
awb#: 173-………………

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Site/Project Name: Caltech Observatory

Client Project No.:

Sampled By: Jason Kline

Comments / Special Instructions: ☐ verbal results needed?

PLM POSITIVE STOP Instructions:
☐ Positive stop per SAMPLE
☐ Positive stop per LAYER

LAB USE ONLY
201900696

	Sample Identification / Description* (Maxmium of 30 Characters)	Date Sampled* (mm/dd/yy)	Collection Medium	Sample Area / Air Volume	Analysis Requested*	Method Reference	*Lab ID*
1	A-24	1/22/2019	Bulk		Asbestos %		201903881
2	A-25	1/22/2019	Bulk		Asbestos %		201903882
3	A-26	1/22/2019	Bulk		Asbestos %		201903883
4	A-27	1/22/2019	Bulk		Asbestos %		201903884
5	A-28	1/22/2019	Bulk		Asbestos %		201903885
6	A-29	1/22/2019	Bulk		Asbestos %		201903886
7	A-30	1/22/2019	Bulk		Asbestos %		201903887
8	A-31	1/22/2019	Bulk		Asbestos %		201903888
9	A-32	1/22/2019	Bulk		Asbestos %		201903889
10	A-33	1/22/2019	Bulk		Asbestos %		201903890
11	A-34	1/22/2019	Bulk		Asbestos %		201903891
12	A-35	1/22/2019	Bulk		Asbestos %		201903892
13	A-36	1/22/2019	Bulk		Asbestos %		201903893
14	A-37	1/22/2019	Bulk		Asbestos %		201903894
15	A-38	1/22/2019	Bulk		Asbestos %		201903895
16	A-39	1/22/2019	Bulk		Asbestos %		201903896
17	A-40	1/22/2019	Bulk		Asbestos %		201903897

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		Kamuela, Hawaii 96743
Phone / Cell No.*	:	
Purchase Order No.	:	
Email Invoice To	:	lehuaenvironmental@gmail.com

Need Results By*:

- ☑ 5 Working Days (WD)
- ☐ 4 WD
- ☐ 3 WD
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- ☐ 1-2 hours

Site/Project Name: Caltech Observatory

Client Project No.:

Sampled By: Jason Kline

Comments / Special Instructions: ☐ verbal results needed?

PLM POSITIVE STOP Instructions:
☐ Positive stop per SAMPLE
☐ Positive stop per LAYER

LAB USE ONLY: 201900696

	Sample Identification / Description* (Maxmium of 30 Characters)	Date Sampled* (mm/dd/yy)	Collection Medium	Sample Area / Air Volume	Analysis Requested*	Method Reference	*Lab ID*
18	A-41	1/22/2019	Bulk		Asbestos %		201903898
19	A-42	1/22/2019	Bulk		Asbestos %		201903899
20	A-43	1/22/2019	Bulk		Asbestos %		201903900
21	A-44	1/22/2019	Bulk		Asbestos %		201903901
22	A-45	1/22/2019	Bulk		Asbestos %		201903902
23	A-46	1/22/2019	Bulk		Asbestos %		201903903
24	A-47	1/22/2019	Bulk		Asbestos %		201903904
25	A-48	1/22/2019	Bulk		Asbestos %		201903905
26	A-49	1/22/2019	Bulk		Asbestos %		201903906
27	A-50	1/22/2019	Bulk		Asbestos %		201903907
28	A-51	1/22/2019	Bulk		Asbestos %		201903908
29	A-52	1/22/2019	Bulk		Asbestos %		201903909
30	A-53	1/22/2019	Bulk		Asbestos %		201903910
31	A-54	1/22/2019	Bulk		Asbestos %		201903911
32	A-55	1/22/2019	Bulk		Asbestos %		201903912
33	A-56	1/22/2019	Bulk		Asbestos %		201903913
34	A-57	1/22/2019	Bulk		Asbestos %		201903914

HAWAII ANALYTICAL LABORATORY, LLC

3615 Harding Avenue, Suite 308
Honolulu, HI 96816
Ph: 808-735-0422 - Fax: 808-735-0047
www.analyzehawaii.com

☐ New Client?

Report To*	Kama Kobayashi
Company	Lehua Environmental Inc.
Address*	PO BOX 1018 Kamuela, Hawaii 96743
Phone / Cell No.*	808-494-0365
Report results to	K. Kobayashi
via email or fax	Jkline.geo@gmail.com, lehuaenvironmental@gmail.com

Invoice To*	Kamalana Kobayashi
Company	Lehua Environmental Inc.
Address*	PO BOX 1018 Kamuela, Hawaii 96743
Phone / Cell No.*	
Purchase Order No.	
Email Invoice To	lehuaenvironmental@gmail.com

Need Results By*:

- ☑ 5 Working Days (WD)
- ☐ 4 WD
- ☐ 3 WD
- ☐ 2 WD
- ☐ 24 hours
- ☐ 6 hours or less
- ☐ 4 hours or less
- ☐ 1-2 hours

Site/Project Name: Caltech Observatory

Client Project No.:

Sampled By: Jason Kline

Comments / Special Instructions: ☐ verbal results needed?

PLM POSITIVE STOP Instructions:
☐ Positive stop per SAMPLE
☐ Positive stop per LAYER

LAB USE ONLY

201900696

	Sample Identification / Description* (Maxmium of 30 Characters)	Date Sampled* (mm/dd/yy)	Collection Medium	Sample Area / Air Volume	Analysis Requested*	Method Reference	*Lab ID*
35	A-58	1/22/2019	Bulk		Asbestos %		201903915
36	A-59	1/22/2019	Bulk		Asbestos %		201903916
37	A-60	1/22/2019	Bulk		Asbestos %		201903917
38	A-61	1/22/2019	Bulk		Asbestos %		201903918
39	A-62	1/22/2019	Bulk		Asbestos %		201903919
40	A-63	1/22/2019	Bulk		Asbestos %		201903920
41	A-64	1/22/2019	Bulk		Asbestos %		201903921
42	A-65	1/22/2019	Bulk		Asbestos %		201903922
43	A-66	1/22/2019	Bulk		Asbestos %		201903923
44	A-67	1/22/2019	Bulk		Asbestos %		201903924
45	A-68	1/22/2019	Bulk		Asbestos %		201903925

Relinquished By (Print and Sign)	Date/Time	Received By (Print and Sign)	Date/Time
Jason Kline	1/24/2019 5:00		

*Sample description can be paint chips, concrete, specific sample collection location, etc...
If matrix is 'soil', please specify if it is a FOREIGN SOIL SAMPLE (outside Hawaii) in the comment section.
All samples submitted are subject to Hawaii Analytical Laboratory terms and conditions.
*Required fields, failure to complete these fields may result in a delay in your samples being processed.

☐ via HAC ☐ via USPS ☐ via drop box ☐ via FedEx ☐ via pick up
awb#: 173-..................

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Honolulu, HI 96816
Ph: 808-735-0422 - Fax: 808-735-0047
www.analyzehawaii.com

☐ New Client?

Report To*	Kama Kobayashi		Invoice To*	Kamalana Kobayashi
Company	Lehua Environmental Inc.		Company	Lehua Environmental Inc.
Address*	PO BOX 1018 Kamuela, Hawaii 96743		Address*	PO BOX 1018 Kamuela, Hawaii 96743
Phone / Cell No.*	808-494-0365		Phone / Cell No.*	
Report results to	K. Kobayashi		Purchase Order No.	
via email or fax	Jkline.geo@gmail.com, lehuaenvironmental@gmail.com		Email Invoice To	lehuaenvironmental@gmail.com

Need Results By*:

- ☑ 5 Working Days (WD)
- ☐ 4 WD
- ☐ 3 WD
- ☐ 2 WD
- ☐ 24 hours
- ☐ 6 hours or less
- ☐ 4 hours or less
- ☐ 1-2 hours

Site/Project Name: Caltech Observatory

Client Project No.:

Sampled By: Jason Kline

Comments / Special Instructions:

☐ verbal results needed?

PLM POSITIVE STOP Instructions:

☐ Positive stop per SAMPLE

☐ Positive stop per LAYER

LAB USE ONLY: 201900696

	Sample Identification / Description* (Maxmium of 30 Characters)	Date Sampled* (mm/dd/yy)	Collection Medium	Sample Area / Air Volume	Analysis Requested*	Method Reference	Lab ID
1	A-69	1/22/2019	Bulk		Asbestos %		201903926
2	A-70	1/22/2019	Bulk		Asbestos %		201903927
3	A-71	1/22/2019	Bulk		Asbestos %		201903928
4	A-72	1/22/2019	Bulk		Asbestos %		201903929
5	A-73	1/22/2019	Bulk		Asbestos %		201903930
6	A-74	1/22/2019	Bulk		Asbestos %		201903931
7	A-75	1/22/2019	Bulk		Asbestos %		201903932
8	A-76	1/22/2019	Bulk		Asbestos %		201903933
9	A-77	1/22/2019	Bulk		Asbestos %		201903934
10	A-78	1/22/2019	Bulk		Asbestos %		201903935
11	A-79	1/22/2019	Bulk		Asbestos %		201903936
12	A-80	1/22/2019	Bulk		Asbestos %		201903937
13	A-81	1/22/2019	Bulk		Asbestos %		201903938
14	A-82	1/22/2019	Bulk		Asbestos %		201903939
15	A-83	1/22/2019	Bulk		Asbestos %		201903940
16	A-84	1/22/2019	Bulk		Asbestos %		201903941
17	A-85	1/22/2019	Bulk		Asbestos %		201903942

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Report To*	:	Kama Kobayashi	Invoice To*	:	Kamalana Kobayashi
Company	:	Lehua Environmental Inc.	Company	:	Lehua Environmental Inc.
Address*	:	PO BOX 1018	Address*	:	PO BOX 1018
		Kamuela, Hawaii 96743			Kamuela, Hawaii 96743
Phone / Cell No.*	:	808-494-0365	Phone / Cell No.*	:	
Report results to	:	K. Kobayashi	Purchase Order No.	:	
via email or fax	:	Jkline.geo@gmail.com, lehuaenvironmental@gmail.com	Email Invoice To	:	lehuaenvironmental@gmail.com

Need Results By*:

- ☑ 5 Working Days (WD)
- ☐ 4 WD
- ☐ 3 WD
- ☐ 2 WD
- ☐ 24 hours
- ☐ 6 hours or less
- ☐ 4 hours or less
- ☐ 1-2 hours

Site/Project Name: Caltech Observatory

Client Project No.:

Sampled By: Jason Kline

Comments / Special Instructions: ☐ verbal results needed?

PLM POSITIVE STOP Instructions:
- ☐ Positive stop per SAMPLE
- ☐ Positive stop per LAYER

LAB USE ONLY: 201900696

	Sample Identification / Description* (Maxmium of 30 Characters)	Date Sampled* (mm/dd/yy)	Collection Medium	Sample Area / Air Volume	Analysis Requested*	Method Reference	*Lab ID*
18	A-86	1/22/2019	Bulk		Asbestos %		201903943
19	A-87	1/22/2019	Bulk		Asbestos %		201903944
20	A-88	1/22/2019	Bulk		Asbestos %		201903945
21	A-89	1/22/2019	Bulk		Asbestos %		201903946
22	A-90	1/22/2019	Bulk		Asbestos %		201903947
23	* A-91	1/22/2019	Bulk		Asbestos %		201903948
24	* A-92	1/22/2019	Bulk		Asbestos %		201903949
25	* A-93	1/22/2019	Bulk		Asbestos %		201903950
26	A-94	1/22/2019	Bulk		Asbestos %		201903951
27	A-95	1/22/2019	Bulk		Asbestos %		201903952
28	A-96	1/22/2019	Bulk		Asbestos %		201903953
29	A-97	1/22/2019	Bulk		Asbestos %		201903954
30	A-98	1/22/2019	Bulk		Asbestos %		201903955
31	A-99	1/22/2019	Bulk		Asbestos %		201903956
32	A-100	1/22/2019	Bulk		Asbestos %		201903957
33	A-101	1/22/2019	Bulk		Asbestos %		201903958
34	A-102	1/22/2019	Bulk		Asbestos %		201903959

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Report To*	: Kama Kobayashi		Invoice To*	: Kamalana Kobayashi
Company	: Lehua Environmental Inc.		Company	: Lehua Environmental Inc.
Address*	: PO BOX 1018		Address*	: PO BOX 1018
	Kamuela, Hawaii 96743			Kamuela, Hawaii 96743
Phone / Cell No.*	: 808-494-0365		Phone / Cell No.*	:
Report results to	: K. Kobayashi		Purchase Order No.	:
via email or fax	: Jkline.geo@gmail.com, lehuaenvironmental@gmail.com		Email Invoice To	: lehuaenvironmental@gmail.com

Need Results By*:

- ☑ 5 Working Days (WD)
- ☐ 4 WD
- ☐ 3 WD
- ☐ 2 WD
- ☐ 24 hours
- ☐ 6 hours or less
- ☐ 4 hours or less
- ☐ 1-2 hours

Site/Project Name:	Client Project No.:	Sampled By:
Caltech Observatory		Jason Kline

Comments / Special Instructions: ☐ verbal results needed?

PLM POSITIVE STOP Instructions:
☐ Positive stop per SAMPLE
☐ Positive stop per LAYER

LAB USE ONLY
201900696

	Sample Identification / Description* (Maxmium of 30 Characters)	Date Sampled* (mm/dd/yy)	Collection Medium	Sample Area / Air Volume	Analysis Requested*	Method Reference	*Lab ID*
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							

Relinquished By (Print and Sign)	Date/Time	Received By (Print and Sign)	Date/Time
Jason Kline	1/24/2019 5:00	Stephanie Iha Stephanie Iha	01-25-19P02:23 RCVD

*Sample description can be paint chips, concrete, specific sample collection location, etc...
If matrix is 'soil', please specify if it is a FOREIGN SOIL SAMPLE (outside Hawaii) in the comment section.
All samples submitted are subject to Hawaii Analytical Laboratory terms and conditions.
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☒ via HAC ☐ via USPS ☐ via drop box ☐ via FedEx ☐ via pick up
awb#: 173-32451230

Page: 3 of 3

Hawaii Analytical Laboratory
ANALYTICAL REPORT

3615 Harding Avenue, Ste. 308, Honolulu, Hawaii 96816
Phone: (808) 735-0422 - Fax: (808) 735-0047

Tuesday, January 29, 2019

Mr. Kama Kobayashi
Lehua Environmental Inc.
P.O. Box 1018
Kamuela HI 96743

Phone Number: (808) 494-0365
Fax Number:
Email: lehuaenvironmental@gmail.com

Lab Job No: 201900732
Date Submitted: 01/28/2019
Your Project: 2019-201, Caltech Observatory - Mold, 1/23/19

Mold and Fungi Indentification

Method: TM E-202 (Bright-field microscopy at 400x to 1000x) - Media: Spore Trap

Sample No	201904096		201904097		201904098		201904099	
Sample Description	012319-M1		012319-M2		012319-M3		012319-M4	
Air volume (L)	150		150		150		150	
Spore Genera	Spores/m3	Raw Count	Spores/m3	Raw Count	Spores/m3	Raw Count	Spores/m3	Raw Count
Alternaria sp.								
Ascospore sp.								
Aspergillus/Penicillium sp.			48	1	48	1		
Basidiospore sp.							48	1
Bipolaris/Drechslera sp.								
Cercospora sp.								
Chaetomium sp.								
Cladosporium sp.	48	1			48	1	96	2
Curvularia sp.								
Epicoccum sp.								
Fusarium sp.								
Hyaline spores, e.g. Acremonium sp.								
Memnoniella sp.								
Myxomycetes/Ustilago/Periconia sp.								
Nigrospora sp.								
Peronospora/Oidium sp.								
Pestalotiopsis sp.								
Pithomyces sp.								
Polythrincium sp.								
Scopulariopsis sp.								
Spegazzinia sp.								
Stachybotrys sp.								
Stemphylium sp.								
Tetraploa sp.								
Torula sp.								
Trichoderma sp.								
Uredinales sp.								
Miscellaneous Unidentified fungal spores								
TOTAL	48	1	48	1	96	2	140	3
Hyphae?								
Debris Rating?								
Date Analyzed	1/30/2019		1/30/2019		1/30/2019		1/30/2019	
Comment:								

Hawaii Analytical Laboratory
ANALYTICAL REPORT
3615 Harding Avenue, Ste. 308, Honolulu, Hawaii 96816
Phone: (808) 735-0422 - Fax: (808) 735-0047

Tuesday, January 29, 2019

Mr. Kama Kobayashi
Lehua Environmental Inc.
P.O. Box 1018
Kamuela HI 96743

Phone Number: (808) 494-0365
Fax Number:
Email: lehuaenvironmental@gmail.com

Lab Job No: 201900732
Date Submitted: 01/28/2019
Your Project: 2019-201, Caltech Observatory - Mold, 1/23/19

Mold and Fungi Indentification

Method: TM E-200 (Bright-field microscopy at 400x to 1000x) - Media: Tape Lift

Sample No	201904100	201904101	201904102	201904103
Sample Description	012319-T1	012319-T2	012319-T3	012319-T4
Spore Genera	Spores/TA	Spores/TA	Spores/TA	Spores/TA
Alternaria sp.			99%	
Ascospore sp.				
Aspergillus/Penicillium sp.			1%	
Basidiospore sp.				
Bipolaris/Drechslera sp.				
Cercospora sp.				
Chaetomium sp.				
Cladosporium sp.	100%	100%		100%
Curvularia sp.				
Epicoccum sp.				
Fusarium sp.				
Hyaline spores, e.g. Acremonium sp.				
Memnoniella sp.				
Myxomycetes/Ustilago/Periconia sp.				
Nigrospora sp.				
Peronospora/Oidium sp.				
Pestalotiopsis sp.				
Pithomyces sp.				
Polythrincium sp.				
Scopulariopsis sp.				
Spegazzinia sp.				
Stachybotrys sp.				
Stemphylium sp.				
Tetraploa sp.				
Torula sp.				
Trichoderma sp.				
Uredinales sp.				
Miscellaneous Unidentified fungal spores				
Spore Volume	Low	Sparse	High	Sparse
Hyphae?	Low		High	
Debris Rating?				
Date Analyzed	1/29/2019	1/29/2019	1/29/2019	1/29/2019
Comment:				

Mr. Kama Kobayashi
Lehua Environmental Inc.
P.O. Box 1018
Kamuela HI 96743

Phone Number: (808) 494-0365
Fax Number:
Email: lehuaenvironmental@gmail.com

Lab Job No: 201900732
Date Submitted: 01/28/2019
Your Project: 2019-201, Caltech Observatory - Mold, 1/23/19

Our determination includes, but not necessarily exclusively, the identification of members of the following commonly found fungal and airborne /surface contaminants:

Alternaria
Ascospore (fungal class)
Aspergillus / Penicillium
Basidiospore (fungal class)
Bipolaris / Drechslera
Cercospora
Chaetomium
Cladosporium
Curvularia
Epicoccum
Fusarium
Hyaline spores
Memnoniella
Myxomycetes / Ustilago (Smuts) / Periconia
Nigrospora
Peronospora / Oidium
Pestalotiopsis
Pithomyces
Polythrincium
Scopulariopsis
Spegazzinia
Stachybotrys
Stemphylium
Torula
Trichoderma
Uredinales (Rusts)
Miscellaneous Fungi Unindentified

Debris Rating	Description
Significant	Non-fungal debris particles are beginning to accumulate and overlap.
Heavy	Non-fungal debris is covering a significant portion of the visual field, results may be biased low.
Overloaded	Non-fungal debris is covering the majority of the visual field, an accurate count could not be obtained.

General Comments

The sample[s] analysis subject of this analytical report were conducted in general accordance with the procedures referenced by the "analytical method" referenced above. Modifications to this methodology may have been made based upon the analyst's professional judgment while considering sample matrix effects encountered. The analysis of this sample relates only to the sub-sample analyzed, and may or may not be representative of the original source and origin of the sub-sample submitted for our analysis. The minimum reporting limit for tape lifts is one observed spore. The total number of spores observed is estimated and reported as "None Detected / Sparse / Low / Medium / High / Heavy spore volume" for tape lift or surface bulk samples. The level of contamination is a subjective measurement and corresponds to the general quantity of spores present in a sample. Reporting limits for air cassette is one spore per 14% of the sample trace observed: 150L=48 spores/m3 (Air) and 75L=96 spores/m3 (air). Fungal element characterization is presumptive in nature and based upon optical spore and hyphae (when present) morphology only. Hyphae or fruiting bodies observed show evidence of previous and/or active growth.Confirmation using other techniques (5-day culturing) may be warranted for conclusive identification. Sample and associated sampling / collection data is reported as provided by client. Unless otherwise indicated, the sample condition at the time of receipt was acceptable. Results are not corrected for field blanks when submitted. This report is not to be duplicated except in full without the expressed written permission of Hawaii Analytical Laboratory. This report should not be construed as an endorsement for a product or a service by the AIHA-LAP, LLC or any affiliated organizations.

Symbols Definition
< This testing result is less than the numerical value listed.
> This testing result is greater than the numerical value listed.
TA = Target Area, the area most likely to contain elements of analytical interest per analyst judgment.
x = Spore types observed but not counted.

Jennifer Hsu Liao
Laboratory Manager

HAWAII ANALYTICAL LABORATORY, LLC
3615 Harding Avenue, Suite 308
Honolulu, HI 96816
Ph: 808-735-0422 - Fax: 808-735-0047

☐ New Client?

Report To*	Kama Kobayashi
Company	Lehua Environmental Inc.
Address*	P.O. Box 1018 Kamuela, Hawaii 96743
Phone / Cell No.*	808-494-0365
Report results to via email or fax	

Invoice To*	Kama Kobayashi
Company	Lehua Environmental Inc.
Address*	P.O. Box 1018 Kamuela, Hawaii 96743
Phone / Cell No.*	808-494-0365
Purchase Order No.	
Email Invoice To	

Need Results By*:

- ☐ 5 Working Days
- ☐ 4 Working Days
- ☐ 72 hours
- ☑ 48 hours
- ☐ 24 hours
- ☐ Rush - 6 hours
- ☐ Immediate - 4 hrs or less

Site/Project Name: Caltech Observatory - Mold

Client Project No.: 2019-201

Sampled By: Kama Kobayashi

Comments / Special Instructions:

☐ verbal results needed?

PLM POSITIVE STOP Instructions:
- ☐ Positive stop per SAMPLE
- ☐ Positive stop per LAYER

LAB USE ONLY
Lab Report No.: 201900732

Sample Identification* (Maxmium of 30 Characters)	Date Sampled* (mm/dd/yy)	Collection Medium	Sample Area / Air Volume	Analysis Requested*	Method Reference	*Lab ID*
012319-M1	1/23/19	cassette	150L	Mold Air		201904096
012319-M2	1/23/19	cassette	150L	Mold Air		201904097
012319-M3	1/23/19	cassette	150L	Mold Air		201904098
012319-M4	1/23/19	cassette	150L	Mold Air		201904099
012319-T1	1/23/19	Tape Lift	2cmx2cm	Mold Tape Lift		201904100
012319-T2	1/23/19	Tape Lift	2cmx2cm	Mold Tape Lift		201904101
012319-T3	1/23/19	Tape Lift	2cmx2cm	Mold Tape Lift		201904102
012319-T4	1/23/19	Tape Lift	2cmx2cm	Mold Tape Lift		201904103

Relinquished By (Print and Sign)	Date/Time	Received By (Print and Sign)	Date/Time
Kama Kobayashi	1/24/19	Anne Antin Anne Antin	01-28-19P12:32 RCVD

Sample description can be paint chips, concrete, specific sample collection location, etc...
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*Required fields, failure to complete these fields may result in a delay in your samples being processed.
Rev 20140701

Page: 1 of 1

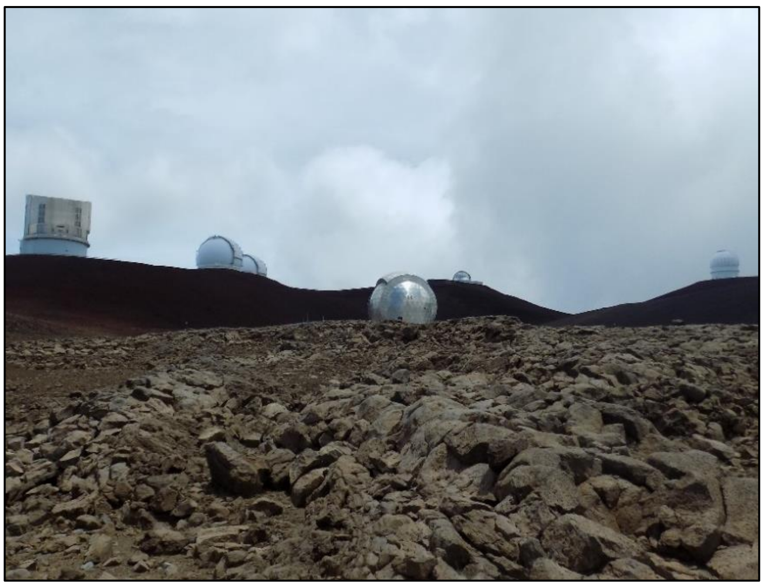
Appendix B. An Archaeological Assessment for the Caltech Submillimeter Observatory Decommissioning Project on Maunakea, TMK: (3) 4-4-015:009 (por.), Ka‘ohe Ahupua‘a, Hāmākua District, Island of Hawai‘i

An Archaeological Assessment for the Caltech Submillimeter Observatory Decommissioning Project on Maunakea

TMK: (3) 4-4-015:009 (por.)

Kaʻohe Ahupuaʻa
Hāmākua District
Island of Hawaiʻi

FINAL VERSION



Prepared By:

Benjamin Barna, Ph.D.

Prepared For:

California Institute of Technology
391 S. Holliston Ave.
Pasadena, CA 91125

January 2021

ASM affiliates
Archaeology • History • Anthropology • Architectural History

Hilo Office: (808) 969-6066 Fax: (808) 443-0065
507-A E. Lanikaula Street, Hilo, HI 96720

Honolulu Office: (808) 439-8089 Fax: (808) 439-8087
820 Mililani Street, Suite 700, Honolulu, HI 96813

ASM Project Number 30400.00

An Archaeological Assessment for the Caltech Submillimeter Observatory Decommissioning Project on Maunakea

TMK: (3) 4-4-015:009 (por.)

Kaʻohe Ahupuaʻa
Hāmākua District
Island of Hawaiʻi

ASM affiliates

EXECUTIVE SUMMARY

At the request of California Institute of Technology (Caltech), ASM Affiliates (ASM) conducted an archaeological survey for the Caltech Submillimeter Observatory (CSO) Decommissioning Project on Maunakea. The CSO is located on 0.75 acres leased from the State of Hawai‘i within the Maunakea Science Reserve in a portion of TMK: (3) 4-4-015:009 in Ka‘ohe Ahupua‘a, Hāmākua District, Island of Hawai‘i. The current study was prepared in support of an Environmental Assessment being prepared for the project under Hawai‘i Revised Statues Chapter 343. Decommissioning of the CSO will involve at a minimum the removal of the above-ground structures and site restoration in accordance with the 2010 Board of Land and Natural Resources approved *Decommissioning Plan for the Mauna Kea Observatories* (Sustainable Resources Group 2010) and the *Cultural Resources Management Plan for the University of Hawaii Management Areas on Mauna Kea* (McCoy et al. 2009). Although the CSO facility site was included in a SHPD-accepted AIS (McCoy et al. 2010), the current archaeological survey was conducted to account for the passage of time, to validate the findings of the prior AIS, and to identify any new find spots that may be present.

The current study includes a direct effects study area where ground disturbance may be anticipated to occur during the decommissioning process and a visual effects study area that includes the viewshed of the CSO facility. The direct effects study area was included in three prior archaeological surveys (McCoy 1982a; McCoy and Nees 2010; McCoy et al. 2010). The visual effects study area was included in these three studies, and also two other archaeological inventory surveys (McCoy and Nees 2009, 2013). No archaeological sites were previously reported within the direct effects study area. The two closest previously recorded sites are two shrines (Sites 50-10-23-16164 and 16165) located 188 meters and 250 meters, respectively, to the south-southwest of the CSO project area. The Mauna Kea Summit Region Historic District (SIHP Site 50-10-23-26869), which encompasses the extent of the glacial moraines and crest of the relatively pronounced change in slope that create the impression of a summit plateau (Log No.: 23155; Doc No.:9903PM07), includes the CSO facility site, although no contributing elements of the district are located within the direct effects study area. Eleven of the historic properties that contribute to the historic district lie within the visual effects study area.

The principal investigator for the current study was Benjamin Barna, Ph.D. Fieldwork for the current study was conducted on May 10, 2018, by Theodore Bibby, Ph. D. and Benjamin Barna, Ph.D.; approximately four person-hours were expended during the archaeological field survey. The current study was undertaken in accordance with Hawai‘i Administrative Rules 13§13–284 and was performed in compliance with the *Rules Governing Minimal Standards for Archaeological Inventory Surveys and Reports* as contained in Hawai‘i Administrative Rules 13§13–276. During the archaeological field survey, the entire (100%) ground surface of the direct effects study area was visually inspected by walking transects oriented parallel to the study area boundaries and spaced no more than 15 meters apart. No subsurface testing was conducted because the entire direct effects study area was previously disturbed by construction activities, covered in some places with recently dumped cinder fill, and known to overlie bedrock. In addition to the pedestrian survey of the direct effects study area, an assessment of the potential visual impacts of the removal of the CSO dome and facilities was made by photographing the CSO facility site from the nearest historic property within the visual effects study area (Site 16164).

As a result of the fieldwork for the current study, no archaeological resources of any kind were identified within the direct effects study area. Likewise, there were no find spots were observed within the direct effects study area. Given these negative findings, it is concluded that CSO decommissioning will have no direct effect on any historic property within the project area. With respect to visual effects, the eleven historic properties (Sites 16164, 16165, 27579, 21438, 21440, 26132, 26133, 26134, 26142, 27585, and 28263) within the viewshed of the CSO facility, and the Mauna Kea Summit Region Historic District (Site 26869), will experience overall beneficial effects from the removal of the CSO facilities. For those sites, the removal of the above-ground facilities will partially restore the appearance of the summit as it was prior to the construction of the CSO. This will result in an enhancement of the integrity of setting, feeling, and association of the eleven sites as well as the historic district. Therefore, because this effect is not “harmful,” the determination of effect for the proposed project in accordance with HAR 13§13-284-14(a) and (b) is “no historic properties affected.”

With respect to the historic preservation review process of the Department of Land and Natural Resources–State Historic Preservation Division (DLNR–SHPD), our recommendation is that no further historic preservation work needs to be conducted within the CSO facility project area prior to project implementation. Archaeological monitoring is recommended as a precautionary measure to ensure protection of Site 21438 (Kūkuhau‘ula), which is adjacent to the Mauna Kea Summit Access Road and the lower portion of the CSO project area, and as a contingency for the discovery of unanticipated archaeological resources. An archaeological monitoring plan in accordance with HAR 13§13-279 will be prepared for acceptance by DLNR-SHPD prior to project implementation.

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1. INTRODUCTION

At the request of California Institute of Technology (Caltech), ASM Affiliates (ASM) conducted an archaeological survey for the Caltech Submillimeter Observatory (CSO) Decommissioning Project on Maunakea. The CSO is located on 0.75 acres leased from the State of Hawaiʻi within the Maunakea Science Reserve in a portion of TMK: (3) 4-4-015:009 in Kaʻohe Ahupuaʻa, Hāmākua District, Island of Hawaiʻi (Figures 1 and 2). The current study was prepared in support of an Environmental Assessment being prepared for the project under Hawaiʻi Revised Statues Chapter 343. Decommissioning of the CSO will involve at a minimum the removal of the above-ground structures and site restoration in accordance with the 2010 Board of Land and Natural Resources approved *Decommissioning Plan for the Mauna Kea Observatories* (Decommissioning Plan) prepared by Sustainable Resources Group Int'l, Inc. (2010) and the *Cultural Resources Management Plan for the University of Hawaii Management Areas on Mauna Kea* (CRMP) prepared by McCoy et al. (2009). Although the CSO facility site was included in a SHPD-accepted AIS (McCoy et al. 2010), due to the passage of time, the current archaeological survey was conducted to validate the findings of the prior AIS and to identify any new find spots that may be present.

The current study was undertaken in accordance with Hawaiʻi Administrative Rules 13§13–284 and was performed in compliance with the *Rules Governing Minimal Standards for Archaeological Inventory Surveys and Reports* as contained in HAR 13§13–276. According to Hawaiʻi Administrative Rules (HAR) 13§13-284-5(b)(5)(A) when no archaeological resources are discovered during an archaeological inventory survey the production of an Archaeological Assessment report is appropriate. Compliance with the above standards is sufficient for meeting the historic preservation review process requirements of both the Department of Land and Natural Resources–State Historic Preservation Division (DLNR–SHPD) and the County of Hawaiʻi Planning Department. This report provides a study area description, a brief culture-historical background, and a discussion of prior archaeological studies in the vicinity of the current study area. A description of methods used during the survey are also presented, along with the results of the current field investigation of the study area and recommendations based on those findings.

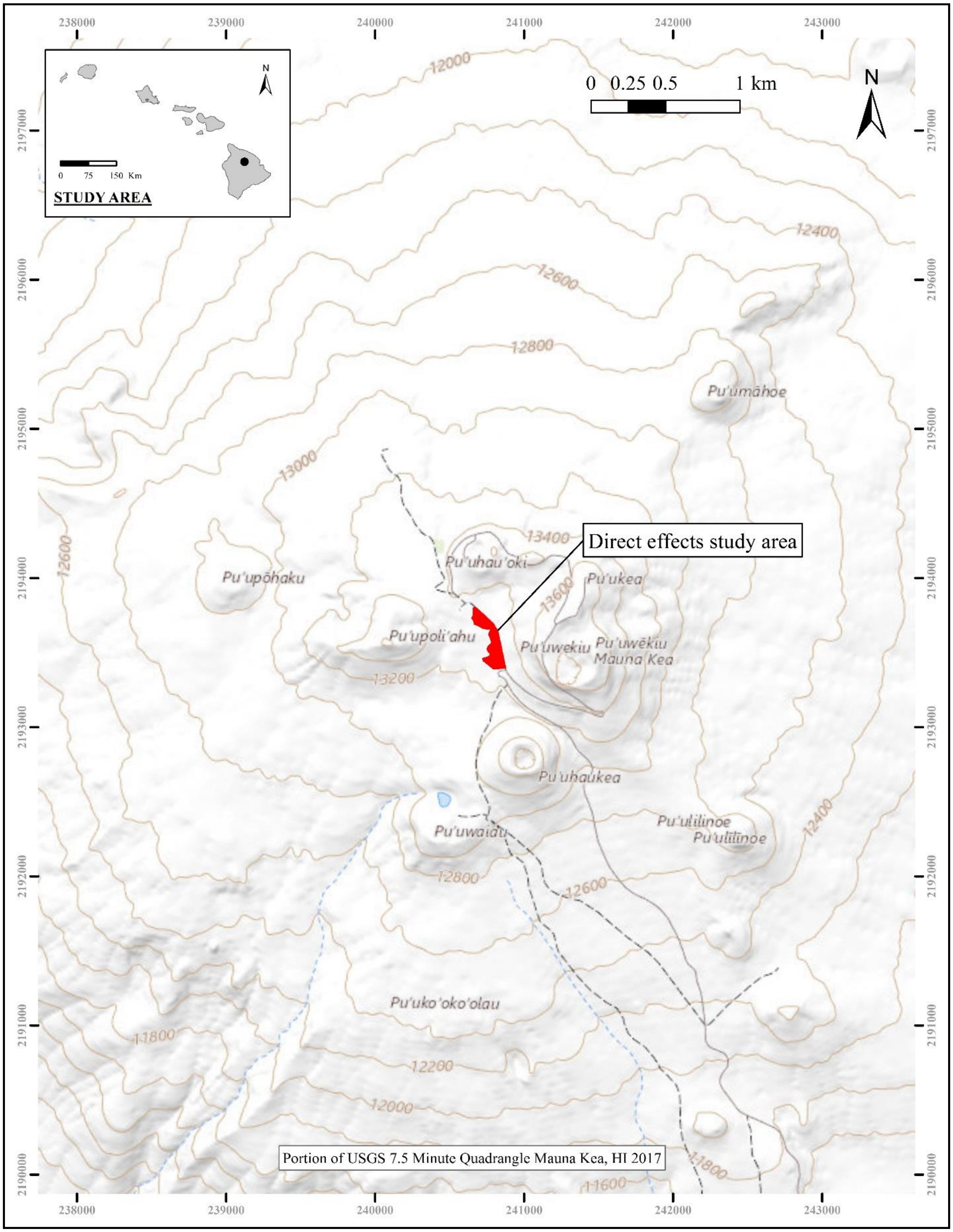

Figure 1. Direct effects study area location.

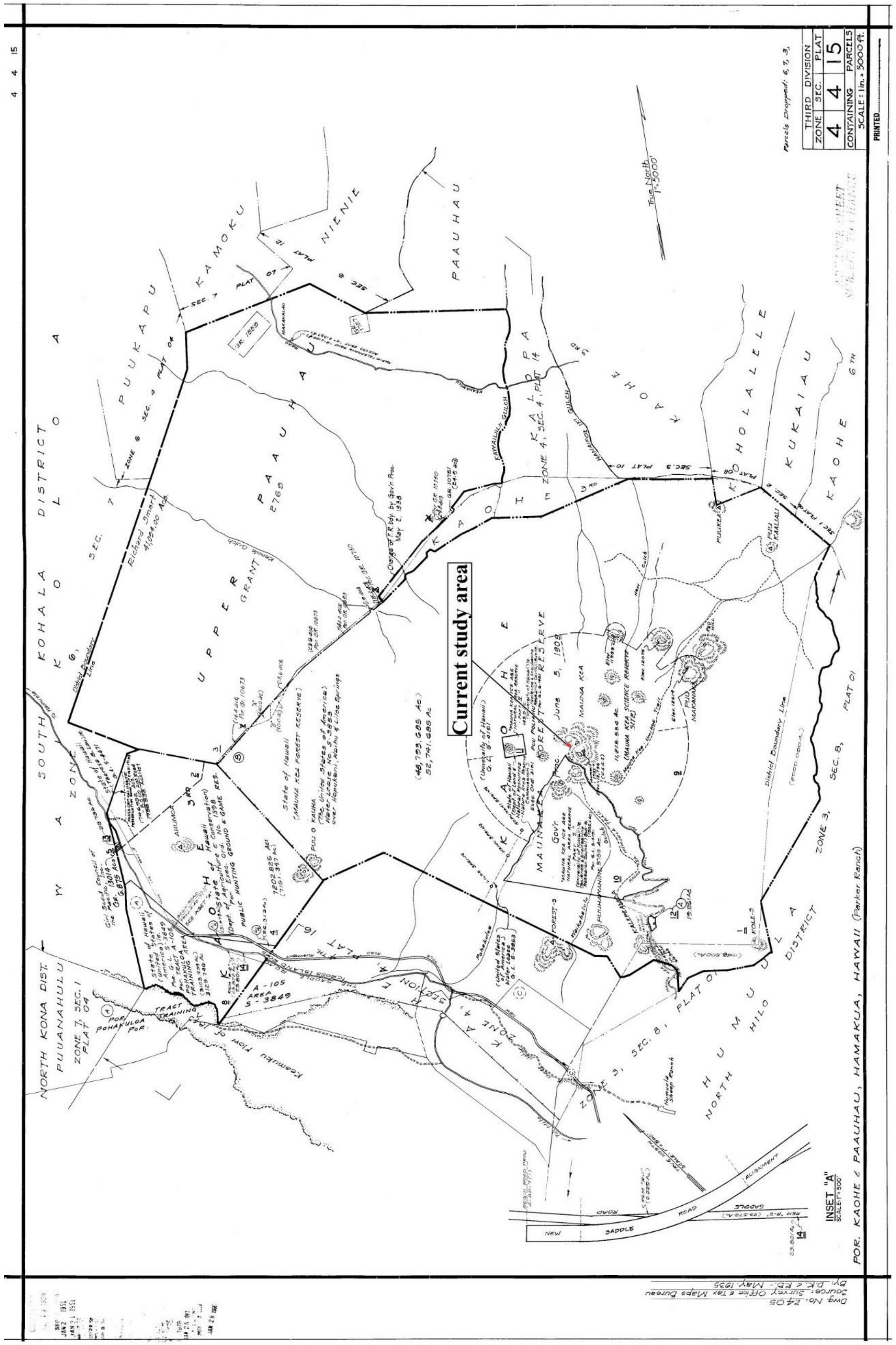

Figure 2. Tax Map Key (3) 7-4-009 showing location of current study parcel (072).

Figure 3. Google Earth™ satellite image showing the direct effects study area (outlined in yellow).

STUDY AREA DESCRIPTION

The current study includes a direct effects study area where ground disturbance and/or the operation of mechanical equipment may be anticipated to occur during the decommissioning process, and a visual effects study area that includes the viewshed of the CSO facility. The direct effects study area (see Figure 3) is located at 13,350 feet altitude near the summit of Maunakea a plateau surrounded by Puʻupoliʻahu, Puʻuhauʻoki, and Puʻuwēkiu (see Figure 1). It includes the 0.75-acre CSO facility, a 460-meter portion of Mauna Kea Access Road, and the batch plant located downhill (southeast) of the telescope site, which is anticipated to be used as a base yard/staging area. The visual effects study area (Figure 5) was calculated using Google Earth's viewshed analysis software based on the 52-foot height of the CSO telescope dome. The CSO facility is located within the Astronomy Precinct of the Maunakea Science Reserve (TMK: (3) 4-4-015:009), and the majority of the road and baseyard/staging area is located outside the Astronomy Precinct but within the Science Reserve. A gravel road (Figure 6) extends to the southeast from the telescope facility and connects to the graded batch plant area (Figure 7).

Geology in the study area (Figure 8) consists of Laupāhoehoe Volcanics comprising a hawaiitic *ʻaʻā* flow which vented, probably from one of the summit cones, and flowed primarily northwest with one lobe extending to the south (Group 70 1982). McCoy (1982a) reported evidence of glaciation in the form of striations, polish, and boulder erratics in the then-proposed CSO site, and these kinds of features are visible outside the current study area. The occurrence of lava tubes in such *ʻaʻā* flows are reported to be rare. Natural soils in this portion of the summit region are extremely limited and are mapped as Lava flows-Cinder land (labeled 8 in Figure 9), which derives from *ʻaʻā* weathering in place. At the time of the current study, several piles of cinders were staged in the batch plant area. The natural ground surface slopes generally toward the south; however, grading for the construction of the CSO has created a level, cinder-covered ground surface around the telescope and its outbuildings. Hydrologically, the *ʻaʻā* underlying the CSO is highly permeable. The nearest surface water is at Lake Waiʻau, located 4,000 feet to the southeast of the CSO facility. Average daytime maximum temperature is 50.1°F and average minimum temperature is 24.8°F. Precipitation averages 8.07 inches per year (Giambelluca et al. 2013) in the form of freezing fog or snow. Above 12,800 feet elevation on Maunakea, the ecosystem is classified as Alpine Stone Desert (Gerrish 2013). Vascular plants are very widely scattered and include two native grasses, *Trisetum glomeratum* (*pili uka*) and *Agrostis sandwicensis* (Hawaii bentgrass); and the endemic fern *Asplenium adiantum-nigrum (ʻiwa ʻiwa*).

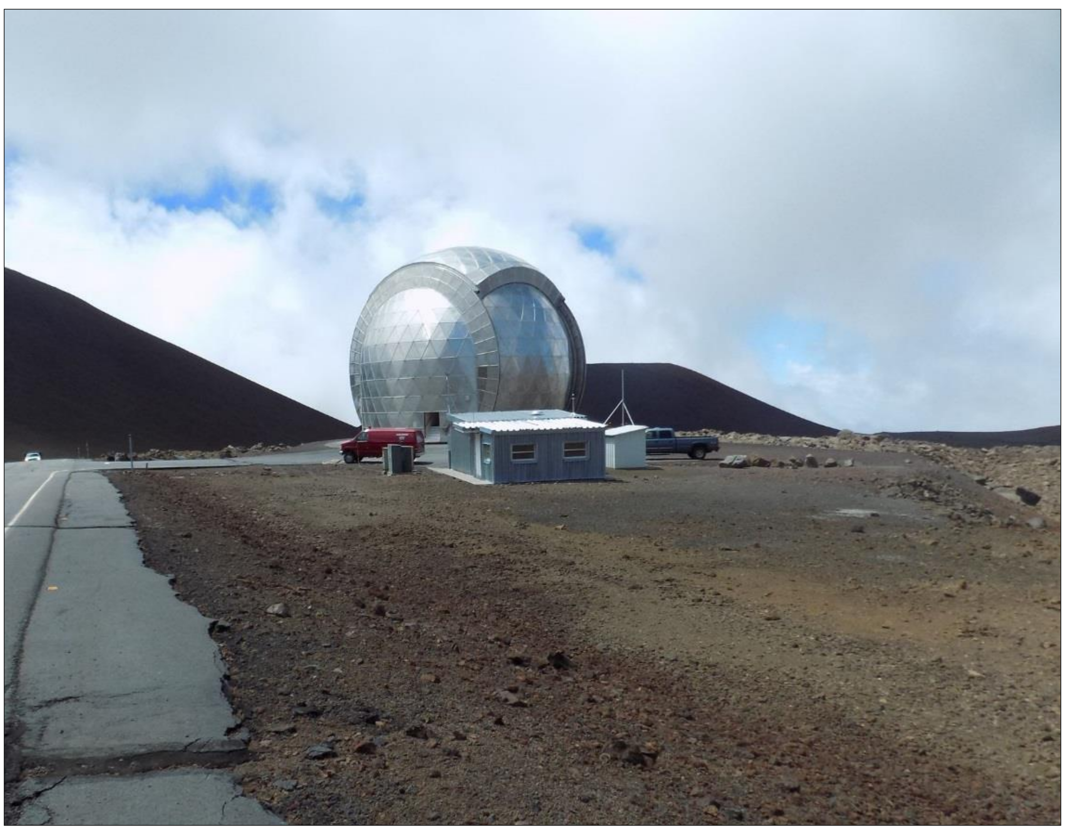

Figure 4. Caltech Submillimeter Observatory facility, view to the southeast.

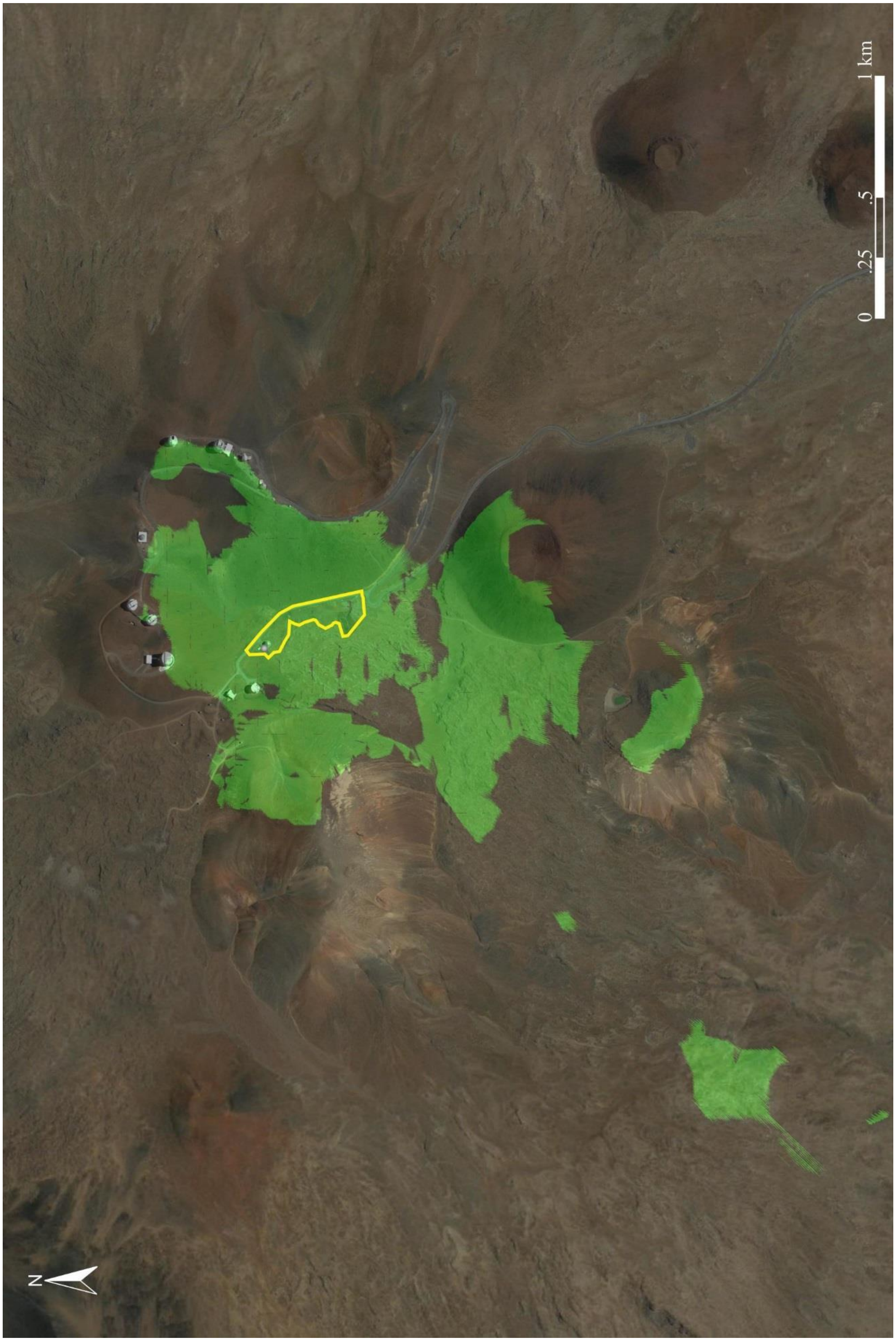

Figure 5. Visual effects study area (shaded green) with direct effects study area outlined in yellow.

Figure 6. Unpaved access road (foreground) leading to batch plant area, view to the southeast.

Figure 7. Batch plant area, view to the southeast.

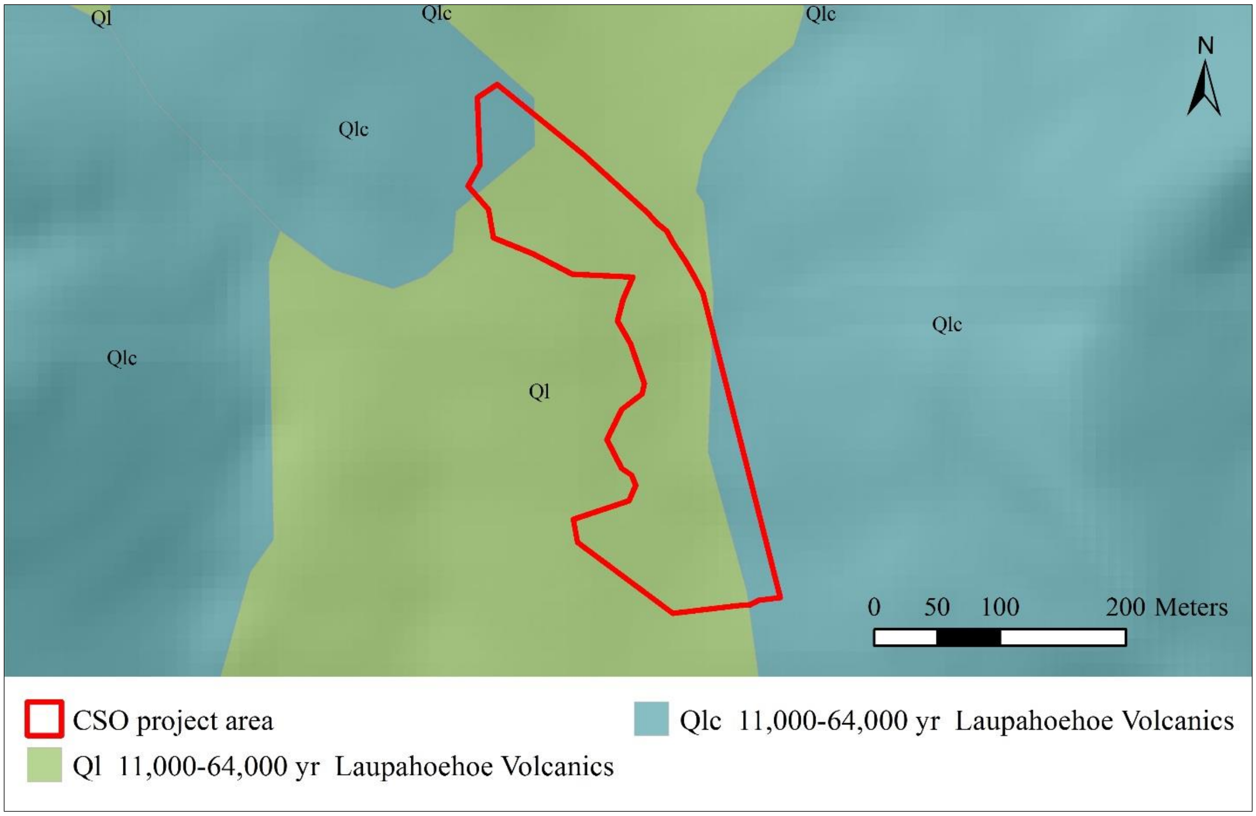

Figure 8. Geology in the direct effects study area.

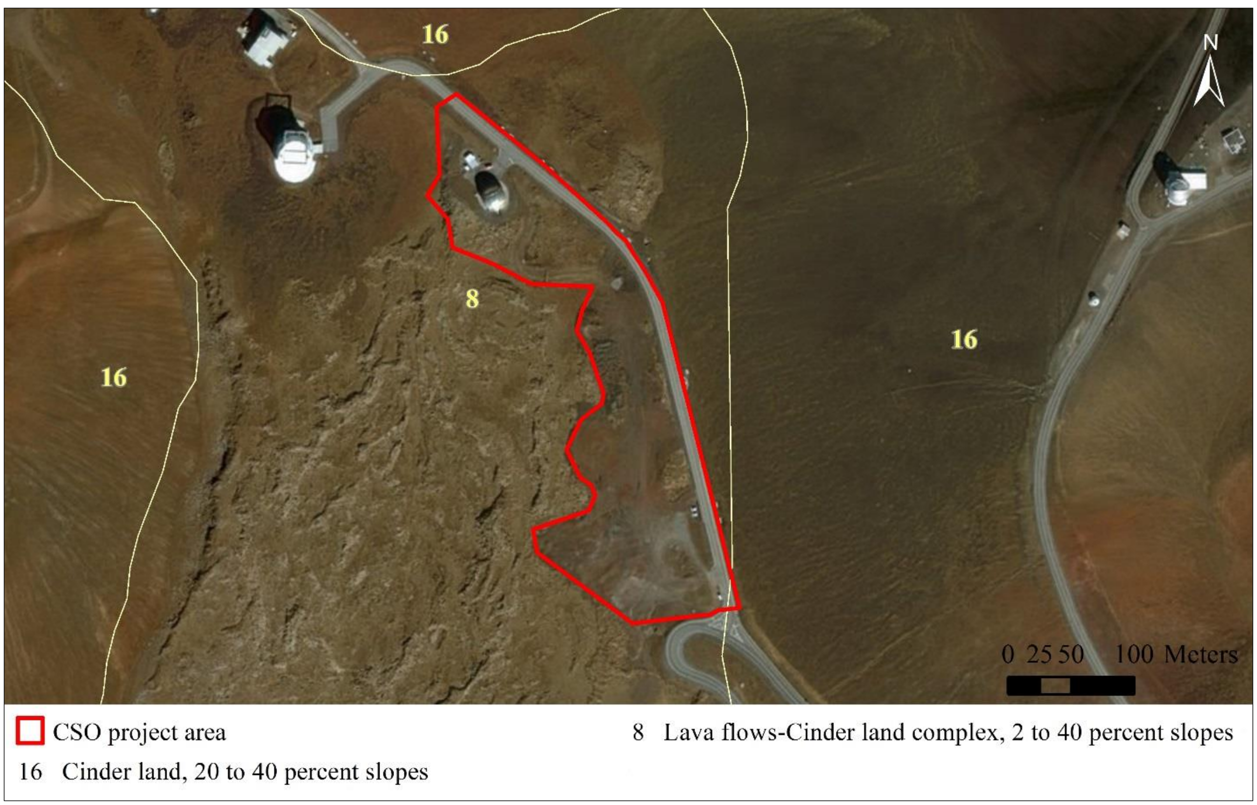

Figure 9. Soils in the direct effects study area.

2. BACKGROUND

To generate a set of expectations regarding the nature of archaeological resources that might be encountered within the current study area, and to establish an environment within which to assess the significance of any such resources, a general culture-historical context for the Hāmākua region that includes specific information regarding the known history of Kaʻohe Ahupuaʻa and the current study area is presented. This is followed by a discussion of relevant prior archaeological studies conducted in the vicinity of the study area.

CULTURE-HISTORICAL CONTEXT

An extensive body of culture-historical information concerning Maunakea and the summit region has been developed over the past three decades through research and consultation. A detailed culture-history of Maunakea and the summit region was prepared by Kumu Pono Associates (Maly and Maly 2005, 2006) using native traditions, historical accounts, and oral history interviews. That study built on prior research (Langlas 1999; Langlas et al 1999, Maly 1998, 1999; McEldowney 1982) and documented a wide range of traditional knowledge and practices associated with the summit region as a traditional realm of Hawaiian *akua* (gods), as a place sacred to contemporary cultural practitioners, and also as the setting for western uses of the mountain as a place of scientific inquiry. The information from these prior studies were incorporated into the CRMP (McCoy et al. 2009) to guide the management of cultural resources on Maunakea, including requirements for the decommissioning process. The abbreviated culture-historical context presented below summarizes these prior culture-historical studies, focusing on human uses of the summit region with potential to leave archaeological evidence. A more comprehensive discussion of the cultural significance of the Maunakea summit region and the mountain as whole will be included in the Cultural Setting Analysis (ASM in prep.) prepared to accompany the environmental documentation for the proposed project. The following abbreviated culture-historical context borrows extensively from the CRMP (McCoy et al 2009) and follows the model presented in the Maunakea Comprehensive Management Plan (Hoʻakea 2009), which describes the history of Maunakea in terms of a Precontact Period (prior to 1778), a Postcontact Period (1778 to the beginning of the 20th Century), and a Modern Period (post-dating the 20th Century).

Although little direct information on the use of the Maunakea summit region is available for this Precontact Period, it is currently thought that access to the summit was limited due to its extreme sacredness. As Maly and Maly (2005) note, the *ʻāina mauna* (mountain lands) of Maunakea were frequented by individuals who traveled there to worship, gather stone, bury family members, or deposit *piko* (umbilical cords of newborn children) in sacred and safe areas. Other uses of the upper elevations of Maunakea included travel across the island, bird-catching, and collecting material for canoe manufacture (Hoʻakea 2009). The summit was accessed by trails leading from every district except Puna (Maly and Maly 2005). Archaeological evidence for ceremonial use of the summit area include *ʻahu* (stone piles or altars) and *kūahu* (a type of shrine), but as McCoy et al. (2009:2–21) state, the nature of those ceremonies is not well understood:

> Although the archaeologically-documented presence of *ahu* and *kūahu* within the summit region of Mauna Kea indicates religious observances of various kinds in the Hawaiian past, no knowledge regarding the traditional practices and beliefs associated with these structures exists today, or if it does the information has not been shared with anthropologists and archaeologists.

During the Postcontact Period, traditional uses of the summit area were undoubtedly affected by Hawaiians' interactions with and reactions to newly-introduced Western ideas and practices. While use of the summit region had apparently been restricted to certain ritual and craft specialists, Europeans were motivated to venture to the summit by science and a spirit of exploration. The first European known to have ascended Mauna Kea was Reverend Joseph Goodrich, in 1832 (Goodrich 1833). During that same year, Dr. Abraham Blatchley and Mr. Samuel Ruggles, also went to the top (Skinner 1934). Other early visitors included botanists James Macrae in 1825 and David Douglas in 1834, and members of the United States Exploring Expedition in 1841 (Wentworth 1935). Maly and Maly (2005) detail other early visits to Maunakea, including expeditions to the summit by astronomers, geologists, surveyors, and other scientists. Several of these early scientific expeditions reported the presence of what are today considered historic properties and archaeological sites, including the adze quarries and traditional burials at Puʻu Līlīnoe.

Not all of the visits to the summit region during this period were led by foreign scientists or explorers. Citing accounts by several different authors, Kamakau (2001), and others, de Silva and de Silva (2006) note that several *aliʻi* ascended Maunakea for ceremonial reasons. Kamehameha I went to Waiau to pray and leave an offering of *ʻawa* (Desha 2000), and Kaʻahumanu made the same journey in 1828 in an unsuccessful attempt to retrieve the *iwi* of her ancestress Līlīnoe (Kamakau 2001). Waiau was also visited by Kauikeaouli in 1830, Alexander Liholiho in 1849, and

Peter Young Ka‘eo in 1854 (de Silva and de Silva 2006:5). In October of 1882, Queen Emma Kaleleonalani and her royal party ascended Maunakea “to demonstrate her lineage and godly connections, and to perform a ceremonial cleansing in the most sacred of the waters of Kāne in Lake Waiau” (Maly and Maly 2005:155). Her journey to the summit was commemorated in several *mele* (songs) and in the names of descendants of its participants, but also physically on the mountain in the form of a pillar of stones observed ten years later by members of a scientific expedition led by W. D. Alexander and E.D. Preston (Maly and Maly 2005).

During the Modern Period, land use on Mauna Kea changed markedly. As the 20th century began, large flocks of feral sheep were devastating the forests on the flanks of the mountain, and governmental response to the damage led to increased access to the summit. To combat the erosion caused by feral grazing, the Civilian Conservation Corps (CCC) undertook a large fencing project during the 1930s (Ho‘akea 2009). At about the same time, the CCC worked to improve roads and build facilities for visitors (Bryan 1939). They constructed a road leading to the summit from Kalai‘ehā that probably followed the ancient Mauna Kea–Humu‘ula Trail. Two cabins (Sites 50-10-23-9074 and 9075) were also built by the CCC in 1936 and 1938, respectively, and the name of the facility, Hale Pōhaku, derives from these stone houses (PCSI 2010). A comfort station (SIHP Site 50-10-23-9076), also built of local stone, was constructed in 1950.

Even during the 1950s, the human impacts on the Maunakea summit were relatively small. The direct effects study area (Figure 10) was still only accessible by foot. After the development of a weather station on Mauna Loa and the Solar Observatory on Haleakalā on Maui in the late 1950s, however, Maunakea attracted the attention of the international astronomy community (Maly and Maly 2005). A test observatory facility was developed on the summit in 1964, which began with the bulldozing of the Mauna Kea Summit Access Road in May of that year, and, a month later, the construction of the Lunar and Planetary Station on the summit of Pu‘upoli‘ahu (Maly and Maly 2005). The success of this project led to the construction of the University of Hawai‘i 88-inch telescope from 1967 to 1970, and also the establishment of the Mauna Kea Science reserve. The summit road was improved in 1970, which allowed much easier access to the summit for private and commercial users and helped to spur additional telescope facility construction.

Construction of the CSO facility began in 1983 and was completed in 1987 (Steiger 2009). As designed, ground-level improvements at the CSO facility (Figures 11 and 12) included, in addition to the concrete foundation and telescope dome, a 6,000 square foot paved parking area with truck access and turnaround, and a 14 by 30 foot paved driveway. Below-ground improvements included utility trenches for conduits, auxiliary generator room and fuel tank, a large underground water tank outside the dome, a sewage holding tank under the dome**,** and an external cesspool (Steiger 2009). The foundation of the telescope dome (Figure 13) was installed on a graded pad located along an existing unpaved road that led to Pu‘upoli‘ahu and to the James Clerk Maxwell Telescope site (Figure 14). Most of the unpaved road has since been incorporated into the Mauna Kea Summit Access Road (see Figure 3), although a 150-meter-long portion of the unpaved road (see Figure 6) remains.

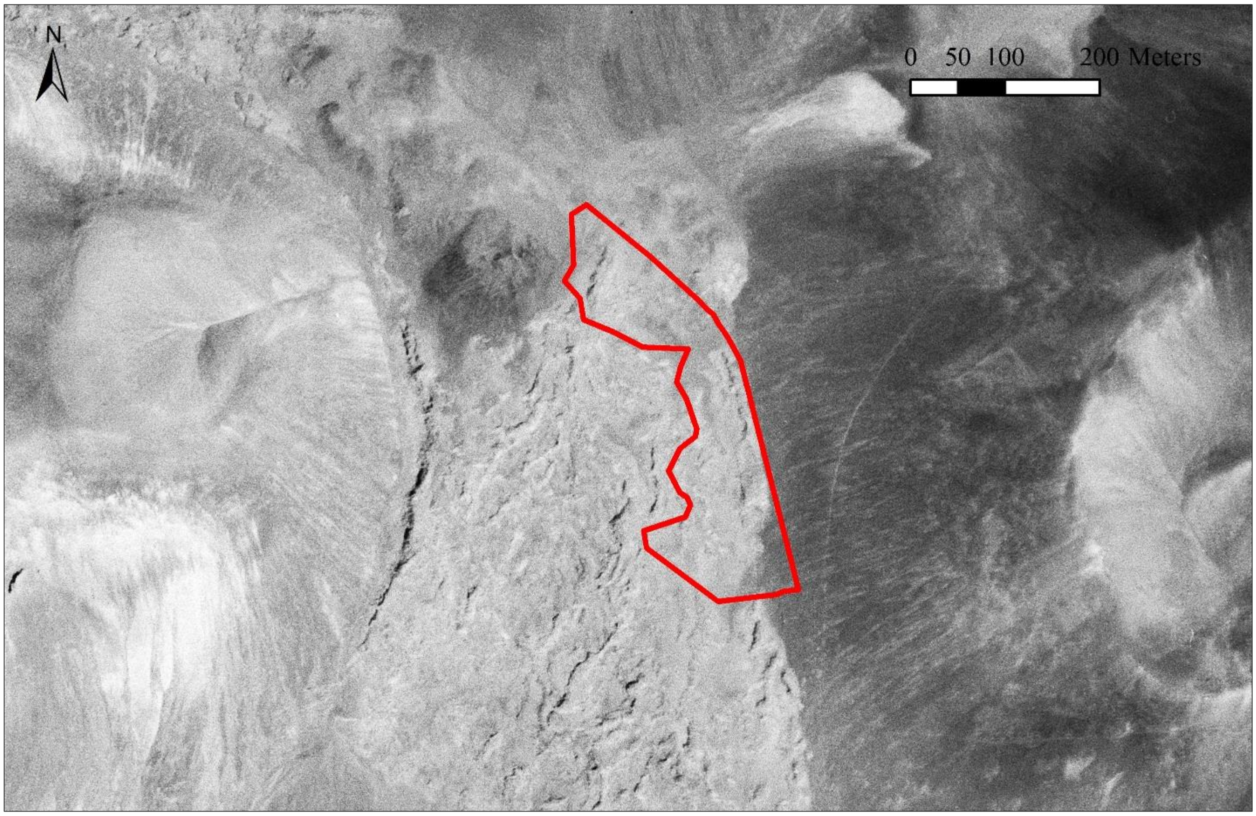

Figure 10. 1954 aerial photograph of the direct effects study area (outlined in red) (USGS 1954).

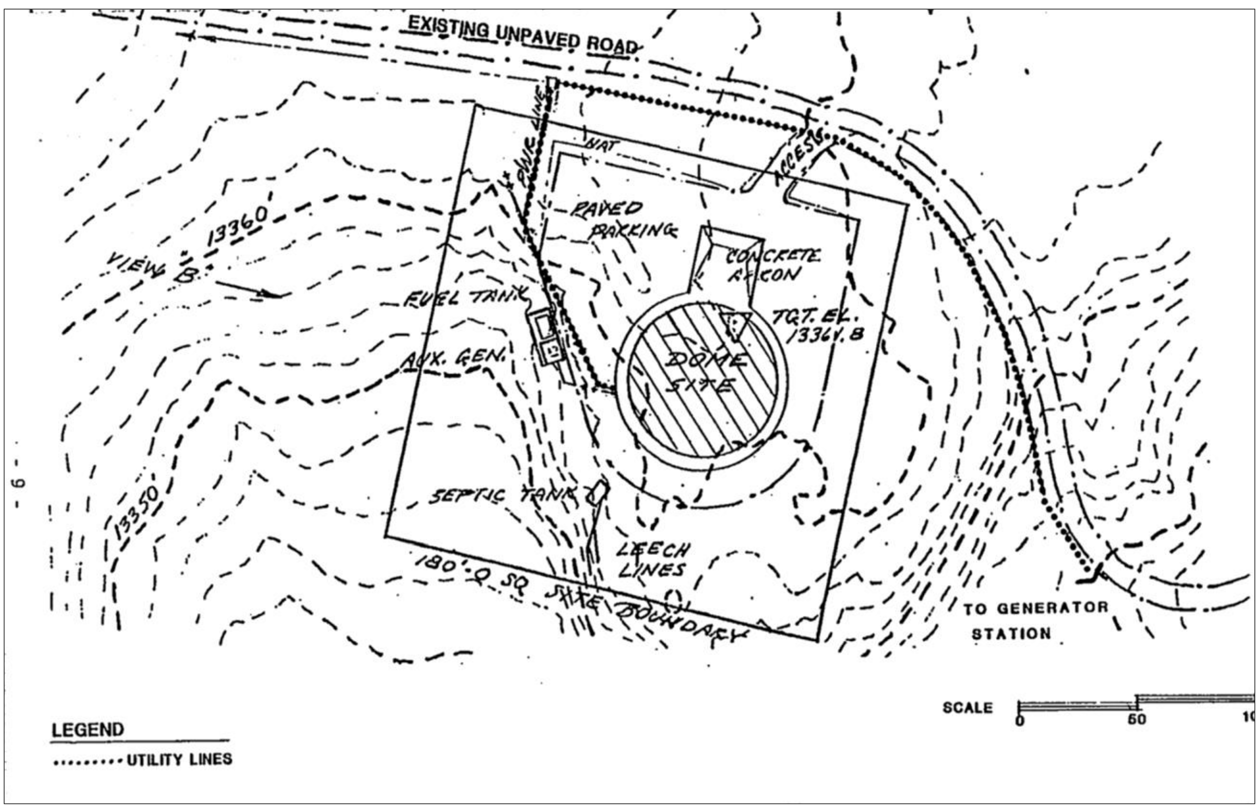

Figure 11. Preliminary plan of CSO facilities (Group 70 1982).

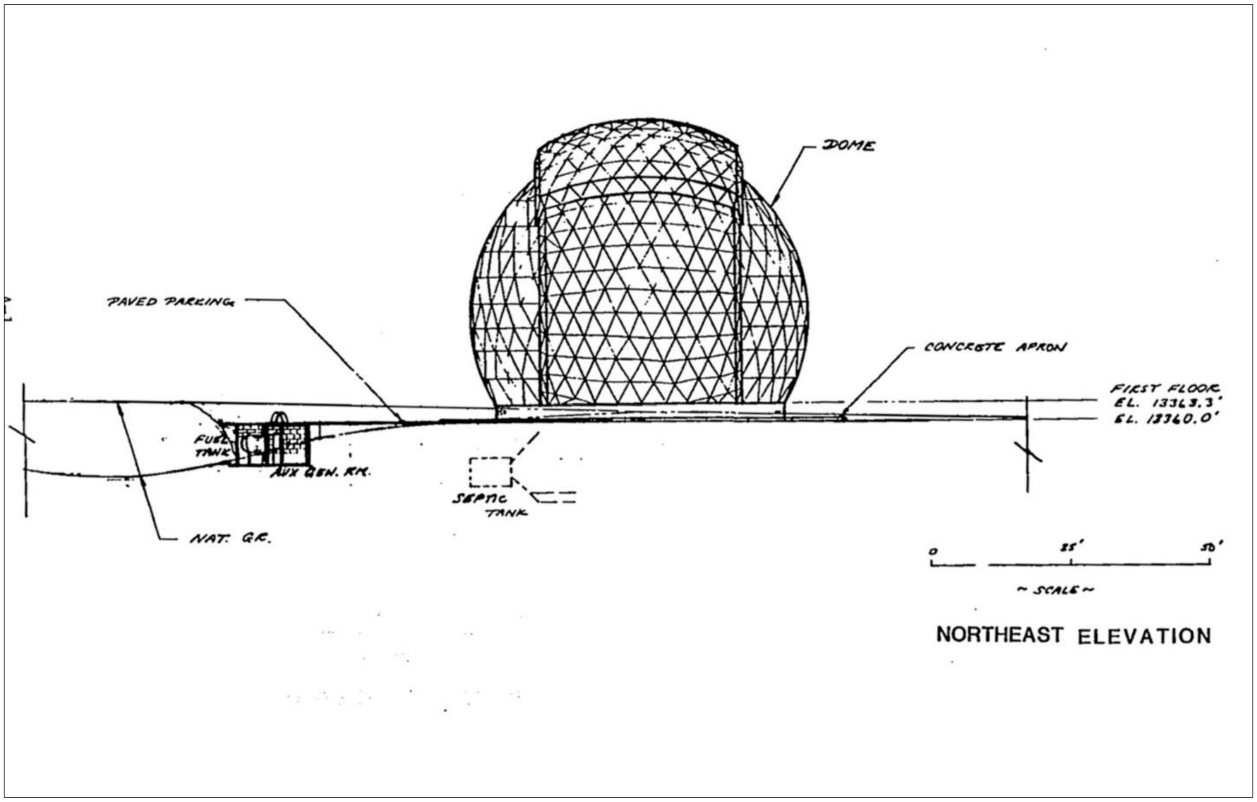

Figure 12. Preliminary elevation of CSO facilities (Group 70 1982).

Figure 13. Observatory and outbuilding foundations in 1985, view to the southwest (Steiger 2009).

Figure 14. CSO under construction, view to the northwest (Steiger 2009).

PREVIOUS ARCHAEOLOGICAL STUDIES

The entire summit region of Maunakea was subject to archaeological inventory surveys between 2005 and 2009. Results of these surveys and summaries of prior archaeological studies were presented in four AIS reports (Table 1). One of these reports (McCoy et al. 2010) presented results of fieldwork conducted within the Astronomy Precinct, where the CSO facility is located. Another report (McCoy and Nees 2010) included results from the entire Science Reserve (which contains the portion of the current study area outside of the Astronomy Precinct). Two other areas in the summit region were also subject to inventory-level surveys: the Mauna Kea Ice Age Natural Area Reserve (McCoy and Nees 2013), which is located to the south and west of the CSO facility, and Lake Waiau (McCoy and Nees 2009), located to the south of the CSO facility. In addition to these studies, portions of the summit region were included in earlier archaeological reconnaissance surveys, academic research projects, and cultural resource management studies associated with the construction of observatories in the Astronomy Precinct. Results of these smaller-scale studies were incorporated in the four AIS reports described above. One of these earlier reconnaissance studies (McCoy 1982a) included the location of the CSO facility, and two others (McCoy 1982b, 1993) were conducted in areas adjacent to the facility. The summary of previous archaeological work presented below is adapted in part from the Science Reserve AIS (McCoy and 2010) and Natural Area Reserve AIS (McCoy and Nees 2013) and documents archived in the SHPD correspondence files. The summary focuses primarily on sites that are either near the CSO facility or are located within the viewshed of the CSO facility.

Table 1. Archaeological Inventory Survey reports for the Maunakea Summit Region.

Year	*Author(s)*	*Scope*	*Number of historic properties*
2009	McCoy and Nees	Lake Waiau	41 sites, 1 TCP
2010	McCoy et al.	Astronomy Precinct	6 sites, 1 TCP
2010	McCoy and Nees	Maunakea Science Reserve	263 sites, 2 TCP*
2013	McCoy and Nees	Maunakea Ice Age Natural Area Reserve	109 sites, 1 TCP**

* Includes McCoy et al. (2010) findings. ** Includes McCoy and Nees (2009) findings.

The CSO facility site itself was subject to an archaeological survey by the B. P. Bishop Museum (McCoy 1982a) in support of the observatory's environmental impact statement. No archaeological sites were observed within the planned CSO project area; however, two shrines (Sites 50-10-23-16164 and 16165) located 188 meters and 250 meters, respectively, to the south-southwest of the CSO project area were briefly described in that report. In a later report produced for a larger archaeological reconnaissance of the summit region McCoy (1982b) provided more detailed descriptions and analyses of these two sites. As part of the Section 106 process for the construction of the Smithsonian Institution Astrophysical Observatory, McCoy (1993) revisited Sites 16164 and 16165 and found them to be located outside the Astronomy Precinct, recommending that they be flagged during construction of the Smithsonian Institution Astrophysical Observatory as a precautionary measure. These two sites are the closest historic properties to the CSO facility.

The 2005-2009 archaeological surveys (McCoy et al. 2010; McCoy and Nees 2009, 2010, 2013) conducted in the summit region recorded 263 historic properties in the Science Reserve (Figure 15) and 109 historic properties in the Mauna Kea Ice Age Natural Area Reserve (Figure 16). Combined, these sites include 3 SHPD-designated Traditional Cultural Properties (TCPs, as defined by Parker and King 1998), 151 shrines, 139 sites comprising the Mauna Kea Adze Quarry Complex, 5 burial features and 56 possible burial features, 23 stone markers or memorials, 4 Historic campsites, 3 temporary shelters, 3 trails, 1 Historic dump, 1 Historic transportation route, 1 petroglyph, and 3 sites of unknown function. The TCPs comprise three *puʻu* (Kūkahauʻula, Site 21438; Puʻu Waiau, Site 21440; and Puʻu Līlīnoe, Site 21439) that were determined to be eligible for inclusion in the National Register of Historic Places based on consultation begun by Langlas (1999) with knowledgeable *kūpuna* (elders). The Mauna Kea Adze Quarry Complex, located near Pōhakuloa Gulch south of the Astronomy Precinct, is partially in both the Science Reserve and the Natural Area Reserve. This complex contains 141 sites that include the quarry, workshop locations used for manufacturing and/or ritual activities, and one habitation rock shelter located outside of the quarry proper. Of the previously recorded historic properties located in the summit region, none are located within the direct effects study area (see Figures 15 and 16).

The Mauna Kea Summit Region Historic District (SIHP Site 50-10-23-26869) encompasses the extent of the glacial moraines and crest of the relatively pronounced change in slope that creates the impression of a summit plateau (Figure 17). The historic district was designated by SHPD during the preparation of a draft historic preservation plan (HPP) for the Science Reserve. While the draft preservation plan was never finalized, elements of the plan were incorporated into the Mauna Kea Science Reserve Master Plan (Master Plan) prepared by Group 70 International (2000) as appendices. The district was initially proposed in the cultural impact assessment for the Mauna Kea Science Reserve Master Plan (PHRI 1999) and was later discussed in a SHPD review of the Draft Environmental Assessment for the Keck Outrigger Telescope project (Log No.: 23155, Doc No.: 9903PM07; Attachment 1) and the Final Environmental Impact Statement for the Keck Outrigger Telescope project (NASA 2005). All of the historic properties located within the district's boundaries are considered to be contributing elements. As a result of the archaeological inventory surveys conducted between 2005 and 2009 (see Table 1), the district was evaluated to be eligible for listing in the National Register of Historic Places under Criteria A, B, C, and D, and was also determined to be historically significant under Criteria a, b, c, d, and e of HAR 13§13-275-6 as a result of the McCoy et al. (2010) AIS. No contributing elements of the Historic District are located within the direct effects study area. Eleven contributing elements (Table 2) of the Maunakea Summit Region Historic District (Site 26869) can be seen from CSO facility (Figure 18). These include two shrines (Sites 16164 and 19165) located to the south of the current study area; one USGS survey marker (Site 27579) located at the peak of Puʻupoliʻahu; the TCPs Kūkahauʻula (Site 21438) and Waiau (Site 21440); four sites (Sites 26132, 26133, 26134, and 26142) located on the rim of Puʻu Waiau that include possible burials, a possible shrine, a cairn, mounds, rock piles, and a lithic workshop; a lithic workshop (Site 27585) located almost three kilometers to the southeast of the CSO facility; and four possible burials (Site 28623) located on Puʻuhaukea.

In addition to archaeological sites and other historic properties, archaeological surveys conducted on the summit since 1997 have been recording "find spots" (called "locations" in early reports), that is, anthropogenic features that are either obviously modern (e.g., camp sites with tin cans, pieces of glass and other modern material culture items), or features that cannot be classified with any level of confidence as historic sites because of their uncertain age and function (e.g., a pile of stones on a boulder) (McCoy 1999). During the Science Reserve AIS (McCoy and Nees 2010), 339 find spots were recorded, and approximately 313 find spots were recorded during the Natural Area Reserve AIS (McCoy and Nees 2013). The placement of objects and features classified as "find spots" by cultural practitioners and other visitors to the summit is understood to be ongoing, and management policies regarding construction of new Hawaiian cultural features and constructions considered to be "find spots" is governed by the Comprehensive Management Plan.

Table 2. Contributing elements of the Maunakea Summit Region Historic District (Site 26869) within the CSO viewshed.

Site no.	*Type(s)*	*Features*	*Type of features*	*Location*
16164	Shrine	2	5, possibly 6, uprights	188 meters SSE
16165	Shrine	1	2 uprights	250 meters SSE
21438	Kūkahau‘ula	1	Maunakea Summit (as Traditional Cultural Property)	149 meters E
21440	Pu‘u Waiau	1	Pu‘u (as Traditional Cultural Property)	1,280 meters S
26132	Possible burial	2	Alignments	1,550 meters SSE
26133	Cairn	1	Cairn	1,545 meters SSE
26134	Possible burials, Possible shrine, Marker/memorial, Unknown function	17	1 terrace, 1 mound/terrace, 4 pavements, 9 mounds, 2 rock piles	1,530 meters S
26142	Workshop	1	Lithic scatter	1,510 meters S
27579	USGS Marker	1	1 USGS marker	630 meters W
27585	Workshop	1	4 adze manufacturing workshops; flakes, hammerstones, cores	2,530 meters SW
28623	Possible burial	4	4 mounds	930 meters SE

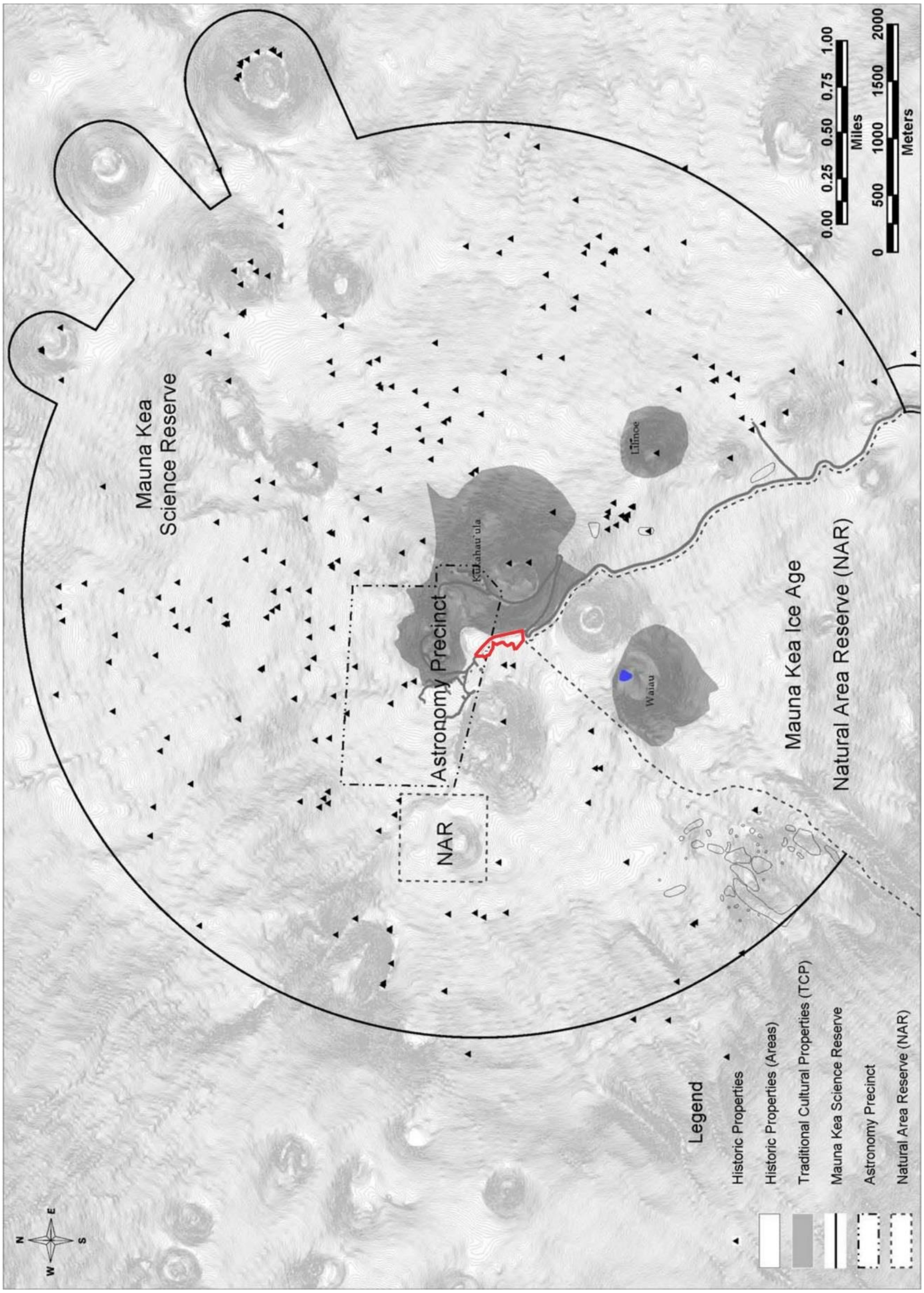

Figure 15. Locations of historic properties in the Mauna Kea Science Reserve, direct effects study area outlined red (after McCoy and Nees 2010).

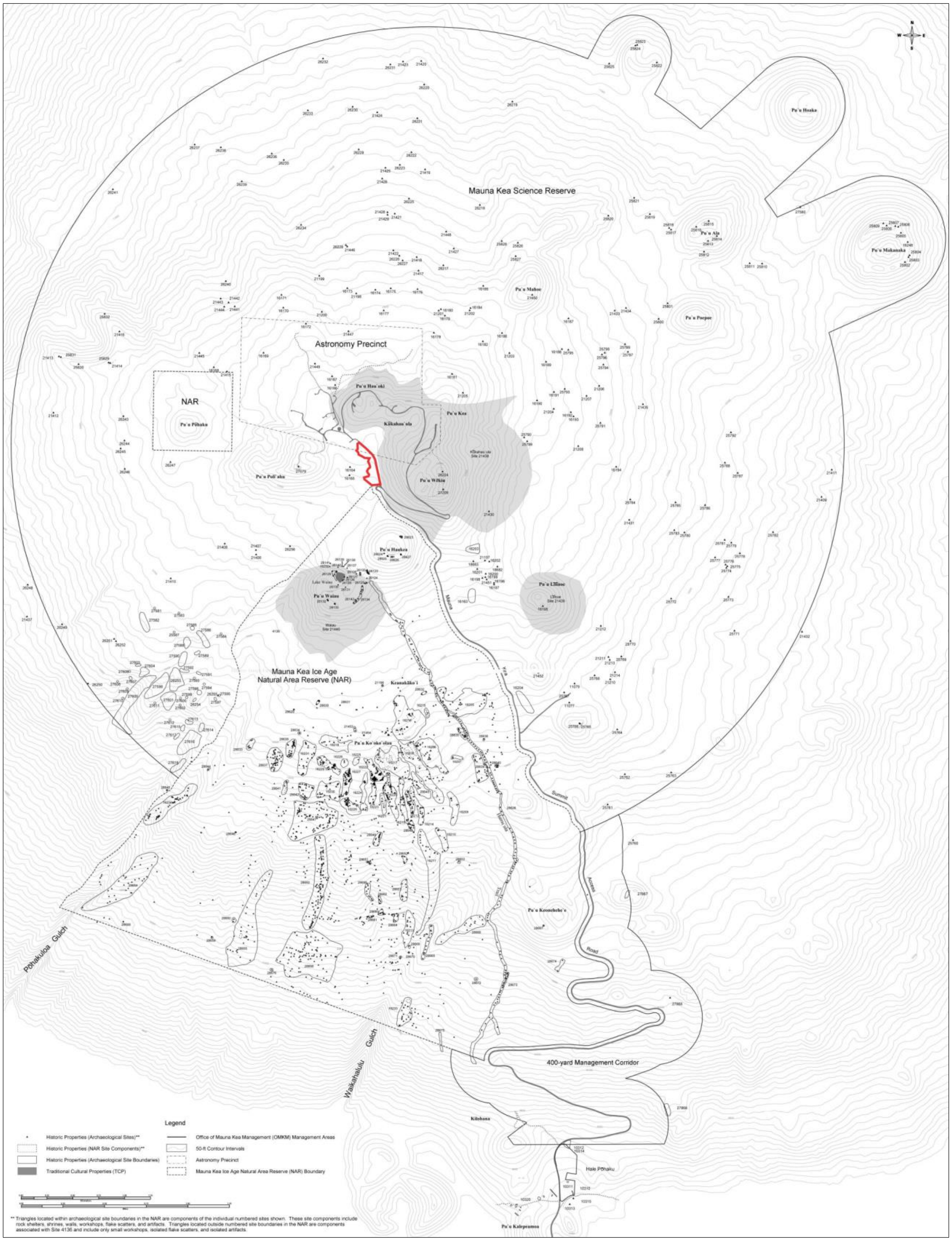

Figure 16. Locations of historic properties in the Mauna Kea Ice Age Natural Reserve Area, direct effects study area outlined in red (after McCoy and Nees 2013).

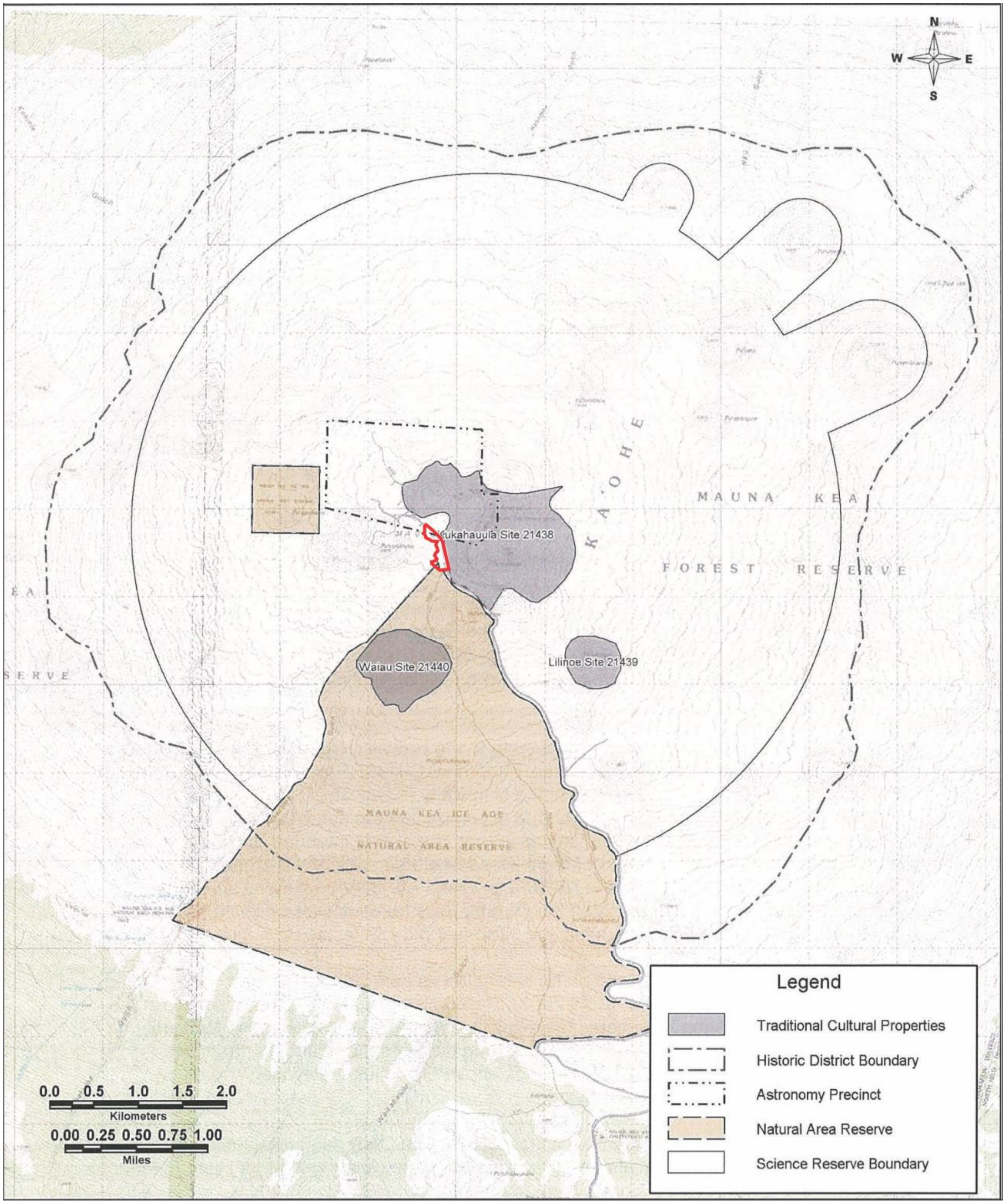

Figure 17.Maunakea Summit Region Historic District (Site 26869) boundaries (after McCoy et al. 2009), direct effects study area in red.

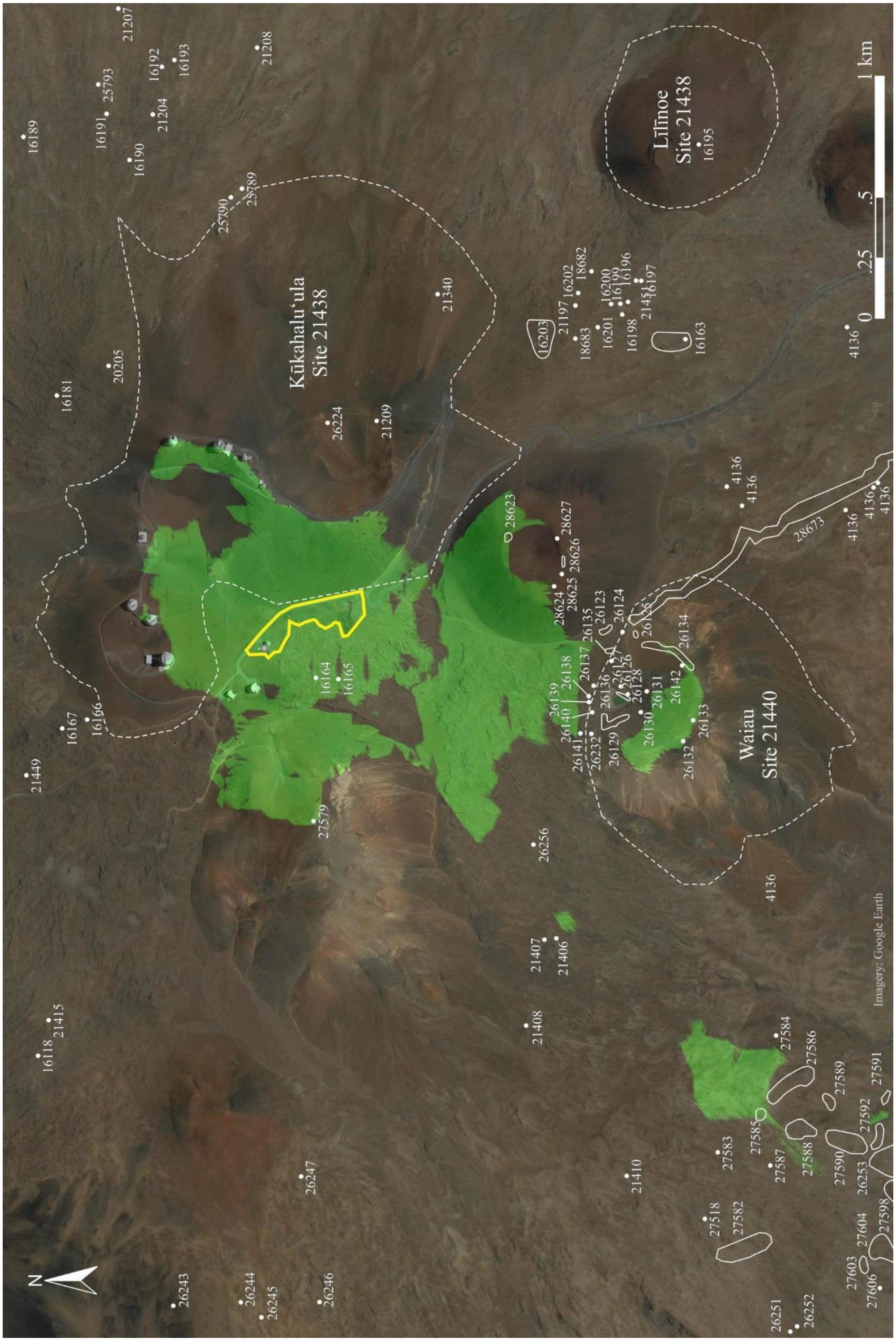

Figure 18. Contributing elements of the Maunakea Summit Region Historic District (Site 26869) relative to the study areas for visual effects (shaded green) and direct effects (outlined in yellow).

3. STUDY AREA EXPECTATATIONS

The entire direct effects study area (Figure 19) was previously disturbed by construction activities, covered with cinder fill, and is known to overlie bedrock. No historic properties have been previously reported within the direct effects study area, nor are any newly identified historic properties are anticipated. While it is extremely unlikely that new historic properties will be identified in the direct effects study area, it is possible that new rock constructions (i.e., “find spots”) may be present.

Figure 19. Direct effects study area showing prior ground disturbances.

4. FIELDWORK

The Principal Investigator for the current study was Benjamin Barna, Ph.D. Fieldwork for the current study was conducted on May 10, 2018, by Theodore Bibby, Ph. D. and Benjamin Barna, Ph.D.; approximately four person-hours were expended during the archaeological field survey.

FIELD METHODS

During the archaeological field survey, the entire (100%) ground surface of the direct effects study area was visually inspected by walking transects oriented parallel to the study area boundaries and spaced no more than 15 meters apart. No subsurface testing was conducted because the entire direct effects study area was previously disturbed by construction activities, covered in some places with recently dumped cinder fill (Figure 20), and known to overlie bedrock. In addition to the pedestrian survey of the direct effects study area, an assessment of the potential visual impacts of the removal of the CSO dome and facilities was made by photographing the CSO facility site from the nearest historic property within the visual effects study area (Site 16164, a shrine located approximately 188 meters south-southeast of the CSO facility). Removal of the CSO facility was simulated by digitally erasing the telescope superstructure from the photographs taken from Site 16164.

FINDINGS

As a result of the fieldwork, no archaeological resources of any kind were identified within the direct effects study area. No find spots were observed within the current study area.

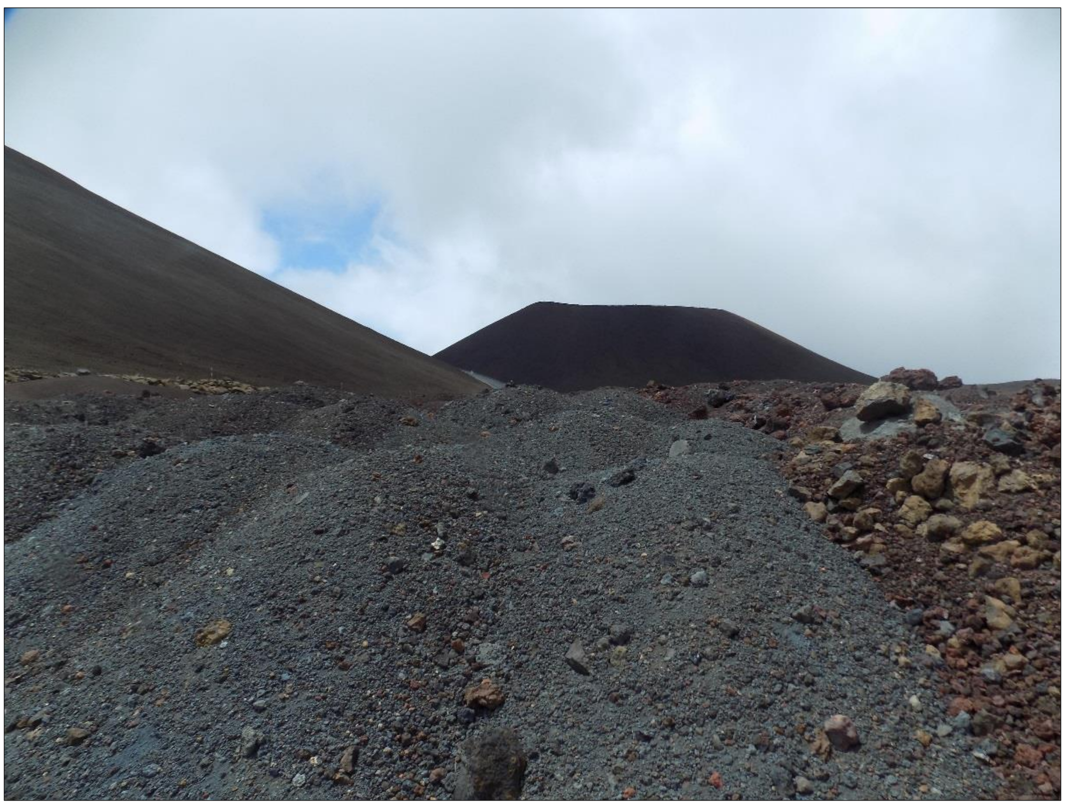

Figure 20. Recently dumped cinder fill in staging area, view to the east.

5. PROJECT DETERMINATION OF EFFECT AND RECOMMENDATIONS

Given the negative findings of the current study with respect to archaeological resources, it is concluded that the Caltech Submillimeter Observatory Decommissioning Project on Maunakea will have no direct effect on any historic property within the project area. With respect to indirect effects, the eleven previously recorded significant historic properties (Sites 16164, 16165, 21438, 21440, 26132, 26133, 26134, 26142, 27579, 27585, and 28623) within the viewshed of the CSO facility, and the Mauna Kea Summit Region Historic District (Site 26869), will experience overall beneficial effects from the removal of the CSO facilities. For those sites, the removal of the above-ground facilities will partially restore the appearance of the summit as it was prior to the construction of the CSO. This will result in an enhancement of the integrity of setting, feeling, and association of the eleven sites as well as the historic district. For example, Figures 21 and 22 provide a comparison of the view toward the CSO from Site 16164. Therefore, because this effect is not "harmful," the determination of effect for the proposed project in accordance with HAR 13§13-284-14(a) and (b) is "no historic properties affected."

With respect to the historic preservation review process of the DLNR–SHPD, our recommendation is that no further historic preservation work needs to be conducted within the CSO facility project area prior to project implementation. Archaeological monitoring is recommended as a precautionary measure to ensure protection of Site 21438 (Kūkahauʻula), which is adjacent to the Mauna Kea Summit Access Road and the lower portion of the CSO project area, and as a contingency for the discovery of unanticipated archaeological resources. An archaeological monitoring plan in accordance with HAR 13§13-279 will be prepared for acceptance by DLNR-SHPD prior to project implementation.

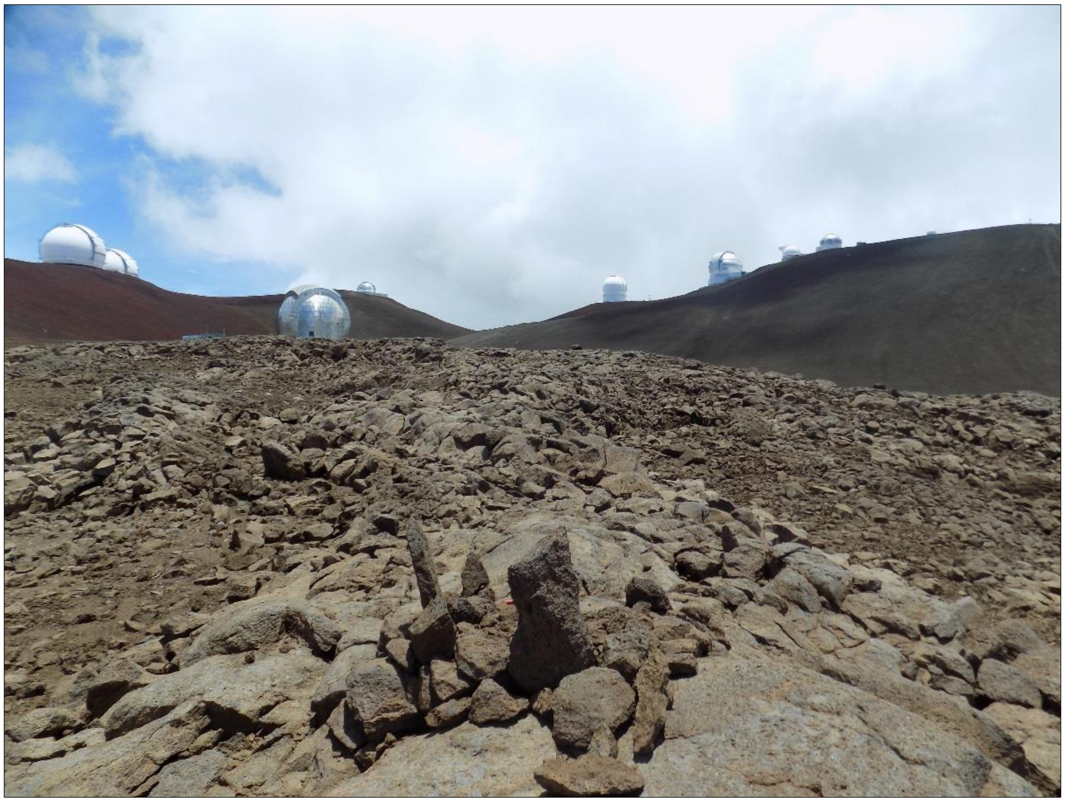

Figure 21. CSO telescope dome (center left) from Site 16164 (foreground), view to the northeast.

Figure 22. Simulation of CSO site viewed from Site 16164 after full removal, view to the northeast.

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APPENDIX A. SHPD REVIEW OF THE KECK OUTRIGGER TELESCOPE PROJECT DRAFT ENVIRONMENTAL ASSESSMENT

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES

HISTORIC PRESERVATION DIVISION
Kakuhihewa Building, Room 555
601 Kamokila Boulevard
Kapolei, Hawaii 96707

TIMOTHY E. JOHNS, CHAIRPERSON
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May 3, 1999

MAY 07 1999

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

LOG NO: 23155
DOC NO: 9903PM07

Dear Dr. McLaren:

SUBJECT: **Request for Historic Preservation (Chapter 6E, HRS) and National Historic Preservation Act (Section 106) Review --W.M. Keck Observatory Outrigger Telescope Project in the Mauna Kea Science Reserve, Ka`ohe, Hamakua, Hawaii Island TMK: 4-4-15:09**

Thank you for your letter of March 17, 1999 and the opportunity to review and comment on the Draft Environmental Assessment (DEA) prepared for the proposal to add four to six 1.8-meter "outrigger" telescopes around the two existing 10-meter Keck telescopes located on Pu`u Hau Oki.

Before discussing our review of the DEA, two aspects of the review process need clarification. First, the DEA and your letter correctly indicate that the project needs to comply with Section 106 of the National Historic Preservation Act (NHPA) because federal funds are being used for the project. Your letter, however, asks that we coordinate our review with the Advisory Council on Historic Preservation (ACHP). According to the Section 106 regulations, it is technically the responsibility of the federal agency, in this case NASA, to determine the effect of a project on historic properties and to consult with the State Historic Preservation Office on its determination. The agency may designate another party, such as IFA, to execute its responsibility. We suggest that you or NASA review our comments on the DEA and, if you agree, submit the recommended determination to our office for our official comment. We would be glad to provide you with any information you need on the Section 106 process. Second, your letter asks us to review the finding of "no significant impact" proposed by the DEA. We do not review determinations of this sort because, if we understand correctly, this assessment considers a combination of factors, issues, and subject matters that are beyond our expertise and jurisdiction. Our assessment of effect in the following discussion conforms with our standard review process and we ask that it be incorporated in the final Environmental Assessment.

2

The DEA proposes that IFA will be requesting a "no effect" determination for the construction of the outrigger observatories when applying for the appropriate permits. To support this finding, the DEA cites past studies and a compliance letter to argue that no historic properties are present in the project area. It notes that no cultural remains were found on Pu`u Hau Oki in a 1982 reconnaissance survey of the summit cones[1] and no sub-surface remains were reported during the construction of the Keck I or Keck II observatories. It concludes that Pu`u Hau Oki appears to be of no particular cultural significance because ethnographic information compiled in conjunction with the 1982 survey did not attribute any particular significance to the *pu`u*.[2] Finally, the DEA cites a "no effect" assessment received from the State Historic Preservation Office (SHPO) for the establishment of optical test sites on Pu`u Hau Oki (Ltr. Wilson to McLaren, June 30, 1998).

As a point of clarification, the first archaeological reconnaissance of Pu`u Hau Oki actually took place in 1981 when a portion of the cinder cone was surveyed as one of the five alternative locations for the proposed Kitt Peak National Observatory data collecting facilities (Ltr. McCoy to Jeffries, June 9, 1981). A third reconnaissance survey of another part of Pu`u Hau Oki was undertaken in 1990 when the 5.1 acre Subaru Observatory site was surveyed[3]. No archaeological sites were found in either of these surveys.

As you are aware, we are currently reviewing historical, ethnographic, and archaeological information on Mauna Kea in the process of preparing an historic preservation plan for the Science Reserve which includes the summit region. During this process, we 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 Kukahau`ula. This single landscape feature is now called Pu`u Hau Oki, Pu`u Kea, and Pu`u Wekiu. Several lines of evidence lead us to the conclusion that the cluster of cones is an historic property. These will be discussed in more detail in documents being prepared for the preservation plan. The first line of evidence indicating the cultural and historical importance of the summit is that, at a minimum, some portion of the summit cluster bore the name Kukahau`ula who appears as a character in recorded Hawaiian traditions and as a figure in legends about Mauna Kea[4]. As a character in traditional histories and genealogies, he is the husband of Lilinoe and is named as an `*aumakua* (family deity) of fishermen. A descendant, Pae, was known as an exceptional fisherman whose bones were coveted for fishhooks by the paramount chief Umi. In one legend, Kukahau`ula is cast in a more fanciful role as the suitor and husband of Poliahu, the deity of snow and, poetically, his name is said to allude to the pink hue that can be seen reflecting from the snow-covered summit. Lilinoe plays a similar role in the mountain's traditions in that she appears both as a traditional character and a mythical

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[4] Kamakau, S.M. *Ruling Chiefs of Hawaii.* Honolulu: Kamehameha School Press, 1961:215-17. Poepoe, J.M. "Kamehameha I, Ka Nai Aupuni o Hawaii, K Liona o ka Moana Pakipika." *Ka Nai Aupuni*, 1906:April 30. Poepoe, J.M. Bishop Museum Genealogy Book 13:20, B.P. Bishop Museum Library. Taylor, E.A. "Ku-Kahau-ula and Poliahu" *Paradise of the Pacific*, Vol. 44(7):12-15, 1931.

figure[5]. She is, however, even more frequently associated with the summit region of Mauna Kea. In addition to being the wife of Kukahau'ula in some traditions, she is said to have been buried near the summit and is called the "woman of the mountain." One tradition has her being an ancestor of the illustrious Mahi family who served as warriors and attendants to the paramount *ali'i* of Hawaii Island. In legends, Lilinoe becomes the embodiment of fine mist, the literal meaning of her name, and as such is the companion or sister of Poliahu.

The names Kukahau'ula and Lilinoe are both attributed to cinder cones in the summit region: Kukahau'ula to the summit and Lilinoe to a cone immediately to the southeast of the summit cluster. These names, along with that of Waiau, appear on the earliest reliable map in 1884 and are repeated in the next survey of the summit region in 1891 and 1892[6]. Kukahau'ula is given as the name of "the highest peak" even earlier in 1873 land boundary testimonies[7]. Of all the place names in the summit region, these three are applied the earliest and most consistently to specific landmarks on the mountain. In compiling the 1892 map of Mauna Kea, W.D. Alexander refers to these as "genuine native names[8]." The place name Poliahu appears in traditions and native testimonies as being applied to a trail, spring, pond, and cave[9], but it is not consistently applied to a single and identifiable landscape feature until 1892 when W.D. Alexander proposes attaching this name to "a nameless peak" in honor of the demigoddes, Poliahu, who figures in the tale of Laieikawai[10].

While the association between the summit and Kukahau'ula is sufficiently clear, it is not as clear which specific topographic features at the summit are encompassed by the name. The conclusion drawn here that Kukahau'ula, and thus its association with a significant individual and character, probably applied to the entire summit cluster relies on four major arguments. First, use of the name Pu'u o Kukahau'ula in the boundary testimonies and in subsequent

[5] Kamakau, S.M. *Ruling Chiefs of Hawaii*. Honolulu: Kamehameha School Press, 1961:215-17, 285. Poepoe, J.M. "Kamehameha I, Ka Nai Aupuni o Hawaii, Ka Liona o ka Moana Pakipika." *Ka Nai Aupuni*, 1906:April 30. Poepoe, J.M. Bishop Museum Genealogy Book 13, page 20, B.P. Bishop Museum Library. Haleole, S.N. "The Hawaiian Romance of Laieikawai.". In *33rd Annual Report of the Bureau of American Ethnology*. Edited by M.W. Beckwith, (1919):480. Taylor, E.A. "Ku-Kahau-ula and Poliahu" *Paradise of the Pacific*. Vol. 44(7):12-15, 1931 Fornander, A. *Fornander Collection of Hawaiian Antiquities and Folk-lore*. Translated and edited by T.G. Thrum. Memoirs of the Bernice P. Bishop Museum, 1919:269. Westervelt, W.D *Legends of Gods and Ghosts*. Boston: H. Ellis, 1915:56.

[6] Lyons, C.J. "North Side of Mauna Kea, Information Sketch." Register Mar 1210, Survey Office, State of Hawaii, 1884 to 1891. Lyons, C.J. "Kaohe and Humuula, Hawaii." Register Map 1891, Survey Office, State of Hawaii, 1891. Alexander, W.D. "Summit Peaks of Mauna Kea." Register Map 1860, Survey Office, State of Hawaii, 1892. Baldwin, E.D. Field Book 323:55, Survey Office, State of Hawaii, 1891.

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[8] Preston, E.D. "Determination of Latitude, Gravity, and the Magnetic Elements at Stations in the Hawaiian Islands, Including a Result for the Mean Density of the Earth, 1891, 1892. In *Report of the Superintendent of the U.S. Coast and Geodetic Survey for the Fiscal Year Ending June 30, 1893, Part II.* Washington: Government Printing Office, 1895:596.

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[10] Preston, E.D. "Determination of Latitude, Gravity, and the Magnetic Elements at Stations in the Hawaiian Islands, Including a Result for the Mean Density of the Earth, 1891, 1892. In *Report of the Superintendent of the U.S. Coast and Geodetic Survey for the Fiscal Year Ending June 30, 1893, Part II.* Washington: Government Printing Office, 1895:596.

notes of field surveys[11] indicates that the name was applied, at a minimum, to the cinder cone (i.e., *pu'u*) as a whole and not just to the highest peak or what would generally be considered the summit in English usage. Second, on the early survey maps (i.e., 1884 to 1891 and 1891), the name Kukahau'ula is written to the east of the cluster of cones and is not immediately associated with a particular point. In contrast, the highest point on the mountain on these maps is labeled the "summit" and "summit cone" and the triangulation marker on the northeastern peak of the cluster is labeled "Mauna Kea."

The third argument is that place names attributed to the summit cluster are relatively modern because these cones were not differentiated by name until after the 1920s. The name Pu'u Kea, the northeastern part of cluster, first appears in 1937 when commemorative names, such as Macrae, Douglas and Goodrich, were given to other unnamed cones. The names Pu'u Wekiu for the southernmost cone in the cluster and Pu'u Hau Oki for the westernmost cone were recorded by Forester L.W. Bryan in the 1920s and were officially adopted by the Advisory Committee on Geographic Names in 1974[12]. Another factor suggesting the relatively modern origin of these three names is that all are highly descriptive in nature, particularly in contrast to those older names which tend to be associated with traditional or legendary characters. Pu'u Hau'Oki literally means "frosty peak," Pu'u Kea means "white peak," and Pu'u Wekiu means "summit peak." Finally, from most angles of approach, these three named cones or peaks have the appearance of a single, although uneven and complex, landscape feature. It is only after a more thorough examination of this feature that one, if so inclined, would begin to differentiate particular cinder slopes with their associated crater features. Most early historic accounts of visits to the summit essentially describe the summit as a single feature with some parts being higher than others. This is also reflected in the early survey maps which, through hatch marks, depict the cluster of cones as a single unit. At this time, it can not be known with certainty how Hawaiians during the early historic period and their predecessors would have viewed the cluster or what purposes they may have had to make and name particular distinctions within the cluster. Given the unified appearance of the cluster and the prominence of the name Kukahau'ula, however, it seems reasonable, if not probable, that this name applied to this entire landscape feature, including that which is now called Pu'u Hau Oki.

Another line of evidence indicating the summit cluster was of particular and singular significance can be drawn from the archaeological data. The distribution of known shrine locations essentially radiates, at various distances, outward from the base of the summit cluster. This suggests that the summit cluster could have been the central focus of ritual observances and that part of these observances was to avoid or stop short of this central feature. This is further supported by there being no records, with one possible exception (i.e., a 1935 photograph of a slab and stone mound at the summit peak[13]), of shrines on the summit cluster. The practice of avoiding or staying outside that area of greatest significance is common in many religious observances recorded throughout the world. Thus the summit cluster could have been a focal point of the presumably long journey to the summit region. Avoidance of the summit, or the summit region as a whole, for fear of the spiritual nature of

[11] Boundary Commission Books for Hawaii, Microfilm in Archives of Hawaii, Vol. B:35, 1873. Baldwin, E.D. Field Book 323:55, Survey Office, State of Hawaii, 1891.

[12] Bryan, L.W. Letter to Libert K. Landgraf, December 31, 1973. Department of Planning and Economic Development. Mark, Shelley. Memorandum to Members of Advisory Council on Geographic Names, March 13, 1974, Department of Planning and Economic Development.

[13] Bryan, E.H. *Mauna Kea Here We Come: The Inside Story of an Scientific Expedition*. Honolulu: Privately Published, 1979:35.

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this area may be one explanation for the number of times native Hawaiian guides refused or found excuses not to accompany early historic visitors to the summit. In discussing his tour of Hawaii Island in 1823, missionary William Ellis noted that he was told "numerous fabulous tales relative to its [Mauna Kea] being the abode of the gods, and none ever approach its summit..."[14]

Given our conclusion that Pu'u Hau Oki is part of an historic property, we believe the proposed construction of four to six outrigger telescopes on the site of the W.M. Keck Observatory will have an "adverse effect" both on this historic property and on the summit region which we believe is eligible for inclusion in the National Register as an historic district. In the historic preservation plan we will also be proposing that the summit region of Mauna Kea is eligible for inclusion in the National Register of Historic Places as an historic district because it encompasses a sufficient concentration of historic properties (i.e., shrines, burials and culturally significant landscape features) that are historically, culturally, and visually linked within the context of their setting and environment. Tentatively the boundaries of this district will coincide with the extent of the glacial moraines and the crest of the relatively pronounced change in slope that creates the impression of a summit plateau surrounding the cinder cones at or near the summit (i.e., generally the area above the 11,600 to 12,000 foot contour). The cluster of cones forming the summit, including Pu'u Hau Oki, would be a contributing property to this district. We believe, however, that these "adverse effects" can be mitigated if appropriate measures are adopted. To be in compliance with the Section 106 regulations, these mitigation measures need to be stipulated in a signed Memorandum of Agreement (MOA). The MOA should also address those activities occurring at the stockpiling area which could affect, indirectly, the surrounding areas which are also part of the historic district.

The MOA should be relatively easy to prepare as the DEA has already proposed many of the measures we would find appropriate, including those to be executed during the construction phases and those designated as long-range plans. Descriptions of these measures would need to be slightly reworded to explain how these actions would specifically curtail any further degradation of the summit *pu'u* or the historic district. For example, appropriate measures would include those proposed to stabilize the cinder cone slopes, control the accidental dispersal of debris during and after construction, determine the disposition of excavated material which cannot be reused on site, minimize the visibility of the outrigger observatories within the summit region as well as from a distance, and reduce noise during construction and operation of the observatories. In the case of Puu Hau Oki, mitigation should focus on measures that would prevent or minimize those actions that would further deteriorate the structural and visual integrity (i.e., shape and contour) of the cinder cone and its crater.

The history of the project site given on page VI-1 indicates that 34 feet of earth was removed from the top of the site during the construction of the Keck I telescope. We would concur that this alteration effectively precludes the presence of burials. What isn't clear is the exact history of the 71,700 square feet, apparently the site of Keck II, which was left "in its natural state." The description says that this area was leveled during the construction of Keck II. The process of leveling this area or covering it with excavated material from the Keck I site would not necessarily preclude the possibility of burials because they could lie at moderate depths below the natural surface. The specific history of the northern part of the project area should be clarified and, if ground surfaces still exist that were only superficially altered, then we feel

[14] Ellis, W. *Journal of William Ellis*. 1827 London ed. and 1917 Hawaii ed. Reprint. Honolulu: Advertiser Publishing, 1963:292.

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some provision for dealing with potential burials. These should be included in the MOA for the proposed excavation of the light pipes, junction boxes and tunnels. In the historic preservation plan we are currently preparing, we will be asking that any excavation taking place on the summit cones be subject to testing and/or monitoring. This measure would address the persistent claim that burials were previously disturbed during construction of an observatory and the fact that known and suspected burials are present on other cinder cones in the summit region. Exceptions would be those areas that have been previously altered to such an extent that this degree of alteration would preclude the possibility of remaining burials.

To be in compliance with the 1992 amendments of the NHPA, the federal agency or its designee needs to consult with native Hawaiian organizations on undertakings that could have a potential effect on historic properties which are of religious and cultural significance to them. We suggest that you consider contacting those native Hawaiian groups and individuals who have been identified as having a particular interest in Mauna Kea during preparation of the new Mauna Kea Master Plan.

On another matter, concerns have been raised that this assessment and the pending permit applications may be approved and construction begin before the new Mauna Kea Master Plan has been completed and adopted. We agree it would be preferable to complete the application process after the new Master Plan has been adopted. While we feel there is sufficient information to assess the effects of this project on historic properties, it would be preferable to know that the final decisions were made within the context of the new, long-term development and management plan for the summit region.

Our detailed comments on the DEA can be found in Attachment 1. If you should have any questions about our review comments please contact either Patrick McCoy (692-8029) or Holly McEldowney (692-8028).

Aloha,

DON HIBBARD, Administrator
State Historic Preservation Division

PM:amk

Attachment 1
Detailed Comments on W.M. Keck Observatory Outrigger Telescope Project in the Mauna Kea Science Reserve

Page S-3, para. 7. A number of the mitigation measures proposed to minimize impacts on the arthropod fauna are also applicable to historic preservation concerns. These should be included in the MOA.

Page S-4, para. 2. The term "historic properties" or "historic sites" should be used instead of "cultural remains" to describe the results of the 1982 archaeological survey of the summit area. This more specifically indicates that the survey was to identify archaeological surface features.

Page S-4, para. 3. This paragraph describes the recent survey work done by our office in 1995 and 1997. As written, this paragraph gives the somewhat misleading impression that this recent work to relocate and assess the condition of sites found in 1982 and 1984 took place near areas where telescopes were being constructed. While it is true that none appear to have been disturbed directly by construction activities, almost all are at quite a distance from existing telescopes. Also we would not refer to the 1995 work as "a full reconnaissance survey." It was simply a survey to relocate and assess previously identified historic properties. It should also be mentioned that the sites being assessed are mostly shrines.

Page S-4, para. 5. Some of the commitments made here to reduce the visual impacts of the observatories and associated infrastructure would be appropriate in the MOA. For example, constructing retaining walls to maintain the structure of the cinder cone and its slopes is a mitigation measure that would help maintain the integrity of this historic property. Constructing the retaining walls of natural-colored materials so that they blend with the existing terrain is another appropriate mitigation measure.

Page S-7, Table S-1 and Page II-15, Table 2-1. In this summary table, Section 106 of the National Historic Preservation Act and the accompanying regulations should be listed under federal compliance and not the state or Board of Land and Natural Resources. The State Historic Preservation Office only plays a role in the Section 106 process, it does not implement the process. This law, like that of NEPA, is triggered in this case by the expenditure of federal funds on the project. Chapter 6E.8 is triggered by the project taking place on state land and the involvement of a state agency.

Pages II-11 and II-13 and Page IV-8. These discussions make numerous commitments that would be appropriate in the MOA. The commitment is made to prevent the accidental dispersal of debris from construction and storage sites (Page II-13, para. 9), but the discussion does not address who is responsible for collecting debris and materials that are dispersed despite the best of intentions. Contingency plans for clean-up should be included. Also, the discussion mentions monitoring by the Mauna Kea Support Services and that additional recommendations by the consulting entomologist will be in the construction contract. Additional recommendations may also result from consultations with the native Hawaiian community.

Page III-9, paras. 3 and 4. This "Cultural Resources" section does not really depict the nature and distribution of known historic properties in the summit region or in these areas closest to the proposed project area. We suggest that this section be revised so that the results of the 1982 and 1984 surveys are better represented in the opening paragraph. It should be made clear that the 40 sites identified during those surveys are almost certainly religious shrines and that these surveys were limited geographically. While it is true that pre-construction surveys have not found historic sites in the summit area, some were found during the survey conducted for the VLBA Antenna. The sentence that "No additional sites were located" is also misleading because the more recent surveys have identified a substantial number of addition shrines in the summit region. Although the reports of these surveys have not been completed, a draft report on site characteristics and distribution patterns was submitted to IFA in February 1999. At a minimum these greater numbers should be mentioned. As we mentioned in an earlier comment (Page S-4, para. 3), our field work in 1995 had other objectives and it is somewhat misleading to say these sites were not damaged by telescope construction when the historic sites are located a considerable distances from the observatories. We are also puzzled by the description of the geological attributes of the Mauna Kea Ice Age Reserve in the "Cultural Resources" section. The adze quarry is appropriate in this discussion but it should also be mentioned after the distribution of known shrines.

Page IV-1, para. 5 and Page IV-2, paras. 1 and 2. As discussed in our cover letter, this history of the project area should be clarified as it is not clear if the 71,700 square feet used for the Keck II Observatory has been substantially or only moderately altered.

Page IV-3, para. 5. The potential need to stabilize the cinder cone and its slopes should be addressed in the MOA as should a commitment to maintain the general shape and form of the cone in a manner that blends with the terrain.

Page IV-3, paras. 7 and 8. The issue of drainage and erosion should be addressed in the MOA because the formation of gullies on the cone slopes would affect the integrity of the historic property. While the mitigation proposed may alleviate the problem, the MOA should probably include a provision for the long-term monitoring of their effectiveness in case unforeseen erosion occurs.

Page IV-8 and IV-9, Historical and Cultural Resources. Our comments on this section are similar to those expressed earlier (Page S-4, para. 3; Page III-9, paras. 3 and 4). We feel the known distribution of shrines in the summit region should be given greater prominence than the adze quarry in this context. It should be explicitly stated that the forty known sites are most likely religious shrines. As we have argued in our cover letter, our assessment of historic properties in the project area and the potential effects of the project is substantially different from that which is stated here.

Page IV-9 and IV-10, Aesthetics. A number of the identified issues in this section and proposed mitigation measures should be included in the MOA. This includes potential affects during the construction period and those that are long-range.

APPENDIX B. SHPD ACCEPTANCE LETTER

DAVID Y. IGE
GOVERNOR OF
HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
FIRST DEPUTY

M. KALEO MANUEL
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
KAKUHIHEWA BUILDING
601 KAMOKILA BLVD., STE 555
KAPOLEI, HI 96707

October 29, 2021

IN REPLY REFER TO:
Project No.2021PR00975
Doc. No. 2110SN17
Archaeology

Sam Lemmo, Administrator
Department of Land and Natural Resources
Office of Conservation and Coastal Lands
1151 Punchbowl St. #131
Honolulu, HI 96813
Attn. Rachel Beasley
Email: rachel.beasley@hawaii.gov

Dear Mr. Lemmo:

SUBJECT: **Chapter 6E-8 Historic Preservation Review**
Request for Concurrence with Project Effect Determination
Caltech Submillimeter Observatory Decommissioning Project
Archaeological Assessment Report
Ka‘ohe Ahupua‘a, Hāmākua District, Island of Hawai‘i
TMK: (3) 4-4-015:009

This letter provides the State Historic Preservation Division's (SHPD's) review of the proposed project and the request from the Department of Land and Natural Resources Office of Conservation and Coastal Lands (OCCL) for concurrence with a project effect determination of "no historic properties affected" for the proposed decommissioning of the Caltech Submillimeter Observatory (CSO). The applicant, California Institute of Technology (Caltech), proposes to decommission its 10.4-meter (34 ft) diameter telescope. The SHPD received this submittal on August 16, 2021. The submittal includes the OCCL's cover letter, an HRS 6E Submittal Form, the CSO site map, and an archaeological inventory survey (Barna 2021) titled "*An Archaeological Assessment for the Caltech Submilimeter Observatory Decommissioning Project on Maunakea, TMK (3) 4-4-015:009 (por.), Ka‘ohe Ahupua‘a Hāmākua District Island of Hawai‘i* (Barna, Jan. 2021) conducted in support of OCCL's determination of effect pursuant to HRS Chapter 6E-8.

The Mauna Kea Science Reserve and Hale Pōhaku mid-level facility totals 11,288 acres. The proposed project area is located at 13,350 feet altitude near the summit of Mauna Kea, a plateau surrounded by Pu‘upoli‘ahu, Pū‘uhau‘oki, and Pū‘uwēkiu. It includes the 0.75-acre CSO facility, a 460-meter portion of Mauna Kea Access Road, and the batch plant located downhill (southeast) of the telescope site, which is anticipated to be used as a base yard/staging area. The CSO facility is located within the Astronomy Precinct of the Mauna Kea Science Reserve (TMK: (3) 4-4-015:009), and the majority of the road and base yard/staging area is located outside the Astronomy Precinct but within the Science Reserve. A gravel road extends to the southeast from the telescope facility and connects to the graded batch plant area. Caltech proposes to remove all aboveground and underground CSO components within the CSO site including, but not limited to, the observatory, outbuilding, foundations, cesspool, utilities, and grounding grid.

Project Description
The purpose of the CSO Decommissioning project is to enable Caltech to conclude its use of the site and surrender its sublease while satisfying its obligations, via Sublease H09176 and other agreements, to UH and the State of Hawai‘i. Pursuant to the Decommissioning Plan, a subplan of the Mauna Kea Comprehensive Management Plan, the

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decommissioning of an astronomy facility in the Science Reserve is a multi-step process involving 1) a notice of intent, 2) an environmental due diligence review, 3) a site deconstruction and removal plan, and 4) a site restoration plan.

The submittal indicates that decommissioning includes removing all existing structures above and below ground infrastructure and restoring the site to pre-telescope construction. Existing aboveground structures present on the CSO Site include: the observatory building, an outbuilding, a water pump shed, and electrical equipment cabinets for a generator and transformer. Caltech proposes to remove all aboveground and underground CSO components within the CSO Site including, but not limited to, the observatory, outbuilding, foundations, cesspool, utilities, and grounding grid. The proposed restoration will include: (a) removing fill placed on the lava flow during construction; (b) filling cavities where excavation occurred with a portion of the fill placed on the lava flow during construction of the CSO, which is native to Mauna Kea; and (c) placing fine ash and small rocks, screened from the existing fill material, onto the site. The applicant proposes complete removal of all improvements on the CSO site and full restoration of the site, to the greatest extent possible, to its pre-construction condition.

Findings
A review of our records indicates that this project area has been included in several archaeological investigations. Prior to CSO construction, an archaeological survey was conducted by the B.P. Bishop Museum in support of the observatory's environmental impact statement. No archaeological sites were observed within the CSO project area; however, two shrines (SIHP 50-10-23-16165 and 50-10-23-16165) were located 188 meters and 250 meters, respectively, to the south-southwest of the CSO project. An archaeological inventory survey (Barna 2021) was conducted by ASM Affiliates to determine the possible impacts to historic properties within the project area. The report included the areas of direct effect that includes the 0.75-acre CSO facility, a 460-meter portion of Mauna Kea Access Road, and the batch plant located downhill [southeast] of the telescope site, which is anticipated to be used as a base yard/staging area. In addition, the report identified the area of visual impacts that was based on the 52-foot height of the CSO facility.

No historic properties were identified within the area of direct effect. Thus, pursuant to HAR §13-275-5(b)(5)(A), the negative AIS results are presented in an archaeological assessment (AA) report. The AA report indicates that 11 historic properties documented outside the area of direct effect, but within the area of visual effect, all of which were identified as contributing historic properties to the Mauna Kea Summit Region Historic District (SIHP 50-10-23-26869). These 11 historic properties consist of the following:

Site No. 50-10-23-	Site Type	No. of Features	Feature Types	Distance in meters (m) from Caltech Project Area
16164	Shrine	2	5, possibly 6 uprights	188 m SSE
16165	Shrine	1	2 uprights	250 m SSE
21438	Kūkahau'ula	1	Mauna Kea Summit (TCP)	149 m E
21440	Pu'u Waiau	1	Pu'u (TCP)	1,280 m S
26132	Possible Burial	2	Alignments	1,550 m SSE
26133	Cairn	1	Cairn	1,545 m SSE
26134	Possible burials, possible shrines, Marker/memorial, Unknown function	17	1 terrace, 1 mound/terrace, 4 pavements, 9 mounds, 2 rock piles	1,530 m S
26142	Workshop	1	Lithic Scatter	1,510 meters S
27579	USGS Marker	1	USGS marker	630 m W
27585	Workshop	1	4 adze manufacturing workshops; flakes, hammerstones, cores	2,530 meters SW
28623	Possible burial	4	4 mounds	930 meters SE

The AA report (Barna, Jan. 2021) indicates that the entire project area (direct impact) has been previously impacted by construction activities associated with the construction of the CSO facility. The area is covered with cinder-fill and is understood to be over bedrock. No additional historic properties have been identified within the current

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project area. The report indicates that it is unlikely that any newly identified historic properties exist within the current project area. The report also indicates that while newly identified historic properties are unlikely, new rock constructions identified as "find spots" may be present. The find spots fall under the jurisdiction of the Office of Mauna Kea Management, pursuant to the Mauna Kea Comprehensive Management Plan (Ho'akea 2009).

The AA report (Barna, Jan. 2021) indicates that based on the negative findings in the survey, the CSO Decommissioning Project will have no direct effects on historic properties. The eleven previously identified historic properties (SIHP 16164, 16165, 21438, 21440, 26132, 26133, 26134, 26142, 27579, 27585, and 28623) in the indirect visual viewshed of the CSO facility, and the overall Mauna Kea Summit Region Historic District (SIHP 26869) will benefit from the removal of the above-ground facilities and improve the overall integrity of the eleven (11) sites and the historic district. The report recommends no further historic preservation work is need prior to the start of construction. However, archaeological monitoring is recommended as a precautionary measure to ensure protection of SIHP 21438 (Kūkahau'ula), which is adjacent to the Mauna Kea Summit Access Road and the lower portion of the CSO project area, and as a contingency for the discovery of unanticipated archaeological resources within the project area.

As a part of the draft environmental assessment (DEA) (July 2021) process, the CSO Decommissioning Project conducted outreach to provide information to the public and gather input on the proposed purpose, scope, potential impacts, and recommended mitigation measures for the proposed project. The DEA indicates that extensive consultation was conducted during the first four months of 2018 with government agencies, organizations, and individuals (a list is provided in the DEA). The summary provided in the DEA indicates that the broad public outreach was appreciated, the removal of the telescope was received favorably, with most people feeling the project would have a positive effect. Principle concerns identified during outreach related to the handling of the closure and removal of the cesspool at the CSO Site and residual impact associated with the 2009 hydraulic fluid leak.

In addition to consultation for the DEA, a cultural impact assessment (CIA; Rechtman 2020) was conducted for the proposed project. The CIA indicates that consultation invitations were sent out in June 2018 and a second round of consultation was conducted in July 2020. The AA report (Barna, Jan. 2021) recommends archaeological monitoring as a precautionary measure to ensure protection of Site 21438 (Kūkahau'ula), which is adjacent to the Mauna Kea Summit Access Road and the lower portion of the CSO project area, and as a contingency for the discovery of unanticipated archaeological resources. The CIA recommends that a cultural monitor be present when ground-altering activities are being conducted for the CSO decommissioning. The role of the on-site cultural monitor will be to provide an appropriate cultural orientation to individuals conducting on-site work, and to provide guidance on following cultural protocols during the decommissioning process.

Determination
SHPD concurs with OCCL's project effect determination of "No historic properties affected." SHPD also concurs with the recommendation of **archaeological monitoring for identification purposes** based on the presence of numerous historic properties on Mauna Kea and because surface and subsurface historic properties have been previously identified within the general vicinity including within the project's viewshed.

The AA report (Barna, Jan. 2021) satisfies the requirements of HAR §13-276-5. **It is accepted**. Please send two hard copy of the AIS report, clearly marked FINAL, along with a text-searchable PDF copy of the report and copy of this review letter to the Kapolei SHPD office, attention SHPD Library. Additionally, please upload one text-searchable PDF of the Final report to HICRIS Project No. 2021PR00975 using the Project Supplement option, and a PDF copy to of the report to Lehua.K.Soares@hawaii.gov.

SHPD looks forward to receiving an archaeological monitoring plan (AMP) meeting the requirements of HAR §13-279-4 for review and acceptance prior to start of construction activities for identification purposes during the decommissioning process and initial ground disturbance.

See SHPD website at: http://dlnr.hawaii.gov/shpd/about/branches/archaeology for a list of firms permitted to conduct archaeological work in Hawaii.

Please submit the AMP and associated review submittal fee to SHPD HICRIS Project No. 2021PR00975 using the Project Supplement option.

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SHPD shall notify OCCL when the archaeological monitoring plan has been accepted and project initiation may occur.

Please contact Sean Nāleimaile at (808) 933-7653 or at Sean.P.Naleimaile@hawaii.gov for questions regarding archaeological resources or this letter.

Aloha,

Alan Downer

Alan S. Downer, PhD
Administrator, State Historic Preservation Division
Deputy State Historic Preservation Officer

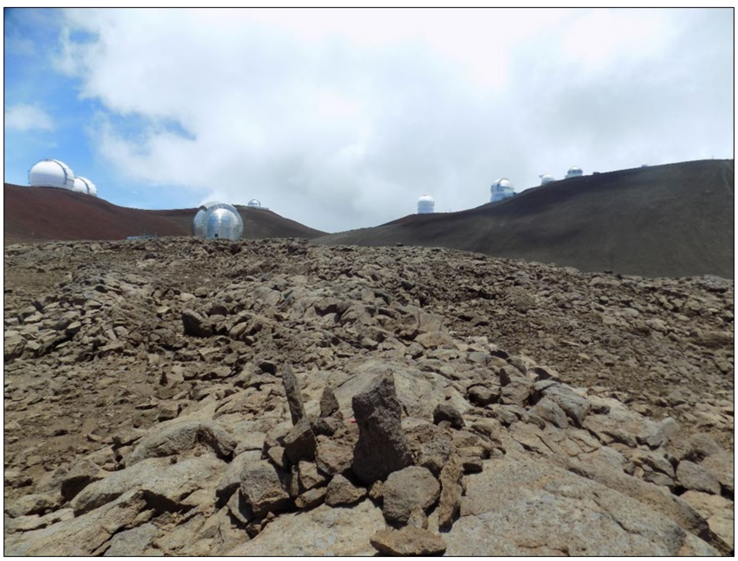
cc: Greg Chun, gchun711@hawaii.edu
Jim Hayes, jim@psi-hi.com
Makena White, makena@psi-hi.com
Ben Barna, bbarna@asmaffiliates.com

Appendix C. Cultural Impact Assessment for the Caltech Submillimeter Observatory Decommissioning Project on Mauna Kea, TMK: (3) 4-4-015:009 (por.), Ka‘ohe Ahupua‘a, Hāmākua District, Island of Hawai‘i

Cultural Impact Assessment for the Caltech Submillimeter Observatory Decommissioning Project on Mauna Kea

TMK: (3) 4-4-015:009 (por.)

Ka'ohe Ahupua'a
Hāmākua District
Island of Hawai'i



Prepared By:

Robert B. Rechtman, Ph.D.

Prepared For:

California Institute of Technology
391 S. Holliston Ave.
Pasadena, CA 91125

November 2021

ASM affiliates
Archaeology • History • Anthropology • Architectural History
Hilo Office: (808) 969-6066 Fax: (808) 443-0065
507-A E. Lanikaula Street, Hilo, HI 96720

Honolulu Office: (808) 439-8089 Fax: (808) 439-8087
820 Mililani Street, Suite 700, Honolulu, HI 96813

ASM Project Number 30400.00

Cultural Impact Assessment for the Caltech Submillimeter Observatory Decommissioning Project on Mauna Kea

TMK: (3) 4-4-015:009 (por.)

Ka‘ohe Ahupua‘a
Hāmākua District
Island of Hawai‘i

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1. INTRODUCTION

At the request of California Institute of Technology (Caltech), ASM Affiliates (ASM) has prepared this Cultural Impact Assessment (CIA) for the Caltech Submillimeter Observatory (CSO) Decommissioning Project on Mauna Kea[1]. The CSO is located on 0.75 acres leased from the State of Hawaiʻi within the Mauna Kea Science Reserve in a portion of TMK: (3) 4-4-015:009 in Kaʻohe Ahupuaʻa, Hāmākua District, Island of Hawaiʻi (Figures 1, 2, and 3). The current study was prepared in support of an Environmental Assessment being prepared for the project under Hawaiʻi Revised Statues Chapter 343. Decommissioning of the CSO will be conducted in accordance with the 2010 Board of Land and Natural Resources approved *Mauna Kea Comprehensive Management Plan: UH Management Areas* (CMP) prepared by Hoʻakea (2009), the *Decommissioning Plan for the Mauna Kea Observatories* (Decommissioning Plan) prepared by Sustainable Resources Group Int'l, Inc. (2010), the site specific *Site Decommissioning Plan for the Caltech Submillimeter Observatory* being prepared by Planning Solutions, Inc. (in prep), and the *Cultural Resources Management Plan for the University of Hawaii Management Areas on Mauna Kea* (CRMP) prepared by McCoy et al. (2009). The current study will also be available to the Office of Maunakea Management (OMKM) for their use in adhering to and enforcing the management action items contained in the CMP and its component sub-plans (i.e., Decommissioning Plan and CRMP).

This CIA was prepared pursuant to Act 50; and in accordance with the Office of Environmental Quality Control (OEQC) Guidelines for Assessing Cultural Impact, adopted by the Environmental Council, State of Hawaiʻi, on November 19, 1997. As stated in Act 50, which was proposed and passed as Hawaiʻi State House of Representatives Bill No. 2895 and signed into law by the Governor on April 26, 2000, "environmental assessments . . . should identify and address effects on Hawaii's culture, and traditional and customary rights . . . native Hawaiian culture plays a vital role in preserving and advancing the unique quality of life and the 'aloha spirit' in Hawaiʻi. Articles IX and XII of the state constitution, other state laws, and the courts of the State impose on governmental agencies a duty to promote and protect cultural beliefs, practices, and resources of native Hawaiians as well as other ethnic groups."

The CSO project area (see Figure 3) is located at 13,350 feet altitude near the summit of Mauna Kea a plateau surrounded by Puʻupoliʻahu, Puʻuhauʻoki, and Puʻuwēkiu (see Figure 1). It includes the 0.75-acre CSO facility, a 460 meter portion of Mauna Kea Access Road, and the batch plant located downhill (southeast) of the telescope site, which is anticipated to be used as a baseyard/staging area. The CSO facility is located within the Astronomy Precinct of the Mauna Kea Science Reserve (TMK: (3) 4-4-015:009), and the majority of the road and baseyard/staging area is located outside the Astronomy Precinct but within the Science Reserve. A gravel road (Figure 4) extends to the southeast from the telescope facility, and connects to the graded batch plant area (Figure 5). Geology in the study area (Figure 6) consists of Laupāhoehoe Volcanics comprising a hawaiitic *ʻaʻā* flow which vented, probably from one of the summit cones, and flowed primarily northwest with one lobe extending to the south (Group 70 1982). McCoy (1982a) reported evidence of glaciation in the form of striations, polish, and boulder erratics in the then-proposed CSO site, and these kinds of features are visible outside the current study area. The occurrence of lava tubes in such *ʻaʻā* flows are reported to be rare. Natural soils in this portion of the summit region are extremely limited and are mapped as Lava flows-Cinder land (labeled 8 in Figure 7), which derives from *ʻaʻā* weathering in place. The natural ground surface slopes generally toward the south; however, grading for the construction of the CSO has created a level, cinder-covered ground surface around the telescope and its outbuilding. Hydrologically, the *ʻaʻā* underlying the CSO is highly permeable. The nearest surface water is at Lake Waiau, located 4,000 feet to the southeast of the CSO facility. Average daytime maximum temperature is 50.1°F and average minimum temperature is 24.8°F. Precipitation averages 8.07 inches per year (Giambelluca et al. 2013) in the form of freezing fog or snow. Above 12,800 feet elevation on Mauna Kea, the ecosystem is classified as Alpine Stone Desert (Gerrish 2013). Vascular plants are very widely scattered and include two native grasses, *Trisetum glomeratum* (*pili uka*) and *Agrostis sandwicensis* (Hawaii bentgrass); and the endemic fern *Asplenium adiantum-nigrum (ʻiwa ʻiwa*).

Located within the boundary of the Mauna Kea Summit Region Historic District (SIHP Site 26869), the CSO project area lies just outside the boundary of the Traditional Cultural Property (TCP) known as Kūkahauʻula (Figure 8). Kūkahauʻula (SIHP Site 21438), along with Puʻulilinoe (SIHP Site 21439) and Puʻuwaiau (SIHP Site 21440) are identified as TCPs in the CRMP (McCoy et al. 2009) and were recognized as such by the State Historic Preservation Division in their acceptance of a series of archaeological studies (McCoy et al. 2010; McCoy and Nees 2009, 2010, 2013) conducted within the Science Reserve and the Mauna Kea Ice Age Natural Area Reserve. Others have suggested that Mauna Kea itself down to the 6,000 foot elevation be designated as a TCP (Maly 1998).

[1] Spellings of Hawaiian place names in this report will follow the spelling conventions of the Hawaii Board on Geographic Names (HBGN) last updated October 2018, which generally follows Pukui et al. (1978).

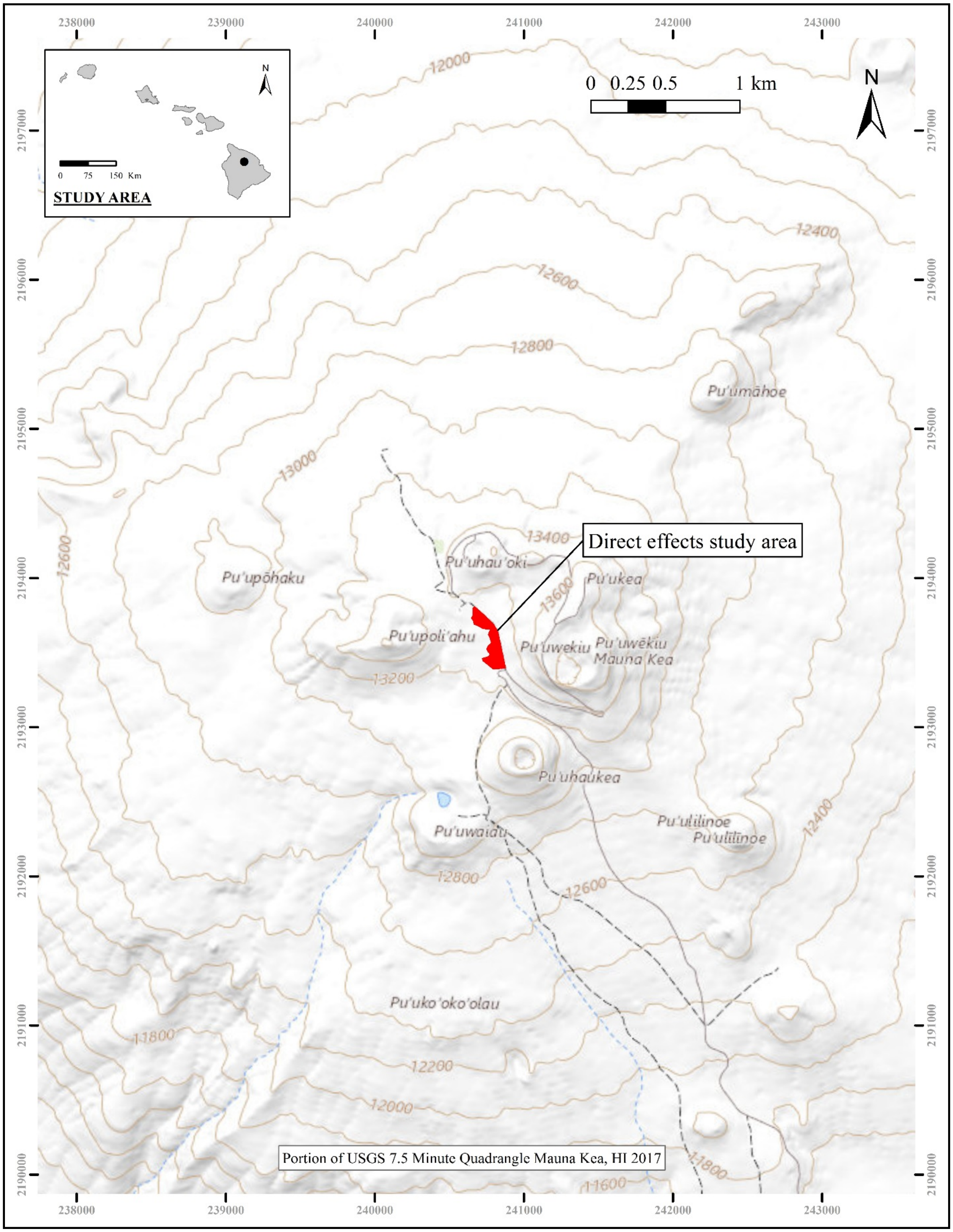


Figure 1. Direct effects study area location.

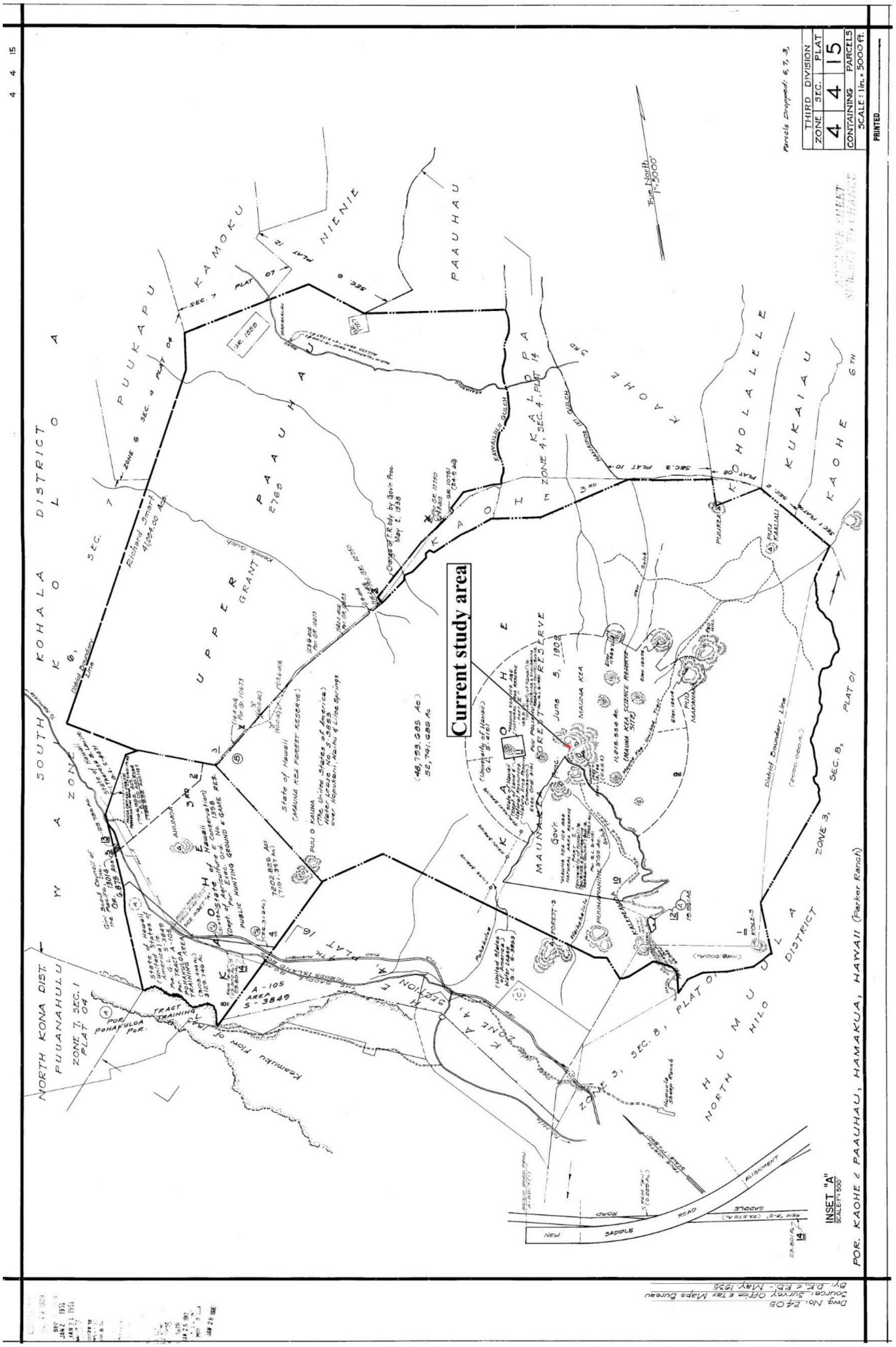


Figure 2. Tax Map Key (3) 7-4-009 showing location of current study parcel (072).

Figure 3. Google Earth™ satellite image showing the direct effects study area (outlined in yellow).

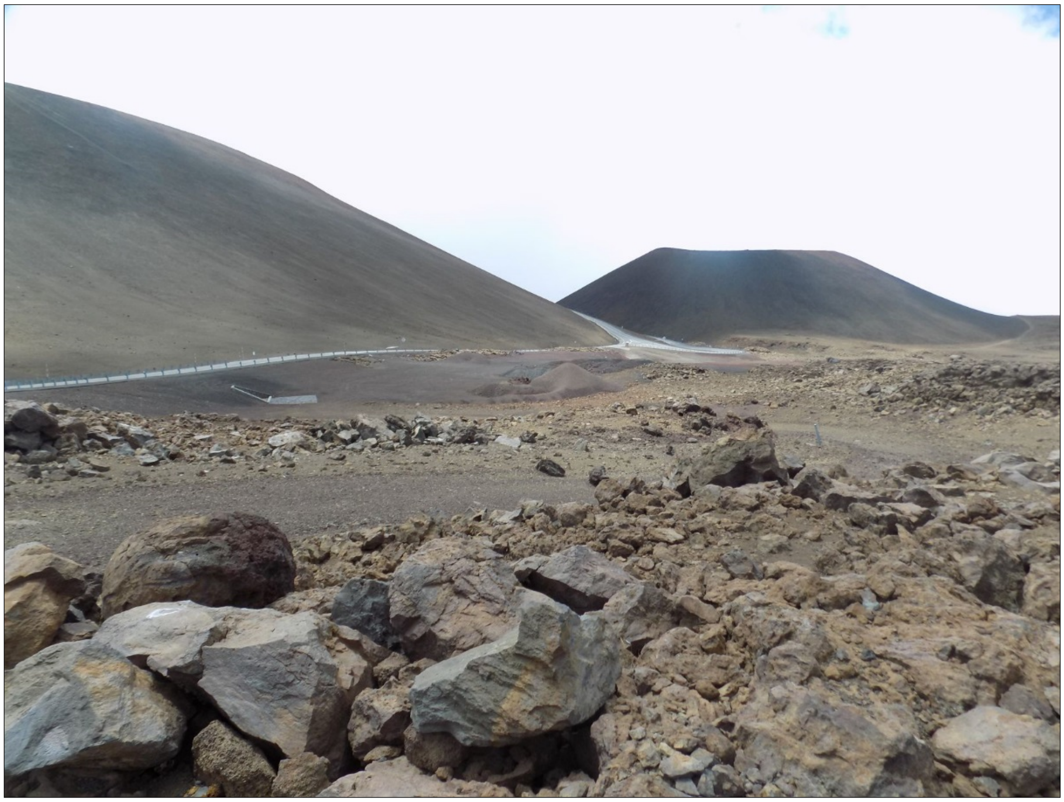


Figure 4. Unpaved access road (foreground) leading to batch plant area, view to the southeast.

Figure 5. Batch plant area, view to the southeast.

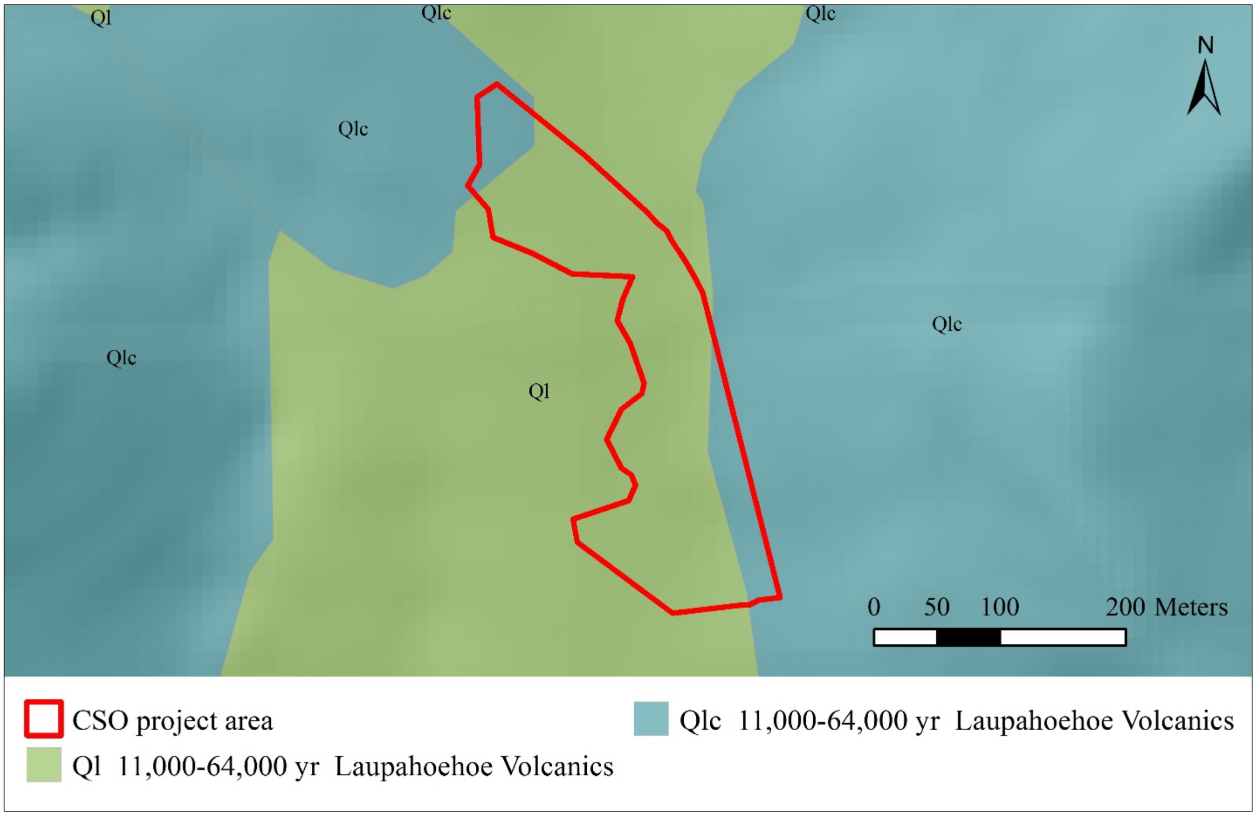


Figure 6. Geology in the CSO project area.

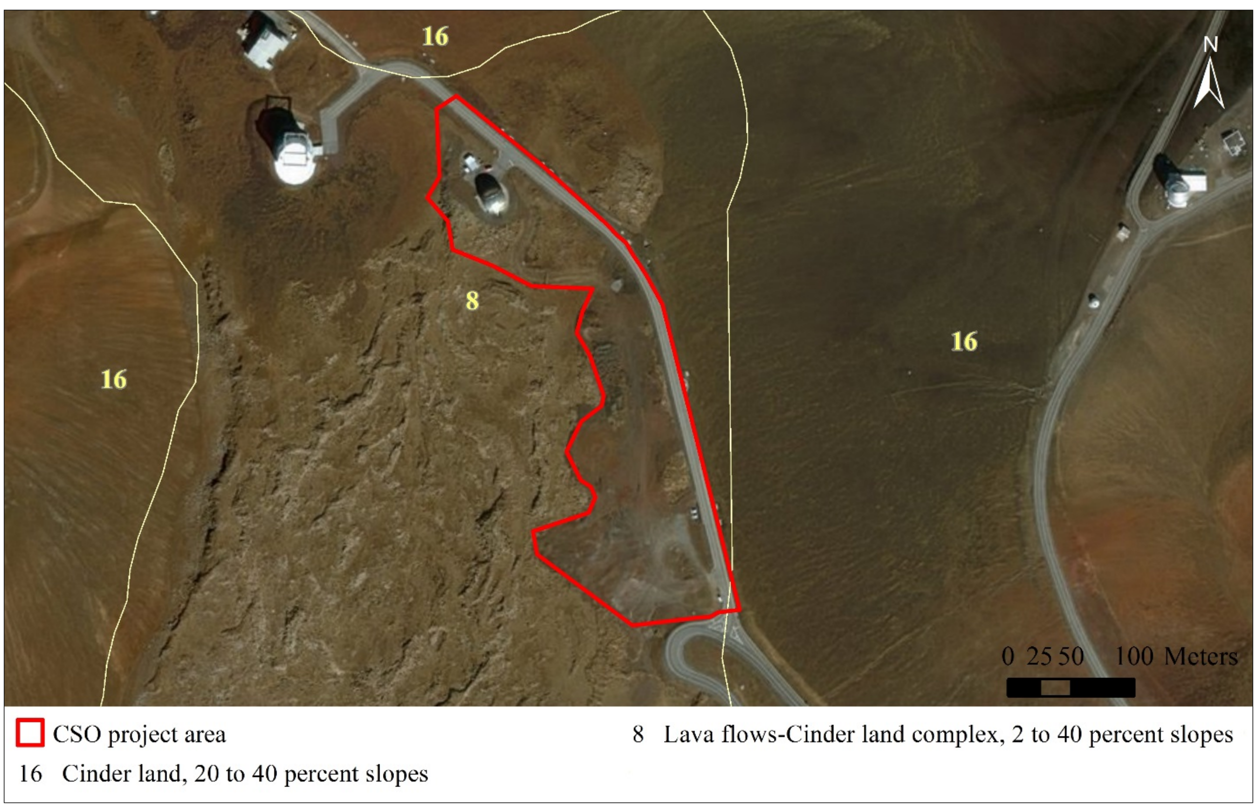


Figure 7. Soils in the CSO project area.

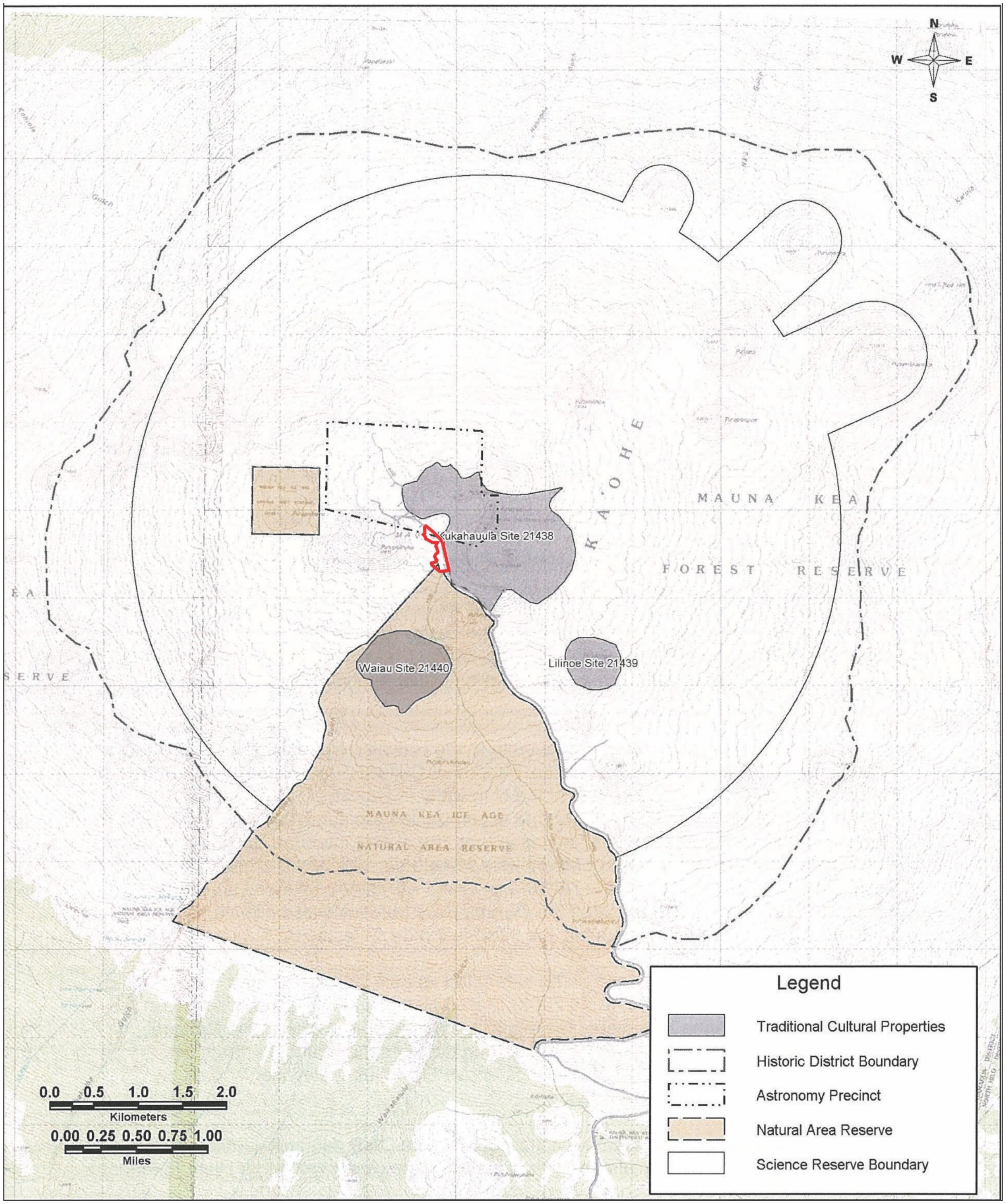


Figure 8. Mauna Kea Summit Region Historic District (Site 26869) and TCP boundaries (after McCoy et al. 2009), CSO project area outlined in red.

The primary objective of the current study is to inform the environmental review process with respect to the most culturally appropriate approach for the proposed decommissioning action. In the most general sense, the action will involve either complete or partial removal of the observatory and related infrastructure; and minimal, moderate, or full environmental restoration. As stated in the Decommissioning Plan (Sustainable Resources Group Int'l, Inc. 2010:1), "[d]ecommissioning refers to a process that results in the partial or total removal of all structures associated with an observatory facility and the restoration of the site, to the greatest extent possible, to its preconstruction condition." The Decommissioning Plan further explains that, "[f]or decision making purposes, the starting point for determining the scope and extent of removal shall be total removal;" and that, [t]he starting point for determining the level to which a site is to be restored shall be total restoration to the pre-construction condition." (ibid:17). The Decommissioning Plan recognizes that complete removal of subsurface infrastructure may be impractical and detrimental to both natural and cultural resources and thus identifies two removal scenarios (complete and partial):

> *Complete infrastructure removal*. Involves removal of the entire facility, including underground utilities, pilings, and foundation to the extent practicable under normal engineering deconstruction practices. Under this scenario, there will be a very large hole in the substrate that needs to be filled prior to restoration efforts. Questions to consider related to filling this hole include what type of material will be used to fill the hole, where will the fill come from, and how stable will the site be. Bringing fill from offsite has the potential to introduce invasive species, and may also be considered by some as culturally inappropriate. Potential future facilities should consider the logistics of stockpiling excavated material for future use in restoration activities. Depending on the type of subsurface foundation material used in the construction of an observatory, removal may be impractical to nearly impossible. In such cases, the foundation should be considered an irreversible impact, left in place, and capped.
>
> *Infrastructure capping*. Capping involves removal of above ground facilities, with or without utilities, and leaves all or part of the underground portion of the facility in place. The remaining infrastructure would be capped with an impermeable material such as concrete and then topped with cinder materials. This scenario would need to ensure that the capped infrastructure was stable and inert, without long-term effects to the surrounding environment.

The Decommissioning Plan also specifies three levels of restoration, all of which "require infrastructure to be removed, including buried utilities and underground structures, unless it is determined that removal would cause irreversible damage to resources." (idib.:26):

> *Minimal restoration* is the removal of all man-made materials and grading of the site, leaving the area in safe condition.
>
> *Moderate restoration* goes beyond minimal to include enhancing the physical habitat structure to benefit the native arthropod community.
>
> *Full restoration* would return the site to its original pre-construction topography, as well as restoring arthropod habitat.

Construction of the CSO facility began in 1983 and was completed in 1987 (Steiger 2009). As designed, ground-level improvements at the CSO facility (Figures 9 and 10) included, in addition to the concrete foundation and telescope dome, a 6,000 square foot paved parking area with truck access and turnaround, and a 14 by 30-foot paved driveway. Below-ground improvements included utility trenches for conduits, auxiliary generator room (outbuilding) and fuel tank, a large underground water tank outside the dome, a sewage holding tank under the dome, and an external cesspool (Steiger 2009). The foundation of the telescope dome (Figure 11) was installed on a graded pad located along an existing unpaved road that led to Pu‘upoli‘ahu and to the James Clerk Maxwell Telescope site (Figure 12). Most of the unpaved road has since been incorporated into the Mauna Kea Summit Access Road (see Figure 3), although a 150-meter long portion of the unpaved road (see Figure 4) remains. The outbuilding is located to the north of the telescope dome adjacent to the paved parking area (Figure 13).

To accomplish the above-stated primary objective, the current study is focused on a review of prior relevant oral-historical interviews along with an attempt to solicit additional interviews specific to the current decommissioning action. Given the substantial body of existing literature that identifies Mauna Kea as a *wahi pana* (storied place) and describes its cultural significance from numerous perspectives, only a summary of the topic is presented in the current document. This is then followed by a review of prior relevant studies and a presentation of prior relevant oral-historical information. The current consultation process is then addressed. The final section of the present document provides an analysis of the proposed decommissioning with respect to appropriateness within a cultural context.

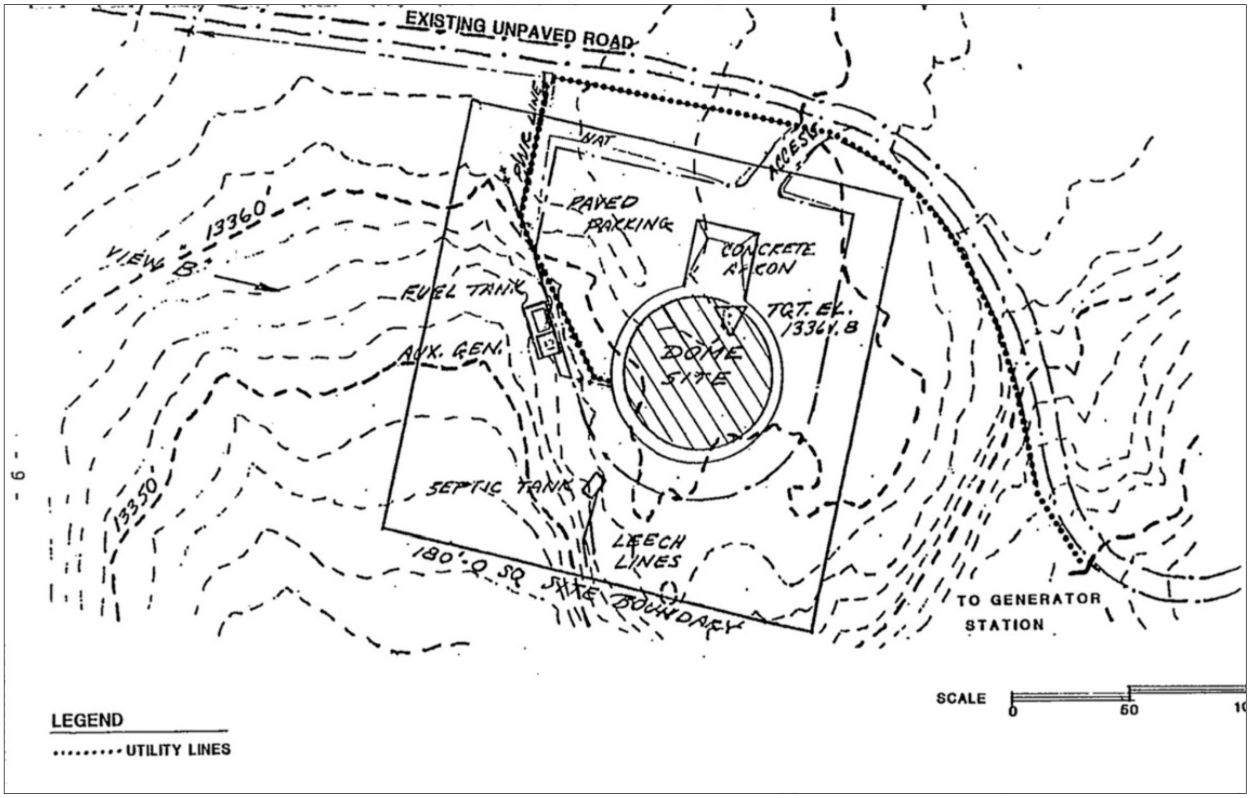


Figure 9. Preliminary plan of CSO facilities (Group 70 1982).

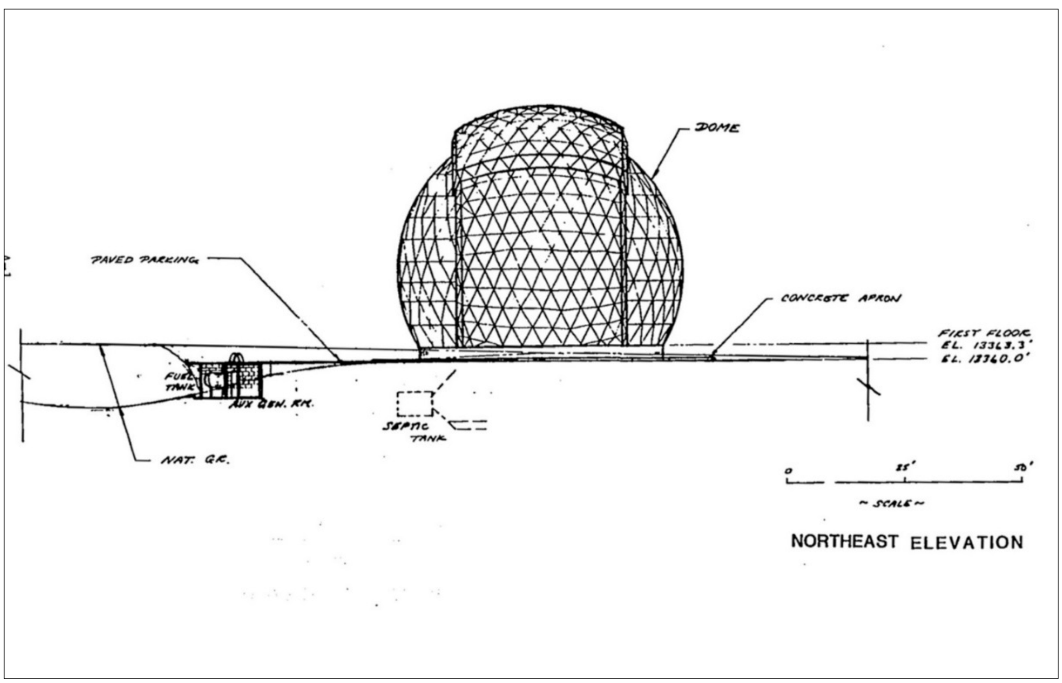


Figure 10. Preliminary elevation of CSO facilities (Group 70 1982).

Figure 11. Observatory and outbuilding foundations in 1985, view to the southwest (Steiger 2009).

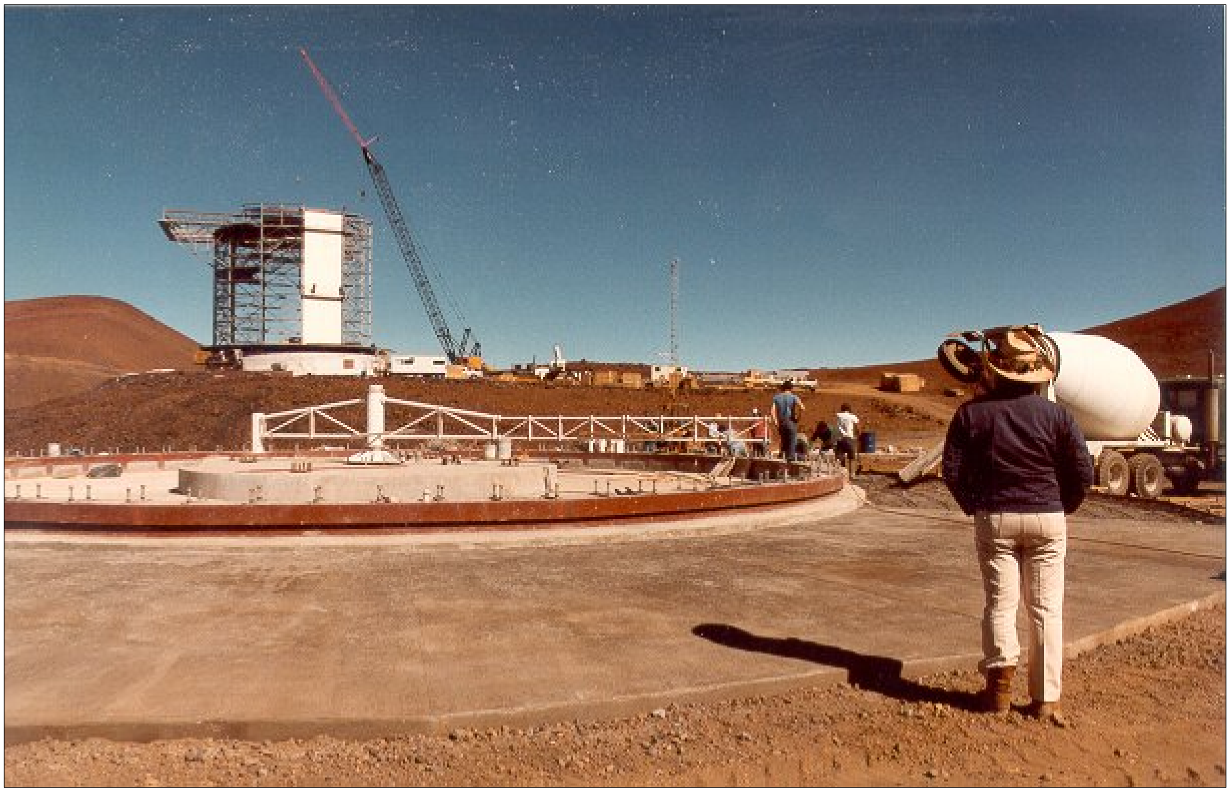


Figure 12. CSO under construction (in foreground), view to the north (Steiger 2009).

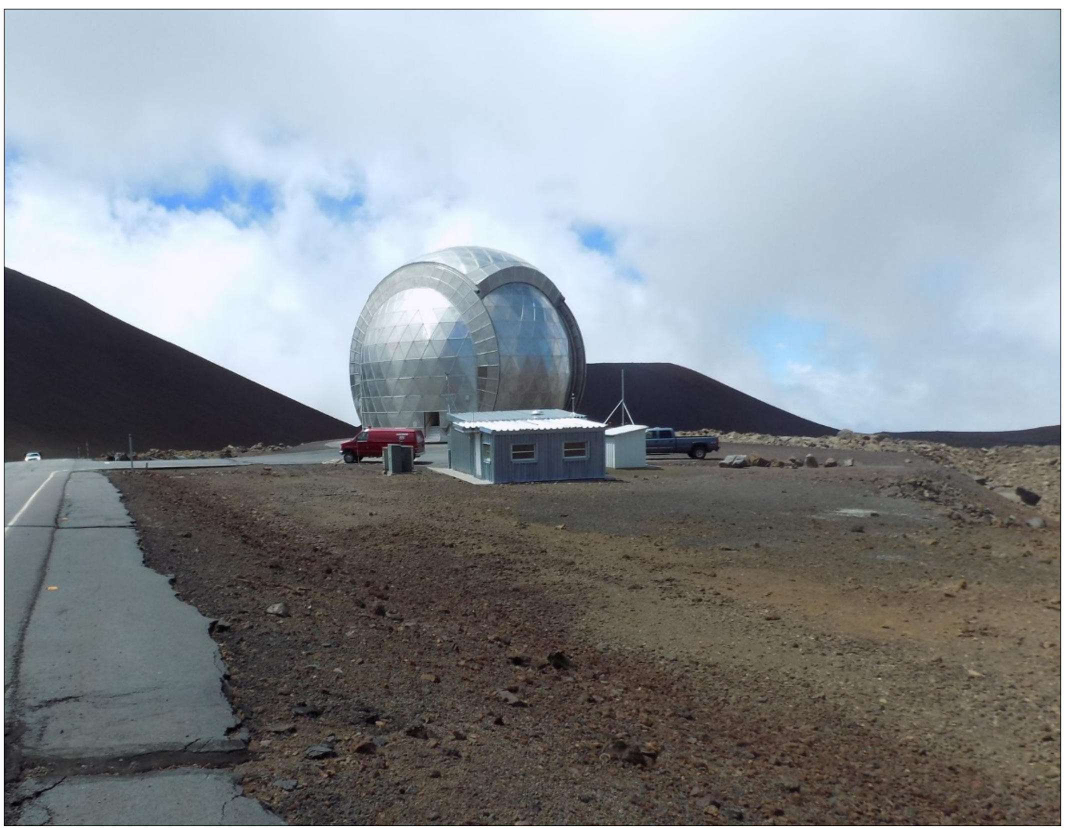


Figure 13. Outbuilding with observatory in background, view to the south.

2. CULTURAL SIGNIFICANCE OF MAUNA KEA

An extensive body of literature describing the significance of Mauna Kea and the summit region has been developed over the past three decades (Kanahele and Kanahele 1997; Lang and Byrne 2013; Langlas 1999; Langlas et al. 1999, Maly 1998, 1999; Maly and Maly 2005, 2006; McCoy et al. 2009; McEldowney 1982; PHRI 1999; Simonson and Hammatt 2010). Through archival research and a compilation of native traditions, historical accounts, and oral-historical interviews, a detailed culture-history of Mauna Kea has been presented that documents a wide range of cultural knowledge and practice associated with the mountain, and more specifically with the summit region and it association with Hawaiian deities. These studies have also recognized Mauna Kea as a landscape that continues to be sacred to contemporary cultural practitioners.

There are the numerous historically documented excursions to Mauna Kea undertaken by Hawaiian *ali‘i* during the nineteenth century. Citing various accounts (Desha 2000; Kamakau 2001 Korn 1958; NASA 2005), de Silva and de Silva (2006) note that several *ali‘i* ascended Mauna Kea for ceremonial reasons. Kamehameha I went to Lake Waiau to pray and leave an offering of *‘awa*, and Ka‘ahumanu made the same journey in 1828 in an unsuccessful attempt to retrieve the *iwi* of her ancestress Līlīnoe. Waiau was also visited by Kauikeaouli in 1830, Alexander Liloliho in 1849, and Peter Young Ka‘eo in 1854. In October of 1882, Queen Emma Kaleleonālani and her royal party ascended Mauna Kea "to demonstrate her lineage and godly connections, and to perform a ceremonial cleansing in the most sacred of the waters of Kāne in Lake Waiau" (Maly and Maly 2005:155). Her journey to the summit was commemorated in several *mele* (songs) and in the names of descendants of its participants, and also physically on the mountain in the form of a pillar of stones observed ten years later by members of a scientific expedition led by W. D. Alexander and E.D. Preston (Maly and Maly 2005). Kanahele and Kanahele also relate that "Emma went to the top of Mauna Kea to bathe in the waters of Waiau. The ceremony was to cleanse in Lake Waiau at the piko of the island." (1997:9).

An explanation of the cultural significance of Mauna Kea was encapsulated in the "Cultural Anchor" prepared by the Edith Kanaka‘ole Foundation contained within the Mauna Kea Comprehensive Management Plan (Ho‘akea 2009:i-ii), and is reproduced in its entirety below:

> **The Birth of Hawai‘i, the Place**
>
> The *ka‘ao*, or sacred records, of the Hawaiian people inform us that the place and space known as Hawai‘i are themselves island descendants of Wākea (sometimes translated as "Sky Father) and Papahānaumoku (literally, the firmament or wide place who gives birth to islands, also referred to as Papa, the creator goddess of Hawai‘i), who conceived and gave birth to the islands of Hawai‘i.
>
> Wākea has many other meanings, two of which speak to the "immensity of our celestial dome." Another refers to "the zone of Kea." Kea refers to "enlightenment" and "progeny." Kea, in simple terms, translates both as "white," a color associated with spiritual enlightenment and the white of "male procreative fluids."
>
> Hawaiian creation chants inform us that Papahānaumoku is an extension of *Haumea* (the-red-sacrifice). *Haumea* is the lava itself, which, after spewing into the atmosphere of Wākea becomes the solid foundation for living. This intercourse between Wākea and Papahānaumoku also produced the mountain child we know today as Mauna Kea. Mauna Kea is both female and male. Mauna Kea's physical manifestations of rock, soil, water and ice, are female attributes; his elevation establishes his maleness, as it brings him closer to the celestial seat of his father Wākea. The equitability of this female-male distribution establishes Mauna Kea as sacred and creates the *piko kapu*, or sacred center, of the island.
>
> **The Birth of Hawai‘i, the Native Being**
>
> The *ka‘ao* also informs us of the birth of Hawai‘i, the native being. Wākea and Papahānaumoku also gave birth to Komoawa and Ho‘ohōkūkalani. Komoawa is both son and high priest of Wākea. Together with Wākea, Komoawa and Ho‘ohōkūkalani established the ancient *kapu* system to regulate human impact on the islands that are the sacred children of Wākea and Papahānaumoku.
>
> Ho‘ohōkūkalani means the "creator of stars." She, in union with Wākea, becomes the celestial womb from which Hawai‘i the original native being takes root, gestates, and is born into a sacred landscape. Yes, the Hawai‘i native, is the descendant of the celestial bodies, the stars themselves. And this moekāpi‘o, or coming together, of Ho‘ohōkūkalani and Wākea, is the primordial union that inserts the Hawai‘i native into the sacred parabola of life between the stars and the earth. The

> *kuahu* or shrine to this "arching reality" is Mauna Kea. At birth, the native being is born into a system that ensured the longevity of the reality of environmental kinship we know as Hāloa.
>
> For this reason, Mauna Kea is sacred. Mauna Kea is where heaven, earth and stars find union. Not just any heaven, but Wākea, not just any earth, but Papahānaumoku, and not just any constellation of twinkling lights, but Hoʻohōkūkalani, whose children descend and return to the stars.
>
> ***Mauna Kea ka Piko o ka Moku***
>
> Mauna Kea is "*ka piko o ka moku*," which means "Mauna Kea is the navel of the island." Understanding the word *piko* may give a deeper understanding of why Mauna Kea is the *piko*, or navel, of the island.
>
> In terms of traditional Hawaiian anatomy, three *piko* can be found. The fontanel is the *piko* through which the spirit enters into the body. During infancy, this *piko* is sometimes "fed" to ensure that the *piko* becomes firm against spiritual vulnerability. For this reason, the head is a very sacred part of the anatomy of the Hawaiʻi native. To injure the head of someone can mark the beginning of a long feud that may go on for generations, hence the need to refrain from insulting the head of a person.
>
> The second *piko* is the navel. This *piko* is the physical reminder that we descend from a very long line of women. The cutting of this *piko* is done with ceremony. And when the stump of the *piko* falls from the belly, the *piko* "relic" is cared for and put in a location that will be beneficial in protecting the future role and function of the child. Should this *piko* be lost or eaten by a rat, it is believed the child will become a wanderer or a thief. Therefore, the bellybutton *piko* was sealed either in rock or sunk to the bottom of the ocean or placed in the lava to protect it. The care of this piko ensured two things: the healthy function of the child and the certification that the child is a product of a particular land base.
>
> The final *piko* is the genitalia. The genitalia are the physical instruments that enable human life to continue. The health of all *piko* ensures that the life of the native person will rest on an axis of spirituality, genealogy and progeny. The absence of one or more *piko* will prevent an entity from becoming whole or complete.
>
> When we understand the three *piko* of the human anatomy, we may begin to understand how they manifest in Mauna Kea. Mauna Kea as the fontanel requires a pristine environment free of any spiritual obstructions. Mauna Kea as the umbilicus ensures a definite genealogy of indigenous relation and function. Mauna Kea as genitalia ensures that those who descend from Wākea (our heaven), Papahānaumoku (our land-base) and Hoʻohōkūkalani (the mother of constellations) continue to receive the physical and spiritual benefits entitled to those who descend from sacred origins.
>
> Thus, Mauna Kea can be considered the *piko hoʻokahi*, the single navel, which ensures spiritual connections, genealogical connections, and the rights to the regenerative powers of all that is Hawaiʻi. It is from this "world navel" that the Hawaiʻi axis emerges.

It is with this epiphenomenal understanding that traditional cultural practices were undertaken on the mountain and continue to take place. Whether traditional or contemporary, cultural practices occur within sacred space as conceived by the practitioners themselves. Mauna Kea can be viewed as a *kuahu* (shrine) to the union of Wākea and Papahānaumoku as well as Wākea and Hoʻohōkūkalani, tying the Hawaiian people to the elder Hawaiʻi, and Hawaiʻi to them. The physical prominence of Mauna Kea as well as its stationing nearest to the heavens holds a spiritual significance for the Hawaiian people, which is expressed in the likening of the mountain to a sacred altar. Ed Stevens, a founder member of Kahu Kū Mauna, and a cultural practitioner with intimate knowledge of Mauna Kea, described the mountain as a physical manifestation of a *lana-nuʻu-mamao*.

Lana-nuʻu-mamao were sacred oracle towers located within *heiau* (places of worship) through which worship and offerings to the gods took place. The tower was comprised of three *kahua* (tiers), the lowest and least restricted being the *lana* where the bestowing of offerings would take place. The second *kahua* was the *nuʻu*, more sacred and reserved for the priests and their attendants. The third and most sacred *kahua* was the *mamao* to which only the high priest and king were allowed to ascend. In consecration of the *heiau* in which it stood, the *lana-nuʻu-mamao* was dressed in white *ʻoloa* (fine tapa) (Malo 1898, 159-176).

When viewing Mauna Kea as a representation of such an altar, several understandings can be reached. Firstly, the mountain like the *lana-nuʻu-mamao*, is a revered medium through which contact is made with the gods. Furthermore, in the three-tiered construct of the *lana-nuʻu-mamao*, physical ascension is tied in with escalating sanctity and restriction. With respect to Mauna Kea, the same pattern of ascension would cause the summit and upper regions of the mountain to be viewed as the *mamao* and to be of the utmost sanctity, thus necessitating the highest levels of restriction.

3. PRIOR STUDIES

The entire summit region of Mauna Kea was subject to archaeological inventory survey fieldwork between 2005 and 2009, the results of which, along with summaries of prior archaeological studies, were presented in four separate AIS reports (Table 1). One of these reports (McCoy et al. 2010) presented results of fieldwork conducted within the Astronomy Precinct, where the CSO facility is located. Another report (McCoy and Nees 2010) included results from the entire Science Reserve (which contains the portion of the current study area outside of the Astronomy Precinct). Two other areas in the summit region were also subject to inventory-level surveys: the Mauna Kea Ice Age Natural Area Reserve (McCoy and Nees 2013), which is located to the south and west of the CSO facility, and Lake Waiau (McCoy and Nees 2009), located to the south of the CSO facility. In addition to these studies, portions of the summit region were included in earlier archaeological reconnaissance surveys. The then-proposed CSO facility site itself was subject to an archaeological survey by the B. P. Bishop Museum (McCoy 1982a) in support of the proposed project's Environmental Impact Statement. No archaeological sites were observed within the planned CSO project area; however, two shrines (Sites 16164 and 16165) located 188 meters and 250 meters, respectively, to the south-southwest of the CSO project area were briefly described in that report.

Table 1. AIS reports for the Mauna Kea Summit Region.

Year	*Author(s)*	*Scope*	*Number of historic properties*
2009	McCoy and Nees	Lake Waiau	41 sites, 1 TCP
2010	McCoy et al.	Astronomy Precinct	6 sites, 1 TCP
2010	McCoy and Nees	Maunakea Science Reserve	263 sites, 2 TCP*
2013	McCoy and Nees	Maunakea Ice Age Natural Area Reserve	109 sites, 1 TCP**

* Includes McCoy et al. (2010) findings. ** Includes McCoy and Nees (2009) findings.

In a later report produced for a larger archaeological reconnaissance of the summit region, McCoy (1982b) provided more detailed descriptions and analyses of Sites 16164 and 16165. And, as part of the Section 106 process for the construction of the Smithsonian Institution Astrophysical Observatory, McCoy (1993) revisited Sites 16164 and 16165 and found them to be located outside the Astronomy Precinct, recommending that they be flagged during construction as a precautionary measure. These two sites are the closest historic properties to the CSO facility. A recent archaeological study (Barna 2018) was conducted of the CSO project area to validate the findings of the prior AIS studies (McCoy 1982a; McCoy and Nees 2010; McCoy et al. 2010); no archaeological resources were identified to exist within the CSO project area.

As a result of the prior archaeological work, the Mauna Kea Summit Region Historic District (Site 26869) was defined and evaluated to be eligible for listing in the National Register of Historic Places under Criteria A, B, C, and D, and was also determined to be significant with respect to Hawai‘i Revised Statues Chapter 6E under Criteria a, b, c, d, and e (McCoy et al. 2010). No contributing elements of the Historic District are located within the CSO Project Area, however the current CSO facility can be seen from eleven contributing elements (archaeological sites) of the Mauna Kea Summit Region Historic District (Table 2) (Figure 14).

Table 2. Sites of the Mauna Kea Summit Region Historic District within the CSO viewshed.

Site no.	*Type(s)*	*Features*	*Type of features*	*Location*
16164	Shrine	2	5, possibly 6, uprights	188 meters SSE
16165	Shrine	1	2 uprights	250 meters SSE
21438	Kūkahau‘ula	1	Mauna Kea Summit (as Traditional Cultural Property)	149 meters E
21440	Pu‘u Waiau	1	Pu‘u (as Traditional Cultural Property)	1,280 meters S
26132	Possible burial	2	Alignments	1,550 meters SSE
26133	Cairn	1	Cairn	1,545 meters SSE
26134	Possible burials, Possible shrine, Marker/memorial	17	1 terrace, 1 mound/terrace, 4 pavements, 9 mounds, 2 rock piles	1,530 meters S
26142	Workshop	1	Lithic scatter	1,510 meters S
27579	USGS Marker	1	1 USGS marker	630 meters W
27585	Workshop	1	4 adze manufacturing workshops; flakes, hammerstones, cores	2,530 meters SW
28623	Possible burial	4	4 mounds	930 meters SE

Barna (2018) also presented a viewshed analysis to assess what affect the removal of the CSO might have on archaeological resources within visual range of the observatory (Figures 14, 15, and 16), and concluded that “the eleven previously-recorded significant historic properties (Sites 16164, 16165, 21438, 21440, 26132, 26133, 26134, 26142, 27579, 27585, and 28623) within the viewshed of the CSO facility, and the Mauna Kea Summit Region Historic District (Site 26869), will experience overall beneficial effects from the removal of the CSO facilities.”

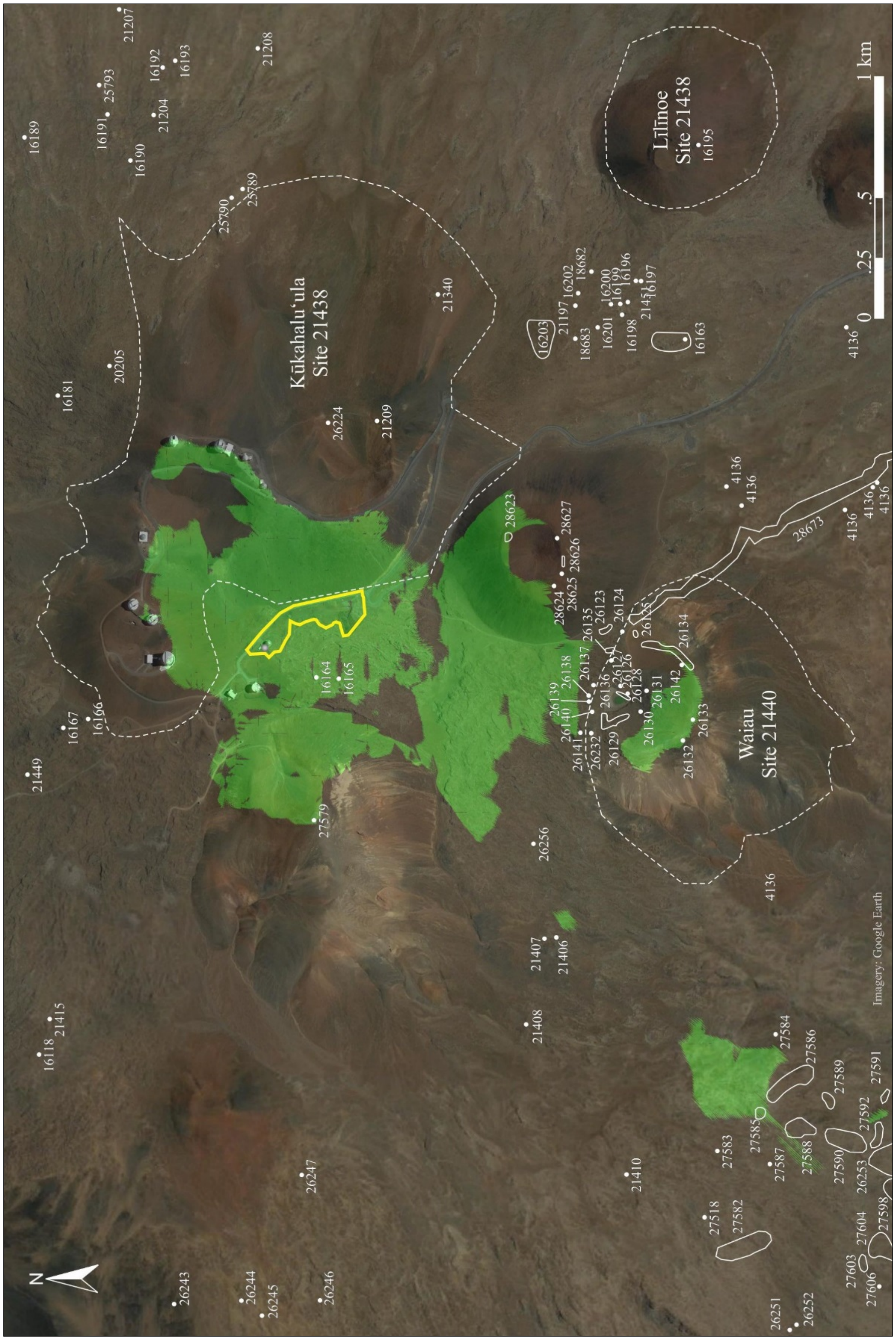


Figure 14. Archaeological sites within the CSO Project Area (outlined in yellow) viewshed (shaded green).

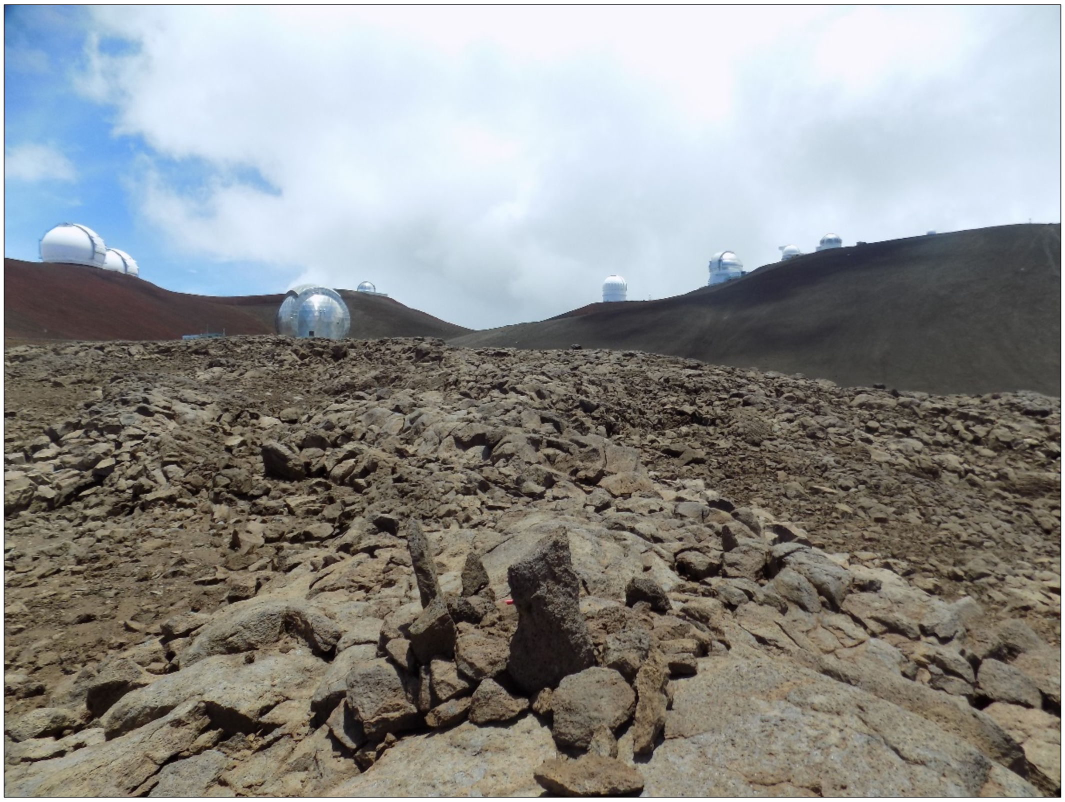


Figure 15. CSO (center left) from Site 16164 (foreground), view to the northeast.

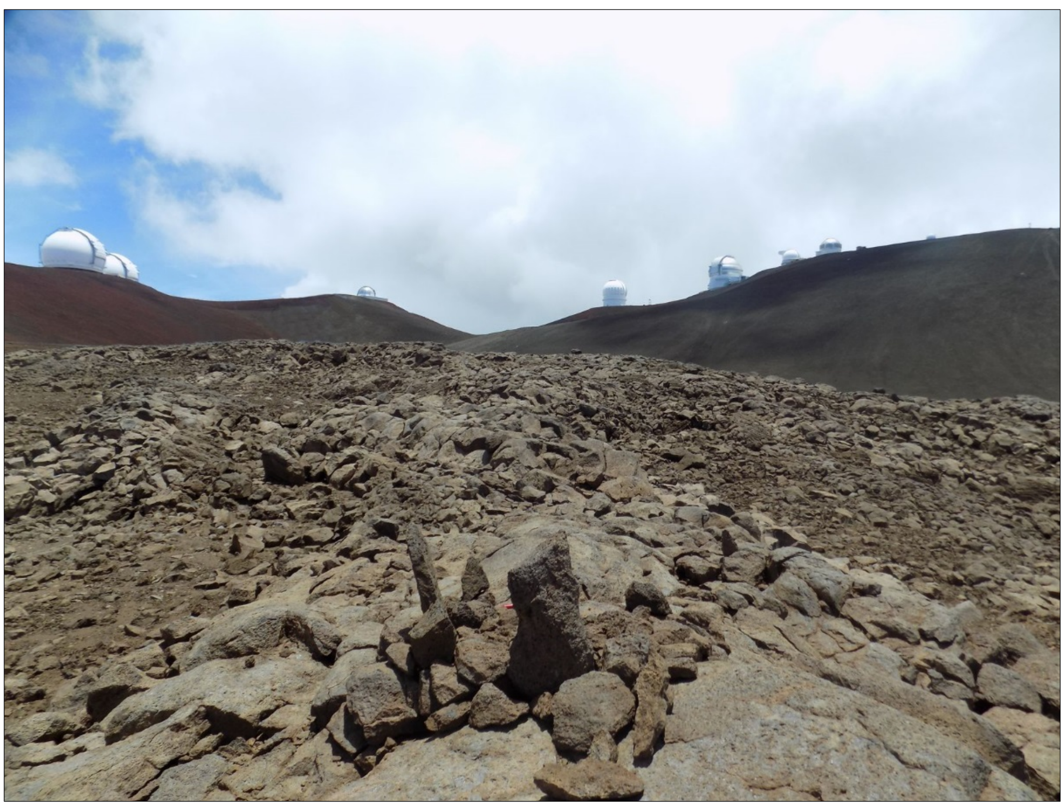


Figure 16. Simulation of CSO site viewed from Site 16164 after full removal, view to the northeast.

In addition to historic properties, archaeological surveys conducted in the summit region since 1997 have been recording "find spots" (called "locations" in early reports). These are anthropogenic features that are either obviously modern (e.g., camp sites with tin cans, pieces of glass and other modern material culture items), or features that cannot be classified with any level of confidence as historic sites because of their uncertain age and function (e.g., a pile of stones on a boulder) (McCoy 1999). During the Science Reserve AIS (McCoy and Nees 2010), 339 find spots were recorded, and 313 find spots were recorded during the Natural Area Reserve AIS (McCoy and Nees 2013). The placement of objects and features classified as "find spots" by cultural practitioners and other visitors to the summit is understood to be ongoing, and management policies regarding construction of new Hawaiian cultural features and constructions considered to be "find spots" is governed by the Comprehensive Management Plan (Hoʻakea 2009). There have been no find spots recorded within the CSO Project Area.

Several cultural studies with oral-historical elements (Table 3) have been conducted that contain information relevant to the current analysis. These studies are briefly summarized below and pertinent information relative to the current study is presented.

Table 3. Prior relevant cultural studies.

Author/Date	***Description***
Kanahele and Kanahele 1997	Social Impact Assessment for the Saddle Road Realignment Project
Langlas et al. 1999	AIS/TCP study for the Saddle Road Realignment Project
Langlas 1999	Supplement to the AIS/TCP study for the Saddle Road Realignment Project
Maly 1998	Archival, Historical Documentary, and Oral-Historic Study
Maly 1999	Archival Literature Review and Oral History Consultation Study
Maly and Maly 2005	Archival, Historical Documentary, and Oral-Historic Study
McEldowney 1982	Ethnographic Background Study for the Mauna Kea Summit Region
NASA 2005	Environmental Impact Statement and NHPS Section 106 Study
PHRI 1999	Cultural Impact Assessment for the Mauna Kea Science Reserve Master Plan
Simonson and Hammatt 2010	Cultural Impact Assessment for the Proposed TMT Observatory

As a part of the Saddle Road Realignment project, Pualani Kanakaʻole Kanahele and Edward L.H. Kanahele conducted a Social Impact Assessment (Kanahele and Kanahele 1997) that described both the traditional cultural significance of the greater saddle road area (including Mauna Kea) as well as the contemporary spiritual milieu in which traditions are interpreted. They also conducted several interviews with native Hawaiians and provided commentary regarding cultural protocols appropriate for the area. They identified the sanctity of Mauna Kea and "strongly recommended" that it not be disturbed by the then proposed Saddle Road project, and further offered if disturbance cannot be avoided "then extreme mitigation should occur." (1997:17).

In 1999 Paul H. Rosendahl, Ph.D., Inc. (PHRI) completed an AIS and TCP study for the Saddle Road Project (Langlas et al. 1999) all in compliance with the Section 106 of the National Historic Preservation Act (NHPA). Several Native Hawaiian organizations were contacted along with twenty-four individuals. Substantial oral interviews were conducted with sixteen individuals with strong connections to the general area. One informant in particular, Henry Auwae, provided a wealth of cultural knowledge regarding the locations of five ritual sites in the vicinity of the proposed road realignment corridors. The Langlas et al. (1999) study provided a comprehensive culture-historical background that included Mauna Kea, but as pointed out by SHPD in their review of the report, lacked an assessment of TCPs on the Mauna Kea that might be affected by the Saddle Road Realignment project. In response, a supplement report was prepared (Langlas 1999), in which several individuals were interviewed specific to their knowledge of cultural places and practices associated with Mauna Kea. Langlas concluded that 'Lake Waiʻau [SIC] and Puʻu Waiʻau [SIC], and the *whole upper zone of the mountain* have been evaluated here as eligible for the National Register of Historic Places." (1999:18, *emphasis mine*).

In 1997, Kepā Maly conducted archival and historical documentary research that included traditional Hawaiian accounts using Hawaiian language newspapers and manuscripts, and *Māhele* records, along with oral-historical interviews. Maly reported that many native Hawaiians expressed feeling "disheartened about the highly visible presence and impact of the telescopes and development on the summit," to which he added:

> As you stand upon Mauna Kea, you must remember that you stand upon sacred ground. Mauna Kea is the piko, and the first-born child of the creative forces of nature that gave birth to all of the islands of Hawaiʻi and the progenitors of the Hawaiian race…Remember, while you stand on this mountain looking heavenward, you have a responsibility to care for your foundation, the mountain itself. In the Hawaiian context, to take the 'right-of-use' naturally meant that you also exercised 'responsibility' for that use. Your responsibility is to assume a role of stewardship for Mauna Kea. (Maly 1998:61)

Two years later, Maly (1999) conducted an oral history and consultation study and archival literature research as part of an update for the Mauna Kea Science Reserve and Hale Pōhaku Complex Development Plan. The study focused on cultural traditions and practices, as well as identifying significant features associated with Mauna Kea for the proper management of these landscapes. As part of this study, Maly conducted twenty-two interviews and included three historic interviews of which Maly both translated and transcribed. All participants, expressed “deeply rooted sentiments” about seeing Mauna Kea and their “spiritual well-being in either viewing, or being on Mauna Kea” (Maly 1999:23). One informant explained that the mountain was so sacred that many did not have a desire to ascend it and added that “one did not need to physically touch the mountain to benefit from its spiritual connection” (Maly 1999:23–24), but by viewing it from afar gave the people spiritual strength. Many expressed a sadness to see observatories from far and ashamed at not halting the desecration of the mountain. Additionally, interviewees stressed the significance of the *pu‘u*, or the cinder-cone hills, and the association with burial sites for the *ali‘i* or ancestors, which they expressed further highlighted the sacredness of the mountain. As a result of consultation, all interviewees commonly expressed their concerns for the number of structures on the mountain and that the mountain be restored to its original condition.

On behalf of the University of Hawai‘i Office of Mauna Kea Management, Kumu Pono Associates (Maly and Maly 2005) undertook archival research to compile a collection of historic records pertaining to the lands surrounding and including Mauna Kea. Building on prior Kumu Pono Associates studies (Maly 1998, 1999) they also conducted additional oral history interviews. This document by far provides the most comprehensive cultural and historical background for understanding the significance of Mauna Kea than does any other literary source. Their review of legendary accounts coupled with nineteenth century writings and firsthand historical accounts paints as undeniable picture of the immense cultural importance of the landscape when taken as a whole. In fact, the Malys’ describe the integrated nature of Mauna Kea’s physical and cultural environment and resources, “with each part contributing to the integrity of the whole cultural, historical, and spiritual setting”. (Maly and Maly 2005:v).

In conjunction with the EIS for the Mauna Kea Science Reserve Master Plan, McEldowney (1982) working for the Bishop Museum prepared an ethnographic background report that was intended to provide a cultural context for interpreting both natural and man-made features of the Mauna Kea landscape. She reviewed numerous published and unpublished sources along with nineteenth century Boundary Commission testimony. While she was able to identify a few traditional practices and places associated with the summit region, she emphasized that much of the activity in the upper mountain area may have been associated with religious practice.

A cultural analysis was part of the NHPA Section 106 study conducted for the Environmental Impact Statement (EIS) for the Outrigger Telescopes at the W.M. Keck Observatory site (NASA 2005). The EIS concluded that installation of the Outrigger Telescopes might result in cumulative cultural impacts to Mauna Kea, but the project proceeded with mitigation measures that were established in the NHPA Section 106 memorandum process. These measures including having both archaeological and cultural monitors present when ground-altering activities were to be conducted. The role of the on-site cultural monitor was both to provide an appropriate cultural orientation to individuals who would be associated with the on-site work, as well as to guide workers during the process to act in culturally sensitive ways.

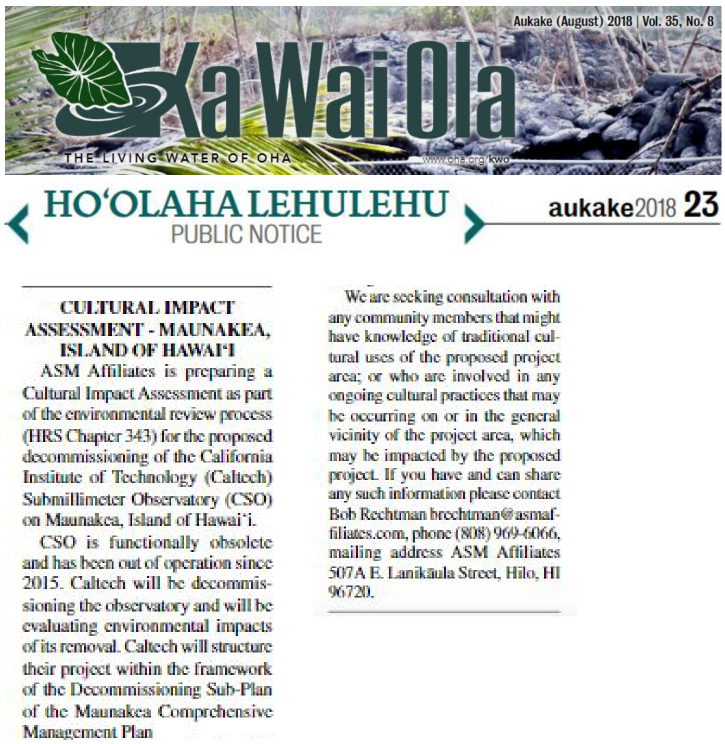
In 1999 Paul H. Rosendahl, Ph.D., Inc. (PHRI 1999) prepared a CIA study to accompany the Mauna Kea Science Reserve Master Plan. It was during this study that the three potential TCPs (Kūkahau‘ula, Pu‘ulilinoe, and Pu‘uwaiau) earlier identified by SHPD were fully discussed, along with four other potential TCPs (Pu‘upoliahu, Pu‘umākanaka and Kaupō, Kūka‘iau–‘Umiko Trail, and Mauna Kea–Humu‘ula Trail). A point attempted to be made by the PHRI (1999) study was that “[t]he basic difference between this indigenous use of the mountain’s sacred summit area for a lithic industry [adze quarry], and the modern day use of the summit for the study of the stars by astronomers is the issues of appropriate protocol and respect.” (1999:47).

In conjunction with the permitting for the proposed Thirty-Meter Telescope, Simonson and Hammatt (2010) prepared a CIA. The document contained a traditional and historical background summary, as well as a summary of prior cultural studies and oral-historical interviews relative to Mauna Kea. Simonson and Hammatt (2010) contacted twenty-eight Hawaiian organizations and thirty-eight community members. They received twenty-five responses and fourteen individuals were interviewed to provide in-depth information, which was reviewed as a part of the current study, and information deemed relevant to the current proposed decommissioning project is present here (see Simonson and Hammatt (2010) for a listing of the organizations and individuals consulted). Three of their interview participants that called for astronomy facilities to be completely removed, suggested that Mauna Kea be repaired to its original condition. Two of their participants discussed the need for decommissioning outdated observatories so that “the summit would be cleared whether it be 20 years or 50 years, whatever time it took . . . there would be no remaining telescope facilities on the summit.” (2010:175). One individual provided comment that the University of Hawai‘i (Institute for Astronomy) would do well if they followed their own cited protocol for sacred places (albeit selectively appropriated from the host [Hawaiian] culture):

E ui no ka ae
Ask permission
E mahalo aku
Give Thanks
E komo me ka hoano
Enter with Reverence
I ka hele aku, e hoomaamau I ka wahi!
When you leave, return it as you found it!

4. CONSULTATION

In an effort to solicit input from concerned Native Hawaiian practitioners and community members, the following public notice was published in the August 2018 edition of *Ka Wai Ola o OHA*; no responses were received:


Aukake (August) 2018 | Vol. 35, No. 8
Ka Wai Ola
THE LIVING WATER OF OHA
www.oha.org/kwo

HO'OLAHA LEHULEHU
PUBLIC NOTICE
aukake2018 23

CULTURAL IMPACT ASSESSMENT - MAUNAKEA, ISLAND OF HAWAI'I

ASM Affiliates is preparing a Cultural Impact Assessment as part of the environmental review process (HRS Chapter 343) for the proposed decommissioning of the California Institute of Technology (Caltech) Submillimeter Observatory (CSO) on Maunakea, Island of Hawai'i.

CSO is functionally obsolete and has been out of operation since 2015. Caltech will be decommissioning the observatory and will be evaluating environmental impacts of its removal. Caltech will structure their project within the framework of the Decommissioning Sub-Plan of the Maunakea Comprehensive Management Plan

We are seeking consultation with any community members that might have knowledge of traditional cultural uses of the proposed project area; or who are involved in any ongoing cultural practices that may be occurring on or in the general vicinity of the project area, which may be impacted by the proposed project. If you have and can share any such information please contact Bob Rechtman brechtman@asmaffiliates.com, phone (808) 969-6066, mailing address ASM Affiliates 507A E. Lanikāula Street, Hilo, HI 96720.

Additionally, consultation invitation letters (dated June 8, 2018) were mailed and emailed to twenty-three individuals and organization (Table 4) that have self-identified as having cultural concern for Mauna Kea, and all of whom filed as intervenors in the recent Thirty-Meter Telescope (TMT) contested case hearing. The text of the letters read as follows.

Aloha e :

As I am sure you are aware, California Institute of Technology (Caltech) is planning to decommission its telescope facility (Caltech Submillimeter Observatory–CSO) located within astronomy precinct of the University of Hawai'i-managed science reserve at Kūkahau'ula in the summit region of Mauna Kea. CSO is functionally obsolete and has been out of operation since 2015. Caltech will structure their project within the framework of the Decommissioning Sub-Plan of the Maunakea Comprehensive Management Plan; and to that end, there should be a protocol established for telescope decommissioning that is both environmentally sound and culturally appropriate.

Caltech has retained ASM Affiliates to prepare a Cultural Impact Assessment related to this, the first Mauna Kea telescope decommissioning project. As a part of our study, I humbly invite you to participate with me; I truly believe that we have an opportunity to shape this process in an appropriate and proper way that can then be used to guide future telescope decommissioning projects. Together we can make this first, the best that we can!

Please contact me by mail, email, or phone (507A E. Lanikaula St., Hilo HI 96720; brechtman@asmaffiliates.com; 808-969-6066).

Me ka ha'aha'a,

Bob Rechtman, Ph.D.
Principal Investigator

Table 4. Individuals and organizations sent consultation request letters.

Name	*Responded*	*Consented*
Joseph Kualii Lindsey Camara	no	n/a
B. Pualani Case	no	n/a
Clarence Kukauakahi Ching	no	n/a
Harry Fergerstrom	yes	yes
Flores-Case ʻOhana (E. Kalani Flores)	yes	no
William Freitas	no	n/a
Cindy Freitas	no	n/a
KAHEA (Yuklin Aluli, Esq.)	yes	no
Tiffnie Kakalia	no	n/a
Kalikolehua Kanaele	no	n/a
C. M. Kahoʻokahi Kanuha	no	n/a
Brannon Kamahana Kealoha	no	n/a
Mehana Kihoi	no	n/a
Glen Kila	no	n/a
Maelani Lee	yes	no
Paul K. Neves	no	n/a
Kealoha Pisciotta	no	n/a
PUEO (Lincoln Ashida)	no	n/a
J. Leinaʻala Sleightholm	no	n/a
Stephanie-Malia Tabbada	no	n/a
The Temple of Lono (Lanny Alan Sinkin)	no	n/a
Dwight J. Vicente	no	n/a
Crystal F. West	no	n/a

Four responses were received from the letter and only one individual accepted the invitation to participate. Yuklin Aluli representing KAHEA responded via email dated June 8, 2018 that “I will be sending your letter on to Kahea’s board, their appeals counsel Richard Wurdeman, and co-counsel Dexter Kaiama. Mahalo, Yuklin.” No further communication was received from KAHEA.

E. Kalani Flores (on behalf of the Flores-Case ʻOhana) responded via email on July 3, 2018 with:

> Aloha e Bob,
>
> What type of consultation is being requested for this project? Also, do you have the scope of the decommissioning plan?
>
> A hui hou, E. Kalani Flores

To which the following reply was offered on July 6, 2018:

> Kalani, mahalo for responding.
>
> I am preparing a Cultural Impact Assessment to accompany the HRS Chapter 343 environment assessment for the decommissioning. The consultation will be to get manao from affected groups and individual about how to avoid impacting cultural resources, practices, and beliefs during the removal of the CSO. Through consultation, I am also seeking input about the entire decommissioning process, including everything from correct cultural protocols initiating the project, to proper practices during the deconstruction, to how the landscape should be restored when the observatory is gone.
>
> I do not believe that there is a finalized scope (I have seen several alternatives proposals) for the decommissioning of the CSO; that is what will be analyzed during the environmental review process.
>
> I am hoping that cultural consultation will ultimately shape the scope of the decommissioning plan!
>
> Please reach out to me so that we can set up a time to meet and discuss. You can call me on my cell anytime (808) 896-3707. Regards,

No further communication was received from E. Kalani Flores.

In an email dated June 11, 2018, Maelani Lee responded:

> Aloha e Bob,
>
> Did you contact any cultural practitioners yet regarding this issue? Did you contact Pua Case? Yes, I think we should work together on this and I can let Hawaiians know to attend as well. Please let me know what you need from me and how I can be of any help.
>
> Mahalo,
>
> Maelani Lee

To which the following was replied:

> Thank you so much for getting back to me. Yes I have contacted Pua as well as all of the folks involved in the opposition to TMT as well as others. I am so happy that you are willing to participate, I will let you know soon about any meetings that might be scheduled to discuss the decommissioning process.
>
> Aloha,

Follow up attempts to contact Maelani were unsuccessful.

Harry "Hank" Fergerstrom initially responded via email, which was followed up by a telephone conversation where he provide his *mana'o* concerning the CSO decommissioning process. First and foremost, Hank was emphatic that every element of the CSO facility, above and below ground level, should be removed for the project to be *pono*. He expressed concerned about too much activity taking place within sacred space and suggested that only one project at a time should occur in the summit region, and that the extent of activity for that project should be kept to a minimum. Hank further recommended that cultural protocols be developed in consultation with practitioners, to act as a guide for behavior and activity during the decommissioning process.

On July 5, 2019, Robert B. Rechtman, Ph.D. was contacted by Jimmy Medeiros, Sr., who had responded to an earlier invitation to consult on this project. Mr. Medeiros indicated that he was a recognized descendant for burial sites in Kaohe Ahupua'a, Hāmākua and that he has long been involved in such issues. When asked about his thoughts on the CSO decommissioning project, he was clear that all of the extant elements of the observation facility should be "completely gone." With respect to restoration of the land following removal, he stated that the "place should be restored as much as can." Mr. Medeiros suggested that the demolition and restoration work should be subject to cultural monitoring, and he requested to be kept informed as he wanted to "stay involved as the process moves forward." A second, in person consultation was conducted with Mr. Medeiros on July 17, 2019 in which he reiterated that the entire above-ground expression of the observatory should be removed and as much of the subsurface infrastructure as possible. He stated that the ground surface should be restored as much as possible to pre-observatory conditions. He expressed concern that all contaminated ground material that may be identified should be removed from the mountain. He again requested that he be included in the decommissioning process as it moves forward, offering his services as a cultural monitor.

At the request of OMKM, Robert B. Rechtman Ph.D., reached out to PUEO (Perpetuating Unique Educational Opportunities for Hawai'i) board member Richard Ha to invite his participation in the consultation process. Mr. Ha was contacted via telephone and he declined participation, instead deferring to PUEO President Keahi Warfield, as well as Kalepa Babayan (Kahu Kū Mauna member). Mr. Ha said he would forward contact information along to Mr. Warfield, but to date no response has been received. Several independent attempts to contact Mr. Warfield have been unsuccessful.

The Office of Hawaiian Affairs (OHA) West Hawai'i branch was contacted for consultation and the office coordinator (Shane Palacat-Nelsen) explained that in his OHA capacity he had no comment as OHA was engaged in a lawsuit with the University with respect to the management of Mauna Kea. He also indicated that he was a member of Kahu Kū Muana and his comments on the project were and continue to be delivered through that committee. Mr. Palacat-Nelson referred ASM to contact Keola Lindsey at the main OHA office on O'ahu for official comments. Mr. Lindsey was contacted and related that if OHA was interested in consulting, they would get back to me. No response from OHA has been forthcoming.

On December 11, 2018, Robert B. Rechtman Ph.D. attended a meeting of Kahu Kū Mauna at which proposed decommissioning alternatives were presented. While all members agreed that total removal and restoration would be the best option, they did leave open the possibility for considering retaining the CSO outbuilding, to be repurposed for OMKM emergency operation use; currently there is no such facility available to the Ranger staff within the Astronomy Precinct, and reusing this structure would be preferable to any potential new construction. In a follow-up meeting with Kahu Kū Mauna on February 12, 2020, and as reiterated in a written correspondence (Palacat-Nelson 2020), Kahu Kū Mauna stresses the importance of acknowledging that "there is a diversity of perspectives regarding the sacredness of Maunakea and some Native [sic] Hawaiians do not view Maunakea as sacred." The current author recognizes that native Hawaiians are not monolithic in their views, and that there may be a multitude of opinions regarding the sanctity of Mauna Kea; however, with respect to conducting a meaningful CIA, it is the *manaʻo* from individuals and organizations that are *maʻa* to traditional cultural resources and practices, and regard such as sacred or significant, that will inform the identification and assessment process. Kahu Kū Mauna requested that a "wider net" be cast to obtain additional consultation.

Peter Young (of Hoʻokuleana LLC) met with Pua Kanahele and Noe Noe Wong Wilson on February 7, 2020 to discuss the decommissioning of CSO. Pua Kanahele and Noe Noe Wong Wilson have been identified as among the leadership of the *Ku Kiaʻi Mauna* on Mauna Kea; however, both noted that they were speaking of their own personal positions and not speaking on behalf of the *Ku Kiaʻi Mauna*. In the meeting the five alternatives of the EA were discussed, and without hesitation and with firm conviction, both noted that any alternative that retains the outbuilding was not acceptable, and that the only viable alternative from a cultural perspective is for the Total Removal of all manmade improvements and the Full Restoration of the site. Alika Desha, a *Nā Aliʻi* with the Royal Order of Kamehameha I was present during the meeting, and while mostly silent, he was in agreement with their position.

A second round of consultation letters were distributed dated July 7, 2020 and sent to the fourteen Native Hawaiian organizations listed in Table 5 below.

Table 5. Organizations sent second round of consultation request letters.

Name	*Responded*	*Consented*
Kohala Hawaiian Civic Club	yes	yes
Waimea Hawaiian Civic Club	no	n/a
Hawaiian Civic Club of Laupāhoehoe	no	n/a
Nā Wahine O Kamehameha	no	n/a
Queen Liliʻuokalani Trust	no	n/a
Kailapa Community Association	no	n/a
Piʻihonua Hawaiian Homestead Community Association	yes	no
Laʻiʻōpua 2020 Association	yes	yes
South Kohala Hawaiian Civic Club	no	n/a
Kona Hawaiian Civic Club	no	n/a
Hawaiian Civic Club of Kaʻū	no	n/a
Royal Order of Kamehameha, Māmalahoa	no	n/a
Waimea Hawaiian Homesteaders' Association	no	n/a
Keaukaha Community Association	no	n/a

Three responses were received from this second round of attempted consultation. On July 20, 2020 Ronald Kodani of the Piʻihonua Hawaiian Homestead Community Association called the ASM office and related that his organization had no cultural input to offer. Velda "Napua" Akamu, President of the Kohala Hawaiian Civic Club responded in the affirmative to the request for consultation in an email dated July 13, 2020; and on July 17, 2020 participated in a telephone interview.

Mrs. Akamu was raised on Hawaiʻi Island in the Kohala area, and as a youth in the 1960s would travel to Mauna Kea as part of school field trips, where they "would walk up the mountain," it was during those visits that she developed her spiritual and cultural attachment to the Mauna that she now shares with her son as they visit Mauna Kea. She considers the mountain sacred space and it is her tradition to request assistance from *kūpuna* through chant and prayer when in that space. When presented with the various alternatives to the removal and restoration of the observatory, she responded that the only viable option from a cultural perspective, is complete removal and restoration of the landscape. When asked specifically about the removal activities, Napua indicated that care should be taken to not harm any other cultural assets and recommended that guidance be sought from within the group of "protectors" with respect to cultural protocols to be implemented during the decommissioning activities.

On September 5, 2020, Kawehi Inaba, President of Laʻiʻōpua 2020, responded by email expressing an interest in participating in the consultation process, and a telephone consultation ensued that same day. Similar to others that were consulted, Mrs. Inaba expressed that the only acceptable option from her cultural perspective would be the complete removal of the observatory facility and as much environmental restoration as would be feasible.

5. IDENTIFICATION AND MITIGATION OF POTENTIAL CULTURAL IMPACTS

The OEQC guidelines identify several possible types of cultural practices and beliefs that are subject to assessment. These include subsistence, commercial, residential, agricultural, access-related, recreational, and religious and spiritual customs. The guidelines also identify the types of potential cultural resources, associated with cultural practices and beliefs that are subject to assessment. Essentially these are natural features of the landscape and historic sites, including traditional cultural properties. A working definition of a traditional cultural property is provided.

> "Traditional cultural property" means any historic property associated with the traditional practices and beliefs of an ethnic community or members of that community for more than fifty years. These traditions shall be founded in an ethnic community's history and contribute to maintaining the ethnic community's cultural identity. Traditional associations are those demonstrating a continuity of practice or belief until present or those documented in historical source materials, or both.

The origin of the concept of traditional cultural property is found in National Register Bulletin 38 published by the U.S. Department of Interior-National Park Service. "Traditional" as it is used, implies a time depth of at least 50 years, and a generalized mode of transmission of information from one generation to the next, either orally or by act. "Cultural" refers to the beliefs, practices, lifeways, and social institutions of a given community. The use of the term "Property" defines this category of resource as an identifiable place. Traditional cultural properties are not intangible, they must have some kind of boundary; and are subject to the same kind of evaluation as any other historic resource, with one very important exception. By definition, the significance of traditional cultural properties should be determined by the community that values them.

It is however with the definition of "Property" wherein there lies an inherent contradiction, and corresponding difficulty in the process of identification and evaluation of potential Hawaiian traditional cultural properties, because it is precisely the concept of boundaries that runs counter to the traditional Hawaiian belief system. The sacredness of a particular landscape feature is often cosmologically tied to the rest of the landscape as well as to other features on it. To limit a property to a specifically defined area may actually partition it from what makes it significant in the first place. However offensive the concept of boundaries may be, it is nonetheless the regulatory benchmark for defining and assessing traditional cultural properties. As the OEQC guidelines do not contain criteria for assessing the significance for traditional cultural properties, this study will adopt the state criteria for evaluating the significance of historic properties, of which traditional cultural properties are a subset. To be significant the potential historic property or traditional cultural property must possess integrity of location, design, setting, materials, workmanship, feeling, and association and meet one or more of the following criteria:

(a) Be associated with events that have made an important contribution to the broad patterns of our history;

(b) Be associated with the lives of persons important in our past;

(c) Embody the distinctive characteristics of a type, period, or method of construction; represent the work of a master; or possess high artistic value;

(d) Have yielded, or is likely to yield, information important for research on prehistory or history;

(e) Have an important value to the native Hawaiian people or to another ethnic group of the state due to associations with cultural practices once carried out, or still carried out, at the property or due to associations with traditional beliefs, events or oral accounts—these associations being important to the group's history and cultural identity.

While it is the practice of the DLNR-SHPD to consider most historic properties significant under Criterion (d) at a minimum, it is clear that traditional cultural properties by definition would also be significant under Criterion (e). A further analytical framework for addressing the preservation and protection of customary and traditional native practices specific to Hawaiian communities resulted from the *Ka Pa'akai O Ka 'Āina* v Land Use Commission court case. The court decision established a three-part process relative to evaluating such potential impacts: first, to identify whether any valued cultural, historical, or natural resources are present; and identify the extent to which any traditional and customary native Hawaiian rights are exercised; second, to identify the extent to which those resources and rights will be affected or impaired; and third, specify any mitigative actions to be taken to reasonably protect native Hawaiian rights if they are found to exist.

The analysis presented below is unlike typical cultural assessments in that there is no disputing that the decommissioning of an observatory facility within the Astronomy Precinct on Mauna Kea would have a positive cultural impact. What is up for review and discussion in this analysis is the identification of those aspects of the decommissioning that could diminish or reverse the positive impact, and the measures that can be taken to avoid or mitigate any potential negative effects.

It was a conclusion of the companion archaeological study (Barna 2018) that the Caltech Submillimeter Observatory Decommissioning Project on Mauna Kea will have no direct effect on any historic property; and with respect to indirect effects, the eleven previously-recorded significant (collectively under Criterion (a), (b), (c), (d), and (e)) historic properties (Sites 16164, 16165, 21438, 21440, 26132, 26133, 26134, 26142, 27579, 27585, and 28623) within the viewshed of the CSO facility, and the Mauna Kea Summit Region Historic District (Site 26869; significant under Criterion (a), (b), (c), (d), and (e)), will experience overall beneficial effects from the removal of the CSO facilities. For these sites, the removal of the above-ground facilities will partially restore the appearance of the summit as it was prior to the construction of the CSO; resulting in an enhancement of the integrity of setting, feeling, and association of the sites as well as of the historic district.

Consistent with recommendations in the archaeological study (Barna 2018), archaeological monitoring is recommended as a precautionary measure to ensure protection of Site 21438 (Kūkahauʻula), which is adjacent to the Mauna Kea Summit Access Road and the lower portion of the CSO project area, and as a contingency for the discovery of unanticipated archaeological resources. An archaeological monitoring plan in accordance with HAR 13§13-279 should be prepared for acceptance by SHPD prior to project implementation. Also, consistent with recommendations contained in the NASA (2005) study, it is recommended that a cultural monitor be present when ground-altering activities are being conducted for the CSO decommissioning. The role of the on-site cultural monitor will be to provide an appropriate cultural orientation to individuals conducting on-site work, and to provide guidance on following cultural protocols during the decommissioning process. In that vein, and as specified in the CMP (Hoʻakea 2009:7-7) and its decommissioning sub-plan (Sustainable Resources Group Int'l, Inc. 2010:ii) as "Management Action CR-1, it is also recommended that a set of cultural protocols be developed in consultation with Kahu Kū Mauna, families with lineal and historical connections to Mauna Kea, as well as cultural practitioners to address all aspects of the demolition and restoration work to be completed as part of the decommissioning process.

The culture-historical background information that has been generated for Mauna Kea as a result of the numerous detailed studies clearly demonstrates the sanctity of Mauna Kea and its summit region. The compiled oral-historical information provides further specific details about the cultural importance of the summit's viewplanes, the traditional significance of individual *puʻu*, and the importance of proper cultural protocol. It is also clear from the oral-historical information that current-day Hawaiian cultural activities on Mauna Kea were noted by the practitioners of those activities to be an exercise in, and extension of traditional and customary practices. What has been expressed by several cultural practitioners in prior and current interviews is that the goal of decommissioning from their perspective would be to ultimately clear the summit of Mauna Kea of "Western" intrusions and return the landscape as best as possible to its pre-development condition. While this ideal is not necessarily achievable given the existing roadways and associated infrastructure, it is the assessment of the current study that any decommissioning proposal that leaves behind physical remnants of a facility, whether above or below the current ground surface, would result in a negative cultural impact with respect to the proposed action. As stated in the Decommissioning Sub-Plan, "Ideally, the target for all sites is restoration to the site's historical condition prior to construction of the facility." (Sustainable Resources Group Int'l, Inc. 2010:23). If this is DLNR and the University's position, adopted through approval of the CMP (and its sub-plans), then as stated in the CMP, the "[d]esired outcome to the extent possible, [is to] reduce the area disturbed by physical structures . . . by upgrading and reusing buildings and equipment at existing locations, *removing obsolete facilities, and restoring impacted sites to pre-disturbed condition*" (Hoʻakea 2009:7-53; *emphasis mine*). Both the CMP and the Decommissioning Sub-Plan indicate that the decommissioning starting point is for the observatories to do their utmost to completely remove all structures and fully restore the site, and based on what was said during consultation, doing less than that could be perceived as improper and culturally offensive.

With the understanding that some negative impacts may result from decommissioning, these impacts would not completely erase the overall positive impact. However, a perception exists that anything short of an attempt at complete facility removal and full environmental restoration would result in a disingenuous decommissioning effort, as well as be an affront to cultural sensibilities. Therefore, it is recommended that the complete facility (above and below ground) be removed and the affected environment be restored to the fullest extent possible. Following this, and the other above-offered recommendations, will help to ensure that the proposed decommissioning will not result in impacts to any traditionally valued cultural or historical resources nor any traditional cultural practices or beliefs.

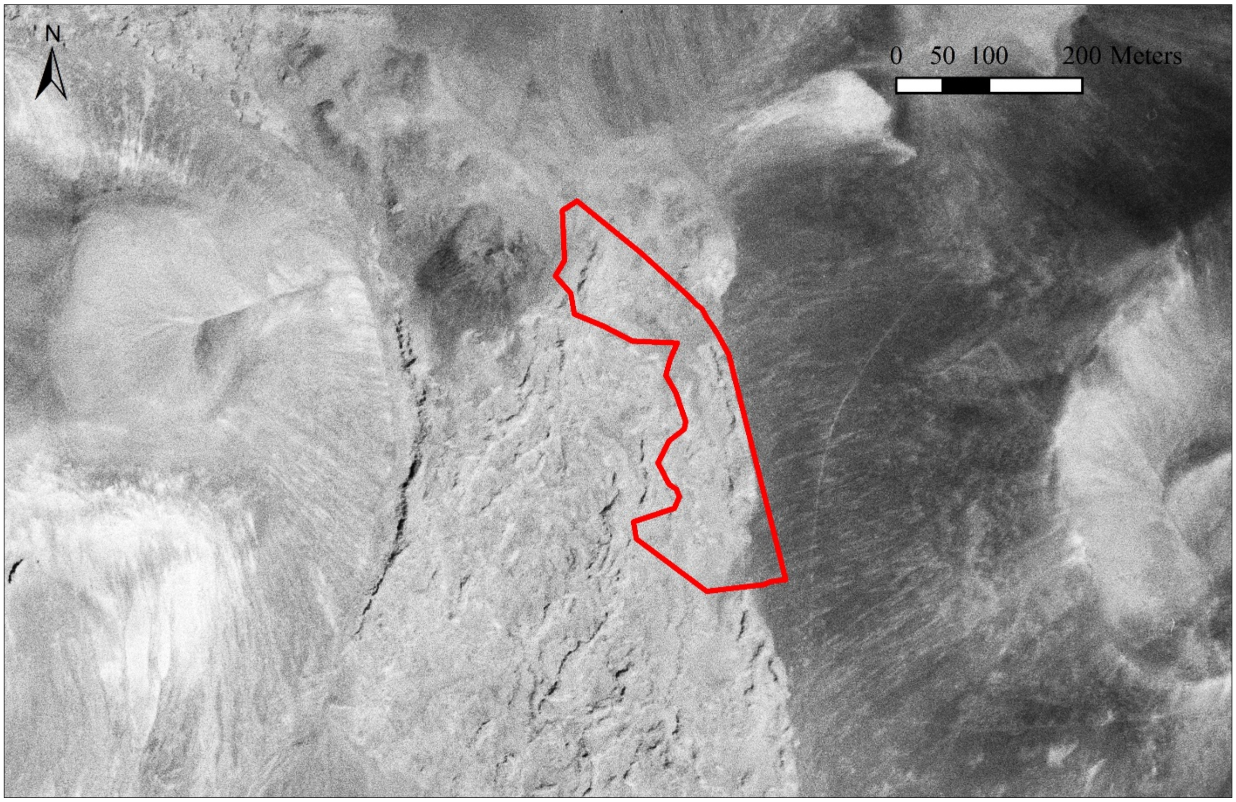


Figure 17. 1954 aerial photograph of the direct effects study area (outlined in red) (USGS 1954).

As the first of no doubt several such projects, the decommissioning of the CSO should set the standard for how to conduct such projects in the future with respect to cultural propriety. As pointed out during a former consultation, and to use the Institute for Astronomy's appropriated proclamation: *I ka hele aku, e hoomaamau I ka wahi!* – When you leave, return it as you found it!

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