



## MEMORANDUM

July 9, 2026

TO: Mauna Kea Stewardship and Oversight Authority

FROM: Greg Chun, Executive Director, Center for Maunakea Stewardship (CMS)

SUBJECT: Action Item: CMS Halepōhaku Educational Nature and Heritage Trail Site Plan Application

- Proposal rec'd: 3/5/2024
- Type A / **B** / C
- CMS project #365
- ED review: 3/7/2024;  
2/6/2026
- EC: 3/14/2024; 2/12/2026
- KKM: 4/2/2026
- MKMB: 11/12/2024;  
4/16/2026
- MKSOA: 5/14/2026

### I. Project Description

CMS seeks to expand ongoing native plant restoration and educational efforts in the Halepōhaku mid-level parcel (“HP”) in actualization of our Restoration Plan. The work includes construction of an additional greenhouse workspace, propagation and outplanting of native plant species, removal of invasive plant species, and creation of an educational walking trail. Included in these materials are CMS’ Nature and Heritage Trail Plan, project proposal, Site Plan application, supporting Powerpoint and images, and standard project conditions.

The following land uses under HAR §13-5-22, each at the Site Plan Approval level, may be determined to apply:

- HAR §13-5-22, P-4, Invasive Species, (B-1) *Removal of invasive species including chemical and mechanical control methods, in an area greater than one acre...* CMS notes its staff and volunteers will only manually remove invasive vegetation using simple hand-tools and with minimal ground disturbance. Removal will occur across the HP parcel.
- HAR §13-5-22, P-9, Structures, Accessory, (B-1) *Construction or placement of structures accessory to existing facilities or uses.* This land use applies to the construction of a greenhouse annex or workspace, to be installed near the existing greenhouse and in support of expanded plant propagation and ongoing partnerships with agencies including Department of Land and Natural Resources Division of Forestry and Wildlife (DOFAW).
- HAR §13-5-22, P-13, Land and Resource Management (B-2), *Planting of native and endemic plants and fence maintenance.* CMS notes the current proposed work will focus on native and endemic species outplanting. CMS has had preliminary discussions with DOFAW to assist in fence maintenance of DOFAW’s silversword enclosure at HP, but CMS has no plans at present for any new fence installation.

### II. Historical and Cultural Resources Identified

The project site is within the Mauna a Wākea Traditional Cultural Property, listed in 2023 as a State Inventory of Historic Places (SIHP) site #50-10-23-31382, and the Mauna Kea Traditional Cultural Property, listed in 2025 on the National Register of Historic Places.



In addition, portions of the proposed work may occur near, but will not impact in any way, the following identified historic properties:

- SIHP sites #50-10-23-9074, 9075 and 9076 (respectively, the two stone cabins and comfort station) which comprise the HP rest camp.
- A lithic scatter or stone tool workshop, formerly SIHP site #50-10-23-10310 (2009 Cultural Resources Management Plan for the University of Hawaii Management Areas on Mauna Kea, Appendix C), renamed the Pu'ukalepeamoia Complex SIHP #16244.
- An ahu-lele within the silversword enclosure managed by Department of Land and Natural Resources.

### **III. Impacts Identified**

The project occurs within previously-disturbed land continuously used since at least the 1920s. CMS does not anticipate any negative adverse impact on cultural resources including viewplanes, nor to any historical, hydrological, geological, or recreational resources. All activity associated with this proposal is limited to the existing HP footprint, which will not be extended or enlarged. The permitted use of the parcel remains unaltered.

### **IV. Recommended Mitigation**

CMS recommends Best Management Practices and other project conditions be adhered to in carrying out this work. The project will not proceed unless and until the Office of Conservation and Coastal Lands (OCCL) issues Site Plan Approval. CMS will comply with any and all conditions.

### **V. Comprehensive Management Plan Compliance**

The request is consistent with the 2022 Comprehensive Management Plan (CMP), approved by the Board of Land and Natural Resources. In fulfillment of the CMP's community review requirements, the proposed use was presented to committees as follows, to no objections:

- Environment Committee (EC) reviews March 14, 2024 and February 12, 2026.
  - Concerns raised during the March 2024 meeting included whether the trail will inadvertently bring public visitors to the closed facilities of Halepōhaku (HP) and spread invasive weeds. CMS staff replied the trail will veer away from HP and, further, that signage should deter unauthorized access to HP. Staff will continue to monitor for and control invasive weeds.
  - Another EC member requested clarification on “sustainable harvesting” mentioned in the Plan. Staff answered that many visitors leave hōkupu on the summit, so the Plan will allow for the harvest of relatively invasives-free botanical items for use in hōkupu.
  - EC also questioned what other information will be on the trail signage. Staff responded that signage for plants will include their scientific name, uses, and other information, and that additional research on content will be done.
  - During the February 2026 meeting, a suggestion was raised to use the trail for mentoring and hosting guest speakers on conservation issues. Manager Yeh replied that was a valuable future addition to the Maunakea Speaker Series.
- Kahu Kū Mauna (KKM) Council, April 2, 2026. KKM expressed enthusiastic support for the project, noting that a larger area is needed for māmane propagation.



- Maunakea Management Board (MKMB) reviews November 12, 2024 and April 16, 2026.
  - During the November 2024 meeting, CMS staff informed MKMB this was an introductory presentation of the Restoration Plan and project, and that a formal proposal would be presented at a later time for approval.
  - At the formal review during MKMB's April 2026 meeting, a question was raised whether consideration had been given to the Americans with Disabilities Act (ADA) requirements. CMS Executive Director Chun replied ADA issues had not yet been addressed, but agreed it may be needed due to the natural sloping in the area. Additional discussion followed about paving the trail and/or installing a boardwalk. Another question regarded the amount of additional area provided by the new greenhouse. Natural Resources Manager Yeh replied the growing space of the new greenhouse represents a 200-300% increase from current and will allow CMS to exceed last year's propagation of 900 plants. Manager Yeh also noted the need for more staff for this expansion.

Following MKSOA review, the Site Plan application will be submitted to the Office of Conservation and Coastal Lands (OCCL) for final approval.

The proposed land is also consistent with UH's General Lease for Halepōhaku (S-5529). Further, CMS' review of the project fulfills numerous CMP actions, including:

- NR-13: Increase communication, networking, and collaborative opportunities that support management and protection of natural resources. *CMS staff have an active collaboration with other agencies including Department of Land and Natural Resources, the Mauna Kea Forest Restoration Project, and Three Mountain Alliance. These ongoing relationships are protecting natural resources under each agency's respective management jurisdictions and across the broader, shared landscape of Maunakea.*
- Permitting and Enforcement, P-1: Comply with all applicable federal, state, and local laws, regulations, and permit conditions related to activities in the UH management Areas.
- P-2: Strengthen CMP implementation by recommending that compliance with the CMP be a condition of permits and agreements.
- P-4: Educate management staff and users of the mountain about all applicable rules and permit requirements

## **VI. CMS Recommendation, with Mitigation Measures**

CMS recommends MKSOA approve this project request to proceed in the review process with the standard project conditions in the attached list. The project will not proceed unless OCCL issues Site Plan Approval. CMS will comply with all conditions.

# Facility Project Proposal for the UH-Managed Lands

Proposals due by the 15<sup>th</sup> monthly

Please mark all that apply to your project

\_Yes\_ Project was reviewed in a 5- or 3-Year Plan (Yes; CMS 3YP 2025-2027)

\_Yes\_ Project is a CMP, lease, or sublease compliance measure

\_No\_ Project involves heavy machinery

\_Yes\_ Project requires ground disturbance such as digging or trenching

\_No\_ Project will result in a change to the facility footprint or use

\_No\_ Project affects a viewplane (e.g., starline or oceanic gridline)

Facility Name

CMS Halepōhaku (HP) midlevel facilities.

Brief Descriptive Title of Project

Halepōhaku Educational Nature and Heritage Trail.

Project Description

The proposed land use aims to reforest the subalpine māmane woodland habitat at Halepōhaku and expand educational opportunities for and collaboration between the various users of Maunakea.

Identified Land Use (see HAR § 13-5-22 through 13-5-25)

The proposed project may involve one or more of the following land uses:

- HAR §13-5-22, P-4 Invasive Species, (B-1) Removal of invasive species including chemical and mechanical control methods, in an area greater than one acre... that results in no, or only minor, ground disturbance.
- HAR §13-5-22, P-9, Structures, Accessory, (B-1) Construction or placement of structures accessory to existing facilities or uses.
- HAR §13-5-22, P-13, Land and Resource Management, (B-2) Planting of native and endemic plants and fence maintenance. New fence ex-closures for native plants or small native wildlife communities, in an area greater than one acre... **Note, the project only involves planting of native and endemic floral species and does not involve any new fence installations.**

Identify the existing CDUP this proposal alters or affects, if any

CDUPs HA 1430, 1819, 3812.

Identify [University of Hawai'i exemption](#) per HAR § 11-200-8(a), if any

- Exemption Class #3: Construction and location of single, new, small facilities or structures and the alteration and modification of same and installation of new, small, equipment and facilities and the alteration and modification of same... (1) Construction or alteration of:

- (c) Greenhouses (10,000 square feet or less)...
- Exemption Class #4: Minor alterations in the condition of land, water, or vegetation; (2) Planting of trees, other plants, and sod.
  - Exemption Class #5: Basic data collection, research, experimental management, and resources evaluation activities which do not result in a serious or major disturbance to an environmental resource. (4) Flora and fauna surveys.

The project is also considered to be an action exempt pursuant to HAR §11-200.1-15

- (3) Construction and location of single, new, small facilities or structures and the alteration and modification of the facilities or structures and installation of new, small equipment or facilities and the alteration and modification of the equipment or facilities...
- (4) Minor alterations in the conditions of land, water, or vegetation; and
- (5) Basic data collection, research, experimental management, and resource and infrastructure testing and evaluation activities that do not results in a serious or major disturbance to an environmental resource.

#### Tax Map Key(s)

(3) 4-4-015:012 - Halepōhaku

#### Proposed Commencement Date

June 2026, pending approvals

#### Proposed Completion Date

June 2028, pending funding and seedling outplanting readiness

#### Estimated Project Cost

\$1,200,000

#### Total size / area of proposed use

First and Second priority areas = 19 acres

Trail = 3.7 acres, within First/Second priority areas

Greenhouse and work space annex = 2,000 sq ft = 0.05 acres, within First/Second priority areas

Total approx. = 19 acres

## Project Purpose and Need

CMS has determined to expand vegetation restoration efforts that were originally approved as mitigation measures pursuant to CDUP HA 3812, Infrastructure Improvements at Maunakea Visitor Center Halepohaku Mid-level Facilities, aka “VIS ingress/egress project.” The project requires construction of a greenhouse annex comprising a second greenhouse and work area to tend the volume of additional seedlings for outplanting. Dovetailing with the increased plant propagation is providing opportunities for visitors, students and researchers to experience community- and place-based learning in stewarding the ‘āina through hands-on service and management activities, self-guided walks on the nature and heritage trail, and other forms of collaborative learning. This project will function as the foundational piece to develop additional future educational experiences.

The proposed project addresses a variety of goals set forth in the Comprehensive Management Plan (CMP; see Table 1 in the attached Restoration Plan). A partial list of CMP goals, those addressing the Natural Resources subplan, is as follows:

- NR-1: Limit threats to natural resources through management of activities and uses. *The proposed land use will expand educational outreach to a wider audience. CMS will provide education about Maunakea’s resources in ways that are scientifically and culturally-informed. Guests will have greater awareness of indigenous knowledge and practices to conduct themselves in more appropriate ways on this sensitive landscape.*
- NR-2: Implement the Maunakea Invasive Species Management Plan. *The project will remove non-native and invasive species, a direct goal of the Invasive Species Management Plan.*
- NR-3: Minimize loss of native biodiversity. *The project will work to accomplish this action through outplanting of a variety of native plant species. CMS maintains current collection permits for seed-collection and gathers seed from the HP area. Native plants are known habitat for native arthropods and fauna such as native forest birds. If only considering the native fauna projected to become established by this proposal, that alone will increase native species biodiversity.*
- NR-6: Conduct educational efforts to generate public awareness about the importance of preserving Maunakea’s natural resources. *CMS’ work will address this through creation of a self-guided trail with interpretive signage describing the cultural, historical and biological resources of and general information about the area. Using the trail, visitors may safely explore and study the native plants and ecosystem of the area.*
- NR-9: Increase native plant density and diversity through an outplanting program: *Expand the existing plant propagation workspace and seedling output by adding a second, more spacious greenhouse with a connected, multipurpose gathering space/workroom;*
- NR-12: Plan and conduct habitat restoration activities, as needed. *Management activity will continue to plan for restoration work at HP.*
- NR-13: Increase communication, networking, and collaborative opportunities that support management and protection of natural resources. *CMS staff have an active collaboration with other agencies including Department of Land and Natural Resources, the Mauna Kea Forest Restoration Project, and Three Mountain Alliance. These ongoing relationships are protecting natural resources under each agency’s respective management jurisdictions and across the broader, shared landscape of Maunakea.*
- NR-14: Follow adaptive management principles when reviewing/updating programs.

- NR-16: Continue long-term monitoring. *CMS' Natural Resources team has active and ongoing monitoring of revegetation rates within the HP area.*
- NR-17: Conduct research to fill knowledge gaps that cannot be addressed through monitoring. *CMS is working to identify research needs regarding the HP parcel and to refine specific research questions.*
- NR-18: Maintain geospatial database of natural resources: *Geospatial data are collected as part of CMS' long-term monitoring of the HP area.*

#### Has professional peer-review occurred

An engineering consultant will prepare the construction drawings of the greenhouse annex, subject to UH and/or RCUH contractual agreements and internal review (e.g., Office of Project Delivery). Review by community advisory boards and the Mauna Kea Stewardship and Oversight Authority will occur in accordance with these boards' scheduled meetings.

#### Are there any related ongoing, pending, or planned projects associated with this submission?

Yes - Ongoing: Mitigation for VIS ingress-egress project.

Pending: Fire Mitigation project, considered to be associated due to location and need to coordinate outplanting with fire mitigation efforts. This project received Site Plan Approval HA 2634 from DLNR Office of Conservation and Coastal Lands.

### Existing Conditions at Project Site(s)

#### Geology & Climate

HP is located at an elevation of approximately 9,200 feet. Climate here is considered subalpine, with a mean annual rainfall of less than 30 inches. The ground surface consists of volcanic rock, cinder and ash, and deep, well- to excessively-drained soils formed in volcanic ash and 'a'a lava.

#### Flora, Fauna, Ecology, Water Resources

The vegetation in this subalpine ecosystem is a mixture of abundant non-native grasses, native mamane (*Sophora chrysophylla*) and xeriphitic scrub. Of native plant species, the most abundant are the māmane and native grasses. There are no federally listed threatened or endangered plant species within the HP parcel itself, although numerous planted 'āhinahina, *Argyroxiphium sandwicense* subsp. *sandwicense*, are found within the Mauna Kea Forest Reserve silversword enclosure adjacent to the HP parcel. No impact to any silverswords, silversword habitat, or visitors to the enclosure is anticipated. Faunal species that either may occur intermittently or are known to occur at HP include a variety of native arthropods; forest birds; and the 'ōpē'āpē'ā, *Lasiurus cinereus semotus* or Hawaiian hoary bat. Besides the 'ōpē'āpē'ā, all mammals known or that may occur intermittently at HP are non-native, including the feral cat, rat, and mongoose. HP is located within the Onomea aquifer system. Groundwater levels are assumed to be at significant depth, likely more than 3,000 feet below ground surface. Water-quality analyses have not detected any levels of bacterial or other pollutants in Maunakea water resources.

#### Historical and Cultural Resources

The project area is located within the Mauna Kea Traditional Cultural Property listed on the National Register of Historic Sites; the Mauna A Wakea Traditional Cultural Property and District, State Inventory of Historic Places (SIHP) #50-10-23-31382, a State of Hawaii-recognized historic district; and within the Pu'ukalepeamoia Complex, SIHP #16244.

In addition, CMS identifies the following historic properties or cultural sites near or within the HP parcel (specific outplanting sites have not been mapped at this time, but will avoid any disruption to these sites):

- a) State Inventory of Historic Places (SIHP) sites #50-10-23-9074, 9075 and 9076 (respectively, the two stone cabins and comfort station) which comprise the Halepohaku rest camp.
- b) A lithic scatter or stone tool workshop formerly SIHP site #50-10-23-10310 (2009 Cultural Resources Management Plan for the University of Hawaii Management Areas on Mauna Kea, Appendix C) and renamed as the Pu'ukalepeamoia Complex SIHP #16244.
- c) An ahu-lele within the DLNR-managed silversword enclosure.

### Recreation

Visitors utilize the HP area to acclimate, sightsee and rest while visiting the UH-managed lands. Project activity may be visible to visitors; moreover, however, the project is anticipated to improve the recreational resources by offering visitors hands-on, service learning opportunities and improved educational materials.

### Built Infrastructure

The existing buildings at HP include the Onizuka Center for International Astronomy Visitor Information Station, Warehouse, Halepohaku astronomy support facilities, Utilities/Maintenance shop, historic stone buildings, greenhouse, and various paved and unpaved parking areas. Utilities in the area include electricity, telecommunications, fuel storage tanks, water tanks, septic system, culverts, and earthen swales. Other minor improvements include street lights, informational signage, VIS pipe gate, guardrails, and safety railings. CMS has worked to restore the natural landscape through invasive species monitoring and removal and native plant restoration efforts at HP.

### Landscaping & Visual Conditions

The HP area is considered developed. Staff conduct vegetation control through manual means of weedeating or hand-pulling non-native plants. A native plant garden surrounding the VIS was begun in 2018. Numerous plants have since naturally established there in addition to the hundreds of greenhouse-raised seedlings.

## Description of the Project

### Location

Work will be conducted across the HP parcel.

### Description of the process of completing the project

- Greenhouse annex: Manually grade foundation area. Construct and paint building. Install interior work benches.
- Educational trail: Conduct weed-control; hand-grade the route of the trail; set biomat or similar erosion control means; outplant and monitor native seedlings; install plant identification tags and small, descriptive trail signs to points of interest.
- Other outplanting in HP parcel: Specific planting sites to be determined.

### Who will do the work?

A majority of the work will be done by CMS staff. A smaller portion of work, primarily with invasive plants removal and native species replanting, may be carried out by service-learning and public volunteer groups.

### Equipment & Transportation

No additional equipment or transportation is needed for the work, which will be conducted using normal work vehicles and handheld equipment.

## Measures to protect the environment and/or mitigate impacts

### Impacts

Impacts will generally be mitigated by adhering to existing ordinances, rules and laws; recommendations provided by consulting entities including the Maunakea Environment Committee, Kahu Kū Mauna Cultural Advisory Council, Maunakea Management Board, Mauna Kea Stewardship and Oversight Authority; CMS standard project approval conditions; and any permit conditions provided by DLNR.

### Protective Measures

See attached standard project conditions list for all measures that will be considered to apply to the project.

### Compliance with Lease, Sublease, or Comprehensive Management Plan (CMP)

The project complies with UH's general lease for HP, S-5529. See prior section "Project purpose and need" for details regarding CMP fulfillment.

### Identify other required or associated permits

None.

### Five Year Outlook

Yes; KKM reviewed as part of CMS' 2025-2027 Three Year Plan and requested in-depth consultation.

## DLNR Evaluation Criteria

After approval by the Maunakea Management Board, the Department of Land & Natural Resources or Board of Land & Natural Resources will evaluate the merits and approve the project based on the following eight criteria (§13-5-30). See <http://dlnr.hawaii.gov/occl/files/2013/08/13-5-2013.pdf>

1. The purpose of the Conservation District is to conserve, protect, and preserve the important natural and cultural resources of the State through appropriate management and use to promote their long-term sustainability and the public health, safety, and welfare. (ref §13-5-1) How is the proposed land use consistent with the purpose of the conservation district?

The proposed land use has been reviewed to ensure alignment with the conservation, protection, and preservation of the State's natural and cultural resources. The project is expected to increase native species biodiversity and abundance in the HP parcel and natural resources such as these are often also considered Hawaiian cultural resources. There are no negative impacts anticipated to public health, safety, or welfare.

2. How is the proposed use consistent with the objectives of the Resource subzone of the land on which the land use will occur?

The objective of the Resource subzone, where the proposed use is located, is "...to develop, with proper management, areas to ensure sustained use of the natural resources of those areas."

The proposed land use is an allowable use within the Conservation District Resource subzone, pursuant to HAR §13-5-24, R-3, Astronomy Facilities, (D-1), under an approved management plan. The approved management plan is the 2022 Maunakea Comprehensive Management Plan Supplement. In addition to the proposed project being more than one identified land use, UH is committed to managing the natural and cultural resources of the UH Management Areas in a way that fulfills the objective of the Conservation District Resource subzone. The project will facilitate sustained use of the site for existing, approved uses. No change in type or intensity of use will occur as a result of this project. Historical resources will not be negatively impacted while cultural/natural and recreational resources may be improved through outplanting and educational efforts.

3. Describe how the proposed land use complies with the provisions and guidelines contained in chapter 205A, HRS, entitled "Coastal Zone Management".

The site is over twenty (20) miles from any coastline and is not connected to shoreline resources. The project will have no effect on any of the coastal resources identified in HRS 205A, including, but not limited to, recreational opportunities, historic resources, scenic and open space, ecosystems, economic uses, beach and coastal dune protections, and/or marine and coastal resources. The project is also not a coastal beach development. Consequently, the project complies with the objectives of HRS 205A.

4. Describe how the proposed land use will not cause substantial adverse impact to existing natural resources within the surrounding area, community or region.

The project within the HP parcel has experienced continuous human activity and development, particularly in the past century, since the construction of two rest houses and comfort station (SIHPs 9074, 9075, 9076) in the 1930s by the Civilian Conservation Corps, development of the HP parcel, and construction of and improvements to Saddle Road. In that time, human activity onsite has primarily occurred in the form of infrastructure development, routine management

of buildings and grounds, research and educational visits, hunting and other consumptive activity, recreation, and cultural practices. Given the existing human activity in the area, and the intent of the proposed project to protect resources, the project is not anticipated to present a substantial adverse impact to existing resources in the surrounding area, community, or region.

5. Describe how the proposed land use, including buildings, structures and facilities, is compatible with the locality and surrounding areas, appropriate to the physical conditions and capabilities of the specific parcel or parcels.

The project seeks to enhance the existing greenhouse and provide a self-guided, educational walking trail for visitors. This is appropriate to the current physical conditions and will improve the existing recreational resources of the parcel.

6. Describe how the existing physical and environmental aspects of the land, such as natural beauty and open space characteristics, will be preserved or improved upon.

It is hoped the project will improve the natural beauty and ecological capacity in that area with outplanting of native species known to occur there which may, in turn, attract native invertebrates and fauna.

7. If applicable, describe how subdivision of land will not be utilized to increase the intensity of land uses in the Conservation District.

No new subdivision of land will occur.

8. Describe how the proposed land use will not be materially detrimental to the public health, safety and welfare.

The project bears no material detriment to public health, safety and welfare.



## SITE PLAN APPROVAL APPLICATION (SPA)

File No:

Acceptance Date:

30-Day Expiration Date:

Assigned Planner:

*for DLNR Use*

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Pursuant to Hawai'i Administrative Rules (HAR) §§13-5-22 through 24, identified land uses beginning with letter (B) require a site plan approval by the department.

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**PROJECT NAME:** Halepōhaku Educational Nature and Heritage Trail

Conservation District Subzone: Resource

Identified Land Use: HAR §13-5-22, P-4 Invasive Species, (B-1) Removal of invasive species including chemical and mechanical control methods, in an area greater than one acre... that results in no, or only minor ground disturbance. HAR §13-5-22, P-9, Structures, Accessory, (B-1) Construction or placement of structures accessory to existing facilities or uses. HAR §13-5-22, P-13, Land and Resource Management, (B-2) Planting of native and endemic plants and fence maintenance. New fence ex-closures for native plants or small native wildlife communities, in an area greater than one acre...NOTE, however, the project only involves planting of native and endemic floral species and does not involve any new fence installation.

*(See Hawai'i Administrative Rules (HAR) §13-5-22 through §13-5-25)*

Project Address: Halepōhaku midlevel facilities

Ahupua'a, District, Island: Kāohe mauka, Hāmakua, Hawaii Island

Tax Map Key(s): (3)-4-4-015: 012, Hale Pohaku Mid-level Facilities (por.)

Proposed Commencement Date: May 2026, pending approvals and funding. Some minor elements of the plan are already ongoing, including plant propagation (as a mitigation measure to CDUP HA 3812) or under regular maintenance activities including limited invasive plant species removal.

Proposed Completion Date: June 2028, pending weather and seedling outplanting readiness.

Estimated Project Cost: \$1,200,000

Total area of proposed use: 21.5 acres

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### ATTACHMENTS

\$50 application fee (*ref §13-5-32 through 34*)

- Location map
- Site plan
- Construction, grading, site restoration, landscaping, or fire buffer plans, as applicable

Note: The application fee for State projects is waived pursuant to HAR §13-5-32.

**REQUIRED SIGNATURES**

**Applicant**

Name: Center for Maunakea Stewardship (CMS)

Title; Agency: University of Hawai'i at Hilo

Mailing Address: 200 W. Kawili Street, Hilo, HI 96720

Contact Person & Title: Greg Chun, Executive Director, CMS

Phone: 808-933-0734

Email: cmshilo@hawaii.edu

Interest in Property: DLNR lands leased to University of Hawai'i, under General Lease S-5529, issued by the State of Hawai'i; management delegated to CMS

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

*Signed by an authorized officer if for a Corporation, Partnership, Agency or Organization*

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**Landowner (if different than the applicant)**

Name: State of Hawai'i (managed by University of Hawai'i under General Lease S-5529)

Title; Agency: Greg Chun, Executive Director, CMS, UH Hilo

Mailing Address: c/o University of Hawai'i at Hilo, 200 West Kawili Street, Hilo, HI 96720

Phone: 808-933-0734

Email: cmshilo@hawaii.edu

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

*For public lands, the government entity with management control shall sign as landowner.*

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**Agent or Consultant**

Agency: Click or tap here to enter text.

Contact Person & Title: Click or tap here to enter text.

Mailing Address: Click or tap here to enter text.

Phone: Click or tap here to enter text.

Email: Click or tap here to enter text.

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

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**For DLNR Managed Lands**

Chairperson, Board of Land and Natural Resources

P.O. Box 621

Honolulu, Hawai'i 96809-0621

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

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## **PROPOSED USE**

Total size/area of proposed use (indicate in acres or sq. ft.): 21.5 acres

Please provide a detailed description of the proposed land use(s) in its entirety. Information should describe what the proposed use is; the need and purpose for the proposed use; the size of the proposed use (provide dimensions and quantities of materials); and how the work for the proposed use will be done (methodology). If there are multiple components to a project, please answer the above for each component. Also include information regarding secondary improvements including, but not limited to, grading and grubbing, placement of accessory equipment, installation of utilities, roads, driveways, fences, landscaping, etc.

CMS has determined to expand vegetation restoration efforts that were originally approved as mitigation measures pursuant to CDUP HA 3812, Infrastructure Improvements at Maunakea Visitor Center Halepohaku Mid-level Facilities, aka "VIS ingress/egress project." The project requires construction of a greenhouse annex comprising a second greenhouse and work area to tend the volume of additional seedlings for outplanting. Dovetailing with the increased plant propagation is providing opportunities for visitors, students and researchers to experience community- and place-based learning in stewarding the 'āina through hands-on service and management activities, self-guided walks on the nature and heritage trail, and other forms of collaborative learning. This project will function as the foundational piece to develop additional future educational experiences.

Listed below are the general work activities, to be completed by CMS staff and volunteers, involved with each project component:

- Greenhouse annex: Manually grade foundation area. Construct and paint building. Install work benches.
- Educational trail: Hand-grade the route of the trail; conduct weed control; set biomat or similar erosion control means; outplant and monitor native seedlings; install plant identification tags and small descriptive trail signs to points of interest
- Other outplanting in HP parcel: Specific planting sites to be determined.

## **PROPOSED EXEMPTION**

An exemption from needing an environmental assessment (EA) refers to specific situations or projects that are not required to undergo the standard EA process due to their minimal potential impact on the environment.

Government agencies should use the appropriate exemption list as concurred by the Environmental Advisory Council as found at [planning.hawaii.gov/erp/agency-exemption-list](http://planning.hawaii.gov/erp/agency-exemption-list)

Private parties should use DLNR's Exemption List as concurred by the Environmental Council on November 10, 2020 as found at [files.hawaii.gov/dbedt/erp/Agency\\_Exemption\\_Lists/State-Department-of-Land-and-Natural-Resources-Exemption-List-2020-11-10.pdf](http://files.hawaii.gov/dbedt/erp/Agency_Exemption_Lists/State-Department-of-Land-and-Natural-Resources-Exemption-List-2020-11-10.pdf)

CMS identifies exemptions pursuant to the University of Hawaii Exemption List defined under HAR §11-200-8(a), Exemption Class #3: Construction and location of single, new, small facilities or structures and the alteration and modification of same and installation of new, small, equipment and facilities and the alteration and modification of same... (1) Construction or alteration of: (c) Greenhouses (10,000 square feet or less)... Exemption Class #4: Minor alterations in the condition of land, water, or vegetation; (2) Planting of trees, other plants, and sod. Exemption Class #5: Basic data collection, research, experimental management, and resources evaluation activities which do not result in a serious or major disturbance to an environmental resource. (4) Flora and fauna surveys. The project is also considered to be an action exempt pursuant to State of Hawaii Department of Health, HAR §11-200.1-15 (3) Construction and location of single, new, small facilities or structures and the alteration and modification of the facilities or structures and installation of new, small equipment or facilities and the alteration and modification of the equipment or facilities... (4) Minor alterations in the conditions of land, water, or vegetation; and (5) Basic data collection, research, experimental management, and resource and infrastructure testing and evaluation activities that do not results in a serious or major disturbance to an environmental resource.

## EXISTING CONDITIONS

Please describe existing conditions on the parcel (geology, ecology, cultural and recreational resources, historic resources, structures, landscaping, etc). Provide information regarding existing buildings and structures as well as infrastructure and utilities as applicable.

### Geology & Climate

HP is located at an elevation of approximately 9,200 feet. At this locality, climate is considered subalpine, with a mean annual rainfall of less than 30 inches. The ground surface consists of volcanic rock, cinder and ash, and deep, well- to excessively-drained soils formed in volcanic ash and 'a'a lava.

### Flora, Fauna, Ecology, Water Resources

The vegetation in this subalpine ecosystem is a mixture of abundant non-native grasses, native mamane (*Sophora chrysophylla*) and xeriphitic scrub. Of native plant species, the most abundant are the māmane and native grasses. There are no federally listed threatened or endangered plant species within the HP parcel itself, although numerous planted 'āhinahina, *Argyroxiphium sandwicense* subsp. *sandwicense*, are found within the Mauna Kea Forest Reserve silversword enclosure adjacent to the HP parcel. No impact to any silverswords, silversword habitat, or visitors to the enclosure is anticipated. Faunal species that either may occur intermittently or are known to occur at HP include a variety of native arthropods; forest birds; and the 'ōpéapéa, *Lasiurus cinereus semotus* or Hawaiian hoary bat. Besides the 'ōpéapéa, all mammals known or that may occur intermittently at HP are non-native, including the feral cat, rat, and mongoose. HP is located within the Onomea aquifer system. Groundwater levels are assumed to be at significant depth, likely more than 3,000 feet below ground surface. Water-quality analyses have not detected any levels of bacterial or other pollutants in Maunakea water resources.

### Historical and Cultural Resources

The project area is located within the Mauna Kea Traditional Cultural Property listed on the National Register of Historic Sites; the Mauna A Wakea Traditional Cultural Property and District, State Inventory of Historic Places (SIHP) #50-10-23-31382, a State of Hawaii-recognized historic district; and within the Pu'ukalepeamo Complex, SIHP #16244.

In addition, CMS identifies the following historic properties or cultural sites near or within the HP parcel (specific outplanting sites have not been mapped at this time, but will avoid any disruption to these sites):

- a) State Inventory of Historic Places (SIHP) sites #50-10-23-9074, 9075 and 9076 (respectively, the two stone cabins and comfort station) which comprise the Halepohaku rest camp.
- b) A lithic scatter or stone tool workshop formerly SIHP site #50-10-23-10310 (2009 Cultural Resources Management Plan for the University of Hawaii Management Areas on Mauna Kea, Appendix C) and renamed as the Pu'ukalepeamo Complex SIHP #16244.
- c) An ahu-lele within the DLNR-managed silversword enclosure.

## Recreation

Visitors utilize the HP area to acclimate, sightsee and rest while visiting the UH-managed lands. Project activity may be visible to visitors; moreover, however, the project is anticipated to improve the recreational resources by offering visitors hands-on service learning opportunities and improved educational materials.

## Built Infrastructure

The existing buildings at HP include the Onizuka Center for International Astronomy Visitor Information Station, Warehouse, Halepohaku astronomy support facilities, Utilities/Maintenance shop, historic stone buildings, greenhouse, and various paved and unpaved parking areas. Utilities in the area include electricity, telecommunications, fuel storage tanks, water tanks, septic system, culverts, and earthen swales. Other minor improvements include street lights, informational signage, VIS pipe gate, guardrails, and safety railings. CMS has worked to restore the natural landscape through invasive species monitoring and removal and native plant restoration efforts at HP.

## Landscaping & Visual Conditions

The HP area is considered developed. Staff conduct vegetation control through manual means of weedeating or hand-pulling non-native plants. A native plant garden surrounding the VIS was begun in 2018. Numerous plants have since naturally established there in addition to the hundreds of greenhouse-raised seedlings.

## EVALUATION CRITERIA

The Department or Board will evaluate the merits of a proposed land use based upon the following eight criteria (*ref §13-5-30(c)*)

1. **The purpose of the Conservation District is to conserve, protect, and preserve the important natural and cultural resources of the State through appropriate management and use to promote their long-term sustainability and the public health, safety, and welfare. How is the proposed land use consistent with the purpose of the conservation district?** (*ref §13-5-1*)

The proposed land use has been reviewed to ensure alignment with the conservation, protection, and preservation of the State's natural and cultural resources. The project is expected to increase native species biodiversity and abundance in the HP parcel and natural resources such as these are often also considered Hawaiian cultural resources. There are no negative impacts anticipated to public health, safety, or welfare

2. **How is the proposed use consistent with the objectives of the subzone of the land on which the land use will occur?** (*ref §13-5-11 through §13-5-15*)

The objective of the Resource subzone, where the proposed use is located, is "...to develop, with proper management, areas to ensure sustained use of the natural resources of those areas." The proposed land use is an allowable use within the Conservation District Resource subzone, pursuant to HAR §13-5-24, R-3, Astronomy Facilities, (D-1), under an approved management plan. The approved management plan is the 2022 Maunakea Comprehensive Management Plan Supplement. In addition to the proposed project being more than one identified land use, UH is committed to managing the natural and cultural resources of the UH Management Areas in a way that fulfills the objective of the Conservation District Resource subzone. The project will facilitate sustained use of the site for existing, approved uses. No change in type or intensity of use will occur as a result of this project. Historical resources will not be negatively impacted while cultural/natural and recreational resources may be improved through outplanting and educational efforts

3. **Describe how the proposed land use complies with the provisions and guidelines contained in chapter 205A, HRS, entitled "Coastal Zone Management" (see 205A objectives on p. 7).**

The site is over twenty (20) miles from any coastline and is not connected to shoreline resources. The project will have no effect on any of the coastal resources identified in HRS 205A, including, but not limited to, recreational opportunities, historic resources, scenic and open space, ecosystems, economic uses, beach and coastal dune protections, and/or marine and coastal resources. The project is also not a coastal beach development. Consequently, the project complies with the objectives of HRS 205A

4. **Describe how the proposed land use will not cause substantial adverse impact to existing natural resources within the surrounding area, community or region.**

The project within the HP parcel has experienced continuous human activity and development, particularly in the past century with the construction of two rest houses and comfort station (SIHPs 9074, 9075, 9076) in the 1930s by the Civilian Conservation Corps, development of the HP parcel, and construction of and improvements to Saddle Road. In that time, human activity onsite has primarily occurred in the form of infrastructure development, routine management of buildings and grounds, research and educational visits, hunting and other consumptive activity, recreation, and

cultural practices. Given the existing human activity in the area, and the intent of the proposed project to protect resources, the project is not anticipated to present a substantial adverse impact to existing resources in the surrounding area, community, or region

- 5. Describe how the proposed land use, including buildings, structures and facilities, is compatible with the locality and surrounding areas, appropriate to the physical conditions and capabilities of the specific parcel or parcels.**

The project seeks to enhance the existing greenhouse and provide a self-guided, educational walking trail for visitors. This is appropriate to the current physical conditions and will improve the existing recreational resources of the parcel.

- 6. Describe how the existing physical and environmental aspects of the land, such as natural beauty and open space characteristics, will be preserved or improved upon.**

It is hoped the project will improve the natural beauty and ecological capacity in that area with outplanting of native species known to occur there which may, in turn, attract native invertebrates and fauna.

- 7. If applicable, describe how subdivision of land will not be utilized to increase the intensity of land uses in the Conservation District.**

No new subdivision of land will occur.

- 8. Describe how the proposed land use will not be materially detrimental to the public health, safety and welfare.**

The project bears no material detriment to public health, safety and welfare.

## **CULTURAL IMPACTS**

Articles IX and XII of the State Constitution, other state laws, and the courts of the State, require government agencies to promote and preserve cultural beliefs, practices, and resources of Native Hawaiian and other ethnic groups.

### **Please provide the identity and scope of cultural, historical, and natural resources in which traditional and customary native Hawaiian rights are exercised in the area.**

Please see prior sections for additional discussion on the identity and scope of historical and natural resources in the area. The proposed land use is anticipated to have no effect on any historical resources and will benefit natural resources.

The 2009 CMP Cultural Resources Management Plan (CRMP) describes cultural practices and beliefs that may occur on the UH-managed lands; citing Maly and Maly 2005: 494-502, 505, the CRMP refers to 'ahu on the pu'u in the lowlands' of Maunakea; however, it is unclear what specific area this refers to and may or may not be within the Maunakea lands. In recent years, cultural practitioners and others have constructed rock stackings in prominent locations in the Maunakea lands. These ahu have been used as places to gather for worship and other practices. Within the HP area, cultural practices include offering of ho'okupu, oli, mele and hula. Other, more discreet practices that have not been documented may also occur.

CMS has been advised to consider impacts to cultural resources such as celestial viewpoints and ocean gridlines which are significant to kilo hoku practitioners. As the proposed use involves no new installations and no heavy/large machinery, the project is not anticipated to affect any viewplanes.

### **Identify the extent to which those resources, including traditional and customary Native Hawaiian rights, will be affected or impaired by the proposed action.**

The project site is on previously disturbed soil/cinder that is regularly accessed for normal maintenance and operation activities. Public visitors may also occasionally walk across the area. CMS does not anticipate any degree of disturbance or impacts to any traditional and customary Native Hawaiian rights, but will conduct formal consultation on this project with Kahu Ku Mauna.

As described in previous sections, CMS anticipates no negligible impact to any natural resources and intends to benefit the natural resources.

### **What feasible action, if any, could be taken by the Board of Land and Natural Resources regarding your application to reasonably protect Native Hawai'i rights?**

The applicant defers to OCCL on feasible actions to reasonably protect Native Hawai'i rights that may be affected by this proposed use.

## CHAPTER 205A – COASTAL ZONE MANAGEMENT

Land uses are required to comply with the provisions and guidelines contained in Chapter 205A, Hawai'i Revised Statutes (HRS), entitled "Coastal Zone Management," as described below:

- **Recreational resources:** Provide coastal recreational opportunities accessible to the public.
- **Historic resources:** Protect, preserve, and, where desirable, restore those natural and manmade historic and prehistoric resources in the coastal zone management area that are significant in Hawaiian and American history and culture.
- **Scenic and open space resources:** Protect, preserve, and, where desirable, restore or improve the quality of coastal scenic and open space resources.
- **Coastal ecosystems:** Protect valuable coastal ecosystems, including reefs, from disruption and minimize adverse impacts on all coastal ecosystems.
- **Economic uses:** Provide public or private facilities and improvements important to the State's economy in suitable locations.
- **Coastal hazards:** Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion, subsidence, and pollution.
- **Managing development:** Improve the development review process, communication, and public participation in the management of coastal resources and hazards.
- **Public participation:** Stimulate public awareness, education, and participation in coastal management.
- **Beach protection:** Protect beaches for public use and recreation.
- **Marine resources:** Promote the protection, use, and development of marine and coastal resources to assure their sustainability.

## CERTIFICATION

I hereby certify that I have read this completed application and that, to the best of my knowledge, the information in this application and all attachments and exhibits is complete and correct. I understand that the failure to provide any requested information or misstatements submitted in support of the application shall be grounds for either refusing to accept this application, for denying the permit, or for suspending or revoking a permit issued on the basis of such misrepresentations, or for seeking of such further relief as may seem proper to the Land Board.

I hereby authorize representatives of the Department of Land and Natural Resources to conduct site inspections on my property. Unless arranged otherwise, these site inspections shall take place between the hours of 8:00 a.m. and 4:30 p.m.

---

*Signature of authorized agent(s) or if no agent, signature of applicant*

## AUTHORIZATION OF AGENT

I hereby authorize *Click or tap here to enter text.* to act as my representative and to bind me in all matters concerning this application.

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*Signature of applicant(s)*

## Prepare to Start the Project

- Identify and comply with other permit requirements, such as County of Hawai'i building permits or Department of Land & Natural Resources permits (see *both*/any applicable DLNR permit and [HAR §13-5-42 Standard conditions](#)).
- Use of real-time GPS during any surveying or equipment operation requires advance written approval from CMS and the Institute for Astronomy. GPS use should be requested at least four (4) weeks prior to the proposed activity.
- Any required Best Management Practices, Communication Plans, contract scope questions, etc. must be finalized and approved by CMS prior to final approval.
- No project work may commence before CMS provides a final, written notice explicitly stating whether the project is approved to commence (i.e., issue a "Notice to Proceed"). The Notice to Proceed will include any additional, project-specific conditions.
- Project approval may not be transferred or assigned without prior authorization. A copy of the approval/permit must be present on-site and available for review at all times while working on UH-managed lands.
- Applicant shall comply with all actions and measures described in the proposal, including (community) benefits, CMP compliance list, and mitigation measures.

## Notifications

- Applicant may request to arrange a pre-construction meeting with CMS before work commences. These meetings review orientation content, implications of project non-compliance, project-specific concerns regarding resource protection, health and safety, visitor and/or traffic impacts, etc. Meetings may be held in person or via phone, webinar, or other means.
- Notify CMS in writing via email to [cmsshilo@hawaii.edu](mailto:cmsshilo@hawaii.edu) at least five (5) days prior to beginning field work on UH-managed lands (Halepōhaku, Road Corridor, Maunakea Science Reserve) with the following:
  - Identify the date that onsite work will commence.
  - Identify by name-of-entity all observatories, contractors, vendors, suppliers, etc. anticipated to be associated with and substantively present on UH-managed lands for the project.
  - Identify the individual(s) who will be coordinating all invasive species inspections.
  - Attest that the observatory or relevant entity will ensure compliance with all permit conditions and communicate with CMS if there is any uncertainty.
  - Notify CMS in writing of any other entities responsible for elements of compliance.
  - Attest that all individuals anticipated to be associated with the project have completed the Maunakea User Orientation.
  - CMS is not liable or responsible for delays due to inadequate or late submissions.

## Onsite Activity

### General

- Use of lighting anytime between sunset to sunrise is prohibited unless described in the project proposal and approved.
- Use of cellphones, other than in airplane mode, is prohibited except in case of emergency.

- Placement of permanent markers, monuments, mag nails, or survey pins, etc. is not allowed without explicit prior approval from CMS (and the State if required). ALL surveyors' work must be shared with CMS in digital format with coordinate info stored in and using a common, transferrable coordinate reference system such as "State Plane Coordinates (NAD83), Hawai'i Zone 1".
- Allow CMS Rangers to visit and monitor activities.

### Transportation and Motorized Equipment

- No use of mechanized equipment is allowed unless authorized by this permit.
- 4-wheel-drive required for travel above Halepōhaku.
- Large, heavy, non-4-wheel-drive or oversized loads must submit notification to the Maunakea Road Conditions listserv, [MK-ROAD-CONDITIONS@lists.hawaii.edu](mailto:MK-ROAD-CONDITIONS@lists.hawaii.edu), at least one day prior to transit. Loads requiring an escort on public roadways must have this escort accompany them to the final destination. Projects failing to submit notification or arrange for escort to the summit may be denied entry to Halepōhaku or above.
- During public closures of the Summit Access Road, vehicle access above Halepōhaku is limited to explicitly-marked observatory, CMS, federal, or state of Hawaii vehicles. Vehicles must be operated by approved employees or representatives on official business and possessing requisite orientation, training, safety, and rescue supplies.
- Motorized equipment, when stationary, must have a drain-pan in place suitable for catching fuel or fluid leaks.

### Debris Prevention and Severe Weather Concerns

- Ensure that any debris, tools and equipment are secured to avoid becoming windblown and are properly stored at the end of each day.
- Projects occurring in the summit region must verify that temporary and permanent infrastructure and improvements can sustain 120 MPH winds and severe weather.

### Environmental Concerns

- All perishable items including food and food containers/wrappers must be removed from the site daily and properly disposed of.
- Properly dispose of all waste material.
- Federal law prohibits feeding or any "taking" (e.g., harassing, harming, killing) of endangered species, including the following which may occur on Maunakea. Employ the following Best Management Practices for species protection:
  - Nēnē, Hawaiian goose (*Branta sandvicensis*). If a nēnē appears within 100 feet (30.5 meters) of ongoing work, all activity shall be temporarily suspended until the animal leaves the area of its own accord.
  - Seabirds, including the endangered Hawaiian petrel (*Pterodroma sandwichensis*)
    - Use red light bulbs outside to the maximum practicable extent.
    - Fully shield outdoor bulbs so the light is only visible from below.
    - Install motion sensors or turn off lights when human activity is not occurring in the area.
    - September-December: Avoid nighttime construction.
  - 'Ōpe'ape'a, Hawaiian Hoary Bat (*Lasiurus cinereus semotus*)
    - Avoid radio-frequency emissions where 'ōpe'ape'a may be present.
    - No barbed-wire fencing allowed.
    - June-November: Do not trim, remove, or disturb trees over fifteen (15) feet in height.

## Invasive Species Prevention

- Employ invasive species prevention best practices, including inspections of materials by a DLNR-approved biologist, as identified in the Maunakea Invasive Species Management Plan, prior to entering UH-managed lands.
  - Inspections can only occur at locations where landowners have given permission (i.e. facilities, baseyards, and vendor locations).
  - Inspections shall not occur on/along the Maunakea lands, at State or County parks, along public roadsides, or on Department of Hawaiian Homelands lands.

## Upon Project Completion

- The project must be completed within the time frame specified in the proposal and, when applicable, as specified by DLNR. Projects that cannot be completed within this timeframe are not allowed to continue (or commence) without explicit prior written approval from CMS.
- Notify CMS in writing when field activity associated with the project is completed.
- Unless otherwise stated in the proposal, copies of all data, field notes, photos, log books, collected specimens, and other forms of documentation will be shared with CMS for future, unrestricted use by CMS or its designee. All geospatial data, metadata or applications must be in a format compatible with CMS GIS software or other industry standard identified in advance.
- Collected specimens that are not consumed in analysis will be returned to CMS unless otherwise specified.
- Provide CMS with electronic and paper copies of all publications resulting from the work. When applicable, annual, final reports must be submitted to CMS.
- When applicable, a brief, approximately 1-page, non-technical summary suitable for public outreach (school groups, community meetings, newsletter articles, etc.) must be provided to CMS within 90 days of project completion or publication. Photos and illustrations are encouraged.

# Nature Trail Plan for Halepōhaku and the Mid-Elevation Facilities on Maunakea, Hawai‘i



CENTER FOR MAUNAKEA STEWARDSHIP



University of Hawai‘i at Hilo

**CENTER FOR  
MAUNAKEA  
STEWARDSHIP**



Prepared by: Justin Yeh, Taylor Warner, and Anuheia Robins  
April 2024

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## 1. Foreword

Maunakea embodies a rich tapestry of cultural, scientific, and ecological significance. As the University of Hawai'i enters a new era of management, the Center for Maunakea Stewardship (CMS) seeks to honor Maunakea's history, ecology, and future potential. This restoration plan aims to restore the subalpine māmane (*Sophora chrysophylla*) woodlands around Halepōhaku, and provide educational and support services for astronomy, conservation, and preservation efforts.

### 1.1 Goals

- 1) **Establish native plant species:** Implement strategic outplanting and nonnative species removal to promote native species recovery.
- 2) **Expand the CMS greenhouse:** Enhance capacity for the propagation of native plants to support restoration efforts on Maunakea.
- 3) **Construct a self-guided educational trail:** Create a trail to educate visitors on Maunakea's history, ecology, and cultural significance.
- 4) **Build a gathering space at Halepōhaku:** Establish a space for collaboration, reflection, and community engagement.

### 1.2 Vision

Maunakea, a revered mountain, where landscape, community, and culture combine to inspire discovery, renewal, and world-class education and research. (Planning Solutions 2022)

### 1.3 Mission

Sustainably steward Maunakea for the benefit of our communities, Hawai'i, and the world, as a publicly-accessible learning landscape where all who visit learn, and those who seek something more discover through rich multi-cultural experiences and engaging multi-disciplinary discourse. Provide equal opportunities across the schools of the UH system and community partners to engage with the mauna in ways that perpetuate and advance knowledge, wisdom, and values while fostering mutual understanding and respect. (Planning Solutions 2022)

### 1.4 Approach

CMS serves as a catalyst for connection, bridging the realms of earth and sky, past and present. Through immersive experiences and storytelling, CMS shares Maunakea's cultural, ecological, and spiritual significance, igniting curiosity and reverence among visitors. In collaboration with volunteers, conservation organizations, and cultural practitioners, CMS strives to foster a sense of belonging and shared responsibility for Maunakea's well-being. By honoring tradition and embracing inclusivity, CMS aims to steward knowledge and inspire appreciation for this extraordinary landscape.

## 2. History of Maunakea, Halepōhaku, and the Maunakea Science Reserve

It is important to first recognize our connections to places. One way is through mo'okū'auhau (genealogies), which shape us through familial, intellectual, and organizational history. Once we recognize our connections to place we must also recognize our kaikua'ana and kaikaina (intergeneration and interdependent) relationships. Understanding our place in these relationships will help us find our kuleana (responsibilities and privileges). The history of Maunakea we share in this document details CMS's mo'okū'auhau and describes our place in relation to the mauna and the responsibilities we have as stewards of Maunakea.

### 2.1 Cultural History of Maunakea

In the Hawaiian worldview, natural and cultural resources were one in the same; the well-being of one depended on the other. Native traditions describe the formation of the heavens, the islands, and all forms of life and nature, in the context of a genealogy (Maly & Maly, 2005). "The epic Kumulipo", Beckwith (1951) explains, "is a genealogical prayer chant linking the royal family to [...] the stars in the heavens and the plants and animals useful to life on earth...". Maunakea is referred to as "Ka Mauna a Kea" (Wākea's Mountain or Wākea's son), and it is considered the first-born child of the island of Hawai'i according to genealogical accounts (Pukui & Korn, 1973); "its integrity and sense of place depends on the well-being of the whole entity, not only a part of it" (Maly & Maly, 2005).

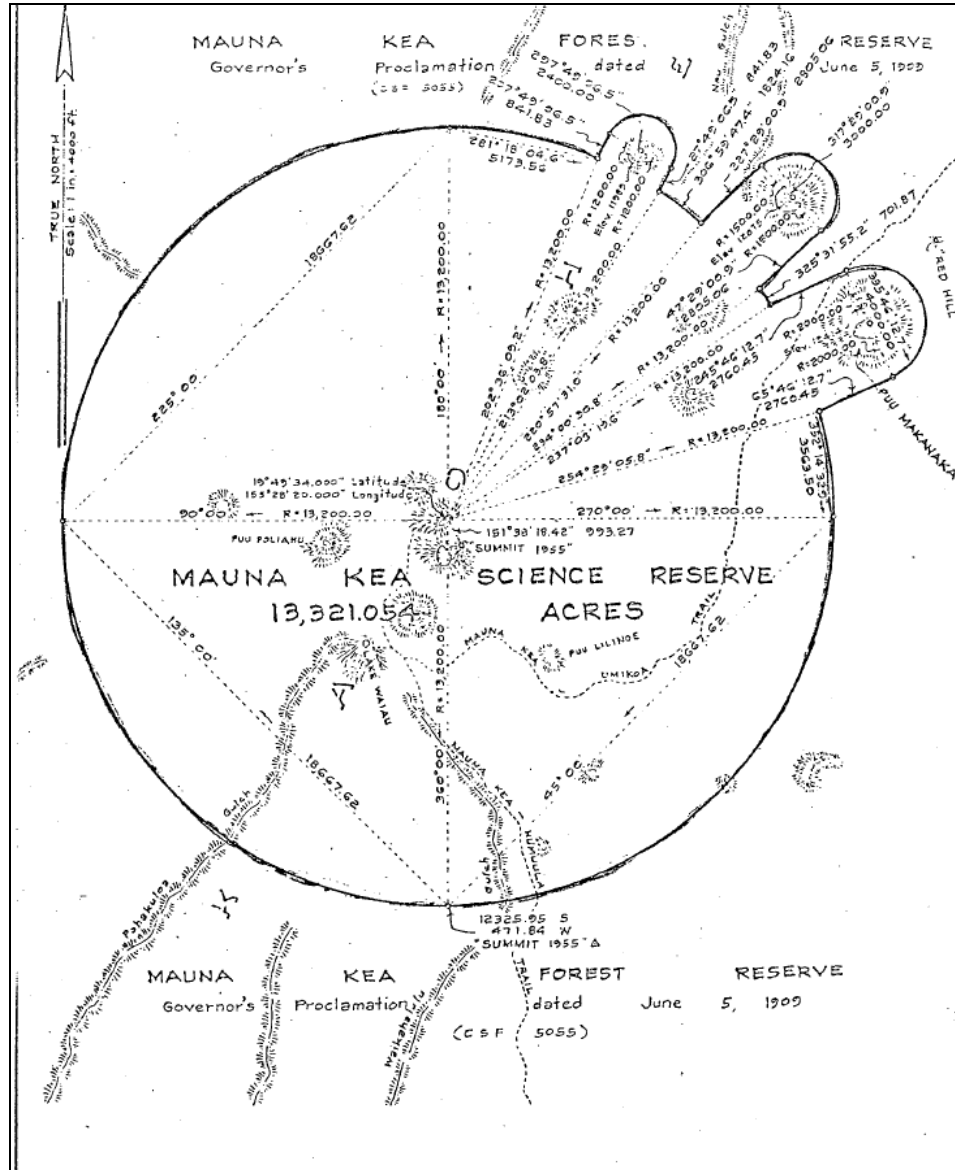
The main body of Maunakea resides in the moku-o-loko, or primary land division, of Hāmākua. Within the Maunakea portion of Hāmākua is the ahupua'a, or secondary division of land, is known as Ka'ohe, whose stewards had the sole privilege of capturing 'ua'u (Hawaiian Petrel, *Pterodroma sandwichensis*) (Maly & Maly, 2005). The name Ka'ohe can be translated as "the bamboo", or named for a type of kalo (taro) that may have been common in the region (Pukui et al., 1974). The moku-o-loko of Hilo also crosses Maunakea land and runs parallel to the main division known as the ahupua'a of Humu'ula. The land of Humu'ula is named for a type of stone (red jasper stone) that was used in making ko'i (adze).

Maunakea was frequented by travelers who came to the upper regions of Maunakea to worship, gather stone, bury family members, or deposit piko (umbilical cords of new-born children) in sacred and safe areas; and by those who were crossing from one region of the island to another (Maly & Maly, 2005). Travel across the 'āina mauna (or mountain lands) is documented in native traditions, which describe ala hele (trails) that approached Maunakea from all moku-o-loko of Hawai'i island, except Puna.

As early as the 1820s, introduced cattle (*Bos taurus*), sheep (*Ovis aries*), goats (*Capra hircus*), and wild dogs (*Canis familiaris*) had made their way up to the mountain lands, significantly altering the natural-cultural landscape of Maunakea (Maly & Maly, 2005). By 1857, Humu'ula and Ka'ohe (which includes the summit of Maunakea) were leased to Francis Spencer and the Waimea Grazing and Agricultural Company (and later leased to Parker Ranch in 1870), which established ranching stations and operations around the mountain lands. As a result, the 'āina mauna has been intensively ranched for more than 150 years (Maly & Maly, 2005). Much of the land leased to Parker Ranch was later turned over to the Territory of Hawai'i in 1905, in part to create the Mauna Kea Forest Reserve and the Pōhakuloa Military installation (Governor's Executive Order No. 1719; and Presidential Executive Order No. 1167). The lease took in all of the mountain lands from the summit of Maunakea, across Ka'ohe, to the Maunaloa boundary.

## *2.2 History of University of Hawai'i Management on Maunakea*

In the 1960s, Hawai'i began economic development projects in the wake of the tsunamis that devastated Hilo in 1940 and 1965. Maunakea was proposed as a site for a telescope, given its great astronomical potential. In 1968, the University of Hawai'i was granted a lease from the recently inaugurated State of Hawai'i of 13,321.054 acres for a term of sixty-five (65) years to establish the Maunakea Science Reserve (MKSR), allowing an observatory to be built/operated in the MKSR under certain terms (General Lease No. S-4191; see Figure 1).



**Figure 1.** Map of the 1968 General Lease No. S-4191, Mauna Kea Science Reserve (State of Hawai‘i, 1968).

The Mauna Kea Plan was adopted in 1977 due to the expansion of astronomy on Maunakea, to control development and resolve conflicting interests between various users. The plan laid out responsibilities for the Department of Land and Natural Resources (DLNR), UH, and the Department of Transportation (DOT). In 1980, the “Halepōhaku Mid-Elevation Facilities Master Plan: Complex Development Plan” was created, assigning UH as the caretakers of the newly built Halepōhaku Mid-Elevation Facilities and Visitor Information Station (VIS; Group 70, 1983). In 1985, the Board of Land and Natural Resources (BLNR) approved the University’s “Mauna Kea Management Plan” with the condition that UH was to incorporate commercial tour activities in the plan (University of

Hawai'i, 1985). This initial management plan addressed UH's responsibility to protect the summit's resources and manage/control visitors to the summit area.

In 1995, BLNR approved the "Revised Management Plan for the UH Management Areas on Mauna Kea" and was adopted by UH and the DLNR. The revised plan tasked UH with managing access to the MKSR, the activities at Halepōhaku and the VIS, regulating commercial tour permit activities, and other special responsibilities on UH managed land (DLNR, 1995). In 1981, the Mauna Kea Ice Age Natural Area Reserve (MKIANAR) was established following the withdrawal of 2,033 acres from the MKSR (Executive Order No. 8101). In 1997, the MKSR 65-year lease was modified to exclude MKIANAR lands, leaving the remaining 11,288 acres under UH management (Executive Order No. 3710). An audit of the management of Maunakea by DLNR found that UH inadequately protected the natural resources of the MKSR. In response, UH produced a master plan that developed rules and regulations, and assessed the impact of each project in the context of the overall footprint on Maunakea.

The "Mauna Kea Science Reserve Master Plan" was approved by the UH Board of Regents (BOR) in 2000. This plan includes a new community-based management structure including the establishment of the Office of Maunakea Management (OMKM) and two community volunteer boards, the Maunakea Management Board (MKMB) and the Native Hawaiian Advisory Council Kahu Kū Mauna (KKM) (Group 70 International, Inc., 2000). The Master Plan limited development to a 525-acre area referred to as the Astronomy Precinct, and designated the remaining 10,700 acres as a cultural and natural preserve.

OMKM developed the Mauna Kea Comprehensive Management Plan (CMP) in 2006 and was approved by the BLNR in 2009. The CMP delineates the natural, cultural, and historic resources on UH managed lands; provides objectives for the protection of those resources; and implements and enforces a permit and sublease monitoring system for astronomy precinct observatories (Ho'akea, 2009). In 2009, Hawai'i State Legislature passed Act 132 granting UH the authority to develop administrative rules consistent with DLNR.

In 2010, the Cultural Resources Management Plan, Natural Resources Management Plan, Decommissioning Plan for Maunakea Observatories, and Public Access Plan for the Management Areas on Maunakea were developed. Consistent with the management plans developed, OMKM created the Maunakea Invasive Species Management Plan, a subplan to the CMP. The plan addresses prevention, early detection, monitoring, rapid response, and control of invasive species. Implementation of the plan began in 2012 and is still ongoing today (Vanderwoude et al. 2015).

In August of 2020, the Center for Maunakea Stewardship (CMS) was established, which combined OMKM and Maunakea Shared Services (MKSS), and formalized the collaborative roles for the UH Institute for Astronomy (IFA) and UH Hilo 'Imiloa Astronomy Center. CMS is responsible for the day-to-day management of UH managed lands, that is, the

mid-level facilities at Halepōhaku, the Summit Access Road and its management corridor, and the Maunakea Science Reserve which includes the Astronomy Precinct.

In 2022 the University of Hawai'i Board of Regents adopted E Ō I Nā Leo (Listen to The Voices) Master Plan for the University of Hawai'i Maunakea Lands Volume 1 and 2. In addition to The Board of Regents, The Board of Land and Natural Resources adopted the Comprehensive Management Plan 2022 Supplement: Management Actions Update Volume 1 and 2.

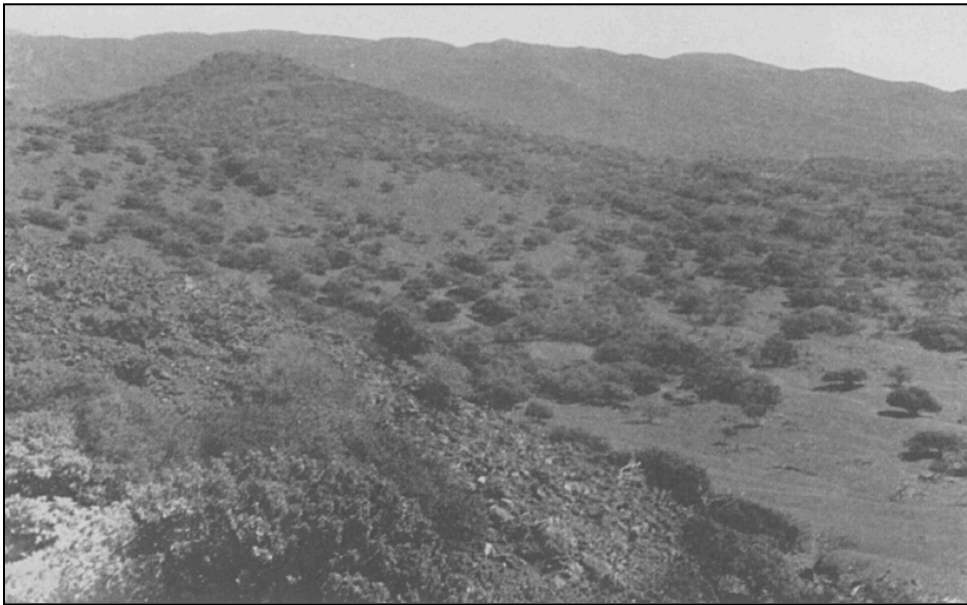
### 2.3 Historical Plant Ecology

Reverend Joseph Goodrich made the first recorded western ascent of Maunakea in 1823 (Goodrich, 1826; Hartt & Neal, 1940). There were five regions of vegetation that Goodrich noted on his trip from the coast (through Waimea) to the summit of Maunakea: a region of cultivation in the first five to six miles; a sandy region with large ferns; a thick forest 10 to 20 miles in width, a savannah-like pasture region where he found grasses, strawberries and raspberries; and a final zone of barren lava (Goodrich, 1826; Hartt & Neal, 1940). Goodrich mentions herds of cattle that he encountered on Maunakea and it is likely that the native flora was already altered by ungulates during this time (Goodrich, 1826; Ellis, 1963). Other early records describe the upper forest, shrublands, and summit region of Maunakea.

In 1940, Hartt and Neal characterized the upper forested region of Maunakea as equivalent to a subalpine zone, with open formations of trees, and curious growth forms in the region of the timberline (Figure 2). Rock (1913) and Hillebrand (1888) named the following as the dominant trees of the upper forest region of Maunakea: māmane (*Sophora chrysophylla*), naio (*Myoporum sandwicense*), koa (*Acacia koa*), and 'ōhi'a (*Metrosideros polymorpha*) (Hartt and Neal 1940). As the upper forested regions became sparse, Maunakea *Dubautia* (*Dubautia arborea*) and *Senecio vulgaris* became the dominant species (Hartt and Neal 1940). Above 10,000 feet, Hartt and Neal observed that Pūkiawe (*Leptecophylla tameiameia*), a shrub, became very common.

A total of 31 species of ferns and flowering plants were found above the timberline. Herbs and grasses found in the alpine zone by Hartt and Neal were *Tetramolopium humile* var. *skottsbergii*, Hawai'i bentgrass (*Agrostis sandwicensis*), sweet vernal (*Anthoxanthum odoratum*), annual bluegrass (*Poa annua*), Kentucky bluegrass (*Poa pratensis*), and pili uka (*Trisetum glomeratum*) (Hartt & Neal, 1940). Shrub species included kūkaenēnē (*Coprosma ernodeoides*) and pūkiawe. Rosette plant species observed included the Maunakea 'āhinahina (silversword; *Argyroxiphium sandwicense* subsp. *sandwicense*), bull thistle (*Cirsium vulgare*), Hawaii wood-rush (*Luzula hawaiiensis*), makou (*Peucedanum sandwicense*), sheep sorrel (*Rumex acetosella*), woodland ragwort (*Senecio sylvaticus*), and dandelion (*Taraxacum officinale*) (Hartt & Neal, 1940). 'Ōhelo (*Vaccinium reticulatum*) was the highest shrub found, growing at 12,250 feet in elevation.

Above the upper forest region is considered an alpine desert where few plant species are found (Hartt & Neal, 1940). The only growth forms included lichens, bryophytes, low shrubs, rosette plants, and small diffuse herbs (Hartt & Neal, 1940). One of such plants, the Maunakea ‘āhinahina (*Argyroxiphium sandwicense* ssp. *sandwicense*), was first observed in the western scientific community by James Macrae in 1825, a Scottish botanist of the HMS Blonde, and was discovered at a point near the summit. According to Hartt and Neil (1940), the ‘āhinahina, popularly believed to be restricted to the high mountain peaks, once inhabited altitudes as low as 6,000 feet. Hartt and Neal believed that the limited vegetation in the alpine region was due to the glaciation of Maunakea.



**Figure 2.** South slope of Maunakea, altitude about 8,000 feet, showing māmane (*Sophora chrysophylla*) in open formation characteristic of the subalpine zone. Photo by C. K. Wentworth (Hartt & Neal, 1940).

#### 2.4 Current Conditions

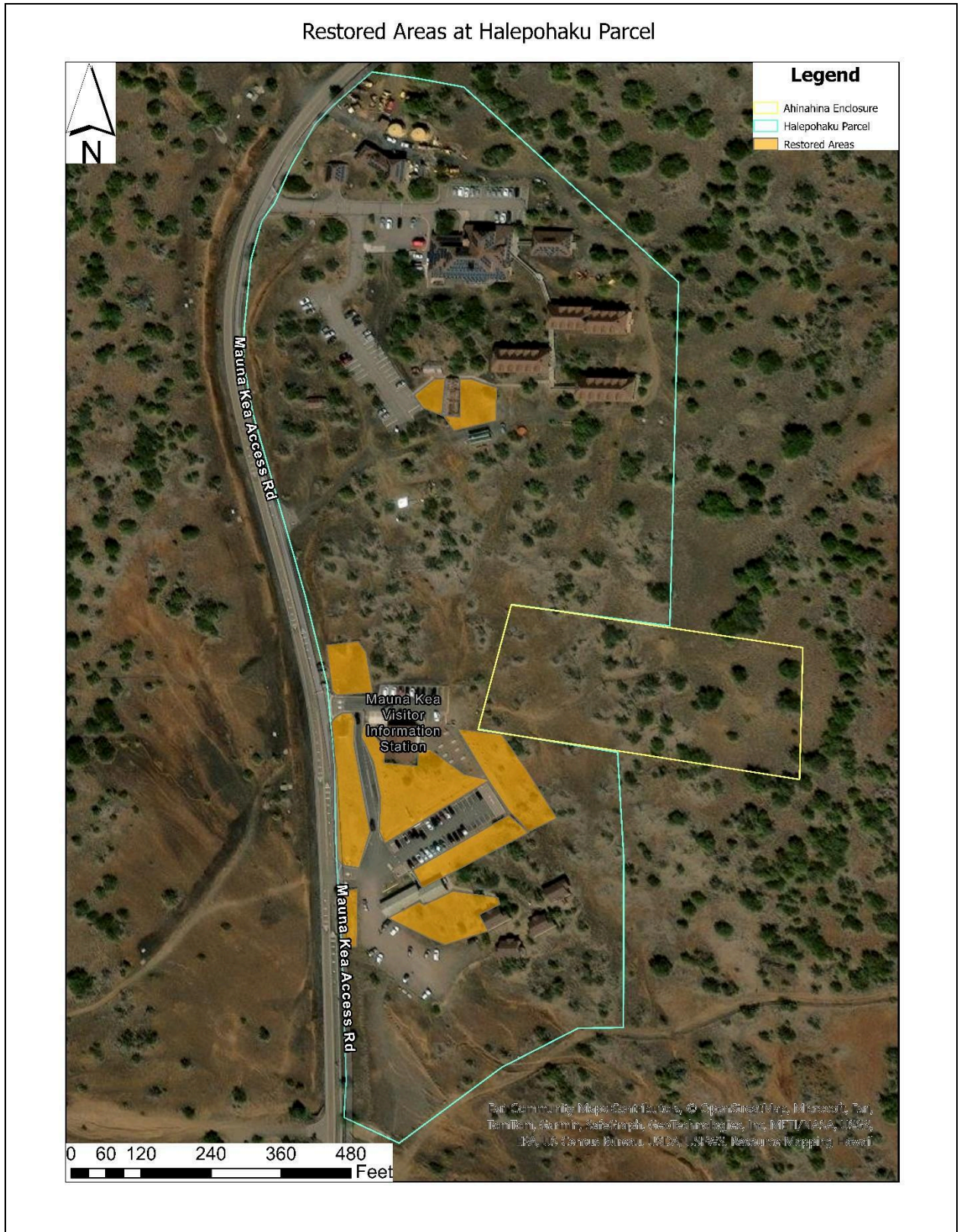
With the introduction and establishment of invasive plant species, extensive grazing by nonnative ungulates, and construction activity related to astronomy development, the land shows heavy scars of use. A baseline botanical survey was conducted in 2011 to characterize the vegetation on UH managed lands (Gerrish, 2013). Gerrish classified the 19.26-acre Halepōhaku unit and parts of the Access Road Corridor as a subalpine māmane woodland (from 9,100 to 9,800-10,100 ft (variable)) with varying substrates of sandy-ash, ‘a‘ā and rubble fields. An alpine ecosystem extends from the māmane tree-line to the summit of Maunakea. The greatest diversity of plant species found in the survey occurred in the māmane woodland, with diversity decreasing with elevation gain (Gerrish, 2013). This alpine ecosystem is characterized by pūkiawe shrublands from 9,800 ft to 11,150 ft, and an alpine stone desert with scattered grasses and ferns from 11,150 ft to 13,796 ft (Gerrish, 2013).

At Halepōhaku, the subalpine māmane woodland is defined by its open canopy of multiple stem māmane trees that vary from 2-5 meters in height. Gerrish found that while the canopy of the surveyed area was dominated by māmane, the ground cover was primarily composed of introduced grasses and herbs [such as fireweed (*Senecio madagascariensis*), mullein (*Verbascum thapsus*), rescue grass (*Bromus catharticus*), ripgut (*Bromus diandra*) and wallaby grass (*Rytidosperema semiannulare*)] to the extent that it was not a native or “natural” plant community (2013). The native shrub cover of pūkiawe and nohoanu (*Geranium cuneatum*), and native grasses (*Agrostis sandwicensis*, *Trisetum glomeratum*, and *Deschampsia nubigena*) are less extensive in the area surrounding Halepōhaku (Gerrish, 2013).

Forest restoration efforts at Halepōhaku began in 2018 to mitigate the environmental impacts of the VIS ingress/egress project, which helped to alleviate traffic and provide a safer turnaround and parking area for visitors. A greenhouse was constructed near Halepōhaku to grow plants on site to replace the estimated 60-65 māmane trees removed due to the project’s construction. CMS has since focused on eradicating invasive and introduced species, and planting native species around Halepōhaku and the VIS. The greenhouse at Halepōhaku was completed in 2020, and CMS is able to propagate native plant seedlings to increase outplant production. It has also led to a partnership with the DLNR and their rare plant program to propagate ‘ahinahina for outplanting efforts done around the circumference of Maunakea. The greenhouse has been revolutionary in terms of CMS’s capacity to restore native plant communities in the subalpine and alpine regions of Maunakea.

With the increased capacity for native plant propagation, community volunteer days were initiated to help clear new outplanting sites, and volunteers have since removed over 10,000 pounds of weeds each year. Within a few years, a total of 148 ‘āweoweo (*Chenopodium oahuense*), 182 māmane, 16 pāwale (*Rumex giganteus*), 4 native grasses, and 33 pua kala (*Argemone glauca*) were outplanted around the VIS (restoration areas shown in Figure 3).

Current natural resource management strategies on UH managed lands have largely been focused on invasive species monitoring and prevention. Adjoining current management practices, CMS proposes implementing a small-scale restoration project for the 19.26-acre Halepōhaku parcel. Restoration and replanting of native species helps to limit revegetation with invasive species and acts as a prevention method. This restoration plan reflects CMS’s shift towards a more biocultural, integrating both natural and cultural resources, managerial approach to better represent the perspectives and needs of the beneficiaries of Maunakea, and to maintain its integrity and sense of place as a sacred mountain.



**Figure 3.** Map of the current restoration areas (highlighted in orange) in the Halepōhaku parcel.

### 3. Why Should CMS Restore Halepōhaku?

Our kuleana is defined by our history and is developed in our comprehensive management plan. This section helps define our organization's kuleana.

This restoration plan aligns with CMS's mission to preserve the cultural landscape and natural resources of Maunakea while fostering collaboration, education, and sustainable stewardship. The Master Plan for University of Hawai'i Maunakea Lands *E Ō I Nā Leo* (Planning Solutions, Inc. & Ho'okuleana, LLC, 2022) outlines key objectives and goals for stewardship, including:

1. Responsibilities to Native Hawaiians: Embrace responsibilities to Native Hawaiians, respecting their religious and cultural practices.
2. Protection of Landscape: Dedicate resources to protect the landscape, flora, and fauna, consistent with the Comprehensive Management Plan (CMP) and recognizing Maunakea's status as a National Natural Landmark.
3. Support for Non-Astronomy Research: Support non-astronomy research and educational activities for which Maunakea is well-suited.

#### 3.1 CMP Management Actions

Per the CMP, CMS is committed to meeting sets of management actions for 12 different subject areas. The goals and objectives of this restoration plan will hit management actions within six of the subject areas as summarized below (see Table 1 for a complete list):

##### 3.1.1 Education and Outreach (EO):

- Develop an education trail and recreation area around Halepōhaku and the Visitor Information Station (VIS).
- Touch upon CMP objectives including signage and interpretive features improvement, expanding outreach partnerships, incorporating community input, and increasing stewardship participation.

##### 3.1.2 Activities and Uses (ACT):

- Restoration of native habitat and educational trail to increase sustainable usage, aligning with access management guidelines and enforcement of administrative rules.

##### 3.1.3 Operations and Implementation (OI):

- Restoration plan development in consultation with relevant agencies and boards.
- Maintain roles of CMS, Maunakea Management Board (MKMB), and Kahu Kū Mauna (KKM), and expand stakeholder interaction.

##### 3.1.4 Facility Planning and Guidelines (FLU):

- Implement facility planning using baseline studies and outplant monitoring efforts.
- Incorporate habitat mitigation plans into project planning processes.

### 3.1.5 Native Hawaiian Cultural Resources (CR):

- Implement CMP actions for Native Hawaiian Cultural Resources through educational trails, signage, and sustainable plant use.
- Engage with Native Hawaiian communities and conduct educational efforts for public awareness and cultural preservation.

### 3.1.6 Natural Resources (NR):

- Expand utilization of Halepōhaku to address natural resource objectives including threat limitation, invasive species management, native biodiversity preservation, climate change adaptation, and habitat restoration.
- Incorporate mitigation plans, conduct habitat rehabilitation, and enhance communication and collaboration for natural resource management.

## **4. Goals and Objectives**

CMS plans to restore the subalpine māmane woodland habitat at Halepōhaku (19.26 acres total) to promote native species recovery, reduce levels of invasive vegetation, and expand education opportunities and collaborations between the various users of Maunakea. The four main goals are to 1) establish native plant species through outplanting and the removal of nonnative species, 2) expand the CMS greenhouse, 3) construct a self-guided educational trail, and 4) build a gathering space at Halepōhaku (see Figure 4 for a map of the proposed restoration area, educational trail, greenhouse, and gathering place).

### *4.1 Native Species Habitat Restoration*

The subalpine māmane woodlands at Halepōhaku is currently dominated by an understory of introduced grasses and herbs that preclude the establishment of native species (Gerrish, 2013). Introduced plant species suppress native forest regeneration through competition for space, light, water, and other nutrients, and can alter landscapes, light regimes and hydrological cycles (D'Antonio & Vitousek, 1992). CMS seeks to restore the māmane woodlands at Halepōhaku to a point where it is a native-dominated community with secure populations of native plant and animal species (e.g. invertebrates and forest birds). Native species habitat restoration at Halepōhaku will increase biological diversity, native wildlife habitat, and opportunities for outdoor recreation. Another primary reason to restore the native vegetation at Halepōhaku is to educate the public and visitors about what the area may have looked like historically before the introduction of invasive species and anthropogenic-driven changes (Gerrish, 2013). Restoration efforts will rely on environmental education and service learning projects to make this a community-involved reforestation and stewardship project.

This restoration cannot proceed without significant control of introduced species. CMS will begin by removing herbaceous and woody nonnative species and by reintroducing native canopy and understory species through the outplanting of seedlings and broadcast seeding. After two years of the initial overstory plantings, less common species will be

outplanted and CMS staff will begin to eradicate the nonnative grasses and broadcast native grass seeds. Our goal is to reduce nonnative species and maintain low population densities after a few years of control work. The workload will drop significantly after initial control and continued follow-up treatment will be required.

Our restoration efforts will be coupled with an outplant monitoring program and vegetation surveys to help track plant growth and survival, and measure landscape changes over time. Natural regeneration (or the presence of established offspring) of outplanted individuals will indicate that restoration efforts are successfully working towards increasing native plant populations. Plant monitoring and vegetation surveys would also provide opportunities for collaborations with researchers and land managers to analyze the effectiveness of different management strategies regarding invasive species management and native plant reforestation. There could even be an opportunity to study the effects of an educational trail on the public's perception of the mauna and land management on Maunakea.

Specifically native plant restoration of the Halepōhaku parcel will be completing the following management actions from our CMP: EO-6, EO-7, EO-8, OI-3, FLU-3, FLU-6, NR-2, NR-3, NR-4, NR-7, NR-9, NR-10, NR-11, NR-12, NR-13, NR-14, NR-15, and NR-16 (please see Table 1 for specific management action descriptions). Through the restoration of the subalpine māmane woodlands, we would be able to gain input from experts, create sites where we would be mitigating future development in the area, collaborate with different agencies on restoration, and establish areas of higher biodiversity.



#### 4.2 Expand CMS Greenhouse

The existing CMS greenhouse (dimensions: 32 ft by 12 ft) is located at Halepōhaku at an elevation of 9,200 ft, and was constructed in 2020 by community members and CMS staff as part of the mitigation plan for the VIS ingress-egress project. Rather than outsourcing plants for restoration elsewhere and risking the introduction of pests and diseases, the CMS greenhouse has played an important role in providing a pest-free and clean environment to grow native seedlings adapted for subalpine and alpine ecosystems. A recent study at Haleakalā on the ‘āhinahina (*Argyroxiphium sandwicense* subsp. *macrocephalum*) found that propagating this species at a high-elevation greenhouse (9,842 ft) enhanced drought resistance and survival when compared to a lower elevation greenhouse (7,004 ft) (Krushelnycky et al., 2020).

Native seedlings are grown in the CMS greenhouse from seeds collected around Halepōhaku. Current plants in propagation include: māmane, pilo (*Coprosma montana*), ‘ūlei (*Osteomeles anthyllidifolia*), ‘a‘ali‘i (*Dodonaea viscosa*), ‘āweoweo, ‘āhinahina, ‘ōhelo, puakala, and pāwale. The CMS greenhouse is considered to be one of the most productive propagation centers for the Maunakea ‘āhinahina. Since 2020, the greenhouse has produced over 580 native plants, 100 of which were ‘āhinahina grown in partnership with DLNR. The 100 ‘āhinahina will be outplanted on the east side of Maunakea in a fenced enclosure to help build up genetic diversity within the species. However, the greenhouse at Halepōhaku is limited in table space, and therefore limited in capacity to propagate native plants.

Expanding the capacity of the CMS greenhouse, by building an additional larger greenhouse, would accommodate for greater native plant propagation, support the ongoing partnership with DLNR, and aid in meeting the management goals outlined in the CMP. With a larger greenhouse, CMS staff would be able to increase the amount of native seedlings grown each year and increase outplant production for this proposed restoration plan. In addition to increasing seedling production, the greenhouse and other resources available at Halepōhaku should be utilized to build relationships with different restoration and conservation organizations as stated in the CMP. By constructing another greenhouse, CMS could provide table space for other organizations working to restore native forests on Maunakea within the subalpine and alpine ecosystems to utilize. Potential organizations that could benefit from a high-elevation greenhouse include the DLNR, Mauna Kea Watershed Alliance (MKWA), Department of Hawaiian Home Lands (DHHL), and the Mauna Kea Forest Restoration Project (MKFRP). CMS seeks to support more environmental preservation around Maunakea to service a broader range of stakeholders.

Expanding the greenhouse would help support CMS’s native plant restoration efforts as well as completing the following management actions from the CMP: EO-6, EO-8, OI-3, FLU-3, FLU-6, NR-1, NR-2, NR-3, NR-4, NR-5, NR-6, NR-9, NR-10, NR-11, NR-12, NR-13, NR-14, NR-15, and NR-16 (please see Table 1 for specific management action descriptions). By creating more space to propagate native species we will have an opportunity to increase

native plant diversity, try new native species not previously recorded at that high of elevation, partner with organizations to help support an ecosystem level approach, and mitigate the ground disturbance through increased outplanting efforts.

#### *4.3 Educational Trail*

Designed in collaboration with the CMS Education and Outreach Coordinator, CMS proposes to build an educational trail at Halepōhaku. This trail would provide self-guided tours through signage, and a trail system that runs through key features in Halepōhaku such as the stargazing area, the historical stone cabins, native plant habitat, the ‘āhinahina enclosure, and the VIS. The primary purpose of the educational trail is to increase knowledge, environmental awareness, and to instill a sense of respect and wonder among all visitors, employees and island residents for Maunakea’s natural, spiritual, cultural, and scientific resources (Sustainable Resources Group Intn’l, Inc. et al., 2010). This educational trail would support the Public Access Plan (PAP), a subplan of the CMP, which provides principles and policies for CMS to manage public, recreational, and commercial activities on UH managed lands (Sustainable Resources Group Intn’l, Inc. et al., 2010).

An educational trail will 1) mitigate and relieve pedestrian traffic at Halepōhaku and on the Maunakea Access Road, 2) encourage proper acclimation for those traveling to the summit with educational activities, 3) provide safer passage to DLNR trails on the west side of the Maunakea Access Road, and 4) educate visitors on the importance of the cultural and natural resources on Maunakea. The educational trail will run through the plant restoration area with marked stations (or stops) at points of natural or cultural interest. These marked stations will convey information to the public about the cultural aspects and history of nearby significant features, flora and fauna within the subalpine māmane woodlands ecosystem at Halepōhaku (i.e., highlight ka’ao, mele, ‘oli, and ‘ōlelo that call to these species and spaces. Emphasize all disciplines of ecology, hydrology, geology, archaeology, history, botany, ornithology, entomology, and climatology) and call out other features of Maunakea that may not be visible from Halepōhaku (i.e., lake Waiau, summit pu‘u, keanakāko‘i, permafrost, wēkiu bug, glacial remnants, etc.).

Currently, the infrastructure at Halepōhaku cannot properly accommodate all visitors during peak visitation periods and can hinder visitors from accessing the educational exhibits, videos, and interactive displays available at the VIS. The proposed public educational trail will provide more public activities at lower elevations to dissipate crowds at Halepōhaku and the summit region, upgrade public safety and health implementations, and better control human impacts on the cultural and natural resources of Maunakea (Sustainable Resources Group Intn’l, Inc. et al., 2010).

Development of an educational trail would help to complete the following management actions from the CMP and PAP: EO-1, EO-5, EO-6, EO-7, EO-8, ACT-1, ACT-5, OI-1, OI-3, CR-1, CR-3, CR-4, NR-6, and NR-13 (please see Table 1 for specific management action descriptions). An educational trail would help us continue building relationships

with community members for the proper signage and information disseminated to the public. It would also allow us to educate the public through interactive learning and recreational activities. Having a designated trail would also help to reduce the impacts and provide safer visitation.

#### *4.4 Gathering Space*

As CMS shifts towards a biocultural management approach, Halepōhaku needs a designated space to cultivate and facilitate the relationship between people, culture, and the natural world. A gathering space would effectuate CMS's intent to increase communication, networking, and collaborative opportunities with stakeholders, community members, and surrounding landowners regarding the management and outreach education of Maunakea's natural and cultural resources.

The proposed gathering space will serve as a designated place for the Natural Resource and Education and Outreach programs to host visitors and community groups, and potentially, be the new VIS stargazing area. As community engagement on Maunakea increases as part of the Education and Outreach Plan, the gathering space will be a meeting place for CMS-affiliated outreach and education events such as guided tours, cultural sensitivity workshops and seminars, community events, performances, and etc. The gathering space will provide a quiet location for users to develop a relationship to the natural world through the practice of kilo (meaning to watch, observe, examine or forecast). The outdoor setting will add an interactive element to the learning experience and can make it more enjoyable for participants.

Once the gathering space is constructed, it will be open to the public for uses that are consistent with CMS's mission to encourage Native Hawaiian and community involvement and programs that protect, preserve and enhance the cultural, natural, educational and scientific resources of Maunakea.

Development of a gathering space would help CMS complete the following management actions from the CMP: EO-6, EO-7, EO-8, OI-1, OI-3, FLU-3, FLU-6, CR-1, CR-3, NR-10, NR-13, and NR-14 (please see Table 1 for specific management action descriptions). Working with different community organizations, and KKM will allow us to appropriately design a gathering space that could be used by multiple organizations. Once completed the gathering space would offer a meeting space and allow for collaboration with different stakeholders.

**Table 1.** A list of the CMP management actions that would be completed via the entirety of this restoration plan.

Management Action	Description	Status
EO-4	Develop and implement a signage plan to improve signage throughout the UH Management Areas (interpretive, safety, rules and regulations)	Ongoing
EO-5	Develop interpretive features such as self-guided cultural walks and volunteer-maintained native plant gardens	Ongoing
EO-6	Engage in outreach partnerships with schools, by collaborating with local experts, teachers, and university researchers, and by working with the 'Imiloa Astronomy Center of Hawai'i	Ongoing
EO-07	Continue and increase opportunities for community members to provide input to cultural and natural resources management activities on Mauna Kea, to ensure systematic input regarding planning, management, and operational decisions that affect natural resources, sacred materials or places, or other ethnographic resources with which they are associated	Ongoing
EO-8	Provide opportunities for community members to participate in stewardship activities	Ongoing
ACT-1	Development and implement robust access management guidelines and procedures	Ongoing
ACT-5	Implement and enforce Maunakea Administrative Rules to reduce impacts of recreational hiking	Ongoing
OI-1	Maintain CMS, MKMB, and KKM in current roles, with CMS providing local management of the UH Management Areas, MKSS providing operational and maintenance services, and KKM providing cultural guidance	Ongoing
OI-3	Maintain and expand regular interaction and dialogue with stakeholders, community members, surrounding landowners, and overseeing agencies to provide a coordinated approach to resource management	Ongoing
FLU-3	Require cataloging of initial site conditions for use when conducting site restoration	Ongoing
FLU-6	Incorporate habitat mitigation plans into the project planning process	Ongoing
CR-1	UH will engage with families with lineal and cultural connections to Maunakea, Native Hawaiian customary and traditional practitioners, and other Native Hawaiian groups, including KKM, toward the development and maintenance of appropriate guidance regarding cultural issues	Ongoing
CR-3	Conducting educational efforts to generate public awareness about the importance of preserving the cultural landscape	Ongoing
CR-4	Collection of information on traditional and customary cultural practices	Ongoing

NR-1	Limit threats to natural resources through management of permitted activities and uses	Ongoing
NR-2	Limiting damage caused by invasive species	Ongoing
NR-3	Minimizing population decline and loss of native biodiversity	Ongoing
NR-4	Minimizing barriers to species migration	Ongoing
NR-5	Addressing climate change	Ongoing
NR-6	Reduce threats to natural resources by educating stakeholders and the public about Maunakea's unique natural resources	Ongoing
NR-7	Delineate areas of high native diversity, unique communities, or unique geological features within the Astronomy Precinct and at Halepōhaku, and consider protection from development	Ongoing
NR-9	Increase native plant density and diversity through an outplanting program	Ongoing
NR-10	Incorporate mitigation plans into project planning and conduct mitigation following new development	Ongoing
NR-11	Conduct habitat rehabilitation projects following unplanned disturbances	Ongoing
NR-12	Create restoration plans and conduct habitat restoration activities as needed	Ongoing
NR-13	Increase communication, networking, and collaborative opportunities, to support management and protection of natural resources	Ongoing
NR-14	Use the principles of adaptive management when developing programs and methodologies	Ongoing
NR-15	Conduct baseline inventories of high-priority resources, as outlined in an inventory, monitoring, and research plan	Ongoing
NR-16	Conduct regular long-term monitoring, as outlined in an inventory, monitoring and research plan	Ongoing

## 5. Implementation

### 5.1 Invasive plant control

#### 5.1.1 Volunteer weed pulls

Invasive nonnative plants are a threat to native species, communities, and ecosystems. The main plant species to control at Halepōhaku are fireweed, mullein, telegraph weed, rescue grass, ripgut and wallaby grass (see Table 2 and Table 3 for a list of nonnative and invasive plant species found in or in areas adjacent to UH managed lands). These species are to be targeted and removed if detected within the Halepōhaku restoration area. The restoration area will be split into first and second priority areas for weed removal.

At CMS, the control/removal of nonnative and invasive plant species is conducted by manual control or hand-weeding, where plants are pulled from the base or loosened and removed using tools such as hand picks. Hand-weeding reduces the need for herbicides and is an effective method to completely remove root systems and reduce future seed set (Motooka et al., 2002). Due to the small number of personnel in the CMS Natural Resources Program, weed pull events with community groups and volunteers will be relied on to clear large areas of the restoration site.

### 5.1.2 Herbicide application

Chemical control using herbicide is an effective method for nonnative plant removal in areas with limited foot traffic by visitors and staff (Motooka et al., 2002). As stated in the 2015 Maunakea Invasive Species Management Plan, herbicides may be necessary to complement manual control in the Halepōhaku area (Vanderwoude et al., 2015). Herbicide use in this area is expected to be limited to foliar spray of glyphosate (Roundup™) with an added surfactant (Vanderwoude et al., 2015). Foliar spray applications, where herbicide is sprayed from either a backpack sprayer or hand pump sprayer, are the most economical method of applying herbicides (Motooka et al., 2002).

CMS will develop safety protocols and follow all federal, state, and local regulations regarding herbicide use. Herbicide users will carefully read and follow the product label directions, use the recommended application rate, and wear appropriate protective gear (Motooka et al., 2002). The UH managed lands are located within the state’s Conservation District Resource Subzone. Application of herbicides and pesticides to an area greater than one acre requires a DLNR-approved site plan (H.A.R. Title 13-5) (Vanderwoude et al., 2015). Herbicide use will be avoided in the alpine stone desert above 12,800 ft elevation, within 15 ft of endangered plants, and within a 200-foot buffer around historic properties (Vanderwoude et al., 2015).

**Table 2.** A list of potential non native and invasive plant species to control/remove from the Halepōhaku restoration area. Species list was adapted from the 2011 Botanical Baseline Survey of UH managed lands on Maunakea (Gerrish, 2013), the Manual of the Flowering Plants of Hawai’i (Wagner et al., 1990), Weeds of Hawai’i’s Pastures and Natural Areas: An Identification and Management Guide (Motooka et al., 2014), the 2015 Maunakea Invasive Species Management Plan (Vanderwoude et al., 2015), and Standard Operating Procedure D: Maunakea Plant Threats, Identification, Collection & Processing Guide (Kirkpatrick et al., 2016).

Scientific Name	Common Name	Family	Life Form	Nonnative/Invasive
<i>Rhytidosperra semiannulare</i>	wallaby grass	<i>Poaceae</i>	Grass	Invasive
<i>Bromus catharticus</i>	rescue grass	<i>Poaceae</i>	Grass	Invasive
<i>Anthoxanthum odoratum</i>	sweet vernalgrass	<i>Poaceae</i>	Grass	Nonnative
<i>Holcus lanatus</i>	velvet grass	<i>Poaceae</i>	Grass	Nonnative

<i>Nasella cernua</i>	nodding needlegrass	<i>Poaceae</i>	Grass	Invasive
<i>Vulpia bromoides</i>	broom fescue	<i>Poaceae</i>	Grass	Nonnative
<i>Bromus diandrus</i>	ripgut grass	<i>Poaceae</i>	Grass	Invasive
<i>Poa pratensis</i>	Kentucky bluegrass	<i>Poaceae</i>	Grass	Invasive
<i>Poa annua</i>	annual bluegrass	<i>Poaceae</i>	Grass	Nonnative
<i>Ehrharta calycina</i>	perennial veldt grass	<i>Poaceae</i>	Grass	Nonnative
<i>Pennisetum clandestinum</i>	kikuyu grass	<i>Poaceae</i>	Grass	Invasive
<i>Dactylis glomerata</i>	orchard grass	<i>Poaceae</i>	Grass	Nonnative
<i>Pennisetum setaceum</i>	fountain grass	<i>Poaceae</i>	Grass	Invasive
<i>Lolium sp.</i>	rye grass	<i>Poaceae</i>	Grass	Nonnative
<i>Senecio madagascariensis</i>	fireweed	<i>Asteraceae</i>	Herb	Invasive
<i>Hypochaeris radicata</i>	catsear flatweed	<i>Asteraceae</i>	Herb	Invasive
<i>Taraxacum officinale</i>	dandelion	<i>Asteraceae</i>	Herb	Invasive
<i>Verbascum thapsus</i>	common mullein	<i>Scrophulariaceae</i>	Herb	Invasive
<i>Verascum vibratum</i>	wand mullein	<i>Scrophulariaceae</i>	Herb	Invasive
<i>Epilobium billaterium</i>	willow herb	<i>Onagraceae</i>	Herb	Invasive
<i>Senecio sylvaticus</i>	woodland ragwort	<i>Asteraceae</i>	Herb	Invasive
<i>Erodium cicutarium</i>	pinweed	<i>Geraniaceae</i>	Herb	Invasive
<i>Rumex acetosella</i>	sheep sorrel	<i>Polygonaceae</i>	Herb	Invasive
<i>Heterotheca grandiflora</i>	telegraph weed	<i>Asteraceae</i>	Herb	Invasive
<i>Senecio vulgaris</i>	groundsel	<i>Asteraceae</i>	Herb	Invasive
<i>Achillea millefolium</i>	common yarrow	<i>Asteraceae</i>	Herb	Invasive
<i>Trifolium arvense</i>	Rabbit foot clover	<i>Fabaceae</i>	Herb	Invasive
<i>Lepidium sp.</i>	peppergrass	<i>Brassicaceae</i>	Herb	Invasive
<i>Oenothera stricta</i>	evening primrose	<i>Onagraceae</i>	Herb	Invasive
<i>Malva parviflora</i>	cheeseweed	<i>Malvaceae</i>	Herb	Nonnative
<i>Mollugo cerviana</i>	carpetweed	<i>Mulloginaceae</i>	Herb	Invasive
<i>Eschscholzia californica</i>	California poppy	<i>Papaveraceae</i>	Herb	Nonnative
<i>Geranium homeanum</i>	cranesbill	<i>Geraniaceae</i>	Herb	Nonnative
<i>Marrubium vulgare</i>	common horehound	<i>Lamiaceae</i>	Herb	Nonnative
<i>Tragopogon porrifolius</i>	salsify	<i>Asteraceae</i>	Herb	Nonnative

<i>Coreopsis lanceolata</i>	ko' o ko' o lau haole, lanceleaf coreopsis	<i>Asteraceae</i>	Herb	Nonnative
<i>Melilotus</i> sp.	sweet clover	<i>Fabaceae</i>	Herb	Nonnative
<i>Verbena litoralis</i>	seashore vervain, ōwī	<i>Vernbenaceae</i>	Herb	Invasive

**Table 3.** A list of nonnative and invasive species currently found in areas adjacent to the UH managed land. These species are to be targeted and removed if detected within the Halepōhaku restoration area. High priority species are shaded and shown in **bold**. Species list was adapted from the Standard Operating Procedure D: Maunakea Plant Threats, Identification, Collection & Processing Guide (Kirkpatrick et al., 2016) and the Manual of the Flowering Plants of Hawai'i (Wagner et al., 1990).

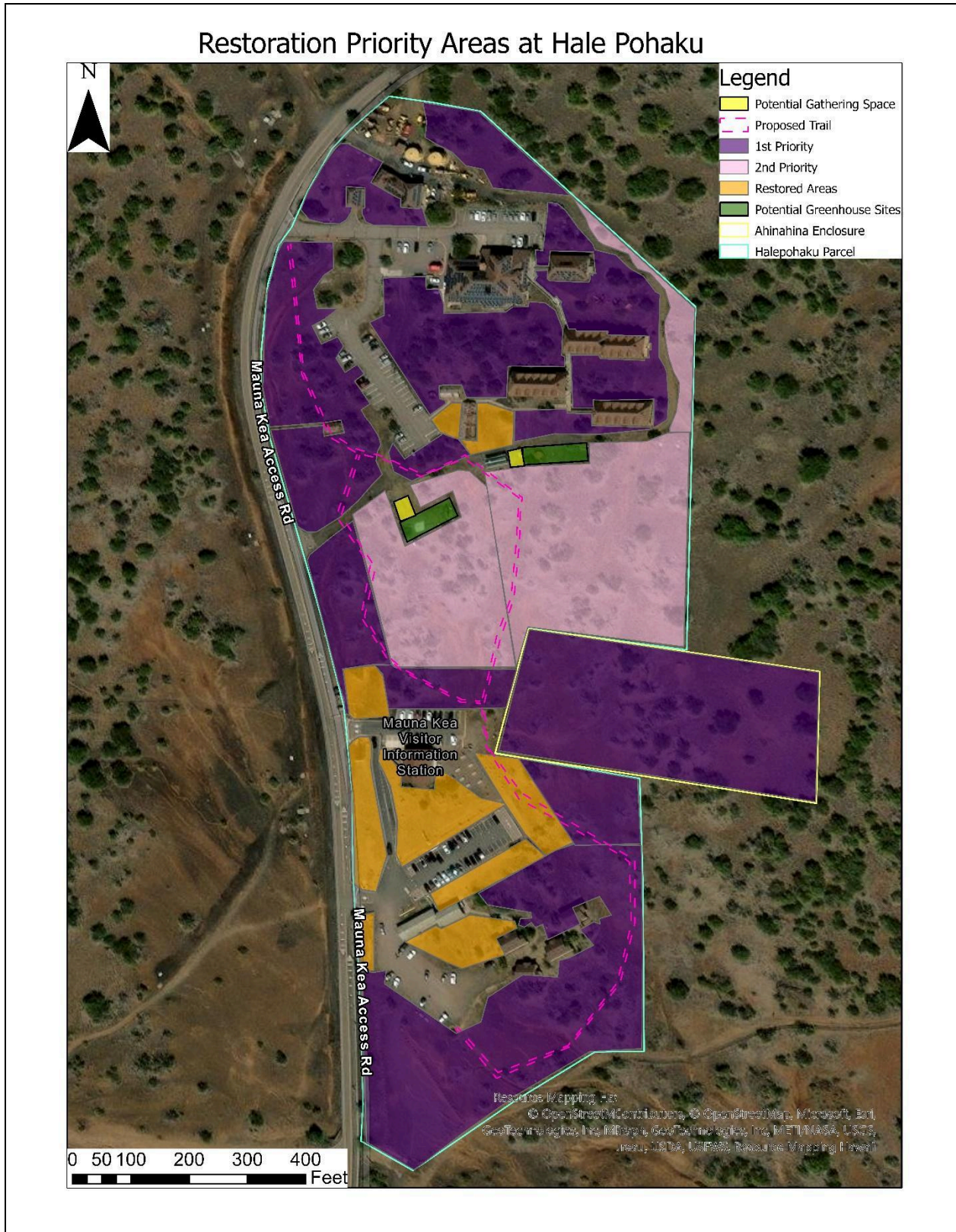
Scientific Name	Common Name	Family	Life Form	Nonnative/Invasive
<b><i>Schinus terebinthifolius</i></b>	<b>christmas berry</b>	<b>Anacardiaceae</b>	<b>Shrub</b>	<b>Invasive</b>
<b><i>Ilex aquifolium</i></b>	<b>English holly</b>	<b>Aquifoliaceae</b>	<b>Tree</b>	<b>Invasive</b>
<b><i>Erigeron bonariensis</i></b>	<b>hairy fleabane</b>	<b>Asteraceae</b>	<b>Herb</b>	<b>Invasive</b>
<i>Delairea odorata</i>	German ivy	Asteraceae	Vine	Nonnative
<i>Lonicera japonica</i>	Japanese honeysuckle	Caprifoliaceae	Vine	Nonnative
<i>Cerastium fontanum</i>	mouse-ear chickweed	Caryophyllaceae	Herb	Nonnative
<i>Stellaria media</i>	chickweed, stitchwort	Caryophyllaceae	Herb	Nonnative
<i>Cryptomeria japonica</i>	sugi pine	Cupressaceae	Tree	Nonnative
<b><i>Salsola kali</i></b>	<b>tumbleweed</b>	<b>Chenopodiaceae</b>	<b>Shrub</b>	<b>Invasive</b>
<b><i>Ulex europaeus</i></b>	<b>common gorse</b>	<b>Fabaceae</b>	<b>Shrub</b>	<b>Invasive</b>
<b><i>Juncus effusus</i></b>	<b>Japanese mat rush, soft rush</b>	<b>Juncaceae</b>	<b>Grass</b>	<b>Invasive</b>
<i>Fuchsia</i> spp.	fuchsia	Onagraceae	Shrub	Nonnative
<b><i>Passiflora tarminiana</i></b>	<b>banana poka</b>	<b>Passifloraceae</b>	<b>Vine</b>	<b>Invasive</b>
<i>Pinus</i> spp.	pine	Pinaceae	Tree	Nonnative
<b><i>Andropogon virginicus</i></b>	<b>broomsedge, yellow bluestem</b>	<b>Poaceae</b>	<b>Sedge</b>	<b>Invasive</b>
<i>Axonopus fissifolius</i>	carpetgrass	Poaceae	Grass	Nonnative
<b><i>Ehrharta stipoides</i></b>	<b>weeping grass, meadow ricegrass</b>	<b>Poaceae</b>	<b>Grass</b>	<b>Invasive</b>
<i>Paspalum dilatatum</i>	dallis grass	Poaceae	Grass	Nonnative
<b><i>Agrostis stolonifera</i></b>	<b>creeping bentgrass</b>	<b>Poaceae</b>	<b>Grass</b>	<b>Invasive</b>

<i>Anemone hupehensis</i>	Japanese anemone	Ranunculaceae	Herb	Nonnative
<i>Rubus argutus</i>	Florida blackberry	Rosaceae	Shrub	Invasive

### 5.1.3 First priority

Nonnative plant removal (through volunteer weed pulls and chemical control) will first be focused around high-traffic areas and the DOFAW-managed 2.25-acre ‘āhinahina enclosure to limit the transport of seeds to the summit by visitors and staff (see Figure 5). The Invasive Species Management Plan (ISMP) calls for a 25-yard weed-free buffer around all facilities, roads, and parking structures, approximately 12.5 acres in total. The ISMP describes a tolerance of 1% ground cover of mature broadleaf plants, and less than 5% total invasive species cover in the buffer zone. Grass cover including invasive grasses may be allowed a higher percent ground cover for dust and erosion control. Work will progress in sections until the 25-yard/12.5-acres buffer and the DOFAW-managed 2.25-acre ‘āhinahina enclosure is completed. As the buffer area becomes manageable, work will intensify in the remaining seven acres of the parcel. Weed removal will be followed up by outplantings to help support and suppress alien and invasive species from repopulating weeded areas.

Complete eradication of all weeds at all times within the buffer zone is unlikely to be achieved. However, the management goal is to replace all invasive grasses with native species. By establishing an annual plant monitoring survey, CMS will be able to document ground cover and identify the species present. By pinpointing areas with the highest concentration of invasive species, CMS can better focus weeding efforts to efficiently meet the plan objectives. Lastly, invasive grasses will be replaced and native grasses will be introduced through broadcast seeding efforts. With the data collected from the 2011 Botanical Baseline Survey (Gerrish, 2013), CMS will be able to document the temporal changes of the vegetation composition and restoration progress.



**Figure 5.** Map of first priority and second priority weed removal and restoration areas.

#### 5.1.4 Second priority

Once invasive species removal and native outplanting are completed in the first priority area, volunteer weed pulls will be moved into the remaining seven acres (areas beyond a 25-yard buffer surrounding facilities) of the restoration site. This second priority area consists of approximately 4 acres that separate the Halepōhaku support facilities from the VIS and an additional 2.76 acres due east of the VIS. Outplanting will gradually happen over time to allow outplanted individuals to become established and gain a foothold in the cleared areas, a process which may be aided by supplemental broadcast seeding of common native species.

Manual weed control will be used to maintain high-traffic areas such as near the VIS and along the educational trail, and chemical weed control will be used to maintain less-trafficked areas with heavy infestations of invasive species. Initially, our goal will be to weed a new area of one to two acres per year and plant overstory species (e.g. ‘āweoweo, māmane, and pilo) that same year. As CMS removes invasive species in new areas, CMS will document the total area cleared. At the end of each year, CMS will assess the restoration progress and track the amount of time (and the associated costs) it takes to maintain the already restored areas.

### *5.2 Outplanting native species*

#### 5.2.1 Nurse Plants

Dry tropical forests and woodlands are among the world's most degraded habitats (Murphy & Lugo, 1986; Pennington & Ratter, 2006). In Hawai‘i, large areas have been converted to pasture, grazed savanna, or for other human uses (Murphy & Lugo, 1986; Pennington & Ratter, 2006). In these ecosystems it can be difficult to restore and establish woody species due to invasive species, harsh climates, low seedling survival rates, and diminished seed banks (Florentine & Westbrooke, 2004). Nurse plants are remnant canopy trees and pre-established woody native plants that facilitate the survival success of outplanted seedlings into these degraded and harsh habitats (Padilla & Pugnaire, 2006; Yelenik et al., 2015). Native seedlings are planted under the canopy or in close proximity to the drip line of nurse plants. Nurse plants provide beneficial functions to seedlings including: shading from harsh sun; protection from wind, temperature extremes and herbivores; lowered water stress; and increased pollinator visitation (Yang et al., 2010; Smit & Ruifrok, 2011). Other benefits include increased water and nutrient availability, reduced soil compaction and erosion, and increased microorganism activity (Yang et al., 2010; Smit & Ruifrok, 2011). This nurse planting method will be utilized at Halepōhaku under remnant māmane trees and ‘āweoweo shrubs to outplant pilo, ‘a‘ali‘i, and other native species.

### 5.2.2 Planting Canopy Tree Species

CMS will begin by planting māmane, pilo, ‘a‘ali‘i, and ‘āweoweo in a 8 ft by 10 ft spacing to help create an overstory in the first year. After two years of the initial overstory plantings, less common species will be outplanted under and between the overstory outplants to provide wind protection and resemble existing natural stands of vegetation within the immediate area. In the third year, CMS will begin to eradicate the grasses and broadcast native grass seeds. All outplants will be cared for up to three years with supplemental watering and weeding (see Table 4 for a list of potential native outplants). Weed removal treatments and follow-up monitoring in outplanted areas will be scheduled as needed to suppress weed populations.

### 5.2.3 Broadcast Seeding

Alternative restoration approaches that can be applied at large scales are needed given the degradation of subalpine forests in Hawai‘i. Broadcast seeding is a plant restoration method whereby native seeds are sown directly onto the ground with the goal of reestablishing plant populations. Broadcast seeding may be a useful method for restoring vegetation in areas like Halepōhaku where the habitat is disturbed, has depleted native seed banks, and experiences extreme climatic conditions. Broadcast seeding is inexpensive (requires less labor and time) and a mixture of trees, shrubs, and groundcover can be sown at the same time. After the clearing and removal of nonnative vegetation from an area, broadcast seeding of common shrub and tree species will be followed. Potential species to broadcast seed within the restoration area include: ‘a‘ali‘i, ‘āweoweo, ko‘oko‘olau, pua kala, pāwale, ‘ena‘ena (*Pseudognaphalium sandwicense*), and na‘ena‘e (*Dubautia scabra*).

**Table 4.** A list of potential native plant species for habitat restoration at Halepōhaku. The species list was adapted from the historical plant communities described by Hartt and Neil (1940), the Manual of the Flowering Plants of Hawai‘i (Wagner et al., 1990), and the 2011 Botanical Baseline Survey of UH managed lands on Maunakea (Gerrish, 2013).

Scientific Name	Common Name	Family	Life Form
<i>Sophora chrysophylla</i>	māmane	<i>Fabaceae</i>	Tree
<i>Chamaesyce olowaluana</i>	‘akoko	<i>Euphorbiaceae</i>	Tree
<i>Coprosma montana</i>	pilo	<i>Rubiaceae</i>	Tree
<i>Dodonaea viscosa</i>	‘a‘ali‘i	<i>Sapindaceae</i>	Tree
<i>Myoporum sandwicense</i>	naio, bastard sandalwood, false sandalwood	<i>Scrophulariaceae</i>	Tree
<i>Osmanthus sandwicensis</i>	hawaiian olive, olopua	<i>Oleaceae</i>	Tree
<i>Pittosporum hosmeri</i>	'a'awa	<i>Pittosporaceae</i>	Tree
<i>Rumex giganteus</i>	pāwale	<i>Polygonaceae</i>	Shrub

<i>Osteomeles anthyllidifolia</i>	‘ūlei	<i>Rosaceae</i>	Shrub
<i>Coprosma ernodeoides</i>	kūkaenēnē	<i>Rubiaceae</i>	Shrub
<i>Geranium cuneatum</i> ssp. <i>hololeucum</i>	nohoanu, hinahina	<i>Geraniaceae</i>	Shrub
<i>Dubautia arborea</i>	na’ena’e, Maunakea dubautia	<i>Asteraceae</i>	Shrub
<i>Dubautia ciliolata</i> ssp. <i>glutinosa</i>	na’ena’e, lava dubautia	<i>Asteraceae</i>	Shrub
<i>Dubautia scabra</i>	na’ena’e	<i>Asteraceae</i>	Shrub
<i>Tetramolopium humile</i>	alpine tetramolopium	<i>Asteraceae</i>	Shrub
<i>Silene struthioloides</i>	alpine catchfly	<i>Caryophyllaceae</i>	Shrub
<i>Chenopodium oahuense</i>	‘āweoweo, ‘āheahea	<i>Caryophyllaceae</i>	Shrub
<i>Leptecophylla tameiameia</i>	pūkiawe	<i>Ericaceae</i>	Shrub
<i>Vaccinium reticulatum</i>	‘ōhelo, ‘ōhelo ‘ai	<i>Ericaceae</i>	Shrub
<i>Fragraria chiloensis</i>	‘ōhelopapa, hawaiian strawberry	<i>Rosaceae</i>	Shrub
<i>Bidens hawaiiensis</i>	ko’oko’olau, beggartick	<i>Asteraceae</i>	Shrub
<i>Argyroxiphium sandwicense</i> ssp. <i>sandwicense</i>	‘ahinahina, Maunakea silversword	<i>Asteraceae</i>	Shrub
<i>Agrostis sandwicensis</i>	Hawai’i bentgrass	<i>Poaceae</i>	Grass
<i>Deschampsia nubigena</i>	alpine hairgrass	<i>Poaceae</i>	Grass
<i>Lachnagrostis filiformis</i>	he’upueo, Pacific bentgrass	<i>Poaceae</i>	Grass
<i>Trisetum glomeratum</i>	pili uka, mountain pili	<i>Poaceae</i>	Grass
<i>Carex macloviana</i>	St. Malo’s sedge	<i>Cyperaceae</i>	Sedge
<i>Carex wahuensis</i>	O’ahu sedge	<i>Cyperaceae</i>	Sedge
<i>Luzula hawaiiensis</i>	Hawai’i wood rush	<i>Juncaceae</i>	Rush
<i>Stenogyne microphylla</i>	little-leaf stenogyne	<i>Lamiaceae</i>	Vine
<i>Stenogyne rugosa</i>	mā’ohi’ohi	<i>Lamiaceae</i>	Vine
<i>Pseudognaphalium sandwicense</i>	‘ena’ena	<i>Asteraceae</i>	Herb
<i>Oxalis corniculata</i>	yellow wood sorell	<i>Oxalidaceae</i>	Herb
<i>Argemone glauca</i>	pua kala, Hawaiian poppy	<i>Papaveraceae</i>	Herb
<i>Solanum americanum</i>	pōpolo, glossy nightshade	<i>Solanaceae</i>	Herb
<i>Ranunculus hawaiiensis</i>	makou, ‘awa kanaloa, buttercup	<i>Ranunculaceae</i>	Herb
<i>Dryopteris wallichiana</i>	Alpine woodfern	<i>Dryopteridaceae</i>	Fern
<i>Asplenium adiantum-nigrum</i>	‘iwa’iwa, spleenwort fern	<i>Aspleniaceae</i>	Fern
<i>Asplenium trichomanes</i>	‘oāli’i, ‘owāli’	<i>Aspleniaceae</i>	Fern

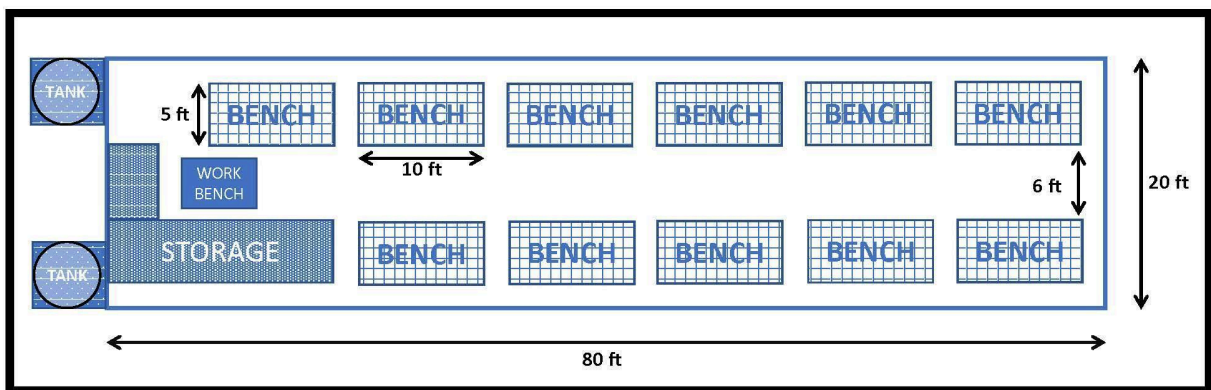
<i>Pteridium aquilinum</i>	kīlau, bracken fern	<i>Dennstaedtiaceae</i>	Fern
<i>Dryopteris wallichiana</i>	alpine woodfern	<i>Dryopteridaceae</i>	Fern
<i>Pellaea ternifolia</i>	kalamoho	<i>Pteridaceae</i>	Fern
<i>Cystopteris douglasii</i>	Douglas' bladderfern	<i>Cystopteridaceae</i>	Fern
<i>Ceratodon purpureus</i>	Sphagnum moss	<i>Ditrichaceae</i>	Moss
<i>Grimmia haleakalae</i>	Moss	<i>Grimmiaceae</i>	Moss
<i>Mielichhoferia nealiae</i>	Copper moss	<i>Bryaceae</i>	Moss
<i>Mielichhoferia pulvinata</i>	Copper moss	<i>Bryaceae</i>	Moss
<i>Orthotrichum hawaiiicum</i>	Moss	<i>Orthotrichaceae</i>	Moss
<i>Orthotrichum hillerbrandii</i>	Moss	<i>Orthotrichaceae</i>	Moss
<i>Racomitrium lanuginosum</i> var. <i>pruinsum</i>	Wooly moss	<i>Grimmiaceae</i>	Moss

### 5.3 Expanding CMS Greenhouse

As mentioned above, this restoration plan includes building an additional greenhouse to support CMS's restoration efforts and to encourage other conservation and restoration organizations to utilize available resources at Halepōhaku. The current greenhouse measures 32 ft by 12 ft with about 60 sq ft of table space for seedlings. With the current space capacity, the greenhouse can produce an estimated 200 plants a year, with seedlings ready to outplant typically after at least 1 year (depending on the plant species). To increase production capacity, the new greenhouse will follow a similar layout as the original but be expanded to include a storage area, two large water tanks, and more table space. The new greenhouse is expected to measure 80 ft by 20 ft with about 550 sq ft of table space for seedlings (Figure 6). The storage area will house the equipment and tools needed for the proposed restoration plan. One water tank will be used for the irrigation misting system inside the greenhouse, and the other water tank will be used as a water catchment storage for supplemental watering and other related uses. At full capacity, the second greenhouse is projected to increase current propagation efforts by more than 900%, and provide space for outside entities to grow and acclimate seedlings intended for subalpine and alpine restoration efforts on Maunakea.

In addition to a new greenhouse, an outdoor bench space will be built to harden older seedlings before outplanting to acclimate them to the natural conditions outside of the greenhouse. The proposed outdoor bench space will be placed near the greenhouses on a level and clean gravel pad with about 5-6 bench surfaces made out of hog panels and chicken wire framed with angle iron that are supported on stacks of concrete blocks. Plants in this bench space will be hand watered as appropriate, possibly once every 3-4 days, or a sprinkler system could be installed. This will alleviate space in the greenhouse to prioritize seed germination.

The solar-powered irrigation misting system of the existing greenhouse is supplied with water from the water tanks located above Halepōhaku, and is manually transferred and stored in a nearby 500-gallon above ground water tank. The existing greenhouse expends about 32 gallons of water a day to cover 60 sq ft of bench space. With a similar irrigation system as the existing one, the new greenhouse is estimated to expend about 293 gallons of water a day to cover 550 sq ft of bench space. The new, larger greenhouse will warrant the need for a water tank larger than 500-gallons to supply enough water for a longer duration of time. To offset increased water usage, an additional large water tank will be used as water catchment storage. Catchment water will be used to water new outplants in the restoration area and plants on the outdoor bench space, as well as other related uses. The use of catchment water for new outplants and plants about to be outplanted will help them to harden and better acclimate to the natural conditions of the restoration site.



**Figure 6.** A conceptual plan for the new CMS greenhouse at Halepōhaku.

#### 5.4 Educational trail

The education trail will be built as a collaborative effort among CMS personnel from different departments, potential outside partners, and community members. The Natural Resource Program will be responsible for the establishment and maintenance of trails (including trail resources such as decontamination stations and signage) and the surrounding restoration area. The Maunakea Rangers and VIS staff will provide supplementary on-site support such as directing visitor traffic, monitoring visitor activities on the trails, and providing medical aid in the case of emergencies. All trails will be developed in cooperation with DLNR, and reviewed and approved by the MKMB, MKSOA, the EC, KKM, the UH BOR, and the BLNR.

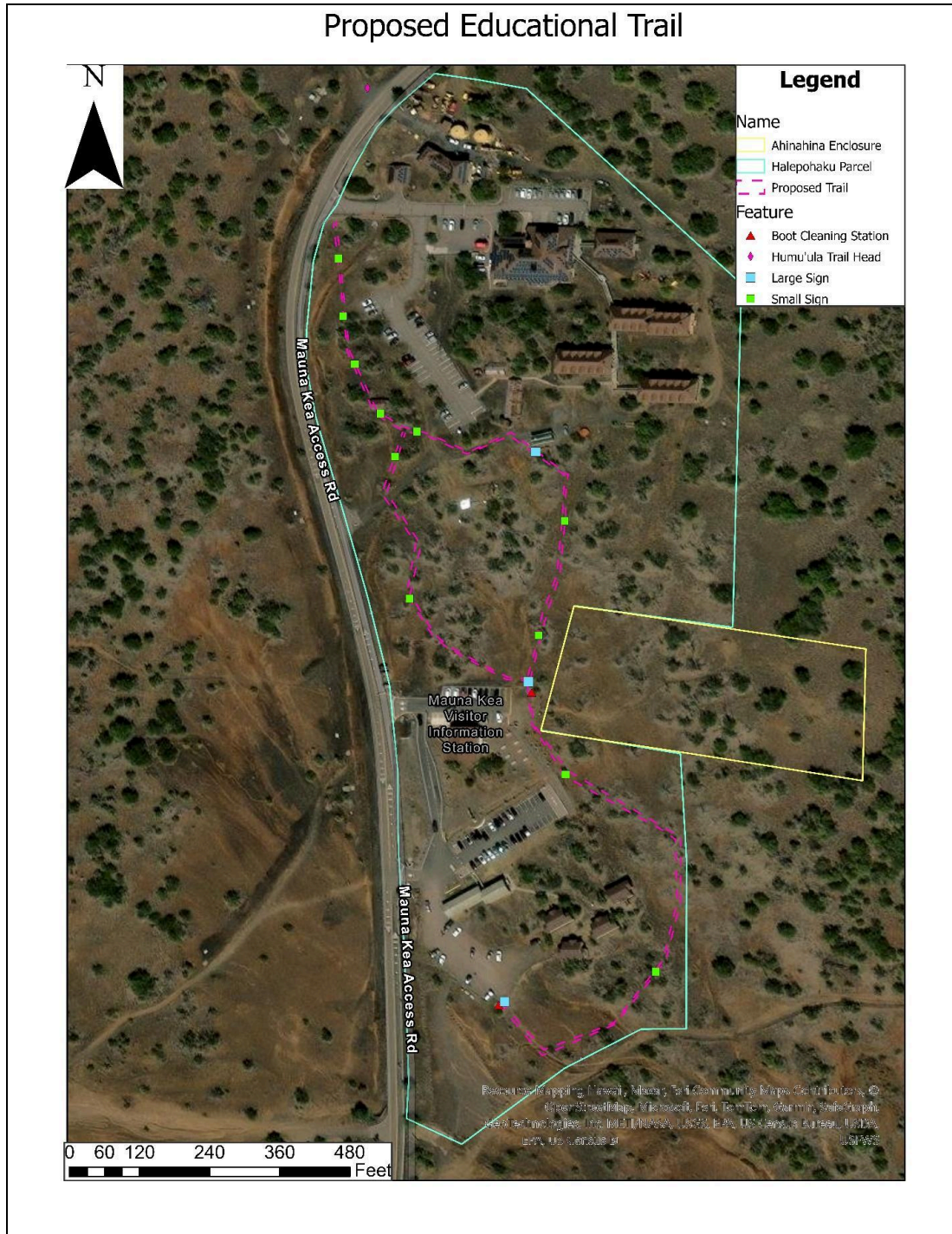
The proposed trail will be about 0.5 miles long and will be between 3-6 ft wide (depending on the landscape). The trail will be lined with rocks found in the surrounding area to mark the path, and a geotextile mat will be placed down and filled in with gravel to reduce erosional impacts (see Figure 7 for map of proposed trail). The Restoration Plan budget includes at least 3 ft by 360 ft of geotextile matting and about 3 in of gravel material.

The section between the upper VIS parking lot and the stone cabins will be constructed first to provide access to the stargazing area from the VIS, and the rest will follow. Once the trail is constructed, invasive plant control and native plant restoration will begin. When native plant species become established in the restoration area, interpretive signage will be installed.

The proposed 0.5-mile educational trail will start at the lower dirt parking lot below the VIS Warehouse and run through key geographical, natural, and cultural features towards the trail end at the Maunakea Access Road and John A. Burns Way junction. From the trailhead, the trail will run due east below the cabins, up through the ingress/egress sidewalk and connect to the VIS picnic area. Here, visitors will be able to stop at the VIS, the 'āhinahina enclosure, and the Ranger check-in point; use the restroom; or continue upwards on the trail towards a new stargazing area for the VIS, the CMS Greenhouse, the stone cabins, and the trail end. At the trail end, trail users have the option to walk across the Maunakea Access Road to other trails or head back downhill towards the VIS and the VIS parking lots.

Throughout the trail system, CMS would highlight the natural, historical, and cultural resources that make Maunakea unique. Interpretive trail materials will be created and implemented by the Natural Resource Program alongside the CMS Education and Outreach Coordinator. There is potential to collaborate with affiliated agencies such as to create interpretive materials. The Restoration Plan budget accounts for 27 interpretive signs of varying dimensions (24"x 36" and 8"x10", subject to change) and at least 1 decontamination station. Interpretive trail materials include decontamination boot stations (including boot brushes and informative signs about invasive species management), educational resources (such as videos and outreach materials), and signage for natural, cultural, and historic features (such as native plants, invasive plants, cultural sites, contextual background about the history of the place, etc.). For example, signage of each native plant species could include cultural uses and their ecological importance. All signage will be developed and implemented in manners consistent with the Maunakea Sign Plan (2017). Essentially, the interpretive trail materials serve to provide visitors with the necessary context to understand the significance of Maunakea and reiterate the importance of protecting its resources.

The Natural Resource Program encourages community involvement in the construction of the educational trail. Hosting internships and student programs (such as the Pacific Island Programs for Exploring Science, Kupu, UH-affiliated groups, etc.), conducting community volunteer workdays, and partnering with other organizations can aid trail building and restoration efforts, and create a better sense of community. In terms of community involvement, the goal of the trail is to create an educational program where visitors and volunteer groups can participate in the long-term implementation and maintenance of the restoration area.



**Figure 7.** Map of the proposed educational trail at Halepōhaku.

**5.5 Gathering Space**

The gathering space will be designed and built as a collaborative project between its two primary users, the CMS Natural Resource Program and the CMS Education and Outreach program. Native Hawaiian groups will be consulted on the appropriate protocols and practices associated with building and using culturally-grounded gathering places such

as hale and halau; and encourage community engagement in the construction, blessing and maintenance of the space. The space will be given a place-appropriate Hawaiian name in consultation with University of Hawaii at Hilo, that honors its purpose in integrating people, places, and resources. Community members and groups will be encouraged to sign up to use the space via a reservation system to avoid double-bookings. Uses of this space will be limited to events and occasions that align with CMS's intent to perpetuate and highlight the significance of Maunakea and its natural and cultural resources.

The gathering space will host a variety of Maunakea users and should be designed to accommodate its multi-function purpose. The gathering space will be an open semi-covered structure built upon a raised wooden platform with one wall serving as a wind block. The gathering space is proposed to be located next to the existing and proposed greenhouse in the area between the HP dorms and the VIS (see Figure 4). The gathering space will be 20 ft by 20 ft, and will be built to hold a desired maximum capacity of 30-40 individuals. The space will feature a storage shed to house equipment and materials associated with the space (e.g., tables, lauhala mats, first aid kit, water jug coolers, and etc.). If the space is used as the new stargazing area, the storage shed can house the VIS' telescope equipment that will be displaced when the stone cabins are refurbished.

### *5.3 Cultural Sites*

#### **Halepōhaku Rest Houses**

The Halepōhaku Rest Camp includes two buildings, Rest House 1 and Rest House 2, constructed in February 1936 and October 1939 respectively (Halepohaku Register Log 1939). Both Rest House 1 and Rest House 2 are deemed eligible for listing on the National Register of Historic Places (NRHP) and Hawaii's State Register of Historic Places under Criterion A for its association with significant historical events and Criterion C for its unique architectural characteristics (PCSI 2010). Constructed by the Civilian Conservation Corps (CCC) as part of President Franklin D. Roosevelt's New Deal policies during the Great Depression, both Rest House 1 & 2 symbolizes the federal government's intervention in economic recovery and public welfare. The CCC's efforts in the 1930s led to substantial improvements and conservation of public lands. Rest House 1 & 2 architectural style represents the Rustic/Regionalism style typical of CCC constructions, blending man-made structures with natural settings and reflecting the ethos of early park planning between 1933 and 1942, emphasizing climate, landscape, and local culture as guided by the U.S. Forest Service and National Park Service philosophy of that era.

The Halepōhaku Comfort Station, constructed by the Territory of Hawai'i's Division of Forestry in 1950, is recommended for listing on the National Register of Historic Places (NRHP) and Hawaii's State Register of Historic Places under Criterion A and Criterion C. It is historically significant for its association with the development of public recreational Territorial parks, expanding on earlier efforts by the Civilian Conservation Corps (CCC) in the 1930s to enhance tourist access to Mauna Kea Forest Reserve through the construction

of Rest Houses. The Comfort Station, though not built by the CCC, reflects the Rustic/Regionalism architectural style typical of CCC-era constructions, emphasizing an organic relationship with the natural setting and blending man-made structures with local materials in harmony with the landscape, echoing the philosophy of the U.S. Forest Service and National Park Service during the 1933-1942 era.

Site 10314, located north above the Halepōhaku Property Boundary, is a cultural site identified in the Archaeological Inventory Survey of the Mauna Kea Science Reserve (PCSI 2010). This site, documented as a lithic scatter, contains concentrated debitage believed to be associated with the production of octopus sinkers. Additionally, two shrines and five lithic scatters, featuring adze manufacturing by-products and octopus sinker manufacturing by-products, were recorded across 40 acres on the west and east sides of the Mauna Kea Observatory Access Road between elevations of 9080 and 9200 feet (McCoy 1985). The site was named Pu'ū Kalepeamoā Site after a large cinder cone at Halepōhaku, from which the stone (primarily dunite and gabbro) used in manufacturing the sinkers was sourced. One of the shrines at this site, identified as having octopus sinker manufacturing by-products interpreted as offerings, highlights the significance of this cultural area (McCoy 1985).

## **6. Determining Restoration Effectiveness**

In order to determine if the restoration efforts and management actions described above are effective, CMS will conduct a vegetation survey of the Halepōhaku parcel, implement a resource monitoring program, and conduct visitor surveys on the sociological impacts of the restoration plan. Vegetation surveys will provide information on the plant communities before and after site restoration (surveys will be done in the first year of the project and repeated every 3-5 years). Monitoring of outplanted seedlings will document survivorship and plant health by species. To evaluate forest conditions and recovery, the botanical surveys and resource monitoring program will help to accomplish management actions NR-15 and NR-16 from the CMP (see section 3.1). Visitor surveys will be conducted to evaluate the impact and effectiveness of the educational and sociological aspects of the restoration plan to improve visitor experiences. The following sections outline the implementation of the vegetation surveys, the resource monitoring program, and the visitor surveys for the restoration plan.

### *6.1 CMS Vegetation Surveys*

As CMS begins to expand restoration efforts to the entire 19.26 acres, it will be important to document how the landscape changes over time. The aim of the CMS vegetation surveys is to assess current conditions and inventory the plant communities; this survey data will be used alongside the Botanical Baseline Survey of 2011 (Gerrish 2013). Resurveying the same areas in 3-5 years (after implementing this plan) will provide quantitative data to determine whether the removal of invasive plants, outplanting of native

seedlings, and maintenance of the area is increasing native plant populations. Vegetation surveys will be summarized in a report that compares community data between survey years.

- Similar to the Gerrish (2013) botanical baseline survey, the 19.26 acres of HP will be surveyed in 50-meter transects with 2- and 6-meter circle plots. A total of 65 transect points will be resurveyed by CMS staff, following 38 of the same exact points used in the botanical baseline survey of 2011 (see Figure 8). In addition to the 38 we have added another 27 random points to help increase our
- Species present and the percent ground cover of native and nonnative species will be recorded. The survey will document whether the native species that are present are outplanted or naturally occurring. If there are new seedlings, they will be recorded as natural regeneration. Ground cover and weeds, especially those near restored areas, will be documented to guide management efforts.
- Photo points of the surrounding area shall be taken in a cardinal direction of 0 degrees heading north uphill at the middle of each sample point in each row.
- Over time, CMS should be able to show that there is a decrease in the amount of invasive and introduced species, an increase in the amount of native species, an increase in plant density in the restoration areas, and sustaining regenerative populations.

## *6.2 Resource Monitoring Program*

Plant survival and growth will be monitored for three years after outplanting to assess the effectiveness of the restoration plan. Annual data summaries will report on survivorship and plant growth/health by species. The data will also provide information about when sufficient canopy is established for planting of understory species, and inform management on the effectiveness of supplemental watering, fertilization, and pest control.

### 6.2.1 Monitoring plant survival

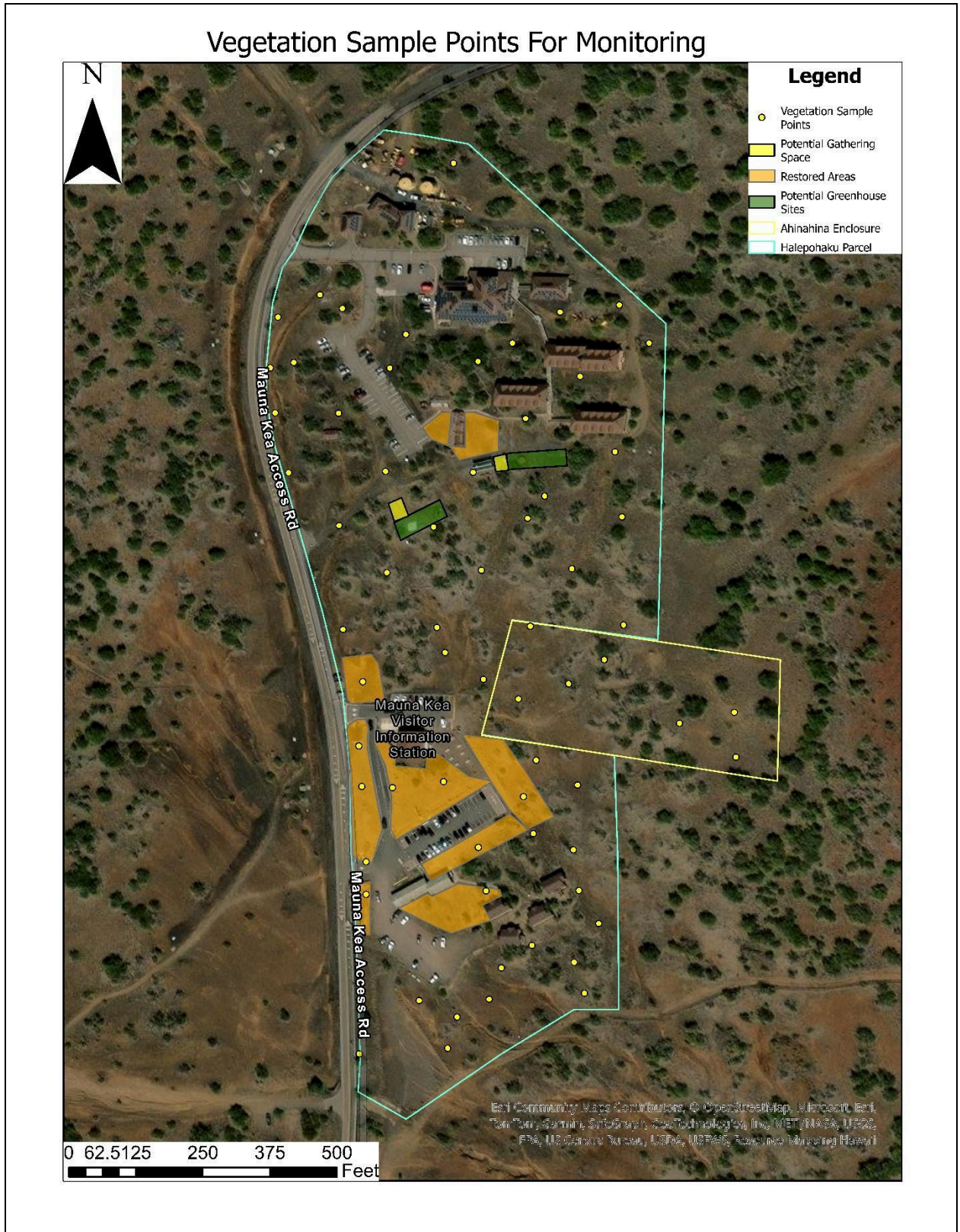
- For each seedling outplanted, CMS staff will record/document the GPS location, date planted, climate information (i.e., has it been cloudy/rainier or clearer/drier than usual), and what section of Halepōhaku it is located in.
- For each plant species, a subset (10%) of the outplanted seedlings will be monitored for three years to assess their survivorship and health. For example, if CMS plants 300 māmane one year CMS would need to monitor 30 individuals from that cohort quarterly for three years.
- Each monitored plant will have a metal tag nailed to the ground near the base of the plant with an identification number and receive a colored pin flag. At the time of planting, the height, crown diameter, and plant vigor will be documented.

- If a monitored outplant dies, CMS will replace the plant but no longer monitor it and consider it a loss in outplant survival rate for that species.
- After three years if the plant has survived CMS will consider it established and maintenance such as supplemental watering, spraying for pests, and fertilization will stop.
- Once an outplant becomes established (three years of survival), it will no longer be part of our quarterly monitoring.

### 6.2.2 Data collection

Quarterly monitoring of outplants will collect the following information:

1. Height, crown diameter, trunk girth, plant vigor, and phenology
  - Height is measured by the tallest point above ground
  - Crown diameter will be measured at the widest point of the plant, and a perpendicular length to that measurement plane. This will give us an estimate of the area that the plant is covering
  - Trunk girth is measured only on tree species with trunks larger than a pencil in girth. Trunk girth is measured on the widest stem, as close to the base of the trunk as possible
  - Plant vigor (or plant health) will be a subjective measurement on a scale of 1-5 based on observation
    - 1 - Completely healthy
    - 2- Over 80% healthy with a little drought stress
    - 3- 50 to 80% healthy with significant stress, and defoliation
    - 4- 25 to 50% healthy with abnormal amount of stress, and close to no new growth
    - 5- 0 to 25% alive, almost no foliage
  - Phenology will record if the plant is flowering, fruiting, or seeding
2. A photo of each monitored plant will be taken quarterly. A photo of each outplanted section will be taken annually



**Figure 8.** Map of Vegetation Survey Sample Points

### 6.2.3 Monthly Inspections of the Educational Trail

In order to compensate for the increased foot travel around Halepōhaku, monthly inspections will be conducted along a 3-meter buffer from the educational trail. Monthly inspections will help to intercept any new species introductions, and document populations of weeds as they spread. Staff will be able to do these inspections and checks when accessing areas along the trail to do weeding, outplanting, and trail maintenance.

### *6.3 Education and Outreach*

The 2010 Public Access Plan states that, “surveys of public users will be conducted to define and monitor the quality of the public experience in the UH Management Areas”. Once the educational trail is completed, a visitor experience survey (or voluntary questionnaire) will be developed to inform managers on the quality of visitors' experience in UH managed lands. A similar survey could be developed for CMS service-learning projects, the stargazing program, and forest restoration volunteer events to gauge the quality of CMS's outreach and education efforts. The survey could be done voluntarily online or on paper (provided at the VIS) and prompt them to rate their satisfaction in education, recreation, overall enjoyment, and etc. Data collected from these surveys will inform management on educational trail/service-learning satisfaction ratings, identify necessary improvements to services or facilities, and identify obstacles to visitor attendance. This information will be integrated with natural and cultural resource monitoring data to form the basis for ongoing adaptive management decision-making.

### *6.4 Restoration Effectiveness*

Our restoration efforts, coupled with an outplant monitoring program and vegetation surveys will track plant growth and survival, and measure landscape changes over time. Restoration of the area surrounding Halepōhaku will be considered a success if there is natural regeneration from outplants, native species density increases and the site retains the restored plant associations. This plan was developed as a flexible document to help guide our restoration efforts and improve upon what restoration that has already been done. CMS will collaborate with all users of Maunakea and strive to become better stewards of the land. In turn, after the entire area of Halepōhaku is restored, CMS can then move on to the access road corridor, and a new plan for the restoration of the alpine shrubland habitat will be developed.

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# RESTORATION PLAN FOR HALEPŌHAKU

CENTER FOR MAUNAKEA STEWARDSHIP  
JUSTIN YEH, TAYLOR WARNER, ANUHEA  
ROBINS



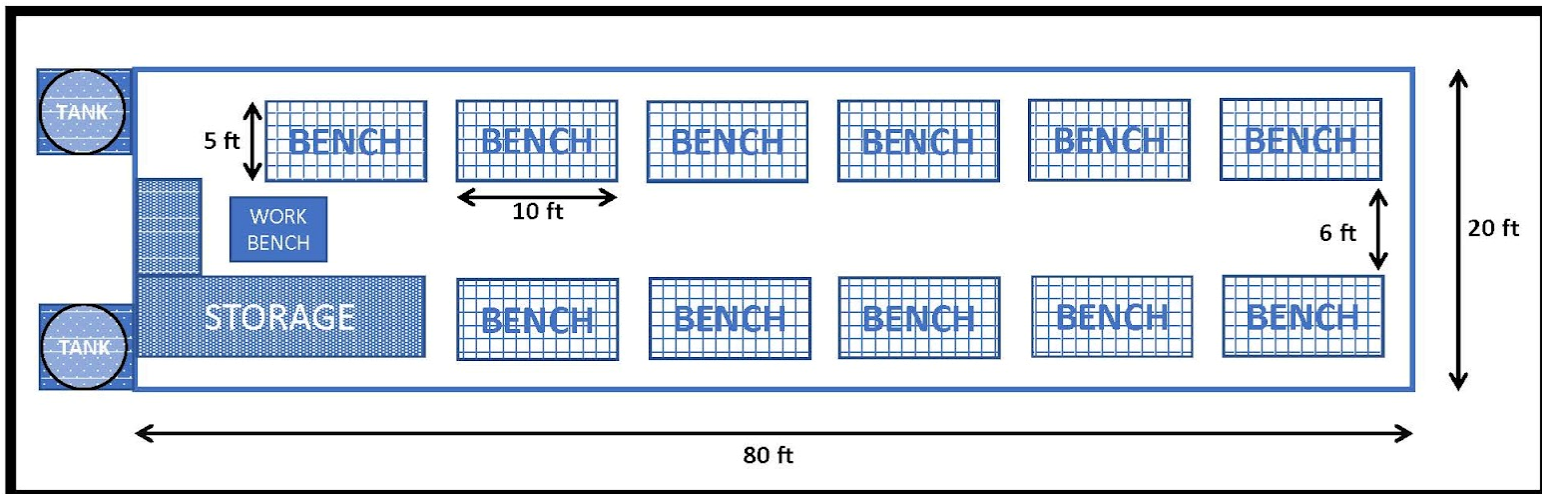
# ESTABLISHING NATIVE PLANT COMMUNITY

- NR-2. LIMITING DAMAGE CAUSED BY INVASIVE SPECIES.
- NR-3. MINIMIZING POPULATION DECLINE AND LOSS OF NATIVE BIODIVERSITY
- NR-4. MINIMIZING BARRIERS TO SPECIES MIGRATION.
- NR-9. INCREASE NATIVE PLANT DENSITY AND DIVERSITY THROUGH AN OUTPLANTING PROGRAM.
- NR-12. CREATE RESTORATION PLANS AND CONDUCT HABITAT RESTORATION ACTIVITIES AS NEEDED
- NR-16. CONDUCT REGULAR LONG-TERM MONITORING, AS OUTLINED IN AN INVENTORY, MONITORING AND RESEARCH PLAN.



# EXPAND CMS GREENHOUSE

- NR-13 Increase communication, networking, and collaborative opportunities, to support management and protection of natural resources
- OI-3. Maintain and expand regular interaction and dialogue with stakeholders, community members, surrounding landowners, and overseeing agencies to provide a coordinated approach to resource management
- EO-07. Continue and increase opportunities for community members to provide input to cultural and natural resources management activities on Mauna Kea, to ensure systematic input regarding planning, management, and operational decisions that affect natural resources, sacred materials or places, or other ethnographic resources with which they are associated.





# BUILDING A GATHERING SPACE AT HALEPŌHAKU

- EO-6 ENGAGE IN OUTREACH PARTNERSHIPS WITH SCHOOLS, BY COLLABORATING WITH LOCAL EXPERTS, TEACHERS, AND UNIVERSITY RESEARCHERS, AND BY WORKING WITH THE 'IMILOA ASTRONOMY CENTER OF HAWAII
- EO-07. CONTINUE AND INCREASE OPPORTUNITIES FOR COMMUNITY MEMBERS TO PROVIDE INPUT TO CULTURAL AND NATURAL RESOURCES MANAGEMENT ACTIVITIES ON MAUNA KEA, TO ENSURE SYSTEMATIC INPUT REGARDING PLANNING, MANAGEMENT, AND OPERATIONAL DECISIONS THAT AFFECT NATURAL RESOURCES, SACRED MATERIALS OR PLACES, OR OTHER ETHNOGRAPHIC RESOURCES WITH WHICH THEY ARE ASSOCIATED.
- OI-3. MAINTAIN AND EXPAND REGULAR INTERACTION AND DIALOGUE WITH STAKEHOLDERS, COMMUNITY MEMBERS, SURROUNDING LANDOWNERS, AND OVERSEEING AGENCIES TO PROVIDE A COORDINATED APPROACH TO RESOURCE MANAGEMENT
- NR-13 INCREASE COMMUNICATION, NETWORKING, AND COLLABORATIVE OPPORTUNITIES, TO SUPPORT MANAGEMENT AND PROTECTION OF NATURAL RESOURCES



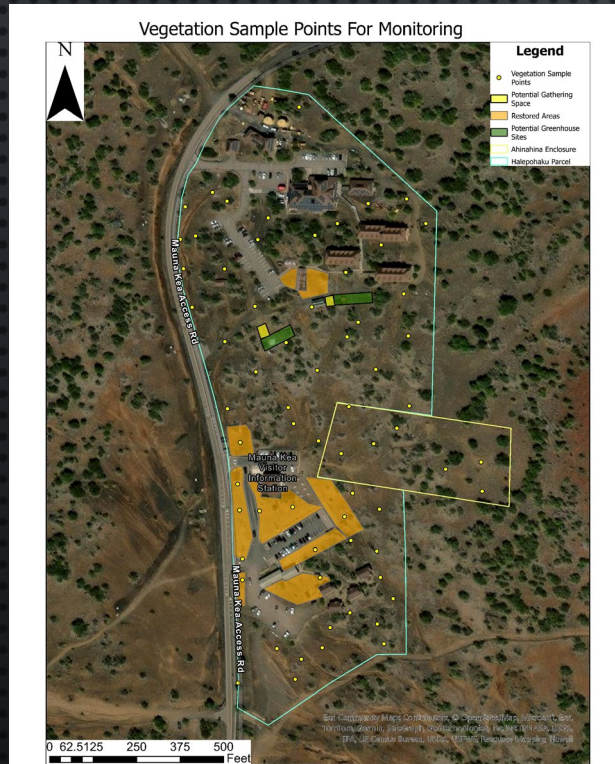


# MONITORING

- OUTPLANT SURVIVAL AND HEALTH
- VEGETATION SURVEYS
- TRAIL INSPECTIONS
- EDUCATION AND OUTREACH SURVEYS

December 2020

December 2023



QUESTIONS/ SUGGESTIONS?



# Proposed Educational Trail

