Biological Setting Analysis: Caltech Submillimeter Observatory Decommissioning

Final Report
November 2019

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Acronyms

BMP	Best Management Practices
CMP	Comprehensive Management Plan
CSO	Caltech Submillimeter Observatory
DLNR	Department of Land and Natural Resources
DOFAW	Division of Forestry and Wildlife
EIS	Environmental Impact Statement
ISMP	Invasive Species Management Plan
OMKM	Office of Maunakea Management
SOP	Standard Operating Procedure

1 Introduction

This Biological Settings Analysis was prepared to support the biological discussion in the various documents associated with the Caltech Submillimeter Observatory decommissioning, most notably an Environmental Assessment and a Conservation District Use Application. The report describes the existing environment with regard to biological resources, outlines the restoration scenarios that may occur as part of the decommissioning process, describes the potential effects on biological resources for the deconstruction and restoration scenarios, and prescribes protocols and mitigation measures for the protection of biological resources to be incorporated into decommissioning planning. This report is not an approval document and does not endorse any particular alternative. Rather, this report is a disclosure document that discusses a range of possibilities, the likely impacts to biological resources, and informs the alternatives that will be analyzed in depth in an Environmental Assessment.

2 Affected Environment: Biological Resources

The Caltech Submillimeter Observatory (CSO) is located on a 0.75-acre site at 13,350 ft. elevation near the summit of Maunakea, Island of Hawai'i. The site is located within the Astronomy Precinct of the Maunakea Science Reserve, on State land that is leased by the University of Hawai'i and managed by the Office of Maunakea Management (OMKM). The project site was disturbed by grading and construction of the CSO in 1987. Other construction in the area during the same period included erection of the James Clerk Maxwell Telescope and a road to access these new observatories. These activities resulted in the sites being leveled and fill being deposited in the area around the project site.

2.1 Habitat

The CSO is located in the alpine stone desert ecosystem, which occurs above the 11,150 ft. elevation on Maunakea. The alpine stone desert is characterized by low precipitation, high rates of evaporation, high wind speeds, high solar radiation, regular freezing and thawing cycles, and a porous substrate. These characteristics limit the development of the plant and animal communities in this zone (Aldrich 2005). The CSO site is located on a lava flow composed mainly of basalt.

2.2 Lichens, Mosses, and Vascular Plants

The plant community in the alpine stone desert consists of species of lichens and mosses with sparsely distributed vascular plants.[1] Lichens are the dominant species present. About half of the lichens recorded on Maunakea have not been identified to the species level and thus are of unknown origin. Twenty three species of lichen and approximately twelve species of moss known to occur within the Maunakea alpine stone desert have been identified to the species level (Berryman and Smith 2011, Smith et al. 1982). All lichen and moss species identified on Maunakea to date are native to the Hawaiian Islands.

Vascular plants grow mainly at the base of larger rocks where soil and water accumulate and they are protected from the wind (Char 1999). The most abundant vascular species in Maunakea's alpine stone desert are two grass species, Hawaiian bentgrass (*Agrostis sandwicensis*) and *pili uka* (*Trisetum*

[1] All discussion on the plant community in general includes lichens. Although lichens are not plants they are often grouped into the vegetative community by land managers for consideration of species presence and effects of management activities.

glomeratum), and two fern species, *'iwa 'iwa* (*Asplenium adiantum-nigrum*) and Douglas' bladderfern (*Cystopteris douglasii*). Of these four species, Hawaiian bentgrass is the most common.

Lichens, mosses, and vascular plants recorded in the alpine stone desert are listed in Table 1 (SRGII 2009 and Gerrish 2011). Gerrish (2011) conducted a botanical survey that by design documented all individual vascular plants, native and non-native, in the vicinity of the project site. None of the lichens, mosses, or vascular plants present within the alpine stone desert are currently listed or proposed for listing as threatened or endangered species.

To determine the presence, abundance and composition of lichens, mosses, and vascular plants throughout the entire project site, a survey was conducted that involved walking transects and recording species presence within and just outside of the site (Appendix A, Medeiros 2019). The survey report details the sparse nature of lichens and vegetation and their locations. Eleven clumps of lichens were observed. The most abundant vascular plant in and near the survey site was the endemic grass *pili uka* (*Trisetum glomeratum*). Most *pili uka* clumps were growing on topographically disturbed areas and one individual was found growing in a crack in the pavement driveway. Several individual *'iwa 'iwa* ferns were found just outside of the east-to-south boundary of the subleased lands, none were found within the subleased lands. No other plant species were recorded.

Table 1. Lichen, Moss, and Vascular Plant Species Recorded in the Summit Region of Maunakea

Species Name	Hawaiian/ Common Name	Origin	Notes	Documented in the Vicinity of the CSO
Lichens				
Acarospora cf. depressa	---	Native	Uncommon	---
Baeomyces skottsbergii	---	Native	Abundance Unknown	Previously Recorded
Candelariella vitellina	---	Native	Common	---
Diploschistes lutescens	---	Native	Abundance Unknown	Previously Recorded
Lecanora muralis	---	Native	Common	---
Lecanora polytropa	---	Native	Abundance Unknown	Recorded during recent survey (Medeiros 2019)
Lecidea skottsbergii	---	Native	Common	Previously Recorded
Lecidea vulcanica	---	Native	Uncommon	---
Physcia dubia	---	Native	Common	---
Pseudephebe pubescens	---	Native	Common	---
Rhizocarpon geographicum	---	Native	Common	Previously Recorded
Umbilicariah hawaiiensis	---	Native	Common	Previously Recorded
Umbilicaria magnussonii	---	Native	Common	Previously Recorded
Umbilicaria pacifica	---	Native	Uncommon	---

Species Name	Hawaiian/ Common Name	Origin	Notes	Documented in the Vicinity of the CSO
Mosses				
Amphidium tortuosum	---	Native	Occasional	Previously Recorded
Andreaea acutifolia	---	Native	Occasional	Previously Recorded
Bryum caespiticum	---	Native	Uncommon	---
Bryum hawaiicum	---	Endemic	Uncommon	---
Encalypta rhabdocarpa	---	Native	Abundance unknown	Previously Recorded
Grimmia apocarpa var. *pulvinata*	---	Native	Occasional	---
Grimmia cf. pilifera	---	Native	Uncommon	---
Grimmia sp.	---	Native	Occasional	Previously Recorded
Pohlia cruda	---	Native	Common	Previously Recorded
Pohlia mauiensis	---	Endemic	Historical Records Only	---
Racomitrium lanuginosum	---	Native	Historical Records Only	Previously Recorded
Rosulabryum capillare	---	Native	Historical Records Only	---
Tortella humilis	---	Native	Uncommon	---
Zygodon tetragonostomus	---	Native	Uncommon	---
Herbs, Ferns, and Grasses				
Agrostis sandwicensis	Hawaiian bentgrass	Endemic	Grass	---
Asplenium adiantum-nigrum	*ʻiwa ʻiwa*	Native	Fern found on lava flows	Recorded during recent survey (Medeiros 2019)
Asplenium trichomanes	*ʻoāliʻi*	Native	Fern, uncommon	---
Cystopteris douglasii	Douglas bladderfern	Native	Fern that grows on weathered rock. USFWS Species of Concern	---
Hypochaeris radicata	hairy cat's ear	Non-Native	Herb	---
Scenecio madagascarensis	fireweed	Non-Native	Herb	Previously Recorded
Taraxicum officinale	common dandelion	Non-Native	Herb	---
Tetramolopium humile humile	alpine tetramolopium	Endemic	Herb	---
Trisetum glomeratum	*pili uka*	Endemic	Grass	Recorded during recent survey (Medeiros 2019)
Vaccinium reticulatum	*ʻōhelo ʻai*	Native	Shrub, unlikely to be in the vicinity of the site	---

2.3 Fauna

2.3.1 Arthropods

Arthropods are the most common fauna present in the alpine stone desert ecosystem. Both native and non-native arthropods inhabit the Astronomy Precinct. Surveys typically distinguish between resident and non-resident species. Resident arthropods are cold-adapted species that occur and survive on the mountain at higher elevations. Non-resident species are those that are brought to the summit by the aeolian drift process (i.e. blown up by the wind) or are inadvertently transported through human activity. Non-resident species die in the cold weather and provide an important food source for resident species.

While the diversity of resident native arthropod species present at the summit is low, arthropod surveys and invasive species monitoring within the Astronomy Precinct indicate that the abundance of resident native arthropods is much higher than resident non-natives (SRGII 2009, Kirkpatrick and Klasner 2015, and OMKM unpublished data). Native resident species include the wēkiu bug (*Nysius wekiuicola*), a noctuid moth (*Agrotis kuamauna*), a hide beetle (*Dermestes maculatus*), the Hawaiian lycosid wolf spider (*Lycosa hawaiiensis*), a bark louse (*Palistreptus inconstans*), and a centipede (*Lithobius* sp.) (Medieiros et al. 2019, Howarth and Stone 1982). Some taxa recorded within the Astronomy Precinct have not been identified to species level, and because both native and non-native species from these families are known to occur in Hawai‘i, the origin is unknown. These include two sheet-web spiders (*Erigone* spp.), an unidentified linyphiid sheet-web spider (Family Linyphiidae), two slender springtails (Family Entomobryidae), and two species of mites (Families Anystidae and Eupodidae) (Howarth and Stone 1982).

Invasive species monitoring is conducted by OMKM annually at various locations at the summit and quarterly at all observatories with the goal of detecting new invasive species threats. Invasive arthropod monitoring at observatories involves placing traps within and around the facilities and retrieving them approximately seven days later. Hand searches around the perimeter of each observatory are also conducted. Specimens are identified to the lowest taxa necessary to determine if the arthropod represents a potential threat as an invasive not currently present at the summit. OMKM staff are responsible for identification. Identification may entail sending specimens to the Bishop Museum staff, Hawai‘i Ant Lab staff, or Department of Land and Natural Resources Division of Forestry and Wildlife (DLNR DOFAW) entomologist for consultation, if necessary. Most invasive species found in perimeter searches or traps outside of observatories are already dead and believed to be products of aeolian drift. If live specimens of invasive species are detected outside of the observatories, further monitoring is done to determine the extent of the population and the potential for eradication. Rapid response protocols and plausible control methods by taxa are detailed in the *Maunakea Invasive Species Management Plan* (ISMP) (Vanderwoude et al. 2015). Table 2 lists arthropods found in and around the CSO during the past five years of invasive species monitoring.

An assessment of the arthropod fauna present at the CSO site was conducted prior to construction of the observatory as part of an Environmental Impact Statement (EIS) (Group 70 1982). Two species of springtails and four species of mites were found in the soil at the CSO site and Hawaiian lycosid wolf spiders (*Lycosa hawaiiensis*) and an anystid mite were found under rocks at the CSO site.

An arthropod survey conducted as part of this project involved sampling by trapping, hand searches, and specimen collection from ice on the north side of the CSO observatory (Table 3, Appendix A, Medieros 2019). The majority of species recorded, with the exception of three, were species not native to the aeolian desert on Maunakea. One native spider species (*Lycosa hawaiiensis*) and one native moth species

(*Agrotis kuamauna*) were recorded, along with one fly species from an unknown origin (*Bradysia* sp.). Arthropods from the *Aphis* genera were found in the traps but could not be identified to the species level. All *Aphis* species in Hawai'i are non-native. *Aphis* species have been previously recorded in the aeolian desert on Maunakea. One member of the survey team who samples arthropods regularly in the UH managed areas on Maunakea, reported previously noting native spiders and caterpillars at or near the CSO site although they were not common in this recent survey (Jesse Eiben, pers. comm. 2018).

None of the arthropods present in the alpine stone desert on Maunakea are currently listed or proposed for listing as threatened or endangered species. The wēkiu bug (*Nysius wekiuicola*), a flightless insect that occurs in the summit region of Maunakea, was listed as a candidate endangered species in 1999 (USFWS 1999). The species was removed from the list in 2011 after it was determined that conservation actions were helping to stabilize population numbers (USFWS 2011). Wēkiu bugs are not found on lava flows or in areas dominated by compacted ash/silt as the habitat is considered unsuitable (UH Hilo 2010, Englund et al. 2007, Porter and Englund 2006). While wēkiu bugs have not been found in the lava flow habitat around the CSO, they are found in the area called the Poi Bowl, directly to the east of the CSO. The Poi Bowl is considered prime habitat for the wēkiu bug and will not be subject to disturbance during CSO decommissioning and restoration activities.

Table 2. Arthropods Found In and Around the CSO During OMKM Invasive Species Monitoring (2013-2017)

Order	Family	Scientific Name	Common Name	Origin
Acari	Unknown	Unknown	mites	Native & Non-native
Araneae	Unknown	Unknown	spiders	Native & Non-native
Coleoptera	Coccinellidae	*Harmonia conformis*	ladybird beetle	Non-native
Coleoptera	Coccinellidae	*Hippodamia convergens*	ladybird beetle	Non-native
Coleoptera	Scarabaeidae	*Onthophagus nigriventris*	dung beetle	Non-native
Diptera	Various	Various	Flies	The majority of fly species are either non-native or of unknown origin.
Diptera	Calliphoridae	Unknown	blow flies	Non-native
Diptera	Sphaeroceridae	Unknown	dung flies	Native & Non-native
Diptera	Syrphidae	Unknown	hover flies	Non-native
Hemiptera	Aphididae	*Aphis* sp.	Aphids	Non-native
Hemiptera	Lygaeidae	*Nysius palor*	seed bug	Non-native
Hemiptera	Pentatomidae	*Bagrada hilaris*	shield bug	Non-native
Hemiptera	Psyllidae	Unknown	jumping plant louse	Native & Non-native
Hymenoptera	Braconidae	Unknown	braconid wasp	Native & Non-native
Lepidoptera	Pieridae	*Pieris rapae*	cabbage butterfly	Non-native
Psocoptera	Psocidae	Unknown	bark lice	Native & Non-native

Table 3. Arthropods Recorded Within the Project Area November/December 2018

Order	Family	Scientific Name	Common Name	Origin
Araneae	Lycosidae	*Lycosa hawaiiensis*	Hawaiian lycosid wolf spider	Endemic
Araneae	Trachelidae	*Meriola arcifera*	spider	Non-native
Coleoptera	Coccinellidae	*Hippodamia convergens*	convergens ladybird beetle	Non-native
Coleoptera	Dytiscidae	*Rhantus gutticollis*	diving beetle	Non-native
Dermaptera	Forficulidae	*Forficula auricularia*	European earwig	Non-native
Diptera	Agromyzidae	*Phytomyza plantaginis*	leaf miner fly	Non-native
Diptera	Calliphoridae	*Eucalliphora latifrons*	blue bottle fly	Non-native
Diptera	Ephydridae	*Hydrellia* sp.	ephydrid fly	Non-native
Diptera	Phoridae	*Diplonevra peregrina*	humpbacked fly	Non-native
Diptera	Sciaridae	*Bradysia* sp.	darkwinged fungus gnat	Unknown
Diptera	Syrphidae	*Allograpta exotica*	hover fly	Non-native
Hemiptera	Aphididae	*Aphis* sp.	Aphids	Non-native
Hemiptera	Psyllidae	*Acizzia uncatoides*	jumping plant louse	Non-native
Heteroptera	Lygaeidae	*Neacoryphus bicrucis*	whitecrossed seed bug	Non-native
Heteroptera	Lygaeidae	*Nysius palor*	seed bug	Non-native
Heteroptera	Miridae	*Coridromius variegatus*	plant bug	Non-native
Heteroptera	Nabidae	*Nabis capsiformis*	pale damsel bug	Non-native
Hymenoptera	Braconidae	*Apanteles* sp.	braconid wasp	Non-native
Hymenoptera	Braconidae	*Biosteres* sp.(?)	braconid wasp	Non-native
Hymenoptera	Ichneumonidae	*Diadegma insulare*	Ichneumon wasp	Non-native
Hymenoptera	Ichneumonidae	*Pristomerus spinator*	Ichneumon wasp	Non-native
Lepidoptera	Noctuidae	*Agrotis kuamauna*	noctuid moth	Endemic
Orthoptera	Gryllidae	*Metioche vittaticollis*	cricket	Non-native
Thysanoptera	Thripidae	*Frankliniella* sp.	Thrip	Non-native

2.3.2 Birds and Mammals

Two endangered birds, *ʻuaʻu* (*Pterodrama sandwichensis* or Hawaiian petrel) and *ʻakēʻakē* (*Oceanodroma castro* or band-rumped storm petrel), may utilize the alpine shrublands and grasslands on Maunakea, but there have been no recorded detections of birds or burrows in the vicinity of the CSO site. Although there are records of pigs and sheep occurring in the alpine stone desert, feral ungulates are not common as there are very few plants to browse. Rodents actively reproduce in the summit region and could be characterized as regularly encountered. The endangered *ʻōpeʻapeʻa* (*Lasiurus cinereus semotus* or Hawaiian hoary bat) has not been detected in the vicinity of the CSO site, but may occur at high elevations. The presence of *ʻōpeʻapeʻa* in the Lake Waiʻau area (~13,000 ft) is currently under investigation.

3 Habitat Enhancement and Restoration Activities

The *Mauna Kea Comprehensive Management Plan* (CMP) requires observatories to develop a restoration plan in association with decommissioning (Ku'iwalu 2009). Site restoration will occur as part of the CSO decommissioning process. Moderate or full restoration is the desired goal. As defined by the *Decommissioning Plan for the Mauna Kea Observatories* (SRGII 2010):

- Minimal restoration is the removal of all man-made materials and grading of the site, leaving the area in a safe condition.
- Moderate restoration goes beyond minimal to include enhancing the physical habitat structure to benefit the native arthropod community.
- Full restoration would return the site to its original pre-construction topography, as well as restoring arthropod habitat.

Moderate restoration would be accomplished by using native material to backfill all cavities remaining after structures and furnishings are removed. Moderate restoration would involve some grading to enhance the physical habitat structure. Some fill placed during construction of the CSO that is not used to backfill cavities may be removed from the project site and stored at a nearby offsite location for later use. The goal of moderate restoration is enhancement of habitat to benefit the native arthropod community, not restoration of the site to pre-CSO topography.

Full restoration would return the site to its original pre-CSO topography and restore arthropod habitat. Full restoration would be accomplished by using native material to backfill all cavities remaining after structures and furnishings are removed, and grading the site. Full restoration would require removal of excess fill placed during construction of the CSO. Excess fill would be removed by means of a loader and dump trucks to an off-site stockpile location on the summit, most likely the Batch Plant Storage Area. Excess fill would be available for use during other decommissioning projects as needed.

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

Passive restoration through natural recruitment of lichens, mosses, and vascular plants as well as the arthropod community is expected once the site has been topographically restored. No out-planting of native species is recommended as few plants were present prior to construction of the CSO, and sparse

plant populations are typical of lava flow habitat in the alpine stone desert. No transfer of arthropods, other than those already present in fill is recommended.

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

4 Potential Effects

Potential effects on biological resources would be same for all the deconstruction and restoration scenarios, except for a No Action Alternative. Under a No Action Alternative, biological resources would remain unimpacted, and both native and non-native species would continue to occupy the project footprint.

Effects Common to All Action Alternatives

Under all deconstruction and restoration scenarios lichens, mosses, and vascular plants present within the project footprint would be subject to disturbance and possible mortality as a result of heavy equipment use, and movement and placement of substrate fill. Adverse impacts include being crushed, buried, or covered in dust. Due to the sparse nature of lichens, mosses, and plants within the affected area and the presence of the same species on adjacent lands, the loss of some individuals does not represent a significant adverse effect nor does it represent a threat to the continued presence of these species on Maunakea. It is expected that lichens, mosses, and vascular plants would recolonize the site after removal of structures and placement of fill, as has been the case in other disturbed areas at the summit. Due to extreme environmental conditions at the summit, recolonization of disturbed areas takes longer than it does at lower elevations. Project protocols would be followed to minimize dust generation including using water to limit the amount of airborne dust and limiting activities during very windy conditions.

Under all deconstruction and restoration scenarios, invasive vascular plant species not currently present may be deposited either via wind or human activity and potentially grow in the newly disturbed areas. Mitigation measures and project protocols would be followed to prevent the establishment of any new invasive plant species. Significant adverse effects related to the introduction of new species of invasive vascular plants are not anticipated due to mitigation measures and extreme environmental conditions that prohibit rapid proliferation.

Under all deconstruction and restoration scenarios there will be some impacts to the arthropod habitat within the project footprint. Heavy equipment use can crush cinder and reduce the size and volume of voids beneath the ground surface, reducing habitat utilized by some native arthropod species. Mitigation measures and project protocols would be followed to minimize the amount of habitat disturbance. These include restricting all vehicles moving in and out of the CSO parcel and staging area to existing roads and driveways and establishing designated routes for large equipment travel when off-road travel must occur. Significant adverse impacts to arthropod habitat are not anticipated.

Under all deconstruction and restoration scenarios there would be some impacts to native and endemic arthropods. Some mortality to arthropods would occur due to use of heavy equipment and moving of substrate around the project footprint and from nearby areas. However, the level of mortality of

arthropods is unlikely to significantly affect the metapopulation of any single native arthropod species within the Astronomy Precinct. The majority of arthropod species recorded at the CSO site are predominantly non-native. Arthropod surveys in areas around the summit have recorded the presence of native arthropods in many previously disturbed areas including around observatory structures, indicating a high likelihood of arthropods recolonizing the site after topographic restoration. Removal of the CSO would have no effect on the process of aeolian drift and thus would not diminish the food supply for resident arthropods. No adverse effects on wēkiu bugs would be anticipated as a result of the deconstruction and restoration activities as lava flows are not wēkiu bug habitat, and restoration activities would not require fill material to be taken from current wēkiu bug habitat. Significant adverse effects to the arthropod community due to CSO decommissioning activities are not anticipated.

The threat of importing new species of invasive arthropods must be considered under all deconstruction and restoration scenarios. However, there are several factors that minimize the likelihood of it happening in connection with decommissioning. Decommissioning involves bringing heavy machinery up to the summit to conduct the activities. There are no building materials or other similar construction items that would be transported from lower elevations on which invasive arthropods could “hitchhike” to the site. As detailed in the ISMP and the CSO decommissioning protocols, all heavy equipment, personal belongings, and vehicles must be cleaned at lower elevations before proceeding up the Maunakea Access Road, reducing the threat of introduction. Additionally, the extreme environmental conditions at the summit are not conducive for the establishment of most arthropod species not already present. The majority of new species of invasive arthropods that have been previously discovered at the summit were found dead. Extreme conditions limit the movement and potentially the reproduction of any new live arthropod species, providing opportunity for eradication. Mitigation measures and project protocols would be followed to prevent the establishment of any new invasive arthropod species. Significant adverse effects related to the establishment of new species of invasive arthropods are not anticipated due to mitigation measures and extreme environmental conditions.

Under all deconstruction and restoration scenarios there is the potential for biological organisms to be exposed to organic compounds (i.e. solids from cesspool) and inorganic chemicals (i.e. petroleum products) due to leaks from motorized equipment, decommissioning of the cesspool, or movement of substrate contaminated during previous hydraulic fluid leaks. Project protocols will detail how to avoid these impacts including installing BMPs to contain any spills, and proper use, storage, and disposal of all hazardous materials. The cesspool shall be removed along with solids present and any fill substrate polluted by cesspool contents. Solids would be tested for potential contaminants in order to determine what sanitary landfill they can be taken to for disposal. The empty cesspool site would be backfilled with native material from the site. In the event that it is unfeasible to remove some portion of cesspool solids, any residue present, and/or a portion of the cesspool rings, no significant adverse impacts to biological organisms are anticipated. Any remaining solids, residue, and/or portions of the cesspool rings would be buried underneath native material used to backfill the site. Any portion of the cesspool rings left would remain at the site where buried (would not move through the soil). Any solids or residue left onsite would be subject to decomposition, albeit very slowly due to the characteristics of the aeolian ecosystem. The only biological organisms likely to come in contact with any remaining solids, residue, and/or portion of the cesspool rings are invertebrates. Given that every effort will be made to remove as much material as possible and that any remaining material will occupy a very small amount of invertebrate habitat, if any

(depending on depth), remains of solids, residue and/or portions of the cesspool rings do not represent a significant adverse impact.

A number of small hydraulic fluid leaks occurred at the CSO between 1990 and 2000 (SRGII 2009). These leaks were noted in the Phase I Environmental Site Assessment. Once the base of the CSO is removed, the substrate surrounding the building site would be tested for the presence of hydrocarbons as part of the Phase II Environmental Site Assessment. Any contaminated soil would be removed from the Astronomy Precinct, although none is anticipated as the fluid spills were contained to the cement pad around the observatory, were very small, and were cleaned up rapidly. Due to project protocols which would be followed, including the removal of any contaminated substrate from the Astronomy Precinct, no significant adverse impacts to biological organisms due to exposure to inorganic chemicals is anticipated.

Under all deconstruction and restoration scenarios adverse effects on native birds or mammals is highly unlikely, as none are known to frequent this part of the Science Reserve.

Effects Limited in Scope to Specific Action Alternatives

Outbuilding. Under a scenario where the outbuilding at the site is left in place, the effects common to all action alternatives would remain the same. The square footage of the area restored to natural conditions would be slightly lower. Existing impacts to biological organisms in the area around the outbuilding would remain.

Infrastructure capping. Under all alternatives the observatory foundation, including footers and slab, will be removed. Under the infrastructure capping scenario all underground utilities (water and electric) will be cut off and each line will be capped in place. Leaving the utility lines in place will not have any impact on biological resources.

5 Protocols and Mitigation Measures for Protection of Biological Resources

This section contains entry/exit protocols, operational protocols, and other measures to be incorporated into CSO decommissioning plans for the protection of biological resources at and near the site. As the target condition at the end deconstruction and restoration is topographic restoration of the site to facilitate passive recruitment of native lichens, mosses, vascular plants, and arthropods, these protocols and mitigation measures are mainly designed to avoid or decrease adverse impacts of decommissioning construction activities.

5.1 Mandatory Training

As required by the *Mauna Kea CMP*, all persons involved with construction activities, including planning, demolition, and site restoration, should participate in a mandatory training about the natural resources on Maunakea. All work will be performed in accordance with the principles and frequency established in the Maunakea User Orientation. The orientation must be repeated every three years. Any person not behaving in a manner consistent with the principles established in the Maunakea User Orientation will be required to leave the project site.

5.2 Minimize Habitat Disturbance

The rocks and cinder on the lava flow where the CSO is located are home to lichens, mosses, and endemic arthropods that can be adversely affected by disturbance, erosion, and dust. BMPs to minimize erosion

and dust due to decommissioning activities will be employed. Disturbance should be minimized in the habitat surrounding the decommissioning site.

Minimize disturbance.

- Decommissioning activities will be limited to the CSO parcel and staging area to the greatest extent possible.
- All project materials will remain within the project site or staging area, and no cinder or other materials should be side-cast into adjacent habitat.
- Temporary fencing will be placed to ensure all project activities and material remain within the project site.
- Any necessary erosion control measures will be maintained in good condition throughout the duration of the project. Erosion control measures will be replaced if degradation is occurring.
- All vehicles moving in and out of the CSO parcel and staging area will use the existing roads and driveways.

Minimize dust generation and spread.

- Water will be applied to substrate to minimize dust generation during decommissioning activities. This includes fill operations where water will be applied directly to excavation sites and cinder fill.
- High winds can spread dust to surrounding habitat. Dust-generating activities will be suspended during high winds.

Establish designated routes for large equipment travel.

- The travel routes for distribution of substrate fill will be well planned prior to collection. This includes routes to be used to back fill the CSO site as well as routes to be used to stockpile any excess fill off site.

5.3 Avoid Introduction of Non-native Species

Introduction of non-native species is one of the main concerns associated with bringing in materials and equipment for decommissioning activities. Avoiding introduction of non-native invertebrates and plant species is a high priority due to the threat they present to native invertebrates and their habitat at or near the summit. Ants are especially threatening, and their introduction should be strictly prevented. Introduced plants can change the microhabitat conditions if they become established, thereby facilitating the establishment of other non-native species.

All Standard Operating Procedures (SOP) detailed in the *Maunakea Invasive Species Management Plan* (ISMP) will be followed to prevent the introduction of new invasive species as well as the spread of existing invasive species (Vanderwoude et al. 2015).[2]

As detailed in ISMP SOP 01 and SOP 02:

- Personal belongings and vehicles are to be cleaned and inspected by the operator prior to arrival at the Saddle Road / Maunakea Access Road junction. The operator of any personal vehicle must remove any plant, animal, or earthen material (i.e. weed seeds, ants, soil, mud, food scraps), that might harbor invasive animals or plant seeds.

[2] The *Maunakea ISMP* and SOP can be viewed online at http://www.malamamaunakea.org/environment/invasive-species

- Heavy equipment brought to Maunakea must be free of large deposits of soil, dirt, and vegetation debris that may harbor alien arthropods and weed seeds.
- Pressure-wash and/or otherwise remove alien arthropods and weed seeds from all equipment and materials before moving them from lower elevations and up the Maunakea Access Road. This cleaning can be done in baseyards in Hilo or Waimea before continuing up Saddle Road.
- Inspect large trucks, tractors, and other heavy equipment before proceeding up Maunakea Access Road. All large deliveries and vehicles and heavy equipment will be inspected by a DLNR-approved biologist for the presence of invasive invertebrates and/or weed seeds. Inspections will be performed below the Saddle Road junction prior to arrival at the project site. Any deliveries or vehicles or equipment found to have weed seeds or invasive invertebrates will be refused entry until deemed clear, at the contractor's expense.

CSO buildings targeted for demolition should be free of invasive species prior to deconstruction.

- OMKM will place traps inside the CSO facility a few weeks before decommissioning activities begin to confirm that there are no new invasive species present that may be released during deconstruction. Any invasive species present will be eradicated prior to decommissioning activities.

5.4 On-site Material Storage and Disposal

Equipment, materials, and trash being stored on site during the deconstruction process can be displaced by high winds or serve as an attractant to non-native species, both of which can possibly cause damage to biological resources.

Store loose tools and small equipment so that they do not damage resources.

- Loose tools or small equipment will not be left unattended and will be properly stored at the end of each day.

Secure deconstruction debris so that it does not damage resources.

- Cover deconstruction trash containers tightly to prevent construction waste from being dispersed by wind.
- Cover deconstruction materials stored at the site with tarps, or anchored them in place, so they are not susceptible to movement by wind.
- Collect any deconstruction materials and trash blown into surrounding habitat, with a minimum of disturbance and as soon as possible following dispersal.
- Ensure all deconstruction waste materials and trash receptacles are secured at the end of each day.
- All deconstruction waste material will be removed from the site and properly disposed of.

Secure personal trash so that it does not damage resources or attract non-native species.

- Outdoor trash receptacles will be provided for ready disposal of lunch bags, wrappers, and other personal trash. These receptacles will be secured to the ground, have attached lids and plastic liners, and be collected frequently to reduce food availability for alien predators.
- All perishable items including food, food wrappers, and containers, etc. will be removed from the site at the end of each day and properly disposed of.

Avoid, and if necessary, contain spills.

- Oil spills and other contaminating events have occurred at observatories in the past. While these spills have always been contained immediately and have not resulted in serious ecological damage, care must be taken to avoid any spills.
- Install BMPs to contain any spills of hydraulic fluid or other chemicals during decommissioning.
- Install BMPs to ensure petroleum products from large equipment will not drip onto the ground while in use or in storage.
- The project staff and contractors will keep a log of hazardous materials brought on-site and follow Federal guidelines specifying the use and disposal of oil, gasoline, dangerous chemicals, and other substances used during decommissioning activities.
- Report spills immediately to a designated project representative and the proper authorities.
- Contain and clean all spills following appropriate protocols.
- Equipment will not be cleaned on-site.

5.5 Monitoring for Invasive Species

Monitor the construction site and staging areas to detect new introductions of non-native arthropod and plant species. Should any new non-native arthropod or plant introductions be detected during monitoring, the current rapid response plan detailed in the ISMP would be followed to reduce adverse impacts. Non-native species of highest concern and plausible control methods are listed in the ISMP.

- Conduct monthly monitoring for invasive species at the site throughout the decommissioning process.
- Conduct quarterly monitoring for invasive species, as part of OMKM's monitoring of existing observatories, for a period of three years post project completion.[3]
- Should the outbuilding remain on-site, it should be monitored during OMKM's quarterly monitoring of observatories as long as the facility remains.
- Should a new invasive species be detected, a rapid response plan would be followed.
    - New invasive plant species would be hand pulled, bagged, and disposed of off-site.
    - If a new species of invasive arthropod is detected, additional traps would be set in the area surrounding the detection location. Additional traps would be used both to determine the size of population and the area occupied as well as serve as a method of potential eradication. Should the species prove to be persistent, DLNR DOFAW would be notified and coordination for eradication would be conducted under DLNR authority and rules. SOPs for monitoring and rapid response detailed in the ISMP would be followed: (http://www.malamamaunakea.org/uploads/environment/MKISMP/SOPC_Invertebrate_ThreatIDCollectionProcessGuide.pdf and http://www.malamamaunakea.org/uploads/environment/MKISMP/MaunakeaInvasiveSppMgmtPlan_PCSUTechR_v191.pdf).

[3] A monitoring period of three years is required per the *Decommissioning Plan for the Maunakea Observatories* (SRGII 2010).

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