CHAPTER 3: NATURAL ENVIRONMENT

This chapter discusses the environmental consequences on the natural environment associated with implementing the project. Discussion of probable impacts addresses the No Action Alternative and the Proposed Action. The No Action Alternative represents a future scenario "without the project" providing a baseline of future environmental conditions to assess and evaluate probable impacts or changes resulting from the proposed project.

Background on Climate

Hawai'i's climate is relatively moderate throughout the island chain, although some variations occur due to the mountainous topography associated with each island. Annual and daily variation in temperature depends on elevation above sea level, distance inland, and exposure to the trade winds. On O'ahu, the Ko'olau and Wai'anae mountain ranges are oriented almost perpendicular to the trade winds, which account for much of the variation in local climatology. O'ahu's temperatures have small seasonal variation such that the temperature range averages only 7 degrees between the warmest months (August and September) and the coolest months (January and February) and about 12 degrees between day and night.

HMP and the Petition Area (project site) are located in Kāne'ohe, in the windward lowlands, a climatic region characterized as being moderately rainy with frequent trade wind showers. Temperatures are nearly uniform and mild compared to other regions on the island. Historic data from a recording station in Kāne'ohe is available for a 111-year period (January 1905 to June 2016). During this time, annual temperatures in Kāne'ohe ranged from an average minimum of 67.7 degrees to an average high of 85.9 degrees. Annual rainfall averages about 53.8 inches per year, with November being the wettest month, with an average of 7.01 inches. The driest months are June and July which both averaged of 2.71 inches of precipitation (WRCC, 2016).

Winds are predominantly "trade winds" from the east-northeast except for occasional periods when "Kona" storms generate strong winds from the south, or when the trade winds are weak and land breeze to sea breeze circulations develop. Wind speeds typically vary between 5 and 15 miles per hour providing relatively good ventilation much of the time. Lower velocities (less than 10 mph) occur frequently when the usual northeasterly trade winds tend to fall giving way to light, variable wind conditions through the winter and on into early spring.

3.1 TOPOGRAPHY AND SOILS

Geologic Background

The Island of O‘ahu was created by three volcanoes; the oldest is the Ka‘ena volcano (4-5 million years) that is now submerged off Ka‘ena Point; the Wai‘anae volcano (3-4 million years) on the west side; and the youngest being the Ko‘olau volcano (2-3 million years) on the east side. Activity of the Ko‘olau Volcano ceased about 1.8 million years ago, and was followed by a long period of subsidence and erosion. Streams carved deep amphitheater-headed canyons in the volcano, gradually destroying the caldera. Both the Wai‘anae and Ko‘olau volcanoes have experienced catastrophic collapses with portions of both calderas falling into the ocean, leaving the two existing mountain ranges. Kāne’ohe is generally located at the southern portion of the Ko‘olau range’s eastern flank, between He‘eia and Kailua.

HMP and the Petition Area are generally located on the western flank of the Oneawa Hills, which form the geographic boundary between Kāne‘ohe and Kailua. This elongated landform trends generally northeast to southwest. The Petition Area is located on the lower elevation of the Oneawa Hills, and generally encompasses a topographic knoll and adjacent lowland basin area at the foot of the hillside. The original Kapa‘a Quarry site is on the side of the Oneawa Hills ridgeline opposite the Petition Area. Mining at the quarry site has created sub-vertical rock cut slope exposures providing an overview of the typical hard rock material believed to form the core of Oneawa Hills.

At its core, Oneawa Hills is composed of massive basaltic caldera-filling lava rock containing some basaltic breccia rock (Geolabs, Inc., 2018). The caldera filing lavas are intruded by a series of volcanic dikes that fed the caldera filling lava extrusion. The combined basaltic rock materials represent the late stage caldera filling lava materials from the old Ko‘olau Volcano vent that spanned the distance between Kāne‘ohe and Waimānalo. The rock material comprising Oneawa Hills belongs to the Kailua member of the Ko‘olau Volcanic Series, and are generally highly to completely weathered at the ground surface. This rock material may also contain buried zones of deeply decomposed rock, which was hydrothermally altered by volcanic fluids and gases following deposition in the caldera.

Site reconnaissance and review of existing geologic information was conducted for the project’s rockfall and slope hazard study to understand the geologic characteristics of the Petition Area. Results of the project rockfall and slope hazard study are discussed in Section 3.2.6. Steeper slopes of the site are likely comprised of soil produced from the decomposition of basaltic rock comprising Oneawa Hills and scattered remnant hard rock outcroppings at surface and subsurface levels. Slopes at lower elevations of the Petition Area are anticipated to contain areas of soil produced from rock weathering with few hard rock outcroppings at the ground surface.

3.1.1 Topography

3.1.1.1 Existing Conditions

The Petition Area generally slopes in a northwest direction from the hillside toward the Pikoiloa subdivision. Site elevations range from 180 feet above mean sea level (AMSL) to 420 feet AMSL. Slope conditions vary significantly. The basin area in the eastern portion of the site has an average slope of 25% to 30% with various smaller ridgelines and valleys found throughout this area. In contrast, slope conditions at upland areas in the western portion of the site, such as the hillside adjacent to Ocean View Garden, have steeper slopes of 90% in some areas. The portion of the site planned for the Cultural Preserve encompasses portions of the Petition Area at low and high elevations. Slope conditions vary significantly as elevation increases within the Cultural Preserve. The Petition Area's existing topographic conditions are shown in Figure 3.1.

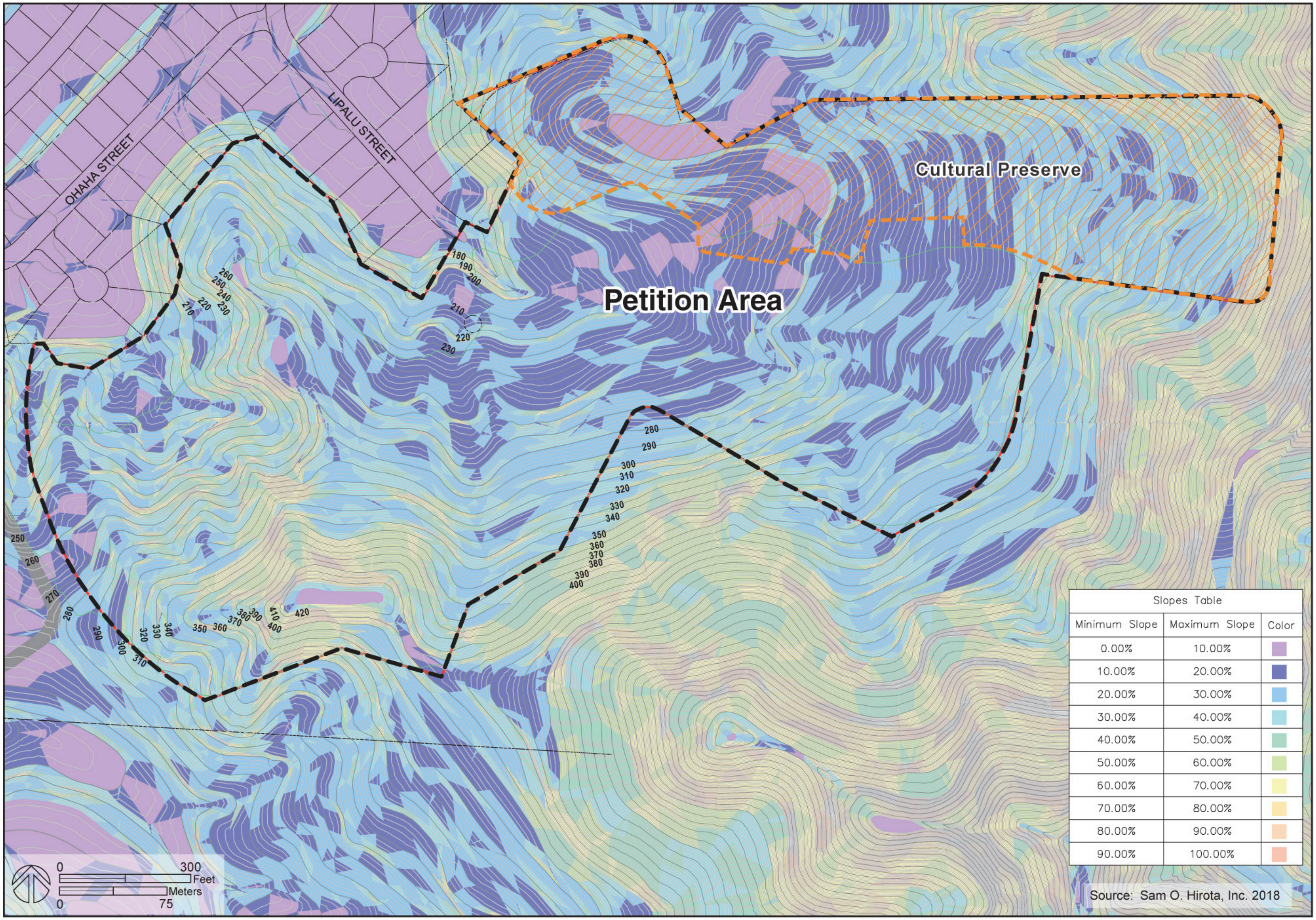
3.1.1.2 Potential Project Impact and Mitigation

No Action Alternative

Existing topographic conditions would generally continue at the Petition Area under the No Action Alternative. Overt evidence of slope instability was not observed during site reconnaissance for the project rockfall and slope hazard assessment (Geolabs, Inc., 2018), indicating site topography is currently stable. However, current topographic conditions within the site would gradually change over time from erosion by natural factors, such as stormwater runoff. Currently, significant rainfall events result in stormwater runoff discharged from the site carrying much soil and debris as discussed in Sections 3.7 and 3.8. Therefore, continued erosion over time would likely increase the width and depths of existing ephemeral drainageways resulting in some minor change to existing topographic conditions.

Proposed Action

A substantial amount of grading activities would occur to develop the cemetery expansion project under the Proposed Action. A preliminary proposed site grading concept was previously shown in Figure 2.3. As discussed in Section 2.2, proposed burial sites along internal roadways within the expansion site would be designed to have slopes no greater than 20% to allow for pedestrian access. Along the fringes of the expansion site, retaining walls and cut/fill slopes would be used to tie into existing grades.



Topographic Map **Figure 3.1**

Hawaiian Memorial Park Cemetery Expansion Project Final Environmental Impact Statement
Kāne‘ohe, O‘ahu, Hawai‘i

In order to achieve the desired finish grades, the lower flank slopes of the Oneawa Hills on the western end of the site would need to be cut. The majority of this western hillside would be excavated reducing it up to 40 feet in height; however, the areas near the top of the hillside would reduce it up to 100 feet in height. This western section is where the most significant changes to existing topographic conditions would occur. Figure 2.4 in Chapter 2 includes a section view showing the existing and proposed topographic change. A smaller ridge line below this hillside in the area generally between Lipalu Street and Ohaha Place would also be excavated up to 60 feet.

The excess soil from excavation activities would be used to fill the lower portions of the site. Areas proposed for fill generally includes areas below the current western hillside, and the majority of the eastern half of the cemetery expansion site. The majority of fill activities would increase the existing height of the site less than 20 feet; however, there are sections that would involve filling areas up to 40 feet in height. Figure 3.2 shows a section view of topographic changes occurring within the eastern half of the Petition Area.

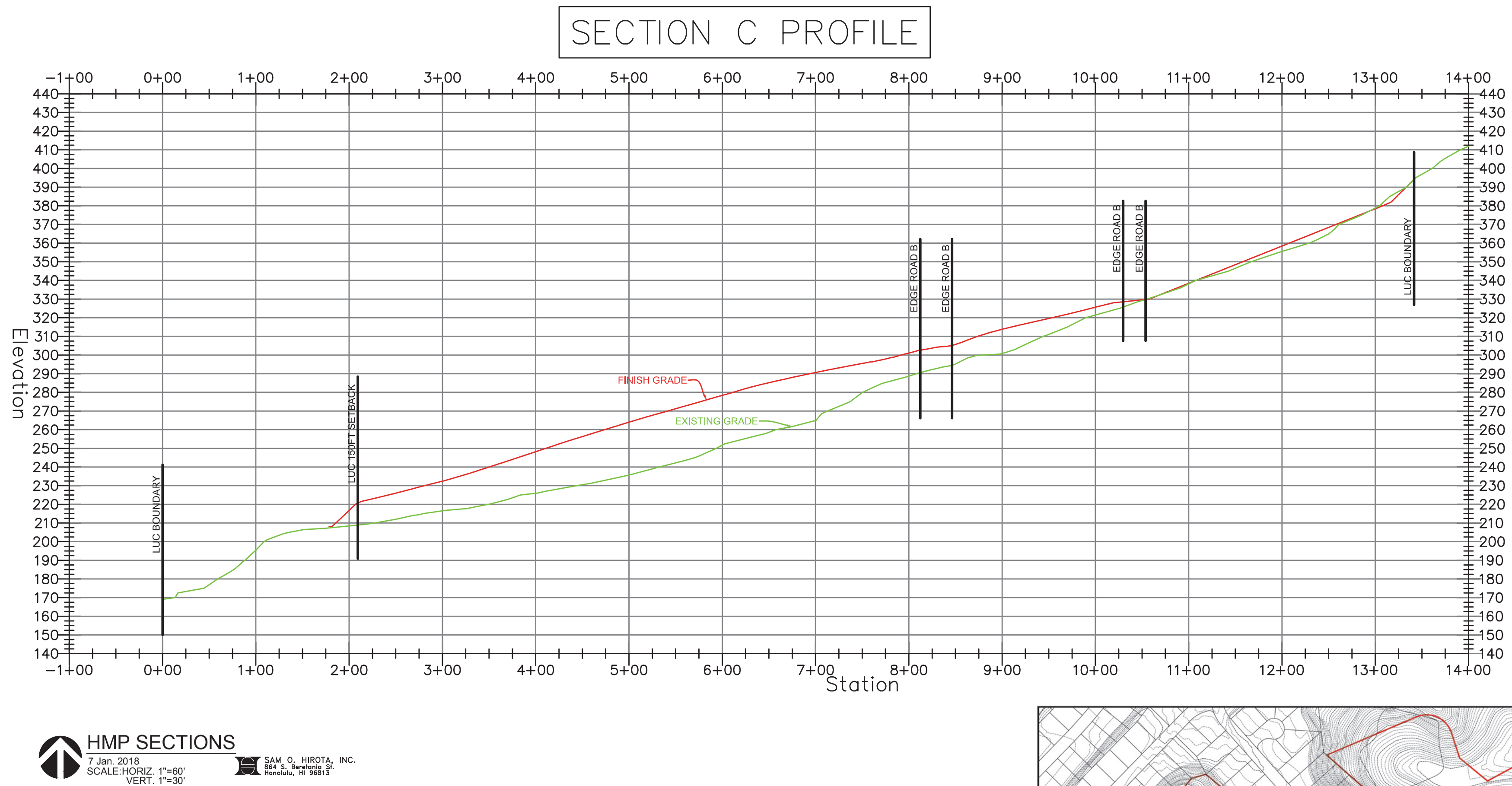
The estimated area of disturbance for earth moving activities is about 33.6 acres. The estimated quantities of excavation and embankment are shown below. Refinements to this grading plan would be determined during the project's design phase when data from a detailed topographic survey is obtained. Therefore, it is anticipated the quantities will be refined as more accurate topographic survey data is available.

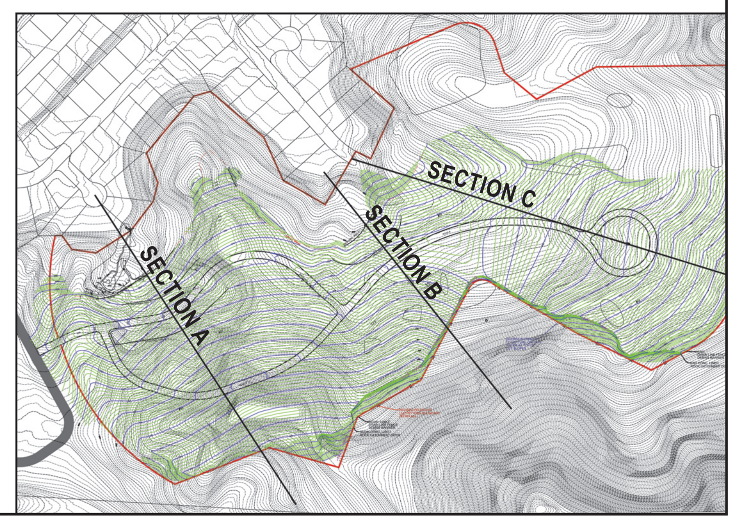
Estimated Excavation	470,960	cubic yards
Estimated Embankment	413,673	cubic yards
Net Change	[57,287]	cubic yards (cut)

It is estimated that over 57,000 cubic yards of excess cut material produced would be either dispersed within the larger HMP property or would be transported offsite. HMP would find appropriate locations to temporarily store material before being hauled away for disposal.

The roadways alignment and earthwork balance requirements under the preliminary grading plan also necessitate the need for constructing retaining walls at various locations within the cemetery expansion site. As previously discussed in Section 2.2, a total of seven retaining walls are planned of keystone design. These retaining walls would be utilized within the western half of the Petition Area, and most are associated with the excavation of the hillside.

These grading activities would alter existing topographic conditions, particularly on the western half of the Petition Area. Removing a portion of the Petition Area's western hillside and lower basin knoll would reduce their heights, but result in a more level to slightly sloped topographic condition. Areas within the Petition Area having steep slopes (greater than 50%) would be improved to reduce slopes to 20% or less.





Section C Profile

Figure 3.2

Hawaiian Memorial Park Cemetery Expansion Project Final Environmental Impact Statement
Kāneʻohe, Oʻahu, Hawaiʻi

The Cultural Preserve would have minimal site disturbance because site improvements would mainly consist of cultural landscape restoration improvements under a preservation plan developed for the long-term maintenance and management of Kawaʻewaʻe Heiau and other cultural sites in the area. Therefore, any improvements would be related to landscaping and maintenance, and would not generate significant long-term or short-term changes to the existing topography in this area.

Proposed Mitigation Measures

The following actions would be incorporated in design plans to mitigate topographic impacts to the Petition Area. Section 2.2 also discussed other best management practices and design criteria that would be incorporated into the project's design.

1. Conduct further geotechnical engineering study, if pertinent, along with a topographic survey to evaluate site conditions in more detail, and determine more specific recommendations for the project's design and development of grading plans.
2. Follow current geotechnical engineering recommendations to limit cut and fill slopes to not exceed a two horizontal to one vertical slope ratio.
3. Limit fill slopes to have benches at a maximum of 30 feet height intervals, and be "keyed" in design to provide additional stability.
4. Install subdrains at the base of fill slopes to assure seepage water does not accumulate at the toe of the slope, to avoid instability.

3.1.2 Soils

3.1.2.1 Existing Conditions

Existing soil conditions discussed are based upon: 1) soil classifications described by the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) (formerly the Soil Conservation Service); and 2) site reconnaissance and soil borings within the Petition Area conducted by Geolabs, Inc.

NRCS Soil Classifications

The USDA NRCS has classified soil types within the Petition Area consisting of the following: 1) Alaeloa Series; and 2) Kāneʻohe Series soils. Figure 3.3 illustrates the NRCS classification of Petition Area soils. A description of these soils is based upon the *Soil Survey, Islands of Kauaʻi, Oʻahu, Maui, Molokaʻi, and Lānaʻi, State of Hawaiʻi* (SCS, 1972).

Alaeloa Series

Alaeloa series soils comprise the dominant soil series in the project expansion area. A broad band of soils from this series exists below the project hillside. The Alaeloa series typically consists of deep and very deep well drained soils forming in material weathered from basic igneous rock. Alaeloa soils have a broad range of slopes from gently sloping to very steep.

Alaeloa Silty Clay 15% to 35% Slopes (AeE). This soil can be found throughout the basin area located at the eastern end of the Petition Area. This soil possess moderate permeability, medium runoff, and moderate erosion risk. The soil type occurs on smooth side slopes and toe slopes.

Alaeloa Silty Clay 40% to 70% Slopes (ALF). This soil is found on upland hillside areas at eastern and western portions of the Petition Area. This soil is most commonly found on 45% to 53% slopes. Erosion risk for this soil is severe and runoff is rapid to very rapid.

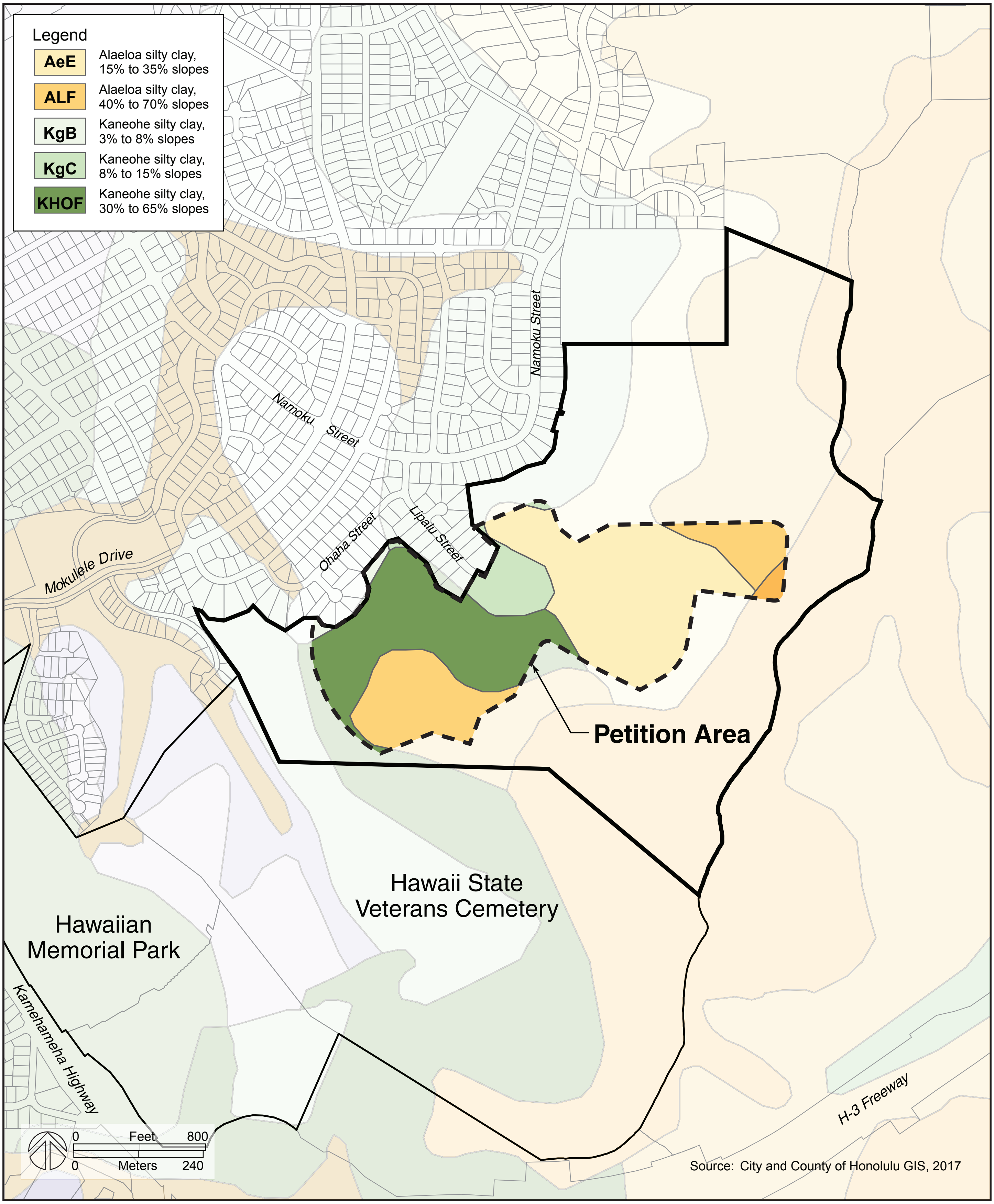
Kāneʻohe Series

The Kāneʻohe series characteristically consists of well-drained soils on terraces and alluvial fans that typically developed in alluvium and colluvium derived from basic igneous rock. These soils are present within gently sloping to very steep areas, and are characteristically found on Oʻahu at elevations ranging from 100 to 1,000 feet AMSL. Where slopes are less than 15%, runoff is medium and erosion hazard is moderate. At slopes greater than 30%, runoff is medium to rapid and erosion hazard is moderate to severe.

Kāneʻohe Silty Clay, 3% to 8% Slopes (KgB). These soils are found in a small portion of the Petition Area near Pikoiloa subdivision properties. This soil occupies uniform slopes with moderately rapid permeability, slow to medium runoff, and slight erosion hazard.

Kāneʻohe Silty Clay, 8% to 15% Slopes (KgC). These soils are found on the lower slopes of the eastern basin area, near Pikoiloa subdivision properties. This soil is characterized by medium runoff and moderate erosion hazard.

Kāneʻohe Silty Clay 30% to 65% Slopes (KHOF). These soils are found on the hillside areas located at the western portion of the Petition Area. This soil characteristically occurs on terrace faces and along drainageways. Runoff for this soil type is medium to rapid and erosion hazard is moderate to severe.



Soils Map **Figure 3.3**

Hawaiian Memorial Park Cemetery Expansion Project Final Environmental Impact Statement
Kāne‘ohe, O‘ahu, Hawai‘i

Geolabs, Inc. Geotechnical Study

Geolabs, Inc. (Geolabs) conducted a geotechnical study to evaluate the existing site conditions for potential rockfall and slope stability hazards, and to provide preliminary geotechnical recommendations for grading and potential rockfall hazard mitigation. The results of this work are documented in Appendix C. Geolabs' work included field reconnaissance to observe the site's slopes, map existing conditions of the surface rock exposures, and test borings at a total of six locations.

Ground surface reconnaissance of the Petition Area's interior and higher elevation slopes was conducted using a handheld GPS unit, topographic maps, and available aerial imagery to navigate and locationally reference features in the field. The discussion of existing conditions is divided into "Basin" and "Upland Slopes" areas. Reconnaissance of the Upland Slope area was limited to foot accessible areas on the mid-slope due to the steepness of this area and its vegetation. Areas examined include a traverse along the Oneawa Hills ridge summit, and traverses made by climbing up primary "U" shaped ravines extending toward the ridge summit.

Basin Area Reconnaissance Results

The Basin Area encompasses the foot of adjacent steeper slopes where gently rolling or sloping terrain can be found along with tributaries of established drainage channels. Existing ground surface inclinations in this area are about 3:1 (Height to Vertical) or flatter. Reddish brown and brown silty and clayey alluvial and or colluvial soils underlie lower portions of the Basin Area, and contain some embedded rock fragments derived from erosion of upland areas. More frequently, exposure of rocky colluvial material consisting of mixed cobbles, boulders, and clayey soils were generally encountered within the tributaries and established drainages emanating from surrounding slopes (Exhibit 3.1). However, the hills at the far northern and northwestern corners

View of Drainage Channel with Cobbles from Alluvial and Colluvial Deposits in Lower Basin

Scoured Subsurface Exposure of Older Alluvial and Colluvial Soil Deposits in Basin

Exhibit 3.1 Existing Soils and Deposits within Basin Area

of the area may be composed of stiff clayey and silty residual soils derived from deep and in-situ decomposition and weathering of rocks.

Visible evidence of extensive areas of dark colored, organic rich soft alluvial soil conditions at the surface were not encountered except in the vicinity of a groundwater spring situated at the northwestern portion of the Basin Area. The spring area contains multiple swale alignments and localized standing water. Therefore, reddish brown clayey soils may be saturated (Exhibit 3.2). Soft soil conditions should be anticipated within and immediately surrounding the groundwater spring discharges.

Exhibit 3.2 Existing Soil Condition Near Spring

Several large isolated boulders were observed having greater than 6 feet in dimension, residing in stable, generally flat ground settings (Exhibit 3.3). No evidence of recent rockslide or depositional events (i.e. missing vegetation) were observed. A parent rock outcrop that could have produced the boulders was not encountered during reconnaissance of the upper slope, except on slopes above the proposed Cultural Preserve area to the east. Therefore, the origin of these anomalous boulders in the lowland basin is suspect and may have resulted from: 1) prehistoric large-scale rockfall or rockslide events occurring in the early evolution of the landscape; 2) erosional remnant rock embedded in underlying basin soils that was "brought" to the surface by stream incision or erosion; or 3) human induced rockfall caused by blasting and heavy exaction of the adjacent rock quarry where earth cuts reach the top of the nearby Oneawa Hills summit.

Exhibit 3.3 Large Boulder Embedded in Soils in Lower Basin

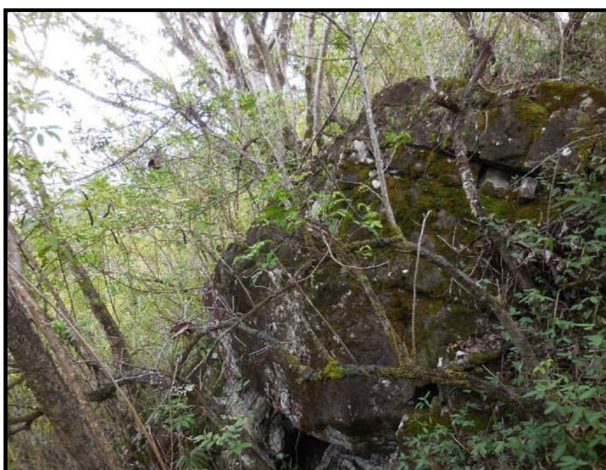
Within and upslope of the proposed Cultural Preserve, numerous large boulders and clusters of large boulders greater than 6 feet in dimension residing on stable ground were found (Exhibit 3.4). Large boulder deposits may be indicative of a prior landslide or rockslide event, given their association with underlying deposits of broken angular gravel and cobbles that were observed in soils of this area. Additionally, numerous scattered individual boulders and clusters of boulders ranging from 3 to 8 feet in size were observed on stable ground settings. The concentration and frequency of boulder deposits suggests a source rock outcropping resides upslope of the Cultural Preserve.

Large rock outcroppings were observed in a steep terrain setting during reconnaissance of the suspected source area extending toward the ridge summit. These rock outcroppings are located directly above the observed deposition area. Therefore, the sub-valley extending toward the ridge summit above the proposed Cultural Preserve area may harbor additional large block rock outcroppings that could present dangerous rockfall activity risk and encroachment upslope of the Cultural Preserve boundary.

Exhibit 3.4 Large Boulder Cluster within Basin of Cultural Preserve

Upland Slopes Reconnaissance Results

The upland slope area encompasses the steeper hillside terrain generally extending upslope and above the Petition Area's boundary. The exception is the far southwestern corner of the Petition Area where some steeper hill slopes are present. Upland hill slope surfaces appear to be primarily composed of residual and saprolitic soils derived from the deep weathering and decomposition of basalt rock. Parent basalt rock typically forms at the core of the Oneawa Hills. As a result, erosional remnant hard rock material ranging from cobble/boulder stones to large blocks in excess of 10 to 15 feet may be embedded in these soils (Exhibit 3.5). In addition, near-surface residual and saprolitic soils are anticipated to transition to hard basaltic rock material at variable depths. The presence of hard and massive rock material embedded in the subsurface is difficult to predict on surface observation alone, given the great variability in depth and extent of weathering and rock decomposition associated with Kailua Volcanic Series lavas.



Large Block Type Rock Outcropping Near Ridgeline Summit Above Cultural Preserve Area

Fractured Rock Outcropping Within Central Area of Cemetery Expansion

Exhibit 3.5 Rock Material Within Upslope Areas

Widely scattered to scattered surface level hard rock outcroppings were observed, primarily on steeper mountain slope segments upslope of the Petition Area. Three general types of basalt rock outcroppings related to the Kailua Volcanic Series lavas and dike rock were observed on upland slopes as discussed below.

1. Isolated, scattered to widely scattered, hard rock masses protruding from the surrounding low relief soil covered ground surfaces. The outcroppings are capable of producing falling rock hazards, and were the most common outcropping type encountered on slopes above the cemetery expansion area. Rocks are predominantly 3 to 5 feet in dimension, generally equidimensional to cylindrical in shape, and ranging from massive to severely fractured.
2. Isolated, very widely scattered, hard rock surfaces with low relief that are generally flush with surrounding soil covered ground surfaces. Flattened outcroppings have limited or no potential to produce falling rock hazards. These were encountered as isolated outcroppings throughout upland slopes in steep slope segments, and in the scoured floor of some ephemeral drainageways.
3. Isolated, very widely scattered, massive, high relief rock outcroppings that appear anomalous to the surrounding landscape and soil covered slopes. These outcroppings are fewer in number, but may produce falling rock hazards. The outcroppings were sporadically encountered in the upper portion of the sub-valley above the proposed Cultural Preserve area located in the northwestern corner of the Petition Area.

No overt visible signs of mass slope instability expressed as recent landslide or debris flow scarification deposits within or adjacent to the Petition Area were observed. Some topographic features resembling localized shallow earth slumps were encountered outside the Petition Area within soil deposits adjacent to the steep upland slope area. Old lump scars were re-vegetated without visible indication of reactivation or continued creep movement.

Given the Petition Area's location within an amphitheater-shaped geomorphic environment, stormwater from steeper slopes appears to concentrate within the area's lower elevation basin. Due to the forested upland environment, appreciable forest litter debris, which include broken rock fragments, may be shed from the steep upland slopes and drainage chutes during high volume storm runoff.

3.1.2.2 Potential Project Impact and Mitigation

No Action Alternative

Existing soils within the Petition Area would not be significantly impacted under the No Action Alternative because the site would continue to remain undeveloped or improved. Area soils would continue to experience erosion, the collection and movement of forest litter debris, and movement of broken rock fragments from natural processes such as stormwater runoff especially during heavy rains. These soils would continue to have poor suitability for agricultural production.

Proposed Action

A substantial amount of grading activities would occur to construct the cemetery expansion that would result in a significant change and impact on existing soils and rock material present. The lower flank slopes of the Oneawa Hills on the western end of the site would need to be cut to achieve desired finish grades. The majority of this western hillside would be excavated generally reducing it up to 40 feet in height, and up to 100 feet in height near the top of the hillside. An estimated 470,960 cubic yards (cy) of soil would be excavated with 413,673 cy of this soil utilized as fill material within the site as part of grading improvements. Therefore, an estimated 57,287 cy of unused excavated material would be produced, and would need to be removed from the site.

These grading activities would result in the removal of considerable amounts of existing soils, mixed cobbles, boulders, and other rock material from the site. About 88% of the excavated material would be used as fill material for lower portions of the Petition Area. This would result in a redistribution of existing soils within the cemetery expansion site. Vegetation, debris, and other unsuitable materials such as larger rocks and boulders would be removed and hauled away for disposal off-site. Potential issues with rockfall are addressed under Section 3.2.

Redistribution of soils within the Project Site associated with the Alaeloa and Kāneʻohe series will occur. Based upon Figure 3.3, the Alaeloa soils associated with the western hillside would be excavated and redistributed as fill material over the Kāneʻohe soils present within the lower basin and/or within the Alaeloa soils present within the eastern half of the expansion area. Some minor excavation of Alaeloa soils within the upper portion of this eastern half would also be redistributed within similar soils lower in this area. Some Kāneʻohe soils would be excavated from a smaller knoll in the lower basin, and redistributed within this western half on top of similar Kāneʻohe soils or within portions of the eastern areas of the site (Alaeloa soils).

The Cultural Preserve (approximately 14.5 acres) requires minimal site disturbance because site improvements would be limited to cultural landscape restoration and the long-term maintenance and security of Kawaʻewaʻe Heiau and other significant sites in the Preserve. Hawaiian burials incorporated into the Preserve would not require major grading or other significant site disturbance. Improvements would not generate significant long-term or short-term changes or impacts to the existing Alaeloa soils in this area.

The Alaeloa series is the dominant soil within the Petition Area, and typically consists of deep and very deep well-drained soils. The Kāneʻohe series similarly consists of well-drained soils. Therefore, the planned redistribution of these soils as part of proposed grading plans would be compatible and not result in adverse long-term effects on soils. Design plans would be developed involving further geotechnical evaluation. Construction work would include the monitoring of site grading operations to observe whether undesirable materials are encountered during the site preparation and excavation, and to confirm whether the exposed soil conditions are similar to that evaluated.

Proposed Mitigative Measures for Short-Term Effects

To address short-term construction-related impacts, BMPs would be implemented to minimize impacts to soils. Permits (including grading, grubbing, stockpiling, and a National Pollution Discharge Elimination System (NPDES) permit) would be obtained after agency review, and would discuss applicable BMPs. An Erosion and Sediment Control Plan (ESCP) must also be prepared. BMPs would be incorporated as part of permit approvals and development of the ESCP. Actual BMPs implemented would be determined during the project's design phase and may include the following:

- Incrementally phase grading activities, limiting disturbed areas to 5 acres to minimize exposure time of cleared surface areas. Graded areas would be stabilized using structural controls (i.e. PVC sheets) before the next phase is initiated.
- Utilize structural (i.e. berms) or vegetative controls (i.e. hydro mulch) to stabilize site soils and minimize the erosive potential of runoff.
- Cease all construction work if an emergency weather warning is issued, with work halted until weather conditions improve.
- Implement sediment basins during the project construction phase to slow the flow of site stormwater, minimizing the erosive impact of stormwater on site topography. A portion of the construction period sediment basins would be retained as a long-term Low Impact Development (LID) strategy.
- No disturbance of existing ground cover more than 20 days prior to the start of construction.

Proposed Mitigative Measures for Long-Term

Substantial grading activities are required for cemetery expansion improvements, resulting in a significant change and impact on existing soils and rock material. Several design measures would be incorporated to mitigate the long-term effects of these changes. These mitigative measures were previously discussed in Chapter 2, and are summarized below:

1. Aerate soils due to the relatively high moisture contents anticipated in subsoils, during construction activities to achieve the 85% relative compaction desired.
2. Perform clearing and grubbing work incrementally due to the larger site.
3. Over excavate soft and yielding areas encountered during clearing and grubbing below areas designated to re77ceive fill material or improvements to expose firm material. The resulting excavation would be backfilled with well-compacted fill material.
4. Prepare subgrade soil again where shrinkage cracks are observed after the subgrade compaction.
5. Re-use on-site soils as a source of fill material provided they are free of vegetation, deleterious materials, and rock fragments greater than 12 inches in dimension. Fill materials within the upper 6 feet of finished grades would contain rock fragments no greater than 6 inches in dimension.

6. Use excavated rock materials less than 12 inches in size as general fill material. These rock materials may need to be processed and crushed to well-graded granular material with an average size of about 6 inches and a maximum size of 12 inches. Boulders less than 2 feet in size may also be used as fill material provided that their usage does not complicate trenching operations, and follows geotechnical engineering recommendations.
7. Install subdrains consisting of 4-inch or larger diameter perforated pipes within the base of the areas filled to drain at the toe of the hill to address potential seepage conditions. This improvement would address the potential accumulation of water along the base of the fill. In general, the subdrains would follow existing drainage patterns within the site.
8. Require slope stabilization through structural controls (i.e. geotextile fabrics) for slopes exceeding 15%. Fill slope would be constructed by overfilling and cutting back to the design slope to achieve a well-compacted slope.
9. Overfill fill slope to compensate for soil settlement given the high degree of settlement anticipated. Fill slope would be allowed to settle for an appropriate period (anticipated 2-6 months) before improvements are constructed.

3.2 NATURAL HAZARDS

3.2.1 Seismic Hazards

3.2.1.1 Existing Conditions

Earthquakes in Hawaiʻi are mainly associated with volcanic eruptions resulting from the inflation or shrinkage of magma reservoirs that shift segments of the State's active volcanoes. Earthquakes may occur before or during an eruption, or from the underground movement of magma toward the surface. However, earthquakes also occur due to the shifting of tectonic plates. Except for the Island of Hawaiʻi, the Hawaiian Islands are generally not situated in a high seismic area subject to numerous large earthquakes (Macdonald, Abbott & Peterson, 1983).

The central region of the Hawaiian Island chain encompassing the islands of Maui and Oʻahu are subject to seismicity associated with tectonic activity on the seafloor. Tectonic activity capable of generating hazardous earthquakes are due to seafloor fractures and suspected faults around the islands. Exhibit 3.6 reproduced from the *Atlas of Natural Hazards in the Hawaiian Coastal Zone* (USGS, 2002) identifies recent (since 1950) significant earthquakes occurring in the Hawaiian Islands until 2002. Since this period, earthquakes with magnitudes of at least 5.0 have occurred on or proximate to Hawaiʻi island. Earthquakes of at least 5.0 in magnitude are considered "strong"

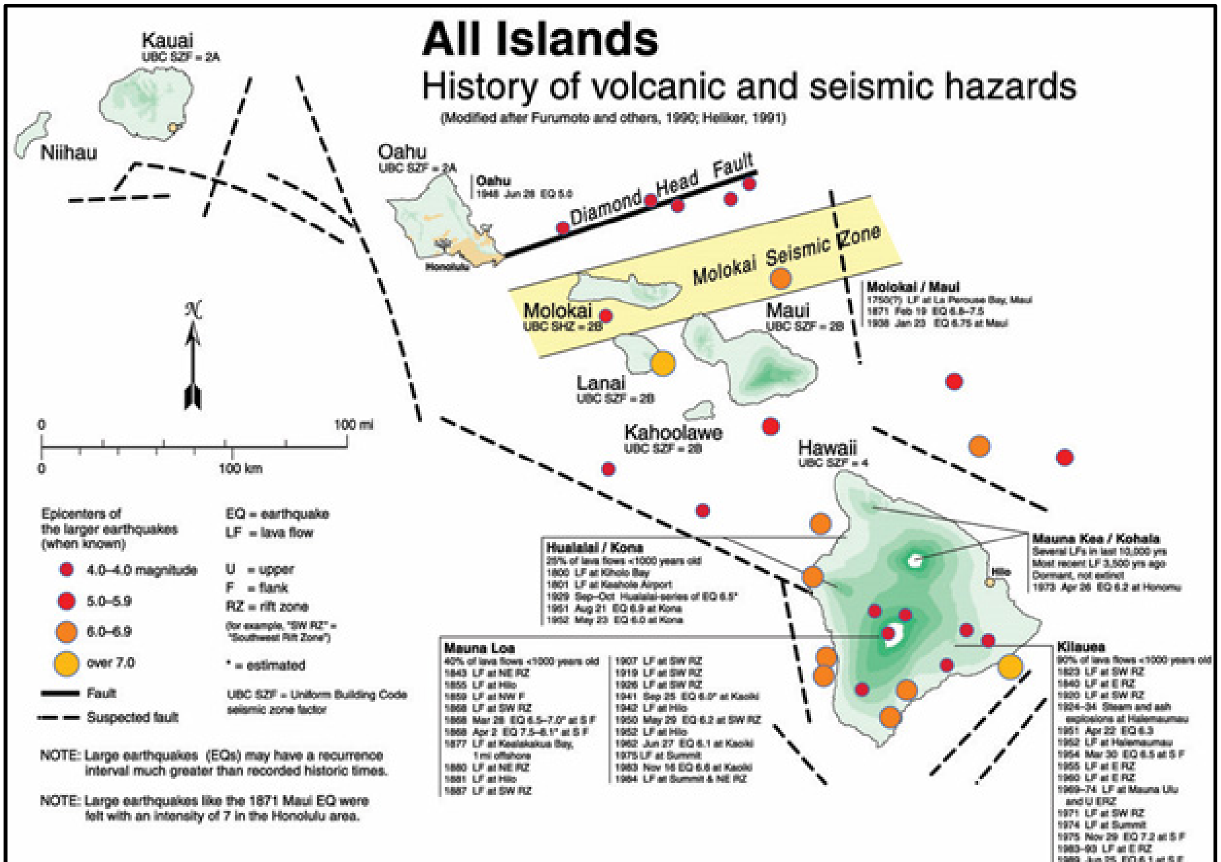


Exhibit 3.6 History of Volcanic and Seismic Hazards
Source: USGS, 2002

by the USGS given their capacity to damage property and endanger lives (USGS, 2002). Most recently, six earthquakes of at least 5.0 in magnitude have occurred on Hawaiʻi Island and are associated with the ongoing 2018 Kilauea eruption (USGS Earthquake Hazards Program, 2018). Exhibit 3.6 also shows major seismic areas affecting Oʻahu, including the Molokai Seismic Zone and the Diamond Head Fault.

The Molokaʻi Fracture Zone is an extension of a transform fault from the East Pacific Rise that extends from Molokaʻi to the Gulf of California. This fracture is tectonic in origin and suspected to contribute to central region seismicity associated with an active seafloor. Because two known earthquakes (1871 and 1938) have occurred along the fracture, it is referred to as the Molokai Seismic Zone (USGS, 2002).

The Diamond Head Fault is said to pass through Oʻahu's Koko Crater and extend along the seafloor northeast of the island. The existence of a Diamond Head Fault was hypothesized in 1980 by scientists from the University of Hawaiʻi on the basis of data from seismic surveys a few years prior. These scientists believed that a 4.8 to 5.0 magnitude earthquake which occurred offshore of Honolulu in 1948, as well as several smaller quakes over the last hundred years, are due to the presence of a Diamond Head Fault. The 1948 Oʻahu quake resulted in broken windows, plaster cracks and ruptures to building walls. However, there remains controversy among scientists today whether the Diamond Head Fault actually exists, and to what extent it can be used to predict future seismic events. Some scientists contend that confirmation of a Diamond Head Fault depends on determining the exact location of the 1948 quake, which is unknown.

Regardless, there exists some seismic risk on Oʻahu. Most of the earthquakes recorded on Oʻahu have been volcanic earthquakes causing little or no damage to the other islands. Available historical data indicates that the number and severity of earthquakes on Oʻahu have been fewer and of lower magnitude than those on other islands such as Hawaiʻi. However, earthquakes of magnitude 5 or higher on the Richter Scale can cause property damage and endanger lives.

The USGS has assigned seismic hazard intensity ratings to all islands on a scale from 1 to 4, with 1 representing lowest hazard and 4 the highest (USGS, 2002). Oʻahu areas possesses a seismic risk ranking of 2 or 3, with the risk ranking assigned dependent on the proximity of the area evaluated to the Molokaʻi Seismic Zone. Southern and eastern facing areas on Oʻahu were assigned a higher seismic risk rating because they are located closer to this zone. The Mōkapu area, which includes the Petition Area, is assigned a volcanic/seismic risk rating of 3 due to its proximity to the Molokaʻi Seismic Zone. This area generally encompasses the Heʻeia, Kāneʻohe, and Mōkapu Peninsula areas. Earthquake hazard risk within the Petition Area is comparable to other areas of Oʻahu proximate to the Molokaʻi Seismic Zone and somewhat elevated compared to western and northern portions of the island. Significant, inhabited structures are not proposed within the Petition Area.

3.2.1.2 Potential Project Impact and Mitigation

No Action Alternative

Although difficult to predict, an earthquake of sufficient magnitude could result in damage to existing vegetation and alter site topographic conditions on the Petition Area. These impacts might also be felt in other areas of Kāneʻohe and the Windward Oʻahu region. However, most of the earthquakes that have occurred in the state have been volcanic earthquakes causing little or no damage on the Island of Oʻahu. The site would remain undeveloped and heavily vegetated under this alternative, and would not be subject to additional seismic risks in comparison to surrounding sites. Therefore, potential impacts would be comparable to other undeveloped areas within Kāneʻohe and the surrounding region.

Proposed Action

Under the Proposed Action, the cemetery expansion area would be graded, and site improvements developed that include roadways and accessory improvements. Seismic risk would therefore slightly increase for the formerly undeveloped Project Site. Site improvements would generally be minimal and include small accessory structures, such as monuments, sidewalks, retaining walls and an internal roadway network. The majority of the new cemetery space would consist of landscaped open space that poses a low earthquake risk. The Cultural Preserve would have a similar low seismic risk because improvements would mainly consist of cultural landscape restoration.

Although construction of accessory structures at the cemetery expansion may result in visitors congregating in certain portions of the Petition Area, overall risk susceptibility to persons at the site after project completion would be low and comparable to other cemeteries in the Windward Oʻahu region. There would be low risk to injury of visitors from structures as compared to more existing urbanized developments, such as surrounding residential neighborhoods or commercial areas.

3.2.2 Hurricane Hazards

3.2.2.1 Existing Conditions

Hurricanes are a type of tropical cyclone with maximum sustained winds exceeding 74 miles per hour. Less severe types of tropical cyclones include tropical storms and depressions. A tropical cyclone is defined as a "non-frontal synoptic scale low-pressure system over tropical or sub-tropical waters with organized convection (i.e. thunderstorm activity) and definite cyclonic surface wind circulation" (HHF 2012). Hurricanes typically dissipate when making landfall, where there is less available moisture that can enter the hurricane system. Hurricanes have affected every island in the State and can cause major damage and injury from high winds, marine over-wash, heavy rains, and other intense small-scale winds and high waves.

Exhibit 3.7 shows the paths of prior hurricanes and tropical storms that affected the Hawaiian Islands from 1950-2016 based upon information from the National Oceanic Atmospheric Administration's (NOAA) website accessed in February 2018. Hurricane Darby recently impacted the State in the summer of 2016, bringing heavy rain and widespread flash flooding to windward areas across the state. The Central Pacific basin had a record number of storms (15) in 2015. Not all of these storms pass directly through the state, and actual hurricane strikes on the Hawaiian Islands are relatively rare in the modern record. More commonly, hurricanes pass close to the islands generating large swells and moderately high winds causing varying degrees of damage (USGS, 2002). Of these storms, Hurricanes Dot (1959), Iwa (1982) and Iniki (1992) directly hit the Island of Kaua‘i. The most recent, Hurricane Iniki, hit Kaua‘i as a Category 4 hurricane, causing nearly $2 billion in damage, more than any other hurricane to affect the state since records began.

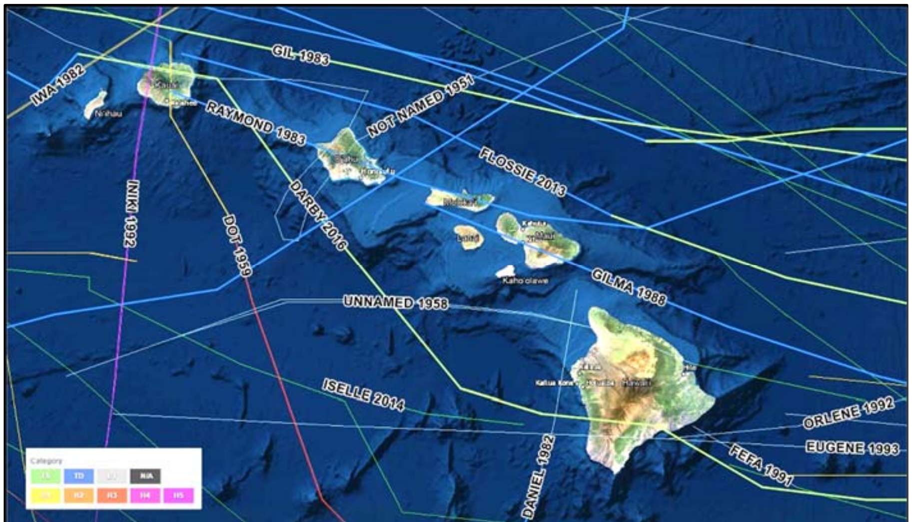


Exhibit 3.7 Major Storm Tracks (NOAA, February 2018)

3.2.2.2 Potential Project Impact and Mitigation

Three significant elements that make a hurricane hazardous are: 1) strong winds and gusts, 2) large waves and storm surge, and 3) heavy rainfall (FEMA, 1993). Hurricane impacts can thus be severe and lead to beach erosion, large waves, high winds, and marine over-wash, despite the fact that the hurricane may not directly hit a particular island (USGS, 2002). Study of the aftermath of Hurricane Iniki found that a significant threat related to hurricane overwash along the coastline in the Hawaiian Islands is due to water-level rise from wave forces rather than wind forces.

No Action Alternative

Hurricane risk for the Petition Area would not be more significant relative to surrounding areas under the No Action Alternative. A hurricane of significant strength and high winds passing directly over or close to the Island of O‘ahu could damage existing trees and vegetation within the site. Heavy rainfall would increase stormwater discharges that would flow downslope to municipal drainage infrastructure. The Petition Area would not be susceptible to wave induced hurricane damage since the site is located upslope (over 200 feet AMSL), and a considerable distance away (over 1 mile) from the coastline.

Proposed Action

Increased hurricane risk relative to surrounding areas is not anticipated under the Proposed Action. A hurricane of significant strength and high winds could damage trees and vegetation within the Petition Area in a manner similar to the No Action Alternative. The Cultural Preserve could receive similar damage to landscaping and vegetation as under the No Action Alternative because this area would remain undeveloped with improvements mainly consisting of cultural landscape restoration.

The cemetery expansion area would change the existing forested vegetation to a more open grassed landscape area that would have a beneficial effect of reducing the potential amount of vegetation debris and branches that could otherwise damage surrounding residential areas after being dispersed by high winds. Monuments and burial plots should be minimally affected from a hurricane.

Proposed grading and site improvements are anticipated to reduce the stormwater runoff rate, resulting in a corresponding decrease in runoff volume (Sam O. Hirota, Inc., 2018). These improvements would create detention basins and improve water percolation with grassed landscaped lawns that would aid in the reduction of stormwater discharges from the site due to a hurricane.

None of these project improvements are intended for permanent habitation or residential occupancy. Cemetery expansion would increase visitors to the Petition Area. However, should a hurricane make landfall on Oʻahu, it is anticipated that sufficient warning would be available and that any visitors would be cleared and directed to a safe location.

3.2.3 Tsunami Hazards

3.2.3.1 Existing Conditions

Tsunami are caused by sudden movement of the seafloor that generates a series of waves which travel across the ocean until they reach a coastline. Seafloor movements may include faulting, landslides, or submarine volcanic eruptions. Landslides originating either under the sea or above sea level and then sliding into the water may also generate a tsunami. Tsunami manifest as either large breaking waves, often largest around headlands where they are concentrated by wave refraction, or as rapidly rising sea levels like a flooding tide. The high degree of volcanism and seismic instability in and around the Pacific Ocean has contributed to a history of tsunami occurrences in Hawaiʻi (USGS, 2002).

The coastline of the Hawaiian Islands is under the continuous threat of tsunami inundation because this region is one of the most geologically active regions on Earth. The geography of the shoreline plays an important role in the form of the tsunami. Tsunami waves may be very large in an embayment, actually experiencing amplification in long funnel-shaped bays. Fringing and barrier reefs appear to have a mitigating influence on tsunamis by dispersing wave energy (USGS, 2002).

In March 2011, a massive tsunami was generated from a large earthquake off the coast of Tohoku, Japan which affected O‘ahu. This tsunami did not result in damages within HMP or the Petition Area. Damage to urban areas along Kāne‘ohe Bay were minimal compared to other areas of the island.

The City’s tsunami evacuation maps for O‘ahu, developed in 1991 and updated in 2010, show the minimum safe evacuation distance from shoreline areas in the event of a tsunami. The evacuation zone is comprised of the inundation zone, i.e., the area where the tsunami is expected to go beyond the immediate shoreline, plus an additional buffer for safety. Following the 2011 Tohoku (Japan) tsunami, there was a newly recognized risk of tsunami from a very large Aleutian event. As a result, in 2015, the City unveiled a new set of “Extreme Tsunami Evacuation Zone (XTEZ)” maps, outlining refuge areas and routes in worst case scenarios.

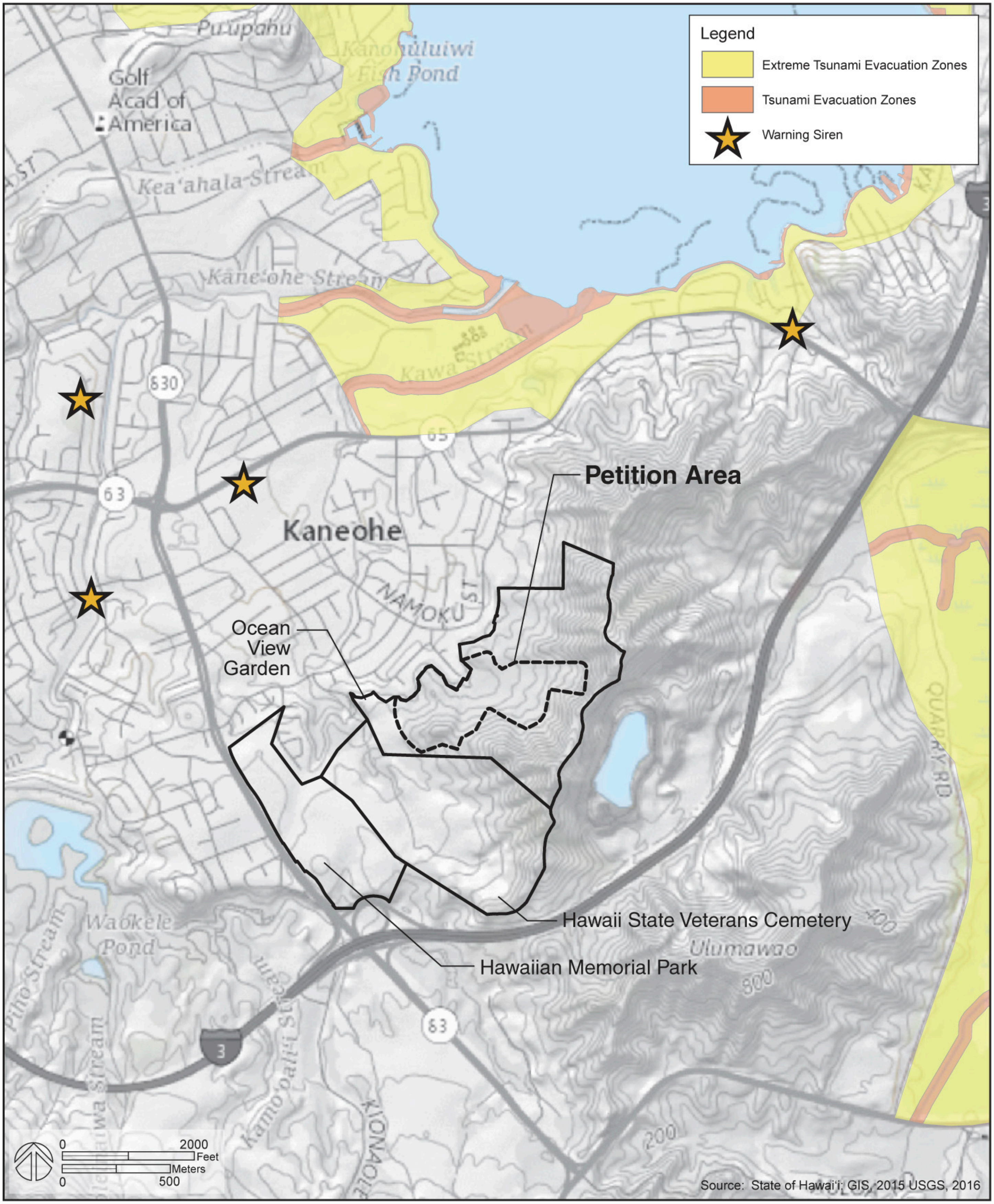
The XTEZ represents a secondary evacuation zone, should an extremely large (9M+) earthquake occur in the Aleutian Islands, generating an especially destructive tsunami in Hawai‘i. Figure 3.4 illustrates both the standard and extreme tsunami evacuation zones. HMP and the Petition Area are well outside both the standard and extreme tsunami evacuation zones.

The State Department of Defense (DOD), Hawai‘i Emergency Management Agency (HEMA) is the emergency management agency for the State and coordinates with the City Department of Emergency Management on disaster warnings for O‘ahu. Warning sirens are located throughout the island primarily along the coastlines and within urban developed areas such as subdivisions. The closet warning siren to the Petition Area is located approximately 0.8 miles away at Castle High School near Kāne‘ohe Bay Drive (see Figure 3.4). Another warning siren is located within the residential subdivision on Apapane Street about 1 mile northwest of the Petition Area. No warning sirens are present within Ho‘omaluhia Botanical Garden, the Pali Golf Course, and Ko‘olau Golf Club located west of HMP, or at Hawai‘i Pacific University to the south.

3.2.3.2 Potential Project Impact and Mitigation

<u>No Action Alternative</u>

Under the No Action Alternative, the Petition Area would not be impacted by a tsunami. Neither the Petition Area nor the HMP existing cemetery are within the City’s standard or extreme tsunami evacuation zones.



Tsunami Evacuation Areas

Figure 3.4

Hawaiian Memorial Park Cemetery Expansion Project Final Environmental Impact Statement
Kāne'ohe, O'ahu, Hawai'i

Proposed Action

Project improvements to expand the cemetery and establish a Cultural Preserve area would not be impacted by a tsunami because the area is outside the City's standard and extreme tsunami evacuation zones. The Petition Area should not be susceptible to tsunami damage since the site is located upslope (over 200 feet AMSL), and a considerable distance away (over 1 mile) from the coastline.

In a letter from the State DOD HEMA on the EISPN, the agency indicated that there is no siren coverage for the project area. However, no warning sirens increasing coverage haven been required for other nearby large recreational areas such as Hoʻomaluhia Botanical Garden, the Pali Golf Course, and Koʻolau Golf Club. Development of the Hawaiʻi State Veterans Cemetery also did not require a warning siren. The expanded cemetery area and Cultural Preserve should be within audible range of existing warning sirens servicing residents in the adjacent surrounding Pikoiloa subdivision, and is located well away from the extreme tsunami evacuation zone. In addition, HMP staff can notify cemetery visitors in the event of pending disaster.

A new warning siren within the Petition Area would be unnecessary because it would only primarily serve a limited number of residences on the eastern half of the Pikoiloa subdivision, which are already serviced by sirens at Castle High School and along Mōkapu Saddle Road. Inland areas surrounding the Petition Area are undeveloped and uninhabited.

The State DOD would like a 121 dc(c) omni-directional siren installed within the Petition Area to improve siren coverage of the area. Although potentially not necessary, the Petitioner would be willing to have the State DOD fund and construct a siren within the Petition Area or within HMP. The State DOD can coordinate with the Petitioner to determine an appropriate location for the State's implementation of such a siren.

3.2.4 Flood Hazards

3.2.4.1 Existing Conditions

The Petition Area is located in the windward lowlands of Kāneʻohe. This is a climatic region characterized as being moderately rainy with frequent trade wind showers. Floods caused by heavy rainfall and strong winds normally occur during the winter months. Historic rainfall data for the region surrounding the Petition Area shows the most frequent rainfall occurring from October to March, varying on average from 4.93 to 7.01 inches per month. Annual rainfall averages about 53.8 inches (WRCC, 2016).

FEMA Flood Zones

The Federal Emergency Management Agency (FEMA) flood hazard area classifications are used to gauge flood hazard risk for the Petition Area. Figure 3.5, Flood Hazard Zones, highlights the flood hazard designations in the vicinity of the Petition Area based upon the State's Flood Hazard Assessment Tool (FHAT). According to both the FHAT and Flood Insurance Rate Map (FIRM) number 15003C0270J (effective November 4, 2014) published by FEMA, the Petition Area is predominantly within Zone D. This designation is assigned to areas where flood hazards are undetermined, but flooding is possible. Zone D areas include the site's upland hillsides and the majority of lowland basin areas. Small portions of the Petition Area adjacent to residences along Lipalu Street are designated Zone X. This designation is for areas determined to be outside the 500-year flood.

Existing ephemeral drainageways within the Petition Area carry stormwater runoff from upland and surrounding areas into the lower basin. Discharges eventually enter two City catchment basins situated at the Petition Area's boundary with residences at the end of Lipalu Street and Ohaha Place. Drainage systems are discussed in greater detail in Chapter 5.

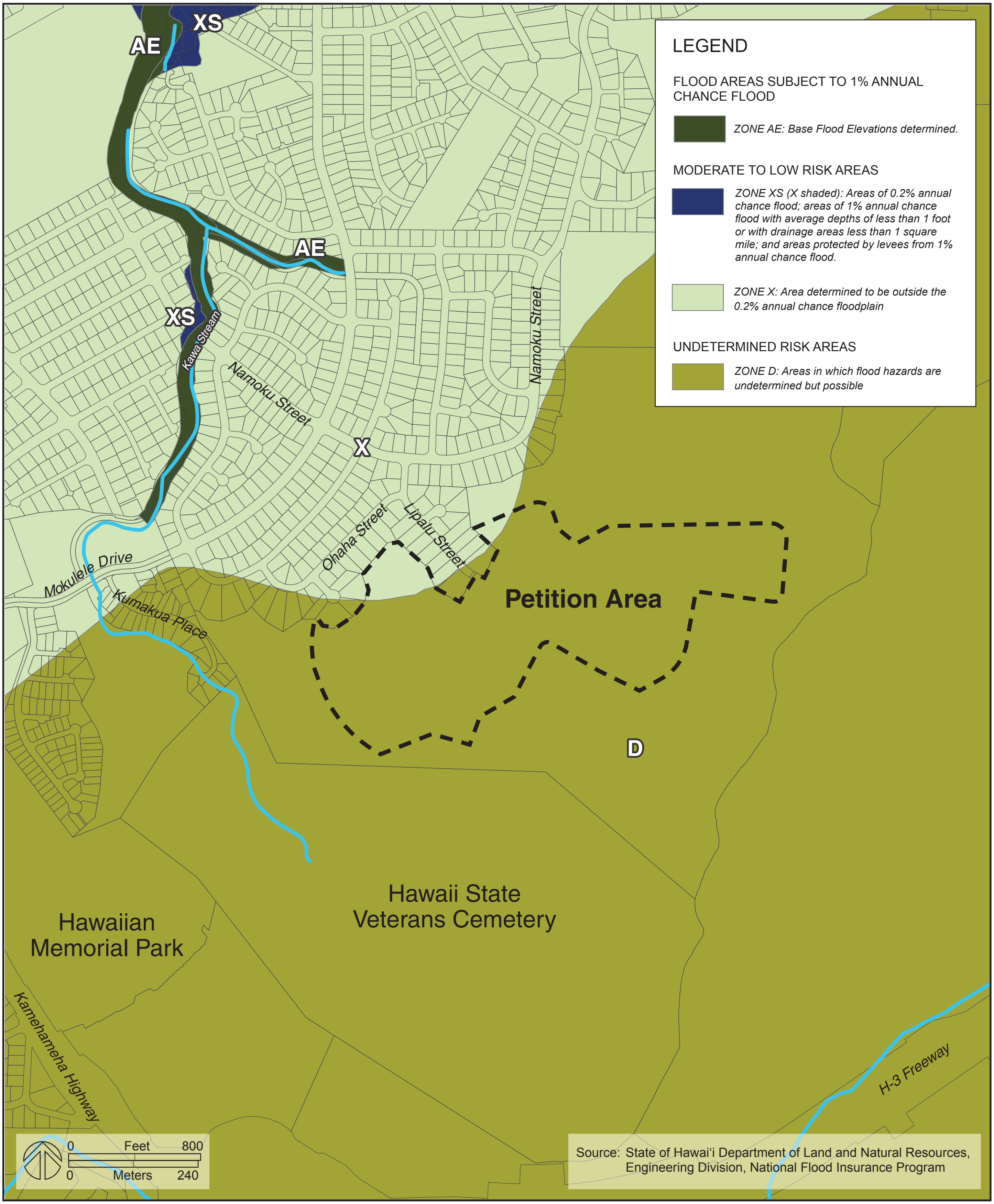
Kāwā Stream begins in a drainage basin in the lower reaches of the Hawai‘i State Veterans Cemetery near the State's existing baseyard facility as shown on Figure 3.5, and generally flows in a north and northwest direction through undeveloped area. Stream flow continues below (west of) HMP's Ocean View Garden through undeveloped areas toward residences along Kumakua Place, and then continues through residential neighborhoods via the City's drainage channel before discharging into Kāne‘ohe Bay. Kāwā Stream is not located within the Petition Area or HMP property.

Flood hazard designations have not been assigned to portions of Kāwā Stream within the Hawai‘i State Veterans Cemetery. The Zone AEF designation is assigned to portions of Kāwā Stream within existing residential areas, downslope and a considerable distance away from the Petition Area. This designation is assigned to floodway areas, which are areas that must be kept free of encroachment so the 1% annual chance flood can be carried without increases in flood heights.

3.2.4.2 Potential Project Impact and Mitigation

No Action Alternative

No changes would occur to Kāwā Stream or potential existing flood hazards associated with surrounding properties under the No Action Alternative because no project improvements would be implemented. The Petition Area would remain heavily vegetated and undeveloped. Stormwater would continue to sheet flow downslope across the area generally following existing drainageways and lower lying areas. These swales would continue to eventually convey stormwaters into existing municipal drainage facilities located at the end of Lipalu Street and Ohaha Street.



Flood Hazard Zones **Figure 3.5**

Hawaiian Memorial Park Cemetery Expansion Project Final Environmental Impact Statement
Kāneʻohe, Oʻahu, Hawaiʻi

Proposed Action

Project implementation should have minimal impact on potential flood hazards associated with lower lying residences, and would not change the current Zone X designation of these areas (located outside the 500-year flood). Kāwā Stream should not be impacted because its route is situated outside (west) the Petition Area, and proposed drainage improvements do not direct flows directly into this stream. Stormwater runoff would be directed into existing City drainage systems serving this area, which eventually discharge into Kāwā Stream. Although the Petition Area is designated as Zone D (undetermined flood hazard where flooding is still possible), major flooding is not known to occur within the lower basin.

Proposed improvements would create topographic conditions suitable for grave site usage and develop a roadways system. Grading improvements would cut a portion of the hillside on the western end and fill lower areas of the basin as previously shown on Figure 2.4. This would level this area of the site so that slopes would be less than 20% and thus reduce the steeper grades of the existing hillside. The eastern end of the cemetery expansion area would similarly be altered creating areas having more gentle slopes. These topographic changes would reduce the rate of stormwater runoff discharging from steeper upslope areas of the site, resulting in a beneficial effect that reduces potential flood hazards.

Drainage calculations from the Preliminary Engineering Report (PER) prepared for this project (Appendix D) indicate that runoff rates and corresponding runoff volumes would decrease due to the reduction in overall site slope as well as landscaping and drainage improvements. Drainage improvements include development of drain inlets along proposed roadways that would convey stormwater into retention/detention basins that would then direct stormwater toward the City's existing catchment basins. Grading and landscaping improvements would improve stormwater permeability within the Petition Area, and decrease the volume of water leaving the site. Results of the project's drainage analysis are discussed in greater detail in Chapter 5 and in the PER included in Appendix D. As a result, the project should have minimal impact on potential flood hazards within the site and for residential areas downslope.

3.2.5 Climate Change and Sea Level Rise

Climate is generally defined as the "average weather" in a location, including patterns of temperature, precipitation, humidity, wind, and seasons. Climate change refers to a long-term shift in established patterns. Scientific observation shows earth's climate has warmed, with changing climatic conditions attributed to rising levels of carbon dioxide and other "greenhouse gases" generated by the burning of fossil fuels. These greenhouse gases trap heat in the atmosphere, causing the earth to warm. This results in wide-ranging impacts including rising sea levels; melting snow and ice; extreme heat events; fires and drought; and extreme storms, rainfall, and floods. Scientist project that these trends will continue, posing potential risks to human health, forests, water supplies, coastlands, and other natural resources.

Global sea levels are rising due to ocean thermal expansion and the melting of ice sheets and glaciers. As the climate and oceans continue to warm, it is projected that global mean sea levels will rise at an increasing rate over the next century and beyond. The Intergovernmental Panel on Climate Change (IPCC), established in 1988, is the leading international body for the assessment of climate change.

3.2.5.1 Existing Conditions

In Hawaiʻi, climate change effects include rising air temperatures, rising sea levels, and warmer, more acidic coastal waters. Sea level rise can exacerbate coastal hazard impacts, and render low-lying coastal areas more vulnerable to tsunami inundation, storm surge, and high water events. Similarly, as sea levels and the adjacent landside water tables rise, coastal areas will experience drainage issues and an increased risk of flooding, especially during heavy rainfall events.

The U.S. Global Change Research Program (USGCRP) has been mandated by Congress to provide assistance on a national and global level so individuals can understand, assess, predict, and respond to human-induced and natural processes of global change. USGCRP's 2014 Third National Climate Assessment evaluated existing and future impacts of climate change on the United States. Assessment efforts confirmed island communities such as Hawaiʻi are especially vulnerable to climate change risk because of their small size, low elevation, remote geographic location, and concentration of infrastructure along coastlines (Leong et al, 2014).

The assessment projected temperatures in Hawaiʻi would rise by 1.5 degrees Fahrenheit (F) to 3.5 degrees F by the mid-century. Hawaiʻi has recently experienced decreasing precipitation with the USGCRP projecting that in the future, the state would experience a small decrease in precipitation during the wet season and a small increase during the dry season. Climate change is expected to result in reduced ground and surface water supplies, less freshwater availability, and increasing likelihood of drought. At the same time, some areas may receive heavier rainfall that can cause flooding, overloading water infrastructure systems or causing sewage contamination.

In 2014, the University of Hawaiʻi at Mānoa Sea Grant College Program (UH Sea Grant) prepared a climate change impacts report. This report provides a foundational understanding of how global climate change effects state ecosystems and resources (UH Sea Grant, 2014). The study provided the following summary of current and projected climate change impacts:

- The rate of warming air temperature in Hawaiʻi has quadrupled in the last 40 years to over 0.3 degrees F (0.17 degrees C) per decade. This warming could cause thermal stress for plants and animals and heat-related illnesses in humans as well as expanded ranges for pathogens and invasive species.
- A decrease in the prevailing northeasterly trade winds which drive orographic precipitation on windward coasts has been recorded over the last 40 years.
- Hawaiʻi has seen an overall decline in rainfall in the last 30 years, with widely varying precipitation patterns on each island. It is projected that Hawaii would see more drought

and heavy rains causing more flash flooding, harm to infrastructure, runoff, and sedimentation.

- Declining precipitation trends have caused a decrease in stream base flow over the last 70 years, and could reduce aquifer recharge and freshwater supplies and influence aquatic and riparian ecosystems and agriculture.
- Sea surface temperatures have warmed between 0.13 degrees F and 0.41 degrees F per decade in the Pacific for the last 40 years. This trend is projected to accelerate and can influence ocean circulation and nutrient distribution.
- Global ocean acidity has increased by 30% due to marine update of CO_2, correlating to a pH change of 0.1. Acidification is expected to continue and could trigger a wide range of impacts on marine biota.
- Sea levels have risen over the last century on each island, averaging 0.6 inches (1.5 cm) on O‘ahu per decade, which has contributed to shoreline recession. Rates of rise are projected to continue to accelerate resulting in a 1-3 foot rise or more by the end of the century. Sea level rise would exacerbate coastal inundation, erosion hazards, beach loss, and damage to infrastructure in low-lying areas.
- Threats to human health posed by Hawaii’s warming climate may include increased heat-related illness and wider ranges of vector-borne diseases such as dengue fever.

Sea Level Rise

Based on measurements at Honolulu Harbor, the mean sea level has increased at an average rate of 1.48 ± 0.21 millimeters (mm) per year (5.88 inches per century) between 1905 and 2017. This rate is less than the global average rate of sea level rise of 1.7 - 1.8 mm per year during the 20th century (NOAA, 2018).

The Sea Level Rise and Coastal Land Use Policy Toolkit published by the UH Sea Grant in 2011 suggests, “the governor or state legislature should direct state agencies to incorporate a sea-level rise benchmark of 1-foot-by-2050 and 3-feet-by-2100 in planning and permitting processes and decision-making” (CICAP, 2011). Geographic Information System data available from NOAA’s web viewer for sea level rise and coastal flooding shows that a 1-foot projected sea level rise would not impact the Petition Area. A 3-foot projected sea level rise similarly would not impact existing portions of HMP or the Petition Area, as indicated in Exhibit 3.8.

Exhibit 3.8 NOAA Projected 3-Foot Sea Level Rise
Source: http://coast.noaa.gov/slr/

3.2.5.2 Potential Project Impact and Mitigation

No Action Alternative

The Petition Area would remain heavily vegetated and undeveloped under this alternative. Existing cemetery operations and visitor activities at HMP would continue as present. Additional greenhouse gas emissions from these operations and activities that would exacerbate climate change impacts are not expected. As a result, increased risk of adverse climate change and sea level rise impacts is not anticipated under the No Action Alternative. As indicated in Exhibit 3.8, existing portions of HMP and the Petition Area should not be affected by sea level rise based upon NOAA's 3-foot projected sea level rise model. Historic data on mean sea level rise over the last 100+ years was less than six inches. Sea level rise mainly impacts urbanized areas of Kāneʻohe near Kāneʻohe Bay, and should not impact existing portions of HMP or the Petition Area.

Proposed Action

Increased risk of adverse impacts from climate change and sea level rise is not expected under the Proposed Action. As indicated by the Traffic Impact Analysis Report prepared for this project, the number of additional vehicle trips that would be generated by project implementation would not result in a significant increase in vehicle trips to HMP. Results of the project Traffic Impact Analysis are discussed in detail in Chapter 5. As a result, significant increases in greenhouse gas emission that would exacerbate anticipated climate change effects are not expected.

In particular, greater variation in precipitation patterns are projected, leading to greater incidences of drought and heavy rain. Heavier rains would increase the likelihood of flooding, infrastructure damage, runoff, and sedimentation. Proposed site improvements would aid mitigation of adverse impacts from heavier rains within the Petition Area. Grading improvements would reduce slopes within the Petition Area, reducing the rate of stormwater discharge downslope. Drainage improvements include construction of retention/detention basins that would further regulate the offsite flow of runoff. Site turf grass landscaping improvements would allow for improved ground water infiltration, further decreasing the volume of offsite runoff. Improved management of site stormwaters would thus aid the reduction of adverse impacts potentially occurring from climate change induced heavy rains.

Decreasing precipitation rates related to climate change have been observed and are expected to continue. Lower precipitation rates would reduce aquifer recharge and freshwater supplies. As discussed previously, project landscaping improvements would allow for enhanced groundwater infiltration, which would aid aquifer recharge with decreased precipitation rates.

As indicated in Exhibit 3.8, improvements proposed for the Petition Area would be located inland of areas potentially affected by sea level rise. Given the historic change in mean sea level at Honolulu Harbor of less than six inches per century, the cemetery expansion area, cultural preserve, and activities conducted in these areas should not be affected by sea level rise.

3.2.6 Rockfall and Debris Hazards

Geolabs conducted a Phase 1 Potential Rockfall and Slope Hazard Assessment to evaluate rockfall hazard risk within the Petition Area. Their full report is included in Appendix C. A computer simulation and statistical analysis of potential rockfall activity for this site using the Colorado Rockfall Simulation Program (CRSP) was performed by Geolabs.

Based on the evaluation of the existing site conditions with respect to potential natural hazards such as rockfall, slope instability, and debris flow, it was determined that the site is suitable for cemetery development and is feasible from a geotechnical point-of-view, provided preliminary design recommendations discussed in Chapter 2 are implemented. Once final grading plans for the project are available, a geotechnical engineer should address the stability of slopes in the post-development condition. Discussion of the rockfall hazard analysis is discussed.

3.2.6.1 Existing Conditions

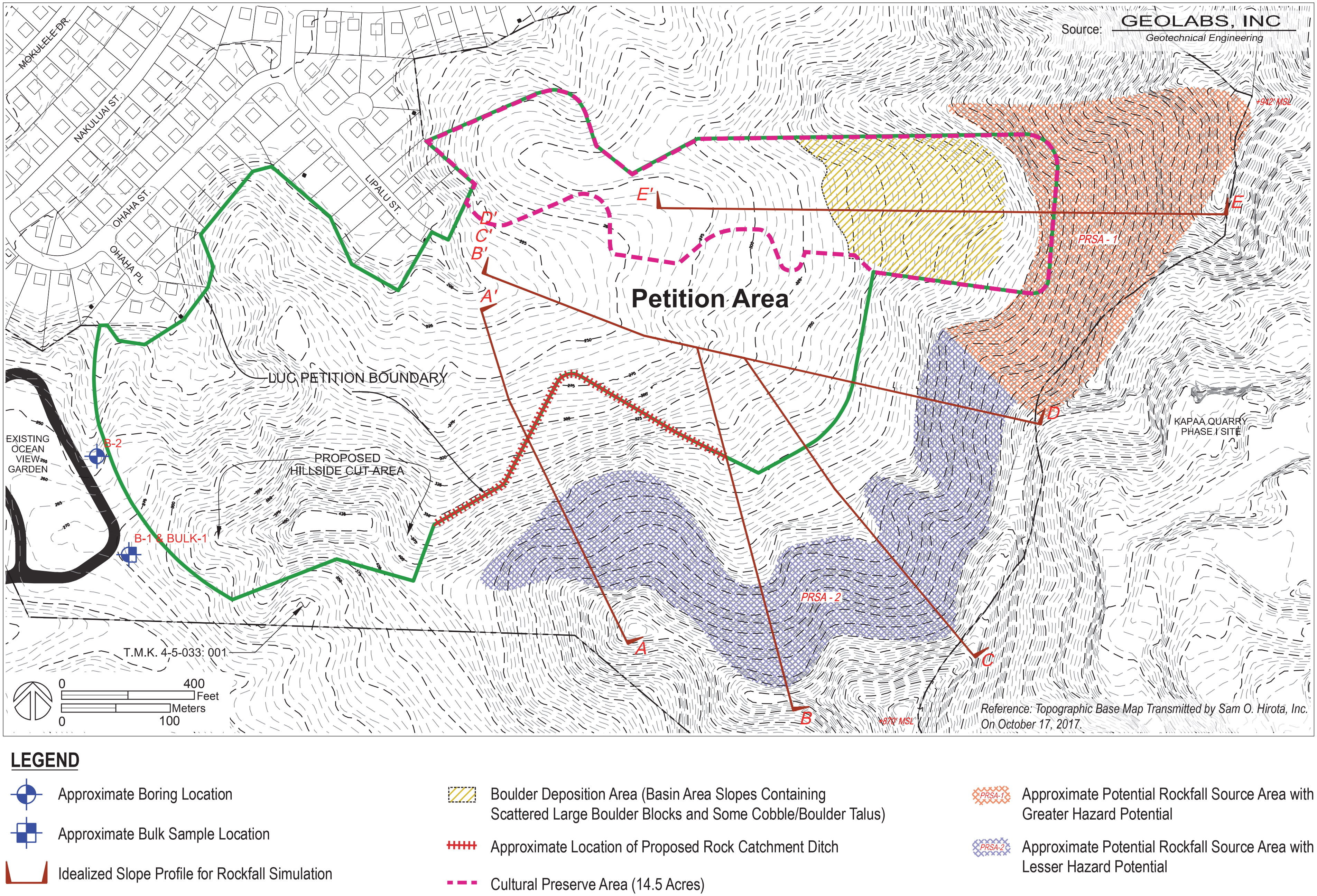
The geotechnical study included ground surface reconnaissance of the Petition Area's interior and higher elevation slopes. The discussion of existing conditions relative to rockfall and slope hazard was divided into Basin and Upland Slopes areas, and was previously discussed in greater detail in Section 3.1.2 (Soils).

Potential Rockfall Hazard

Some upland (mauka) portions of the proposed cemetery expansion area may be exposed to potential rockfall hazard from adjacent steep mountain slopes. Areas posing rockfall risk are shown on Figure 3.6. These areas are identified as Potential Rockfall Source Areas 1 (PRSA-1) and 2 (PRSA-2).

The greater risk for potential rockfall encroachment involves the sub-valley at the far northeastern portion of the Petition Area located upslope of the proposed Cultural Preserve. This portion of the site may possess moderate risk for potential or potentially dangerous rockfall activity. Greater risk is anticipated in this area due to the large number and size of existing boulder deposits encountered on lower elevation slopes within the proposed Cultural Preserve. The presence of existing boulder deposits and their depositional characteristics suggest evidence of significant older rockfall events that have deposited rocks within this area.

There also appears to be a more frequent occurrence of widely scattered large-block, high relief, massive rock outcroppings that could represent potential rockfall source material on slopes above the proposed Cultural Preserve. This source of rockfall risk is identified as PRSA-1 in Figure 3.6. Additionally, the alignment of the proposed Cultural Preserve area boundaries with respect to topographic conditions aids in the natural containment of rockfall within area boundaries.



Potential Rockfall Source Areas

Figure 3.6

Hawaiian Memorial Park Cemetery Expansion Project Final Environmental Impact Statement
Kāne'ohe, O'ahu, Hawai'i

The analysis shows the central portion of the cemetery expansion area is exposed to a generally low to moderate potential for rockfall encroachment. This lower rockfall encroachment risk is anticipated due to the reduced number and size of existing rock outcroppings encountered within PRSA-2 upslope. The identified potential rockfall source area also appears to have a lower density of rock outcroppings and less extensive reach in terms of elevation span on the hillside.

As shown on Figure 3.6, there was no area of potential rockfall encroachment identified for the western end of the Petition Area.

Preliminary Rockfall Simulation Analysis

The CRSP is a computer program that is a widely accepted engineering tool used to estimate potential rockfall activity by simulating the activity based on input parameters that are assigned on a site-specific basis. Identification of existing rockfall sources, deposition areas, and probable falling rock trajectories through site reconnaissance efforts supported computer simulations for potential falling rock conditions. Field information obtained was used to define various input parameters needed for the CRSP. Estimates can aid the statistical evaluation of the probable level of risk for a defined location and support the design of site specific rockfall mitigation measures, if appropriate. Simulation results are summarized below.

Five (5) idealized slope model profiles of the Petition Area were developed for the CRSP analysis (identified as Slope Profiles “A” through “E” on Figure 3.6). The selected slope profiles extend from the ridgeline summit down through the Petition Area interior. The profile locations were selected to ideally represent the existing slope conditions where potential rockfall encroachment is suspected based on site reconnaissance. The CRSP evaluated the statistical probability for potential rockfall encroachment from upslope areas for the five selected profiles.

Rockfall protection criterion is defined as the probable interception and catchment of 90% of probable rockfall hazards assessed by the CRSP. If statistical rockfall encroachment is 10% or less, a hazardous rockfall condition is considered a remote risk and rockfall protections may not be warranted, unless field observation or other information support a higher probability of encroachment. The 90% rock catchment criterion is a target that is commonly used in engineering practice for evaluation criteria. A 100% criterion is impractical to achieve.

Cultural Preserve. Moderate risk for potential rockfall encroachment is estimated for a portion of this area’s mid to upper elevation basin slopes and adjacent steep mountain slopes. Slope Profile “E” indicates that under the existing natural site condition, approximately 86% of simulated rockfall involving boulders of 3 and 5 feet in dimension could pass below the Cultural Preserve’s upslope area (elevation about 500 feet AMSL). No simulated rockfall should pass the area’s mid-elevation analysis point (elevation about 335 feet AMSL). Thus, the model indicates that the simulated falling rock would come to rest in the mid- to upper half of the area.

Central Cemetery Expansion Area. A low to moderate risk for potential rockfall encroachment is estimated for the steep mountain up slopes and lower elevation basin slopes at the central portion of the cemetery expansion area. Rockfall simulation conducted for Slope Profile "A" indicates that under the existing condition, approximately 64% to 66% of simulated rockfall involving boulders 3 and 5 feet in dimension could enter the upslope boundary of this area (elevation about 316 feet AMSL).

Eastern Cemetery Expansion Area. There is limited potential for rockfall encroachment along the remaining eastern portion of the cemetery expansion area. Rockfall simulation analysis for Slope Profiles "B", "C" and "D" indicate a probability of 10% or less for simulated rockfall to enter into cemetery expansion area. Slope Profiles "B" and "C" indicates that no simulated rockfall would enter the upslope cemetery boundary. Slope Profile "D" indicates that about 8% to 9% of simulated rockfall could enter the cemetery expansion area (between elevation 370 and 400 feet AMSL.

Landslide and Debris Flow Hazard

A number of converging ephemeral drainageways emanate from the adjacent upland slopes and pass through the Petition Area. These drainageways could be capable of transmitting appreciable stormwater runoff. A rapid increase in discharge during storm conditions (flash-flood conditions) should be anticipated in the normally dry drainage channels.

No record or documentation of previous debris flow or landslide activity within the Petition Area is known, and no overt visible evidence of significant debris flow deposits or evidence of recent ground scour was observed. However, the potential for transmission of debris laden within stormwater runoff should be considered due to the large area of steep forested slopes that have appreciable forest litter debris on the ground surfaces.

In addition, local areas of exposed soil and gravel/cobble talus were encountered within the steep upland drainage chutes above the Petition Area. These loose alluvial/colluvial deposits have some potential to be scoured and entrained in heavy stormwater runoff from the upper mountain slopes. However, it appears that the existing natural flatter ground topography at the foot of steeper terrain combined with the existing dense vegetation growth could provide some natural buffer, and reduce the risk for debris laden runoff.

3.2.6.2 Potential Project Impact and Mitigation

No Action Alternative

Elevated rockfall hazard risk is not anticipated under the No Action Alternative because no site improvements would not be implemented under this alternative. As a result, current rockfall hazard risks and landside debris hazards estimated for this area would continue and effect mid- to lower portions of the site's basin.

Proposed Action

The rockfall and slope hazard assessment study determined that the site is suitable for cemetery development and that the project is geotechnically feasible. Grading activities would result in the removal of existing boulders and rock outcrops within the cemetery expansion area, or such rocks would be buried by fill. Therefore, there should be no rockfall hazards emanating from within the cemetery expansion area. The rockfall hazard would remain from upslope areas above and outside of the Petition Area situated within the central and Cultural Preserve sections of the area. The western end of the Petition Area is not subject to rockfall hazards.

Cultural Preserve. The area with greatest rockfall hazard is above the Cultural Preserve. This area is intended for cultural landscape restoration and maintenance to support cultural practices, preserve historic sites, and accommodate some burials following traditional native Hawaiian protocols. Therefore, site disturbance and topographic changes that may contribute to increased rockfall hazards would not be significant. Site disturbance would be mainly associated with landscaping activities, and should not occur in the upper most portion of the area where the rockfall source is located (PRSA 1 on Figure 3.6).

The upper slopes of the Cultural Preserve would be subject to rockfall, but the lower half of the site would not. As a result, rockfall mitigation and protection measures are not required for the Cultural Preserve. The Preserve would be managed by the Koʻolaupoko Hawaiian Civic Club, and thus not be open to the general public, further reducing potential injury. However, the following mitigative measure is proposed:

Proposed Mitigative Measures

1. Rockfall hazard warning signage would be posted at appropriate entry locations to the Cultural Preserve to alert permitted visitors of the potential for falling rock hazards in the mauka portion of the area.

Eastern Cemetery Expansion Area. The eastern portion of the cemetery expansion site generally covering the area from the central section east toward the Cultural Preserve would be subject to limited potential for rockfall encroachment. As previously discussed, Slope Profiles “B” and “C” indicate that no simulated rockfall would enter the upslope cemetery boundary, and Slope Profile “D” had a probability of less than 10% occurrence of rockfall. Therefore, the developed cemetery should not be significantly impacted by rockfall hazards in this area, and no mitigative design measures are necessary.

Central Cemetery Expansion Area. The central portion of the cemetery expansion site would be subject to rockfall hazards from upslope areas as discussed for Slope Profile “A.” Therefore, the following design mitigation measures are proposed:

Proposed Mitigative Measures

1. Construct an approximately 1,000-linear foot long concrete lined catchment ditch along a portion of the upslope cemetery development boundary. The proposed location of this ditch is shown in Figure 3.6, and was discussed as part of proposed project design measures in Chapter 2, which included a conceptual schematic design. A 5-foot deep "V" shaped catchment ditch would be effective at containing simulated falling rock and reducing potential rockfall encroachment to acceptable levels.
2. Install chain link fencing along and upslope from the catchment ditch to reduce potential introduction of large quantities of organic debris into the ditch from the adjacent upslope forest area. If feasible, a 10-foot wide vegetation free clear zone may be implemented upslope from the ditch and encompassing the chain link debris barrier fence.
3. Inspect periodically the rock catchment ditch with possible periodic clearing of accumulated debris to maintain the intended rock catchment capacity.

Construction of a rockfall catchment ditch should provide a high level of safety against rockfall hazard affecting the area of cemetery expansion based on past applications of similar mitigation methods. The design and location of the catchment ditch would be further refined as part of the design phase of the project as final grading plans are developed.

Landslide and Debris Flow Hazard. Grading activities would result in the removal of existing landslide and debris flow hazards within the cemetery expansion area. Landscaped grass areas created for burial spaces would be a significant improvement removing existing vegetation litter debris and exposed soil and gravel/cobble talus. The modified topography would reduce steeper upper slopes and create a gentler topography that would eliminate potential landslide hazards. Therefore, remaining potential for impacts on the cemetery from debris flow would be from upslope areas. To mitigate this, the following is proposed as part of project design:

Proposed Mitigative Measures

1. Construct a surface drainage interception system consisting of an interceptor ditch network with appropriate debris barriers and discharge outlets to reduce the potential for storm water runoff encroachment along the upper boundary of the site. The existing natural flatter topography at the foot of steeper terrain combined with the existing dense vegetation growth could also provide some natural buffer, and reduce the risk for debris laden runoff from reaching the drainage interception system.

3.3 BOTANICAL RESOURCES

A botanical survey of the Petition Area was conducted by LeGrande Biological Surveys, Inc. (LeGrande, 2018). Field studies were conducted over several days in September 2017. Results from a prior botanical survey occurring in 2006 in the same general area were considered in this new 2018 botanical survey. The survey area included the proposed cemetery expansion area; a buffer extending into the Cultural Preserve; as well as a buffer outside the cemetery expansion boundary in all directions. The objectives of field studies were to: 1) describe existing vegetation; 2) list all species encountered; and 3) identify threatened or endangered plant species. Survey methodology and results are summarized below with the survey report included in Appendix E.

Methodology

Before initiating field work, existing botanical research pertinent to the Petition Area was reviewed. A walk through survey method was used, requiring that the survey area be inspected on foot. GPS was utilized to locate boundaries and track transects examined. Notes were recorded on plant associations and distribution, disturbances, topography, and other relevant details. Plant identifications were made in the field. Plants that were not positively identified were collected for later determination and for comparison with recent taxonomic literature.

3.3.1 Existing Conditions

The majority of the Petition Area is characterized as being a Lowland Alien Wet Forest dominated by introduced plant species. The area has been disturbed historically, being previously used for pineapple cultivation and dairy farming activities. Alteration of native plant habitat has been in place for some time with few native plant elements remaining. Feral pigs (*Sus scrofa*) continue to degrade the vegetation and understory plants by rooting, resulting in soil disturbance.

None of the plant species observed in the Petition Area are threatened, endangered or a species of concern. The entire survey area can be characterized as a highly disturbed Schefflera/Java Plum forest. A total of 109 plant species were observed within the survey area. Of this total, 91 (84%) are alien (introduced), seven (6%) are Polynesian introductions, eight are indigenous (native to the Hawaiian Islands and elsewhere), and three are endemic (native to the Hawaiian Islands). A total of 10% are native species. An inventory of plants observed is provided in the project botanical survey included in Appendix E.

Cemetery Expansion Area

The existing Ocean View Garden area is dominated by mowed grass and landscape plantings. The edges of the landscaping area consist of weedy sections dominated either by tall trees such as Java Plum (*Syzygium cumini*), Albizia (*Falcataria moluccana),* and Mango (*Mangifera indica*) (Exhibit 3.9). Smaller shrubs also dominate the area, including Koa Haole (*Leucaena leucocephala*), Sourbush (*Pluchea carolinensis*), and Hilo Holly (*Ardisia crenata*). Grass species found in this area consist of Sourgrass (*Digitaria insularis*), Broomsedge (*Andropogon virginicus*), and Molasses Grass (*Melinis minutiflora*). A spring present in the northwestern section of the Petition Area near Ohaha Place is dominated by introduced plant species such as Laua‘e (*Phymatosorus grossus*) and some vestiges of Kalo plants scattered along spring banks or in pools.

Exhibit 3.9 Existing Vegetation Along Ocean View Garden (LeGrande, 2018)

The remaining undeveloped section surveyed is dominated by an alien forest of Octopus Tree (*Schefflera actinophylla*) and Java Plum. Some of the shallow gulches are dominated by hau thickets. An area in the eastern section of the Petition Area is dominated by large Mango trees (Exhibit 3.10). Other scattered trees include African Tulip (*Spathodea campanulata*), Date Palm (*Phoenix dactylifera*), and Chinese Banyan (*Ficus microcarpa*). Shrub species include Slender Mimosa (*Desmanthus pernambucans*), Shoebutton Ardisia (*Ardisia elliptica*), and Kolomona (*Senna surattensis*).

Forested Section of Octopus Tree and Fiddlewood

Eastern Area Dominated by Mango Trees

Exhibit 3.10 Existing Vegetation Within Cemetery Expansion Area (LeGrande, 2018)

In open areas, vines such as Obscure Morning Glory (*Ipomoea obscura)*, Little Bell (*I. triloba*), Maile Pilau (*Paederia foetida*), and Ivy Gourd (*Coccinea grandis*) were observed along the ground or in trees and shrubs. Groundcover consists mainly of fern species such as Laua`e (*Phymatosorus grossus*) and Pala‘a (*Sphenomeris chinensis*). The alien grass species, Basket Grass (*Oplismenus hirtellus*), was also observed. A few small patches of the native fern Pala‘a were observed along drier areas of the ridge tops.

Seven Polynesian introduced plant species were observed within the survey area. They include Ti, Kalo (*Colocasia esculenta*), Niu (*Cocos nucifera*), Kukui (*Aleurites moluccana*), Mai‘a (*Musa* sp,), Noni (*Morinda citrifolia*), and Hau (*Hibiscus tiliaceus*). Kukui and Hau were found scattered throughout the survey area, especially in small gulches and ravines. Ti plants were observed along the Petition Area boundary, within scrub vegetation, as well as along several ridges in the cemetery expansion area. A few coconut trees were observed near the bottom of the gulch at the end of Lipalu Street.

Eight indigenous species were observed infrequently in the area; ‘Uhaloa (*Waltheria indica*), Hala (*Pandanus tectorius*), Pala‘a (*Sphenomeris chinensis*), Moa (*Psilotum nudum*), Palapalai (*Microlepia strigosa*), ‘Ekaha (*Asplenium nidus*), Popolo (*Solanum americanum*), and Ka‘e‘e or Sea Bean (*Mucuna gigantea*). Ka‘e‘e is an indigenous species with stunning yellowish-green flowers that grows on all the main Hawaiian Islands. The various populations observed is robust, but is being smothered by other vine species such as Maile Pilau and passion fruit as shown on Exhibit 3.11. Several of the seed pods were observed to have insect damage.

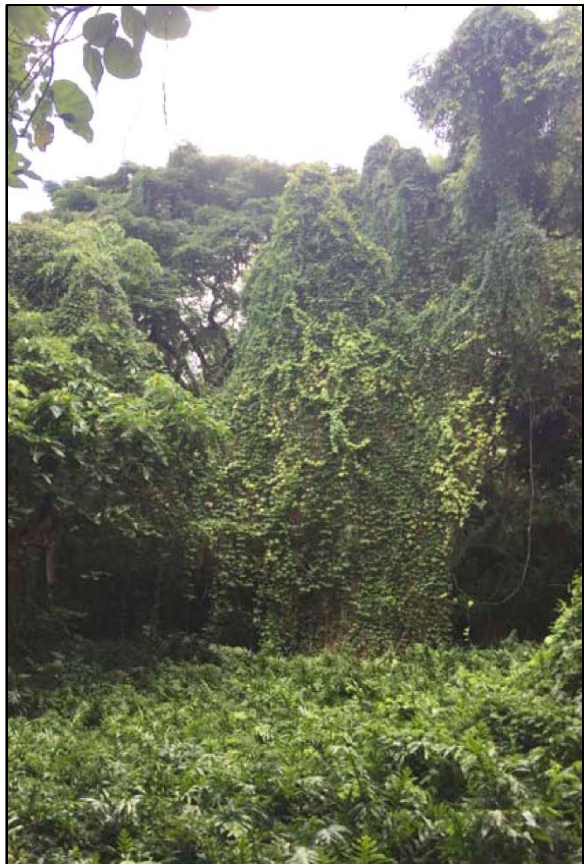
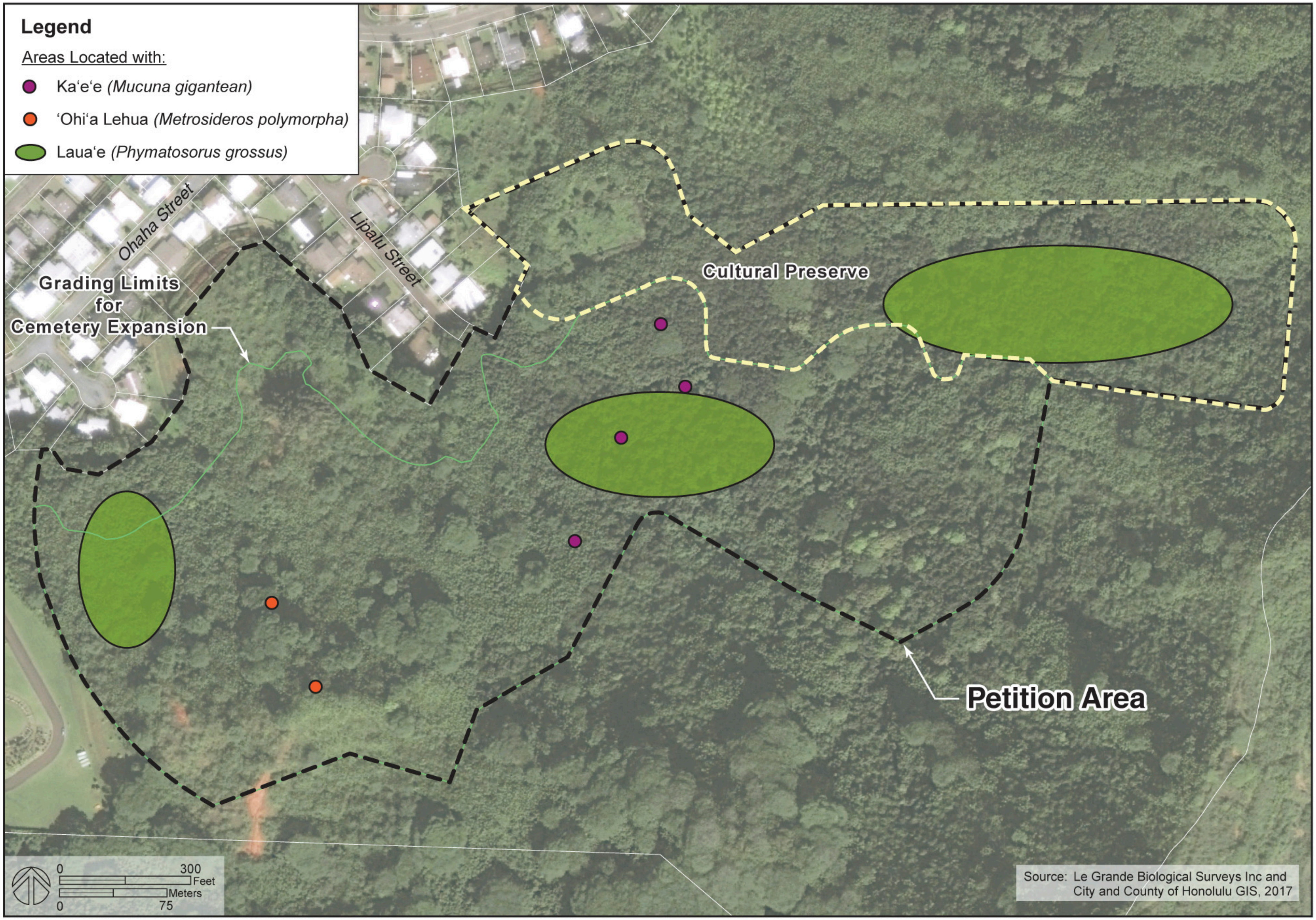


Exhibit 3.11 Ka‘e‘e Covered by Other Vine Species and Laua‘e Groundcover (LeGrande, 2018)

Table 3.1 includes a listing of indigenous and endemic species identified within the Petition Area. The three endemic species include the two koa trees observed near the Kawa‘ewa‘e Heiau, as well as ‘Akia (*Wikstroemia oahuensis var. oahuensis*) and ‘Ohi‘a Lehua (*Metrosideros polymorpha*) trees that were observed infrequently near the Ocean View Garden boundary and upper elevations on the ridgeline in the southwestern section of the Petition Area. Figure 3.7 shows the location of these ‘Ohi‘a Lehua along with other notable plants.



Botanical Map **Figure 3.7**

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Table 3.1
Indigenous and Endemic Botanical Species Observed

Scientific Name	Common Name	Status
PTERIDOPHYTES		
ASPLENIACEAE		
Asplenium nidus L.	ʻEkaha	Indigenous
DENNSTAEDTIACEAE		
Microlepia strigosa (Thunb.) C.Presl	Palapalai	Indigenous
LINDSAEACEAE		
Sphenomeris chinensis (L.) Maxon	Palaʻa	Indigenous
PSILOTACEAE		
Psilotum nudum (L.) P. Beauv.	Moa, Upright Whisk Fern	Indigenous
MONOCOTS		
PANDANACEAE		
Pandanus tectorius Parkinson ex Z	Hala	Indigenous
DICOTS		
FABACEAE		
Acacia koa A. Gray	Koa	Endemic
Mucuna gigantea (Willd.) DC. ssp. *gigantea* Ohashi & Tateishi	Sea Bean, Kaʻeʻe	Indigenous
MYRTACEAE		
Metrosideros polymorpha Gaudich	Ohia Lehua	Endemic
SOLANACEAE		
Solanum americanum Mill.	Popolo	Indigenous
STERCULIACEAE		
Waltheria indica L.	Uhaloa	Indigenous
THYMELAEACEAE		
Wikstroemia oahuensis (A.Gray) Rock var. *oahuensis*	Akia	Endemic

Source: LeGrande, 2018

Vegetation Within Cultural Preserve Area

The area proposed for a Cultural Preserve was surveyed, which included the Kawaʻewaʻe Heiau. The main section of the heiau was observed to be cleared of most plant species in the prior 2006 botanical survey. The most recent survey found the area to be overgrown, and the heiau itself mostly obscured with vegetation. Some plants growing within the heiau structure include Ti (*Cordyline fruticosa*), Papaya (*Carica papaya*), and Spanish Needle (*Bidens pilosa*). Two juvenile Koa (*Acacia koa*) trees were observed at the southern end of the heiau. These trees appear to have been planted. The remainder of the Preserve area to the east is dominated by thickets of Christmas Berry, Java Plum, and Guava with a thick understory of Lauaʻe fern and Basket Grass.

Laua‘e Fern

Laua‘e (*Phymatosorus grossus*), were identified in expansive and widely spread areas within the cemetery expansion site as well as within the Cultural Preserve. Exhibit 3.12 shows an area of the proposed Cultural Preserve that has laua‘e populated on the ground. Figure 3.7 identifies the general areas where this plant species are located. Many believe *P. grossus* is the Laua‘e fern discussed in native Hawaiian stories and legends. However, evidence about this species suggests *P. grossus* was introduced to the islands in the early 20th century (Honua 2018).

Exhibit 3.12 Laua'e Within Proposed Cultural Preserve (LeGrande, 2018)

The name "Laua‘e" was originally associated with *Microsorum spectrum*, which is an endemic species. *P. grossus* is similar in both frond size and scent to *M. spectrum*. The fern species known in Hawaiian lore as "Laua‘e" is likely *M. spectrum* rather than *P. grossus*. However, the name "Laua‘e" is now associated with *P. grossus*. *M. Spectrum* specimen were not observed in the Petition Area. Both the introduced and endemic Laua‘e varieties possess native Hawaiian cultural significance and are used in cultural practices.

Wetlands

There are no wetlands present within the Petition Area. This includes the results of a wetland assessment of the seep area conducted by AECOS, Inc. (Appendix O).

The wetland data determination form was used to characterize the area just upslope of an incised channel near the seep. It is a location within the area selected as most likely to be wetland based on topography. Filling in of the wetland data sheet followed methods described in Corps of Engineers Wetland Delineation Manual ("Manual"; USACE, 1987) and Regional Supplement for Hawai‘i and Pacific Islands. Other sources used for the delineation effort included: the National Wetlands Inventory (NWI) Wetlands Mapper (USFWS, n.d), USDA-NRCS web soil survey, and the State Flood Hazard Assessment Tool.

Within the survey area, hydrophytic vegetation was present only within parts of the seep channel. A relatively bare ground of flat area was also investigated and tested for the presence of wetland. The absence of ground cover there is due to shading by the closed canopy of octopus (*Schefflera actinophylla*) and Java plum (*Syzygium cumini*) trees. The soil tested conforms with the mapped soil type of Kaneohe silty clay and is not on the list of hydric soils. Therefore, this area is not a wetland. Although wetland plants are rooted in a few short segments of the seep channel, the channel is best classified as a tributary rather than a wetland because: 1) plants cover less than 5% of the area; and 2) the channel has been carved by flowing water and physical indicators of flow are apparent in the channel. The seep channel and a segment of the incised channel have physical indicators of flow (i.e., bed and banks and ordinary high water marks).

3.3.2 Potential Project Impact and Mitigation

No Action Alternative

Botanical resources within the Petition Area would not be impacted under the No Action Alternative. The site would continue to be dominated by alien species with a smaller proportion of native species found in various areas of the site. Existing native plant populations would generally remain growing in their general locations with some expansion or decrease depending upon climate conditions and expansion by other invasive plant species.

Proposed Action

The Proposed Action would significantly alter the present botanical characteristics of the area proposed for the cemetery's expansion because this site would undergo extensive grading activities (cut/fill). However, proposed improvements would not impact Federal or State-listed threatened or endangered plant species or species of concern because none were observed within the Petition Area.

After grading activities, the current Lowland Alien Wet Forest character that is dominated by introduced plant species would change to an open landscaped character consisting mainly of grass and landscaping plantings typical of cemetery areas used for burial spaces. Fringe areas surrounding landscaped burial areas would likely become dominated by other existing surrounding vegetation and trees that are mainly introduced plant species. This would result in a similar condition to the buffer area surrounding Ocean View Garden (refer to previous Exhibit 3.9). This would include areas that are left undeveloped (e.g. spring area to the northwest) or serve as vegetative buffers between residences or upslope areas. Figure 3.7 identifies the general areas where notable plant species are located and would be impacted.

The majority of existing plant species (90%) that would be displaced due to grading activities within the cemetery expansion area are alien (84%) or of Polynesian introductions (6%). The introduced fern species commonly known as Laua‘e *(P. grossus)* would be impacted by grading activities within the cemetery expansion area, but not within the proposed Cultural Preserve. The endemic fern also known as Laua‘e, *M. spectrum*, was not observed within the Petition Area. Although *M. spectrum* is likely the fern known in native Hawaiian legend as Laua‘e, both the introduced and the endemic species possess native Hawaiian cultural value. Given the cultural value of *P. grossus*, specimen of this fern species could be used to landscape the cemetery expansion area to perpetuate its presence in the area.

Native plant populations that include the Ohiʻa Lehua and Kaʻeʻe populations would also be displaced due to grading activities. The first species mentioned is endemic, and seeds or cuttings from extant plants could potentially be collected and grown to use in replanting efforts in and around the cemetery expansion area or within the Cultural Preserve. The Kaʻeʻe population observed is being smothered by other vine species, and several of the seed pods observed have insect damage and thus did not appear to be viable for replanting. Fill activities planned in this area would impact these vines. As a result, horticulture experts could be consulted to provide the best techniques to propagate the plants either by vegetative cuttings or seed germination.

The vegetative character of the Cultural Preserve would remain similar to existing conditions because no major site disturbing improvements are proposed in this area. The proposed Cultural Preserve is an appropriate location where native and Polynesian introduced plants displaced by cemetery expansion activities could be replanted, particularly in the area surrounding Kawaʻewaʻe Heiau. Native plants would also be used in the landscaping of the cemetery expansion area that would help to perpetuate these extant taxa in the immediate area.

The presence of plants, such as ʻOhiʻa Lehua, ʻAkia, and Lauaʻe, within the Cultural Preserve or cemetery area would support its use for cultural practices. Seeds and cuttings from these plants found on site could be collected and grown for these efforts. Lauaʻe could also be used in landscaping of the cemetery expansion area.

Proposed Mitigative Measures

To mitigate the impacts to existing indigenous and endemic plant species from this project, the following measures are proposed.

1. Seeds or cuttings from extant indigenous and endemic plants would be collected and grown to use in replanting efforts in and around the cemetery expansion area or within the Cultural Preserve.
2. The preservation plan to be developed for the Cultural Preserve would include landscaping guidance related to the preservation of the Petition Area's indigenous and endemic plant species. Landscaping guidance would use information resulting from the botanical survey to establish proper collection and replanting procedures.
3. The spring area in the northwest section of the Petition Area near Ohaha Place would not be developed for cemetery burial plots, and BMPs would be designed for implementation to minimize short-term construction-related effects in this area.