Avian diversity and densities observed aligned with the location and predominantly alien vegetation present on site. Three introduced species, the Red-vented Bulbul (*Pycnonotus cafer*), Zebra Dove (*Geopilia striata*), and Red-whiskered Bulbul (*Pycnonotus jacosus*) accounted for 51% of the total number of avian species recorded. The Red-vented Bulbul was the most commonly tallied species, accounting for 19% of the species observed. Survey results are presented in Table 3.2.

Table 3.2
Avian Species Detected In the Petition Area

Common Name	Scientific Name	Status	Relative Abundance
PHASIANIDAE - Pheasants & Partridges Phasianinae - Pheasants & Allies			
Domestic Chicken	*Gallus* sp.	A	1.63
COLUMBIFORMES COLUMBIDAE Pigeons & Doves			
Rock Pigeon	*Columba livia*	A	**1 - 10**
Spotted Dove	*Streptopelia chinensis*	A	1.63
Zebra Dove	*Geopelia striata*	A	5.50
CHARADRIIFORMES CHARADRIIDAE – Lapwings & Plovers			
Pacific Golden-Plover	*Pluvialis fulva*	IM	**1 - 4**
PELECANIFORMES ARDEIDAE – Herons, Bitterns & Allies			
Cattle Egret	*Bubulcus ibis*	A	**1 - 31**
PELECANIFORMES PYCNONOTIDAE - Bulbuls			
Red-vented Bulbul	*Pycnonotus cafer*	A	6.75
Red-whiskered Bulbul	*Pycnonotus jocosus*	A	5.38
CETTIIDAE - Cettia Warblers & Allies			
Japanese Bush-Warbler	*Horomis diphone*	A	0.13
ZOSTEROPIDAE - White-eyes			
Japanese White-eye	*Zosterops japonicas*	A	4.88
TIMALIIDAE - Babbler			
Chinese Hwamei	*Garrulax canorus*	A	0.13
Red-billed Leiothrix	*Leiothrix lutea*	A	2.13
TURDIDAE - Thrushes			
White-rumped Shama	*Copsychus malabaricus*	A	2.50
STURNIDAE - Starlings			
Common Myna	*Acridotheres tristis*	A	1.38

Table 3.2 (Continued)
Avian Species Detected In the Petition Area

Common Name	Scientific Name	Status	Relative Abundance
FRINGILLIDAE - Fringilline and Carduline Finches & Allies Carduelinae - Carduline Finches and Hawaiian Honeycreepers			
House Finch	*Haemorhous mexicanus*	A	0.88
PASSERIDAE - Old World Sparrows			
House Sparrow	*Passer domesticus*	A	0.25
CARDINALIDAE - Cardinals & Allies			
Northern Cardinal	*Cardinalis cardinalis* *THRAUPIDAE* – Tanagers *Thraupinae* - Core Tanagers	A	0.25
Red-crested Cardinal	*Paroaria coronate*	A	0.75
ESTRILDIDAE - Estrildid Finches			
Chestnut Munia	*Lonchura atricapilla*	A	0.50

Key:
ST Status
A Alien – Introduced to the Hawaiian Islands by humans
IM Indigenous Migrant – Native but not restricted to the Hawaiian Islands, migratory, non-breeder in Hawaii
RA Relative Abundance - Number of birds detected divided by the number of point counts (~8)
Source: Rana, 2018

The findings of the avian survey are consistent with the current habitats present within the survey, which are dominated by alien plant species. This avian survey is also consistent with a prior faunal survey conducted for the property in September 2006 (Bruner, P., 2006). During the 2006 survey, 14 avian species were recorded. The current survey documented the same 14 species, plus an additional five other species. All species except the Pacific Golden-Plover recorded in this survey are alien to the Hawaiian Islands.

Pacific Golden-Plover are a native, indigenous migratory shorebird species. This species nests in the high Arctic during late spring and summer months. They later return to Hawaiʻi and the Tropical Pacific in the fall and winter months each year. This species usually returns to the Arctic in late April or early May. They are widely distributed in the Hawaiian Islands during winter months.

No owl species were recorded in this survey. There are two resident owl species on Oʻahu, which are the introduced Barn Owl (*Tyto alba*) and the indigenous endemic sub-species of the Short-eared Owl, or Pueʻo as it is locally known (*Asio flammeus sandwichesis*). The Pueʻo has darker colored feathers than the Barn Owl and is comparatively smaller (National Wildlife Health Center 2016). While both species are found on all the main Hawaiian islands, Pueʻo have become increasingly scarce on Oʻahu. The island's Pueʻo population is listed as an endangered species by the State of Hawaiʻi, but is not listed under federal statute.

Pueʻo forage in grasslands, agricultural fields and pastures, as well as upland forested areas (Bruner 2006). This owl species occupies a variety of habitat including wet and dry forests and most commonly inhabit open areas such as grassland, shrubland, and montane parkland (Conry et al. 2015). It is possible that Pueʻo occasionally use resources in the general Petition Area on a seasonal basis. This species is not habitat restricted on Oʻahu, though there is likely less suitable nesting habitat than there once was. Pueʻo face daunting odds given Oʻahu's high population density. They are a ground nesting diurnal species, and the sheer numbers and density of mammalian predators on Oʻahu makes it very difficult for this species to successfully nest, except within protected areas with a strong mammalian predator control program in place.

Seabird Species

Although seabirds were not detected in the course of the survey, several seabird species potentially overfly the site on occasion. These species include the Wedge-tailed Shearwater or ʻUaʻu Kani (*Puffinus pacificus*), the "threatened" Newell's Shearwater (*Puffinus auricularis newelli*), and the "endangered" White Tern (*Gygis alba*).

The Oʻahu population of White Tern (*Gygis alba*) is listed as an endangered species by the State of Hawaiʻi, but it is not listed under federal statute. This ephemeral species was not recorded during this survey, nor was it expected. The current resident population of White Tern on O'ahu is found on the leeward side of the island concentrated in the Waikiki area.

The primary cause of resident seabird mortality is thought to be predation by alien mammalian species at nesting colonies. The second most common cause of mortality for locally nesting seabirds occurs when they collide with man-made structures after they are disoriented by exterior lighting. If these seabirds are not killed outright, the dazed or injured birds are easy targets for predation by feral mammals.

3.4.2 Potential Project Impact and Mitigation

No Action Alternative

Avian species within the Petition Area and immediate area would not be impacted under the No Action Alternative because no improvements or site development would occur. The majority of avian species found in the area would continue to be alien species. The Pacific Golden-Plover may continue to be found in existing areas of HMP.

Community members have previously commented on sighting avian species thought to be Pueʻo within or in the vicinity of the Petition Area. These individuals believe Pueʻo are present within the area. Although the avian survey did not identify indigenous, endemic Pueʻo or introduced Barn Owl in the Petition Area, Pueʻo may use Petition Area resources on a seasonal basis. Although this species may be seasonally present, the Petition Area likely does not function as a long term habitat given the lack of suitable foraging or nesting habitat in the area. Additionally, the sheer numbers and density of mammalian predators in the Petition Area make it difficult for Pue‘o to successfully nest in this area. Therefore, it is likely Pue‘o would only be present in the Petition Area on a seasonal basis, if at all. Seabirds may potentially continue to overfly the Petition Area on occasion.

Proposed Action

Project implementation initiated under the Proposed Action is not expected to have a significant impact on avifaunal species because the majority of species present are alien. Grading improvements for the cemetery expansion site would change the landscape from a Lowland Alien Wet Forest to an open landscaped character consisting mainly of grass and landscape plantings. This open grassed landscape should have minimal impact on alien avian species. The Pacific Golden-Plover’s migratory pattern that involves returning to Hawai‘i in the fall and winter months each year, should not be impacted by this project. This species would continue to be widely distributed in the Hawaiian Islands. The Cultural Preserve would not involve any major site development that would significantly alter the existing landscape and vegetation.

Pue‘o would continue to only be present in the Petition Area on a seasonal basis under the Proposed Action. The open grassed landscape created by cemetery expansion improvements would not serve as suitable foraging or nesting habitat for the Pue‘o. Therefore, Pue‘o likely would not inhabit the Petition Area on a long term basis under the Proposed Action. However, the project would have a minor positive impact on Pue‘o that may be seasonally present. Replacement of forested area with open grassed landscape would reduce habitat for mammalian predators. This would benefit the nesting success of seasonally present Pue‘o.

The O‘ahu population of White Tern (*Gygis alba*) should not be impacted by the project since this ephemeral species was not recorded during this survey, nor was it expected. The current resident population of White Tern on O’ahu is found on the leeward (Honolulu) side of the island concentrated in the Waikīkī area.

Protected seabirds are threatened of being downed after becoming disoriented by outdoor lights during the nesting season. The two main areas that outdoor lighting could pose a threat to these nocturnally flying seabirds are: 1) possible night-time construction activities; and 2) streetlights or other exterior lighting within the cemetery expansion during the seabird fledging season, which runs from September 15 through December 15th.

However, the project should not impact protected seabirds because: 1) no night-time construction is planned, and 2) no exterior lighting is planned as part of site improvements. The Cultural Preserve would remain similar to present conditions with select portions of the area revegetated with native plants. No outdoor lighting is planned and cultural activities would occur during daylight hours.

3.4 MAMMALIAN RESOURCES

The mammalian survey was conducted by Rana Biological Consulting concurrently with the avian survey and was limited to visual and auditory detection coupled with visual observation of scat, tracks, and other animal signs (Rana, 2018). A running tally was kept of all terrestrial vertebrate mammalian species detected within the Petition Area during time spent on site.

3.4.1 Existing Conditions

Three terrestrial mammalian species were detected on site during the survey. Numerous dogs (*Canis familiaris*) were heard barking from areas outside the survey area. One small Indian mongoose (*Herpestes auropunctatus*) was seen close to the dead end of Lipalu Street and the Petition Area. A small amount of pig (*Sus scrofa*) rooting was found within the lower section of the proposed cemetery expansion area, indicating that feral pigs may be present. Field surveys conducted by others (Dr. Steven Montgomery) have also identified the area by the spring as being disturbed by feral pigs, which is destructive for that habitat used by the endangered damselfly (Exhibit 3.13). No mammalian species currently proposed for listing or listed under the federal or State of Hawaiʻi endangered species statutes was recorded on site.

Exhibit 3.13 Night Camera Photo of Feral Pig Disturbing Spring Area (Montgomery, 2017)

The findings of the mammalian survey are consistent with the current habitat present on the site and the current land use of the area surveyed. All mammalian species detected are alien species and deleterious to native ecosystems and their dependent organisms. Although rodents were not identified during this survey, it is likely that one or more of the four established alien Muridae species found on Oʻahu use resources found within the Petition Area on a seasonal basis. These are the European house mouse (*Mus musculus domesticus*); roof rat (*Rattus rattus*); brown rat (*Rattus norvegicus*); and black rat (*Rattus exulans hawaiiensis*). These human commensal species are drawn to areas of human habitation and activity, and are deleterious to native ecosystems and dependent species.

No endangered Hawaiian hoary bats were detected on site. It is only recently that this species has been recorded on a regular basis on the Island of Oʻahu. It is possible that this species may use resources in the Petition Area on a seasonal basis.

3.4.2 Project Impacts and Mitigation

No Action Alternative

Mammalian resources would not be impacted under the No Action Alternative. The Petition Area would continue to remain as a lowland forest with predominantly alien vegetation and undeveloped. Mammalian species present on site would continue to consist of alien species that are deleterious to native ecosystems and dependent species.

Proposed Action

The Proposed Action would have no significant or adverse impact on mammalian species, because identified species on site are alien. Grading improvements for the cemetery expansion site would change the landscape from a Lowland Alien Wet Forest to an open landscaped character consisting mainly of grass and some other landscape materials that are not attractive habitats for mammalian species. The property would now be utilized for human activities that would generally discourage their presence.

The Proposed Action would reduce feral pig destructive foraging activities due to habitat loss. Areas outside of the improved cemetery would continue to provide habitat for pigs. Fencing proposed around the seep would prevent feral pigs from entering and conducting destructive activities to the endangered damselfly's habitat. The project would thus have a positive effect in limiting some of the destructive pig activities within the Petition Area.

Although Hawaiian hoary bats were not detected in the Petition Area, the bats may be present on a seasonal basis. Therefore, cemetery expansion activities that clear large trees and shrubs during birthing and rearing season (June 1 through September 15) may impact Hawaiian hoary bat. During this period, female bats and their pups may be unable to quickly vacate their roosts as vegetation is cleared. If trees or shrubs suitable for roosting are cleared during birthing and rearing season, there is a risk that juvenile and adult bats could inadvertently be harmed.

Proposed Mitigative Measures

The following measure would be implemented to mitigate adverse impacts to Hawaiian hoary bats that may be present on a seasonal basis:

1. Avoid disturbance of woody vegetation taller than 15 feet (4.6 meters) during bat birthing and rearing season.

3.5 INVERTEBRATE RESOURCES

An invertebrate survey was conducted by Dr. Steven Lee Montgomery (Montgomery, 2017). Field surveys were conducted from July to December 2017. Results from a prior invertebrate survey conducted in 2008 was considered in analysis for the current survey. The primary purpose of this survey was to determine the presence or absence of endemic or indigenous terrestrial invertebrates, especially species listed under federal or state threatened and endangered species statutes. Survey methodology and results are summarized below with the survey report included in Appendix G.

Methodology

Field surveys were conducted over a period of several months from July to December 2017 to include dry and wet conditions and to ensure observation and collections occurred during the day and night. The survey focused on finding endemic and indigenous Hawaiian species. No attempt was made to collect or completely document common alien arthropod species present in the area. Prior to the initiation of fieldwork, a general assessment of site terrain and habitats was conducted through review of maps and prior reports. Surveys occurred during the day and night, with the property traversed to survey all habitat types. Pathways were also followed to search for any springs or native botanical resources and other host plant options for native invertebrates. Survey methods included visual observation, searches of host plants, usage of sweep nets, and light sampling.

3.5.1 Existing Conditions

Plant and invertebrate populations are interdependent, with the presence of host plants serving as a means of gauging invertebrate health. The Petition Area has historically been used by humans for agriculture and ranching. Feral pigs are also present and continue to degrade vegetation and understory plants by rooting, resulting in soil disturbance. These factors likely contribute to the limited number of native plants identified on site. The lack of native plants capable of serving as arthropod host sites may explain why few Hawaiian arthropods were identified. A review of archaeological surveys of the area and field surveys conducted indicate that lava tubes potentially supporting cave-adapted native invertebrates are not present within the Petition Area.

The only federally listed endangered species observed was the Blackline Hawaiian Damselfly (*Megalagrion nigrohamatum nigrolineatum*). Remaining native Hawaiian invertebrates (endemic) sighted are widespread in distribution. Invertebrates endemic to Hawaiʻi identified in this survey are outlined in Table 3.3, and a full listing of other introduced species is included in the invertebrate survey report in Appendix G. There were no indigenous species identified during the survey. The survey report also provides additional details for select invertebrates that impact the survival of native invertebrates.

Table 3.3
Endemic Invertebrate Species Detected Within the Petition Area

Species	Common Name	Status	Comments	2008	2017
INSECTA					
DIPTERA	Flies and Mosquitoes				
Chironomidae	Midges				
Chironomus hawaiiensis		End	Prey of damselfly		X
Ceratopogonidae	Biting Midges				
Dasyhelea hawaiiensis					
Forcipomyia howarthi		End	Prey of damselfly		X
Ephydridae	Shore flies				
Brachydeutera hebes	Shore fly	End	Feeds on algae, fresh water		X
HEMIPTERA: HETEROPTERA	True Bugs				
Lygaeidae					
Nysius terrestris	Seed bug	End	On Portulaca		X
LEPIDOPTERA					
Cosmopterigidae	Case Bearers				
Hyposmocoma		End	At light	X	X
Crambidae	Micro-Moths				
Eudonia	Moss Moth	End		X	X
ODONATA	Dragonflies Damselflies				
Coenagrionidae					
Megalagrion nigrohamatum nigrolineatum	Blackline Hawaiian Damselfly Rainbow-eye Damselfly pinao anuenue	End	Endangered		X
Status: End: Endemic to Hawaiian Islands					
Source: Montgomery, 2017					

Blackline Hawaiian Damselfly (*Megalagrion nigrohamatum nigrolineatum*)

Native Hawaiian damselflies are a cluster of 25 species that have diversified from a single waif arriving in Hawai‘i, and now occupy many aquatic niches and rain forests. The Blackline or Rainbow-eye Damselfly on O‘ahu was formally named by R.C.L. Perkins in 1899. This species of native damselfly has been historically noted as a common species from sea level to 2,400 feet in elevation. However by 1996, this species had appeared to be extirpated from the Waianae Mountains. The Blackline Hawaiian Damselfly is present in the Ko‘olau Range only as scattered colonies, breeding in pools along upland streams and in seepage fed pools along overflow channels. The native damselflies were observed along a seep located in the northwestern corner of the Petition Area that is fed from a human developed well. This well was likely created during the area’s former use as a dairy farm.

Exhibit 3.14 Blackline Hawaiian Damselfly Resting on Site. Photo Montgomery 2017

The brown, inch-long damselfly nymphs favor a concealed existence clinging under stones or hiding in algae masses, both in moving and quiet waters, for long intervals. Exhibit 3.14 shows a native damselfly specimen resting on a leaf. The Hawaiian Damselfly's diet includes bloodworms, which are the larvae of *Chironomus hawaiiensis*, *Forcipomyia howarthi*, *Tanytarsus*, *Culex*, *Limonia* and Scatella shore flies, sowbugs (*Philoscia angusticauda*), and oribatid mites. Kalo is one of the few emergent water plants available as a host site in the Petition Area for native damselfly habitat. Some of these kalo specimen were seen with broken, pig chewed petioles.

On sunny days, up to eight males were sighted spaced out along the seep's waters. With thick cloud cover and much decreased sunlight, two to one were present, at mid-day, likely because damselflies had risen into trees to roost. One major threat to this species is predation on naiads (immature damselfly specimen) by alien fish, especially the Western Mosquitofish (*Gambusia affinis*), Sailfin molly (*Poecilia latipinna*), and the Guppy (*Poecilia reticulate*). Feral pigs are another threat because of their destructive rooting activities. The pig's wallowing and rooting for worms are a major alteration and disruption of the breeding and resting places of the damselfly.

Other invertebrate species that can affect the Hawaiian Damselfly or its habitat are summarized below.

1. <u>Red-rimmed Melania (*Melanoides tuberculata*)</u>. These freshwater snails were sited within the area used by native damselflies. However, these species do not compete with native damselflies for food resources as they subsist on algae and debris, and are often associated with kalo roots.
2. <u>Culicidae Mosquitoes (*Melanoides tuberculata*)</u>. The Southern House Mosquito (*Culex quinquefasciatus*) and Forest Day Mosquito (*Aedes albopictus*) are breeding in small numbers in the small flowing water of the seep and cement-encased spring source feeding it. The Cannibal Mosquito (*Toxorhynchites amboinensis*) also feeds frequently in these water receptacles, and are cannibalistic, feeding as predators on the larvae of other mosquito. Larvae of the Southern House Mosquito were found only in a few 1- to 2-inch deep pools associated with this seep, and serve as one food source for damselfly young.
3. <u>Hymenoptera (Wasps, Bees, Ants) and Formicidae (Ants).</u> Alien ants are known to prey on other insects and are documented as a factor in the limited presence of native arthropods. Ants are noted as a primary threat factor for the Blackline Hawaiian Damselfly in the 2011 Listing of Endangered Species. Alien ants observed in the Petition Area include the Long-legged ant (*Anoplolepis gracilipes*), Big-headed ant (*Pheidole megacephala*), and the Glaber ant (*Ochetellus glaber*). The Long-legged ant

was not observed in the 2017 survey, likely due to the presence of the Big-headed ant. These species maintain separate territories and do not overlap in distribution. The Big-headed ant is considered a threat to emergent damselflies.

Individuals trespassing into the Petition Area may be a threat to Damselfly present at the seep. Trespassers traveling near the seep could inadvertently disturb Damselfly breeding and resting sites. Trespassers also risk harming Damselflies directly while specimen are resting and molting on dead leaves or small sticks in stream margins or muddy areas. The coloring of the Damselfly make them difficult to see, creating risk that specimen could be stepped on by trespassers.

Other Notable Invertebrates Not Found

In addition to the presence of feral pigs, the area has a long history of human use that has been destructive to native plants. These uses have included Hawaiian agriculture, rice and pineapple cultivation, cattle ranching and coffee cultivation. The resulting extremely low level of native plants serving as arthropod hosts leads to the low level of Hawaiian arthropods present within the Petition Area. Nevertheless, consideration of other native federally protected invertebrate species (snails, spiders, and insects) was considered, and a summary is provided below.

1. The archaeological survey of the Petition Area indicated no lava tubes are present that could support cave-adapted native invertebrate species. The invertebrate study similarly did not observe any indication of lava tubes within the Petition Area.
2. No native mollusks were observed during the invertebrate survey.
3. O’ahu does have protected snail species, but existing vegetation, the presence of rats, and predation by the introduced Rosy Wolf snail (*Euglandina rosea*) make this site unsuitable habitat for endangered native Hawaiian endemic snails.
4. No native *Drosophila* (fly) were observed within the Petition Area, and this property is now unsuitable habitat for any of the endemic *Drosophila*, some being listed as endangered or threatened. These native Hawaiian picture wing flies require a native environment with host flora not present within the Petition Area.
5. The endangered Blackburn’s sphinx moth (*Manduca blackburni*) was not found during the survey. Historically, the moth is known from drier locations, and critical habitat established for the moth on O’ahu is many miles away. Neither the moth’s solanaceous native host plant, (‘aiea (*Nothocestrum* sp.)), nor the alien host tree tobacco (*Nicotiana glauca*) were observed on the site or identified by the botanical survey conducted.

3.5.2 Project Impacts and Mitigation

No Action Alternative

Adverse impacts to invertebrate species present are not anticipated under the No Action Alternative. Existing portions of the project serving as habitat for the limited number of native invertebrate species present would be maintained because no site improvements would occur within this area. The majority of invertebrate species present are introduced species likely due to the lack of native plants on site that might serve as host sites for these species. Native Hawaiian invertebrates (endemic) sighted are widespread in distribution.

Native Hawaiian Damselfly observed along the seep would continue to be negatively impacted by feral pigs. The destructive activities of these pigs would continue to disrupt this Damselfly habitat. Other threats to this species from mosquito fish and alien ants would continue. Individuals trespassing into the Petition Area would also threaten the survival of Damselfly present. Trespassers could inadvertently destroy Damselfly habitat near the seep or harm Damselfly resting and molting at the muddy areas and margins of the seep. Damselfly would continue to face comparatively greater risk of impacts from continued disruption of their habitat by feral pigs.
without project implementation.

Proposed Action

Improvements implemented under the Proposed Action would not adversely impact native invertebrate species present, which are widespread in distribution, or federally or state-listed endangered or threatened species.

Usage of native vegetation in site landscaping of the proposed cemetery expansion area and select portions of the proposed Cultural Preserve would increase the presence of native vegetation on site. Overall, these plants would provide additional habitat for native invertebrates. Landscaping improvements using native plants would provide beneficial habitat and refuge for native arthropods along with supporting cultural values. Such landscaping improvements would be developed as part of the design plans developed for this project.

Grading improvements would not adversely impact the seep located in the northwestern corner of the Petition Area that provides habitat for Blackline Hawaiian Damselfly. This area is planned to be preserved, and would not be impacted by grading activities. As discussed in Section 3.6, design measures would be incorporated into grading plans to minimize fill effects on the spring and seep serving this damselfly habitat. Project improvements are not expected to adversely impact Damselfly present. Damselfly populations and human developments can co-exist. For example, a population of *M. xanthomelas* at a stream course at Tripler Army Hospital has been sustained by managing piped water for 20 years. On Lānaʻi, *M. xanthomelas* was found breeding in a large, ornamental pond behind The Lodge at Kōʻele. Although adverse impacts from project implementation are not anticipated, measures are proposed to mitigate existing impacts from predators and trespassers as well as ensure the seep remains as a functional Damselfly habitat.

Proposed Mitigative Measures

To minimize potential effects on the endangered damselfly, the following measures are proposed:

1. Conduct regular inspection of the seep to ensure the present low trickle flow of water is continued. Inspection could involve development of a monitoring plan during the project design phase. The plan would include BMP measures (i.e. erosion control) and would be implemented during the project's construction phase. Inspection of the seep should be conducted before the start of construction to establish baseline water flow conditions. Monitoring would occur during construction with the seep area inspected on a weekly basis to evaluate water flow in coordination with BMP measures. Once construction concludes, monitoring would continue for an additional six months to ensure continued seep water flow. Inspections would occur weekly for the first three months and every two weeks thereafter if conditions are satisfactory. After the six month period elapses, HMP staff would conduct monthly water flow inspections. If water flow is significantly disrupted measures would be implemented to supplement short-term water flow (i.e. piping in of new water). Appropriate measures would be determined through consultation between the contractor and the design team or other specialists to evaluate conditions and resulting measures. This has been successful at another site for a related endangered damselfly (Evenhuis et al. 1995).
2. Monitor as part of seep inspections to ensure non-native fish, such as the Western Mosquitofish, are not present within this habitat area. Individuals conducting seep water flow inspections should be aware of the presence of alien fishes and should notify experienced biologists if fishes are sighted to ensure prompt identification and removal.
3. Construct fencing around the damselfly habitat to protect native damselfly from disturbance by feral pigs. Fencing should consist of hog wire designed with a lower barbed strand to resist digging.
4. Place small sticks upright and away from the edges of waterlogged areas to serve as molting safe zones to avoid predation during molting. These sticks would protect naiads because ants would not cross water barriers.
5. Coordinate with the U.S. Fish and Wildlife Service (FWS) to establish a habitat restoration and conservation program for this damselfly's habitat under the Partners for Fish and Wildlife program. An agency and landowner partnership can be established that can potentially specify joint stewardship and monitoring responsibilities of this habitat area with the FWS. Such a partnership would support the restoration of this endangered species and provide educational opportunities.

3.6 GROUNDWATER RESOURCES

This section discusses groundwater resources present with the Petition Area. Tom Nance Water Resource Engineering (TNWRE) conducted a groundwater assessment to evaluate project impacts to groundwater resources (TNWRE, 2018). As part of this analysis, TNWRE investigated a seep located in the northwest corner of the Petition Area, which is immediately downslope from a shallow man made well. A copy of TNWRE's report is included in Appendix H.

3.6.1 Existing Conditions

3.6.1.1 Geologic Setting and Regional Groundwater

The existing HMP and Petition Area are located within the former caldera of the Ko'olau Mountain (referred to as the Kailua Caldera). The caldera filling lavas beneath the Petition Area are a part of the Kailua Member of the Ko'olau volcanics (Exhibit 3.15). The basalt flows are dense, massive, and relatively impermeable due to almost complete filling of interstices with secondary minerals resulting from hydrothermal alteration. Clinker beds, where they occur, have been cemented into hard and essentially impermeable breccia. Joints of intruded dikes are also filled with secondary minerals. Therefore, development of even a moderate capacity well anywhere in the Kailua volcanics beneath the Petition Area or other HMP property would not be possible. It is significant that the deep weathering of the Kailua volcanics across the Petition Area has resulted in stiff silt and clay residual soils underlain by saprolite to depths exceeding 50 feet (TNWRE, 2018).

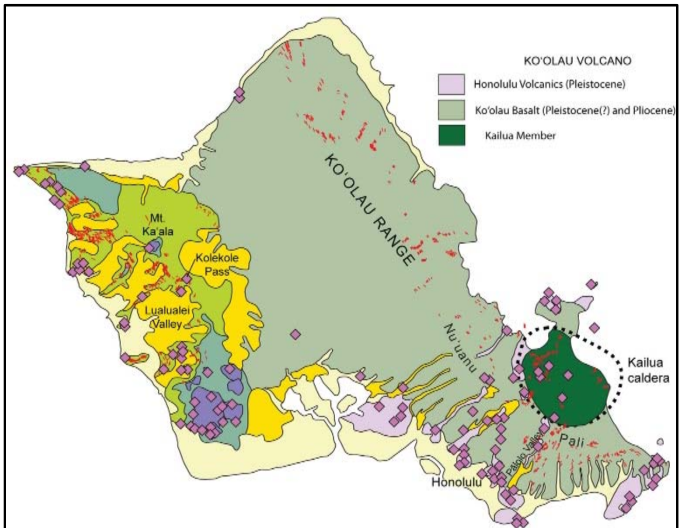


Exhibit 3.15 Kailua Caldera Location

<u>Regional Watershed Background</u>

The State of Hawai'i has identified 19 watersheds in the Ko'olaupoko area of O'ahu, which encompasses much of the windward side of the island and includes the Petition Area. Studies of this watershed area include the State Commission on Water Resource Management's (CWRM) *Water Resource Protection Plan* (CWRM 2008), the State DLNR, Division of Aquatic Resources' (DAR) *Atlas of Hawaiian Watersheds and Their Aquatic Resources* (DAR 2008), the City's *Ko'olau Poko Watershed Management Plan* (KPWMP) (Townscape, 2012), and the *Ko'olaupoko Watershed Restoration Action Strategy* (KBAC 2007).

The Kāneʻohe watershed, which surrounds the Petition Area, is subdivided into northern, central, and southern regions (KBAC, 2007). The Petition Area is located within the larger watershed's southern region that reaches from Heʻeia southward, and includes ridgelines between Kāneʻohe and Kailua. The southern region is characterized as being the most urbanized portion of this watershed and is the portion most impacted by adjacent land use. This region is almost entirely developed with most of its streams channelized. The Petition Area is located within the southern region's Kāwā watershed. Figure 3.8 illustrates the general boundaries for the Kāwā watershed within the larger Kāneʻohe watershed based upon the KPWMP. The majority of the Petition Area is located in the southeastern portion of the Kāwā watershed (DAR Watershed Code 32011).

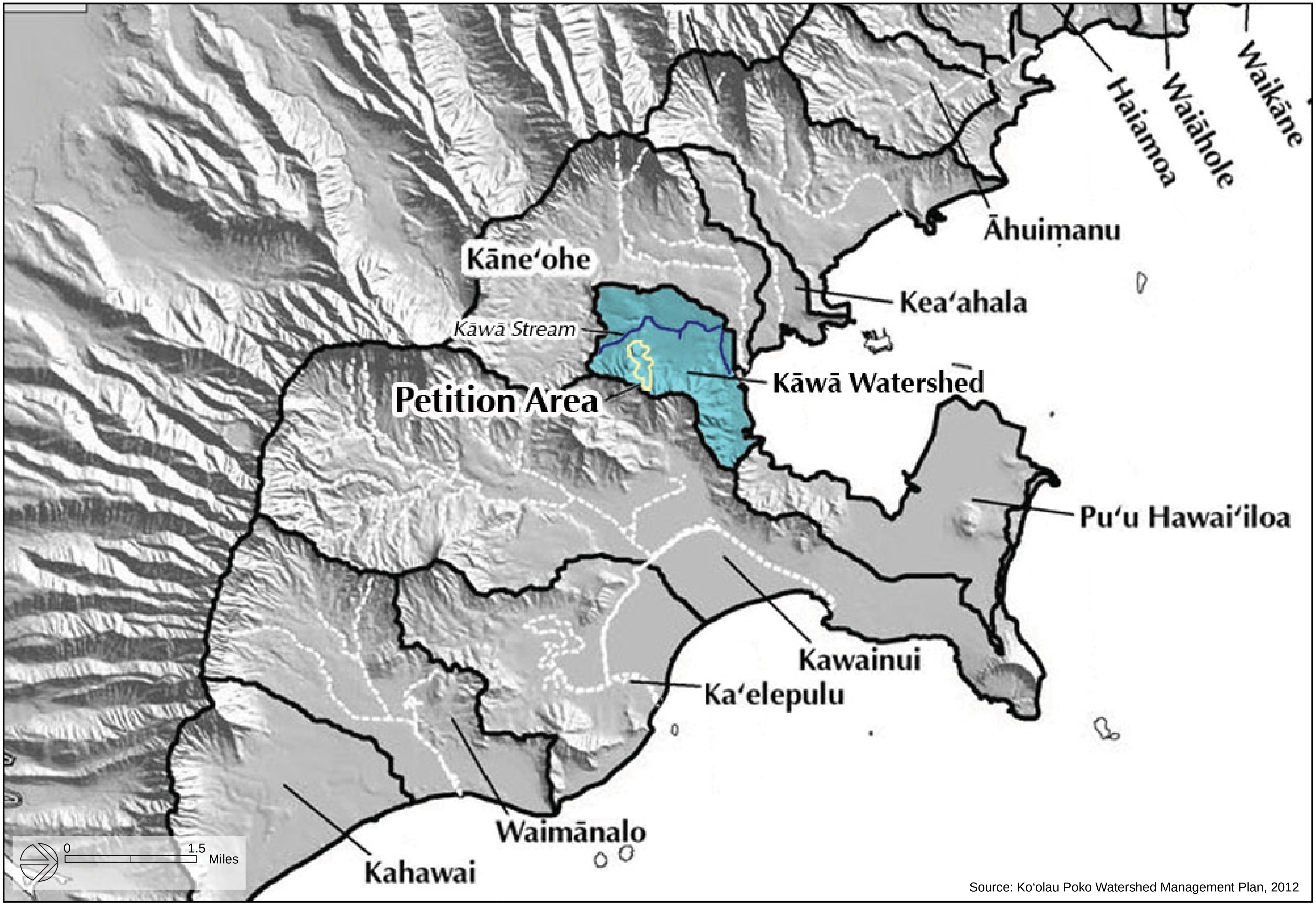
The Kāwā watershed is generally bounded by the Oneawa Hills on the east, residences along Kāneʻohe Bay Drive to the north, portions of Kāneʻohe town on the west, and residences near Kamehameha Highway on the south. The KPWMP estimates this watershed to be about 2.1 square miles. The watershed has a maximum elevation of 938 feet rising above its lowest elevation at sea level (KBAC 2007). As shown on Figure 3.8, Kāwā Stream is the single stream flowing through this watershed. Other freshwater inputs including runoff, springs, ephemeral drainageways, and intermittent streams that feed water and sediment into the system. Land within the Kāwā watershed includes both public and privately-owned land.

Regional Groundwater

The State DLNR, Commission on Water Resource Management (CWRM) has established groundwater hydrologic units to provide a consistent basis for groundwater aquifer management. The State's *Water Resources Protection Plan* establishes an aquifer coding system classifying the State's aquifers by geology and water characteristics (CWRM 2008). The coding system is comprised of Aquifer Systems located within larger State Aquifer Sectors.

The Petition Area is located within the Koʻolaupoko Aquifer System (30603212) that is situated within the larger Windward Aquifer Sector (306). The Koʻolauloa, Kahana, and Waimānalo aquifer systems are also included in the Windward Aquifer Sector. The Koʻolaupoko Aquifer System extends from the mauka flanks of the Koʻolau Mountains to the shorelines of Kāneʻohe Bay, and is about 11 miles wide.

The system has an estimated sustainable yield of 30 million gallons per day (gpd) (CWRM 2008). This figure is derived from analytical ground water models and represents the amount of water that may be drawn from the aquifer without impairing its capacity to replenish itself. The aquifer's sustainable yield figure does not include water removed from the system by the Waiahole Tunnel. The majority of Koʻolaupoko ground water sources are located in the Koʻolaupoko Aquifer System of which the greatest sources of developable water is high level dike water located along portions of the Koʻolau Mountain Range proximate to the Kāneʻohe and Kahaluʻu communities.



Ko‘olau Poko Watershed Management Plan (Townscape, 2012) **Figure 3.8**

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

Groundwater is stored in subterranean aquifers, which are permeable rock formations saturated with water. Groundwater can be brought to the surface through natural springs or pumping. In Hawaiʻi, groundwater is the primary source of municipal water and is also used for agricultural and industrial purposes. The most abundant form of groundwater on Oʻahu is the basal aquifer, a lens of fresh to brackish water floating on sea water. Waters flowing freely to the surface from wells tapping into the basal aquifer are referred to as artesian.

Groundwater within the Koʻolaupoko Aquifer System is stored within dike compartments in the upper portion of a saturated aquifer that are not in contact with seawater. Waters within higher level aquifer systems, such as those at higher elevations closer to the Koʻolau Mountain Range are used for drinking and are classified as fresh relative to water salinity. Higher level waters of the aquifer system are considered irreplaceable and vulnerable to contamination.

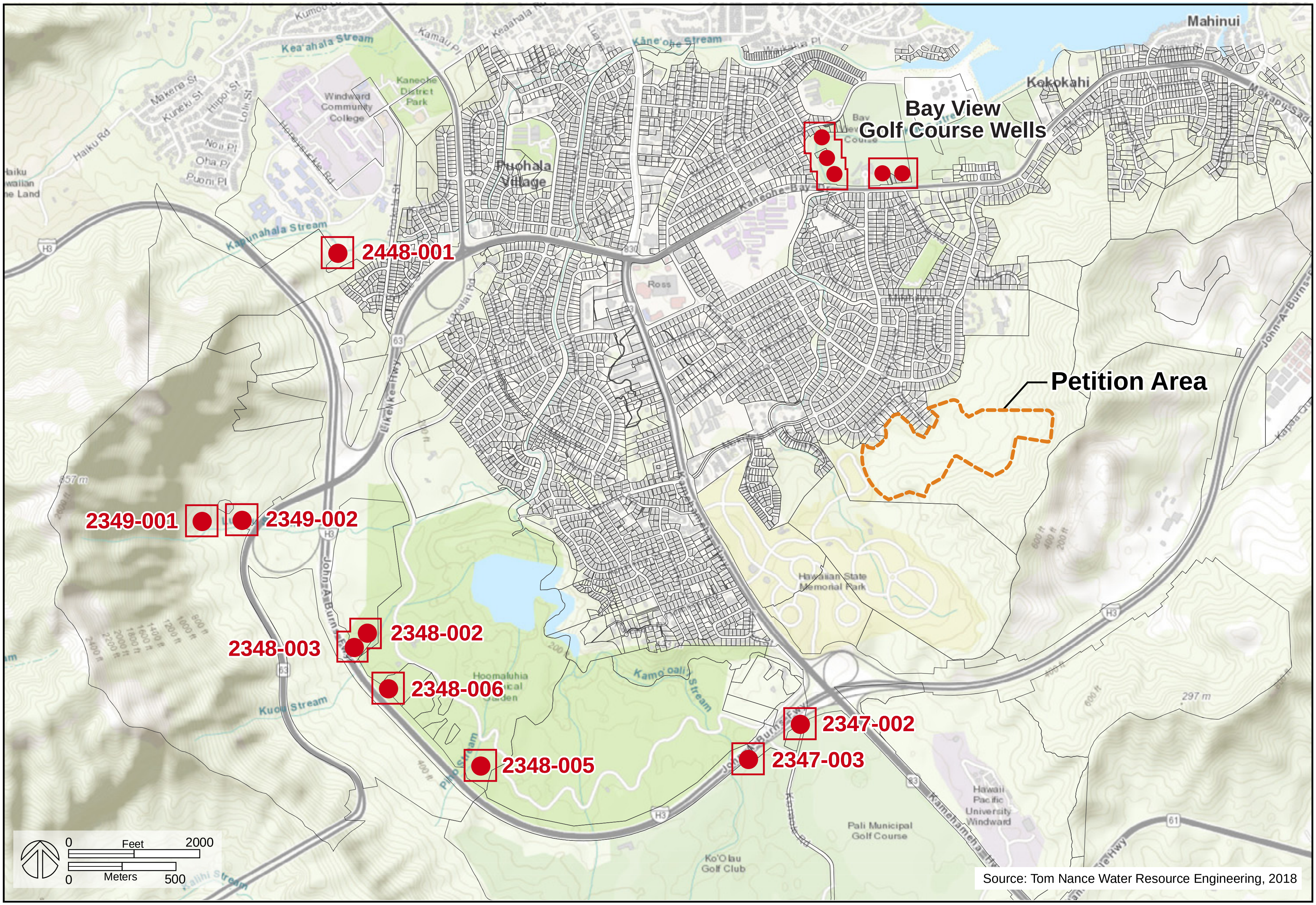
3.6.1.2 Groundwater Usage and Water Quality

The CWRM has set the aquifer's sustainable yield at 30 million gallons per day (mgd) and has issued water use permits to 19 wells with a total permitted use of 10.312 mgd. Based upon monthly pumping data, the total use by these wells has closely matched the combined permitted use amount. Of the 19 wells in the aquifer with permitted use permits, nine are pertinent to the project and are nominally located upgradient of the Petition Area. The Bay View Golf Course Wells are located downgradient of the Petition Area. These wells are shown on Figure 3.9. Most notable is that these nine wells tap into high level groundwater standing between 200 and 570 feet above sea level, apparently all drawing from dike confined compartments in the Koʻolau's dike complex.

Since the mid-1990s, total pumpage of all nine wells has been less than their combined permitted use. Five wells (Bay View Golf Course) located downgradient from the Petition Area are not pertinent to the project and are also shown on Figure 3.9. All five are shallow irrigation wells of modest capacity within the Bay View Golf Course. They draw water exclusively from the overlying alluvium of clayey silt and gravel rather than from the volcanics at depth (TNWRE, 2018).

<u>Groundwater Quality</u>

The quality of groundwater in the Koʻolaupoko Aquifer System is considered high, and meets Federal and State drinking water standards (Townscape, 2012). The BWS and the State Department of Health (DOH) regularly monitor drinking water quality for over 100 types of contaminants with testing performed at the water source. Monitoring for certain contaminants, such as coliform bacteria, is conducted throughout the distribution system. Contaminants that may enter drinking water due to water flowing through the delivery system, such as lead and copper, are tested both at the source and also at the consumer's tap. To further safeguard drinking water sources from contamination, BWS, DOH, and the U.S. Environmental Protection Agency (USEPA) have several other monitoring and treatment programs.



Locations of Actively Used Wells Near Hawaiian Memorial Park **Figure 3.9**

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

The State DOH administers the underground injection control (UIC) program to protect the quality of state underground drinking water sources from pollution by subsurface disposal of fluids under Chapter 11-23, HAR (State, 2000). Under these regulations, UIC maps show exempted aquifers from underground source drinking water situated below (makai) this line. Exempted aquifers are those that: 1) do not currently serve as a source of drinking water; and 2) will not in the future serve as a source of drinking water due to several criteria.

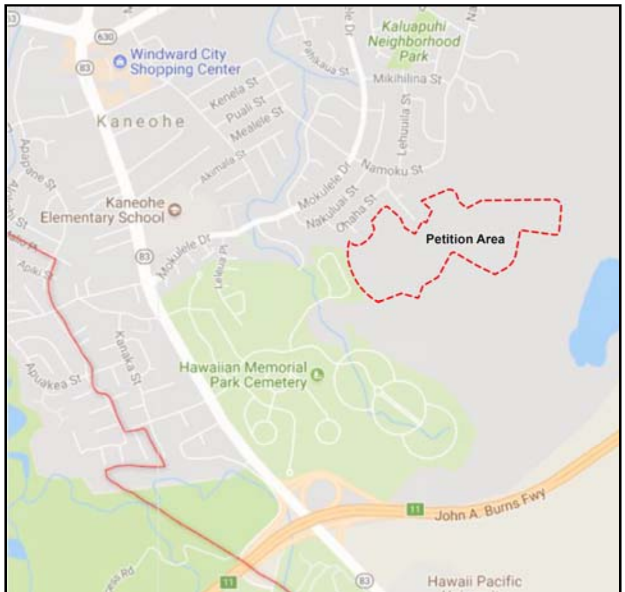


Exhibit 3.16 State DOH UIC Line (Red)

The UIC line generally runs mauka of Kamehameha Highway as shown on Exhibit 3.16. Therefore, the Petition Area is located below and well away from this UIC line indicating it is situated above an exempt portion of the Koʻolaupoko Aquifer.

3.6.1.3 Shallow Well and Seep Within Petition Area

There is an existing shallow well and perennial seep within the northwest corner of the Petition Area, located about 300 feet east of the roadway serving the Ocean View Garden as shown on Figure 3.10. The well is 11.5 feet deep below the top of its square-shaped concrete rim. The opening of the concrete top is 2.65 by 2.90 feet in dimension. The dug borehole below the concrete is substantially larger than this opening. Exhibit 3.17 is a schematic cross section of the well portraying its probable dimensions. Exhibit 3.18 includes a photo of the well concrete rim.

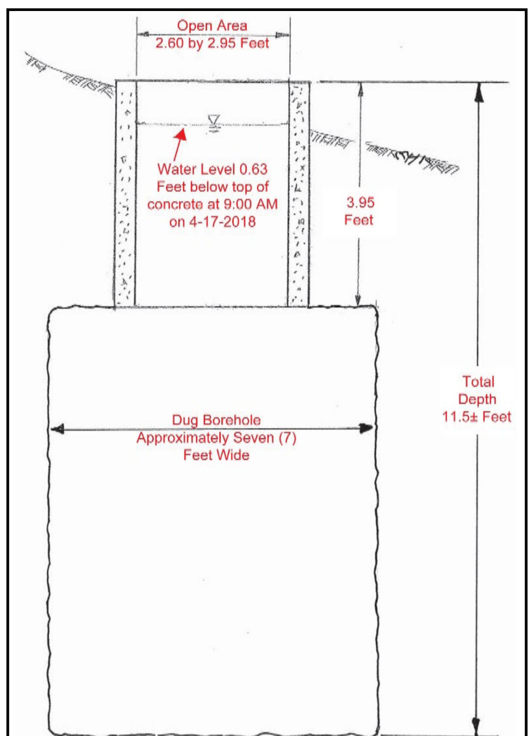
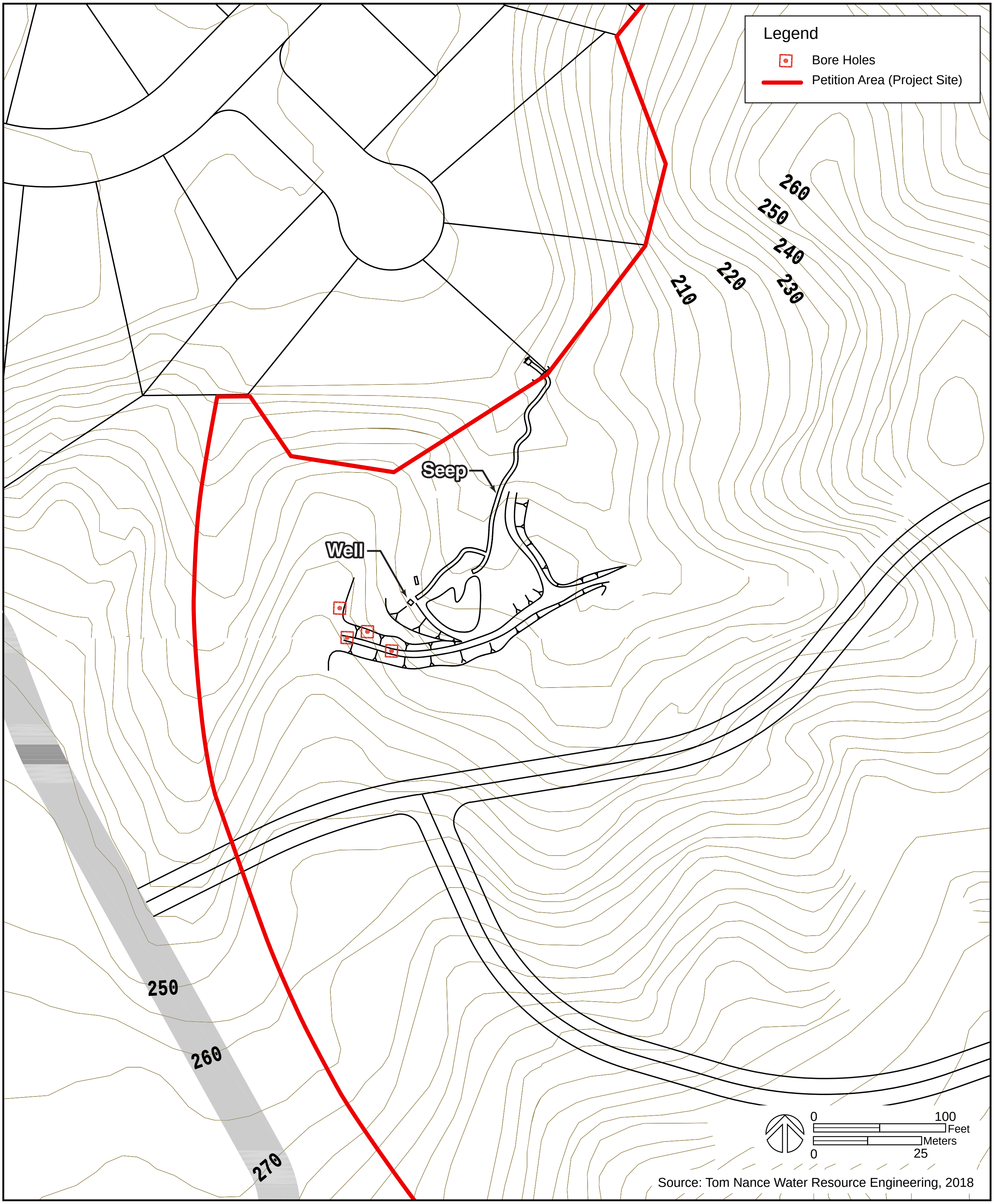


Exhibit 3.17 Existing Well Dimensions

As measured a number of times during the field investigation, the water level in the well was consistently above the ground level on the downstream side of the well. The well is not registered with the CWRM, and no information about its installation or past use could be found. Based on an old pipe laying nearby, it may at one time have been a modest source of supply.



Location of Well, Seep and Borings **Figure 3.10**

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

Photo of Well Concrete Rim   Mauka View of Seep from Well

Exhibit 3.18 Photos of Existing Well and Seep

A small but perennial seep emerges about four feet downslope from the well (see Exhibit 3.18). Further down the waterway, the flowrate in the waterway continuously increases along the route to its ultimate discharge into the drain inlet at the end of Ohaha Place. Given the additions to the flowrate enroute downslope, it is more accurate to describe the seep as an area of discharge rather than a discharge from a single point (TNWRE, 2018).

<u>Groundwater Testing Above Well</u>

Two types of field investigation were undertaken to assess whether the well and seep are from a shallow perched water source. This investigation consisted of: 1) drilling four boreholes directly upslope of the well and seep; and 2) conducting a siphon and pump test of the well to determine if subsurface leakage from the well is creating the seep that emerges just four feet downslope.

<u>Results of the Boreholes Drilled</u>

Figure 3.10 identifies the approximate locations of the four boreholes drilled above the well and seep. Although an obvious perching member was not encountered in the borings, the water level response in all four boreholes was informative. Water was not encountered in the boreholes until each borehole had been drilled down to between 15 to 20 feet below ground.

After reaching that depth, the water level in each borehole rose up very slowly. The geotechnical boring results included in the groundwater study (Appendix H) document this slow filling in each of the boreholes. As the tabulation of approximate water levels in the boreholes and the well show, the semi-confined groundwater residing in the poorly permeable residual soil has a relatively steep downslope gradient.

Results of Siphon and Pump Testing the Well

Testing of the well was undertaken with two basic objectives: 1) to confirm that the semi-confined groundwater occurrence found at the four boreholes directly upslope also exists at the well; and 2) to confirm that the seep that emerges four feet downslope of the well is a result of subsurface leakage from the well. Both aspects of the groundwater occurrence were confirmed by the test.

The initial intent was to run the test by siphoning from the well (and discharging downslope to maintain the siphon) rather than by pumping. Siphoning began at about 30 gallons per minute (gpm), but the siphon was lost in less than 10 minutes. An attempt to restart the siphon also failed, this time in less than five (5) minutes. Thereafter, the well was pumped with a small, 1/4 horsepower sump pump, first at 17 gpm and then at about 15 gpm. The results are summarized below:

1. When the water level in the well was drawn about halfway down the concrete well head, the seep that emerges about four feet downslope stopped flowing. Clearly, the seep is maintained by subsurface leakage from the well.
2. Over the period of intermittent siphoning and then pumping, a total of 1,615 gallons was removed from the well. About 950 gallons was estimated to be removed from storage in the well itself, and the remaining 665 gallons flowed from the area into the well. That inflow was at an average of about 4.3 gpm.
3. The recovered water level manually measured showed the water level had risen up inside the concrete well head, but not high enough to have started flow in the downstream seep. Average inflow to the well was approximately 3.1 gpm.
4. The well's water level was checked on the following day. The water level had fully recovered (actually to a level 0.1-foot higher than at the start of the test the day before). The seep below the well was fully restored at that time.

Therefore, the groundwater study shows the seep is maintained by the natural discharge of groundwater moving downslope through the poorly permeable residual soils overlying the unweathered Kailua volcanics. In the vicinity of the well and four test boreholes upslope from the well, the groundwater is actually semi-confined. The groundwater movement is through underlying soils at depths of 10 feet or more rather than through the surface soils. The upper end of the seep begins about four (4) feet downslope of the well, and water flow in the upper one third to one half of the linear seep is maintained by subsurface leakage from the well. Further downslope, flow in the seep increases continuously to its ultimate discharge into the Ohaha Place drainage system.

3.6.2 Project Impacts and Mitigation

No Action Alternative

Under this alternative, the Petition Area would remain highly vegetated and undeveloped because there would be no grading improvements or other site development occurring within the area. Therefore, there would be no change to current groundwater conditions within the Petition Area or conditions occurring at the well and seep. Water would continue to slowly flow into the seep by subsurface leakage occurring from the well. Groundwater recharge would not be reduced given the continued vegetated condition of the area. Existing cemetery conditions and operations at HMP would continue, and these activities would not impede groundwater recharge.

Proposed Action

The proposed Cultural Preserve should have no impact on groundwater conditions within the Petition Area because no major site improvements would occur that may impact soils or groundwater conditions. The well and seep would not be impacted because the Cultural Preserve is located on the far eastern end of the Petition Area, well away from the seep.

The expansion of the cemetery would include extensive grading activities and site development that would significantly change the existing topography of the site. Grading improvements also include construction of a sequence of three (essentially parallel) retaining walls upslope of the well and perennial seep, and fill heights for the cemetery of about 10 to 30 feet behind these walls. The groundwater study evaluated whether these retaining walls and/or the fill behind them may intercept, impede, or reroute the groundwater flow that maintains the perennial seep.

Based upon these tests, it was determined that grading improvements should not have a significant impact on the Petition Area’s underlying groundwater conditions or the well and seep. The entire Petition Area overlies caldera-filling volcanics that are virtually impermeable. As such, grading improvements and cemetery use of the area do not have the potential to impact ongoing or possible future uses of groundwater drawn from the permeable Koolau volcanics of the Koolaupoko Aquifer System.

Regarding the well and seep, the footings of the retaining walls proposed as part of the project grading plan would be too shallow to intercept the groundwater moving downslope. The retaining walls and fill behind them would include subsurface drains (discussed in Chapter 2).

Proposed cemetery expansion improvements are expected to have a minimal impact on the quality and volume of groundwater underlying the aquifer. The project would not significantly impact the regional watershed area or the aquifer sustainable yield of 30 mgd. Some potable water would be used to irrigate the cemetery expansion area, but the wet climate of the windward district reduces the amount of irrigation required. Cemetery operational staff indicate that irrigation is rarely needed. Water used for irrigation would have a negligible effect on the aquifer system's sustainable yield. As previously discussed, existing wells within the aquifer have a total permitted use of 10.312 mgd, and total use closely matched the permitted use volume. Additional water for irrigation use for the project would have minimal change to this use, which is well below the aquifer's sustainable yield.

These improvements would also have minimal effect on the water quality of the underlying groundwater because the entire Petition Area overlies caldera-filling volcanics that are virtually impermeable. The Petition Area is located below and well away from the UIC line that generally runs mauka of Kamehameha Highway, and is thus situated above an exempt portion of the Ko'olaupoko Aquifer.

Proposed Mitigative Measures

The weight of the fill material has the potential to compress existing soils and interrupt or redirect groundwater migration that is moving downslope. This could reduce the permeability of these already poorly permeable soils, impeding or re-routing the downslope direction of the groundwater flow. To ensure that the quantity and direction of groundwater flow is maintained to the well and the seep, the following design measures are proposed.

1. Possibly three deeper subsurface drains would be constructed within the fill area above the seep. These drains would generally be aligned perpendicular to the retaining walls and installed at depths to intercept and convey the flow of groundwater to the well and seep. Their possible alignments are shown conceptually on Exhibit 3.19 (also shown on Figure 2.3).
2. Their exact locations, alignments, and depths would be determined with the drilling of additional boreholes as part of the project's design phase in developing final grading plans.

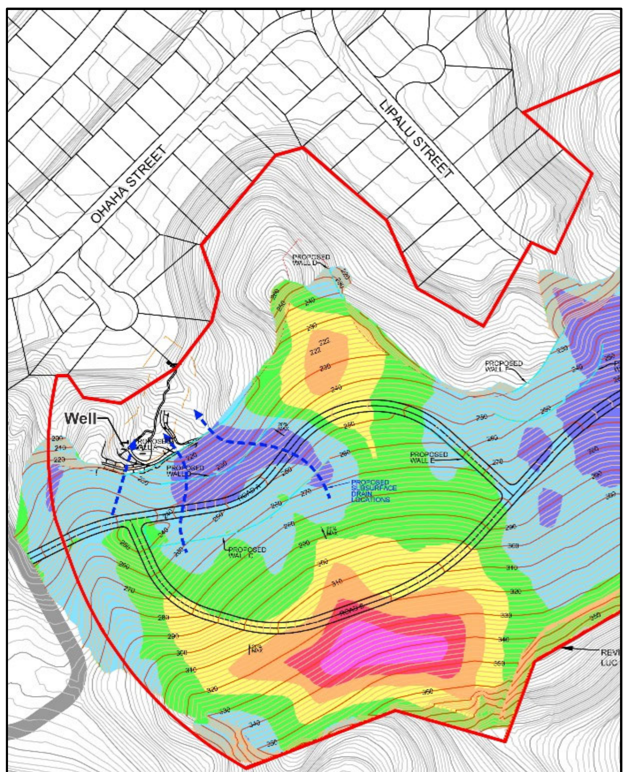


Exhibit 3.19 Conceptual Alignments of Subsurface Drains

3.7 SURFACE WATERS

3.7.1 Existing Conditions

This section discusses surface water resources present with the Petition Area. Element Environmental, LLC (E2) conducted a water quality assessment to evaluate project impacts to water resources pertinent to the project (Element Environmental, 2018). A copy of this report is included in Appendix I.

3.7.1.1 Streams and Drainageways

There are no perennial or intermittent streams within the Petition Area. The most proximate surface water resource to the Petition Area is Kāwā Stream, and its location is shown in Figure 3.11. The Petition Area is generally located within a broad natural drainage basin created by the topography of the surrounding hillside. As a result, stormwater runoff flowing from upland areas sheet flows across the site following natural drainage patterns, and merges in low lying portions of the site during periods of heavy rainfall. Ephemal drainageways within the Petition Area carry stormwater runoff into the City’s drainage system, which eventually feeds into Kāwā Stream.

Kāwā Stream

Kāwā Stream is a perennial stream located outside the Petition Area, and has a total run of approximately 2.8 miles of main and tributary stream courses serving a 1.13 square mile watershed area. The Hawai‘i Stream Assessment (HSA) classifies Kāwā Stream (HSA Code 3-2-11) as a continuously flowing stream (OLI, 2002). This stream begins within the Hawai‘i State Veterans Cemetery. The upper portion of the stream within the Veterans Cemetery is classified as intermittent under the HSA, flowing only during periods of heavy rain (OLI, 2002).

This intermittent portion of the stream begins at an open concrete box culvert situated near the Veterans Cemetery baseyard. This box culvert collects sheet flow draining downslope from cemetery lawns. This intermittent stream section becomes perennial further downslope where the stream crosses the access road to Ocean View Garden. This section of the stream and other nearby branches drain forested lands in the vicinity. These tributaries of Kāwā Stream converge and flow downslope toward the Parkway subdivision.

Kāwā Stream continues to travel downslope through residential areas, while other perennial tributaries merge before eventually discharging into the southern portion of Kāne‘ohe Bay. The stream receives perched groundwater input and storm runoff that originate from both forested and urbanized areas. A stream bioassessment report for Kāwā Stream determined this stream does not generally provide good habitat for native aquatic organisms, nor does it support substantial populations of native fish or crustaceans (Burr, 2001).

Streams and Drainageways

Figure 3.11

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

Ephemeral Drainageways

There are two existing ephemeral drainageways within the Petition Area that carry stormwater runoff from upland and surrounding areas into the lower basin as previously shown on Figure 3.11. Discharges from these drainageways eventually enter two City catchment basins situated at the Petition Area's boundary with residences at the end of Ohaha Street and Lipalu Street.

One ephemeral drainageway generally serving the central and eastern end of the Petition Area, including the Cultural Preserve, discharges runoff into a catchment basin at the end of Lipalu Street. This drainageway is unimproved within the Petition Area except near the catchment basin where there is a concrete wall, rock wall, and fencing (Exhibit 3.20). This drainageway serves a watershed area (referred to as the Lipalu watershed) estimated to be approximately 73-acres in size. Less than half of this watershed includes the Petition Area (Exhibit 3.21).

Improved Drainageway by Lipalu Street **Unimproved Section of Drainageway**
Exhibit 3.20 Photos of Lipalu Ephemeral Drainageway

The second ephemeral drainageway at Ohaha Place serves a smaller basin encompassing the western end of the Petition Area. This includes the area where the well and seep are located. Stormwater sheet flows from upland areas into the lower basin area, eventually merging into and entering the catchment basin at the end of the Ohaha Place.

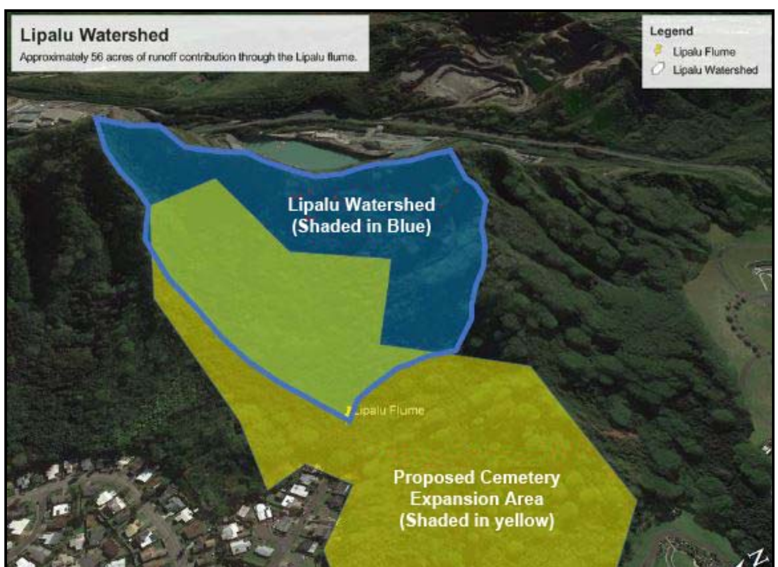


Exhibit 3.21 Lipalu Watershed (Element Environmental, 2018)

3.7.1.2 Surface Water Flow Rates

The volume of groundwater input to Kāwā Stream above the USGS monitoring station across the street from the Bayview Golf Course was estimated to average around 600 gallons per minute (gpm) between December 2017 and February 2018 (Element Environmental LLC, 2018). Synoptic streamflow measurements were made at multiple locations within the watershed after five days with no rainfall on February 12, 2018. Exhibit 3.22 shows the flow rates measured in various portions of Kāwā Stream and its tributaries. In particular, measurements at the Parkway site indicated a flow rate of 25 gpm, reflecting the approximate baseflow volume originating from the basin next to residences located below (makai of) the existing HMP.

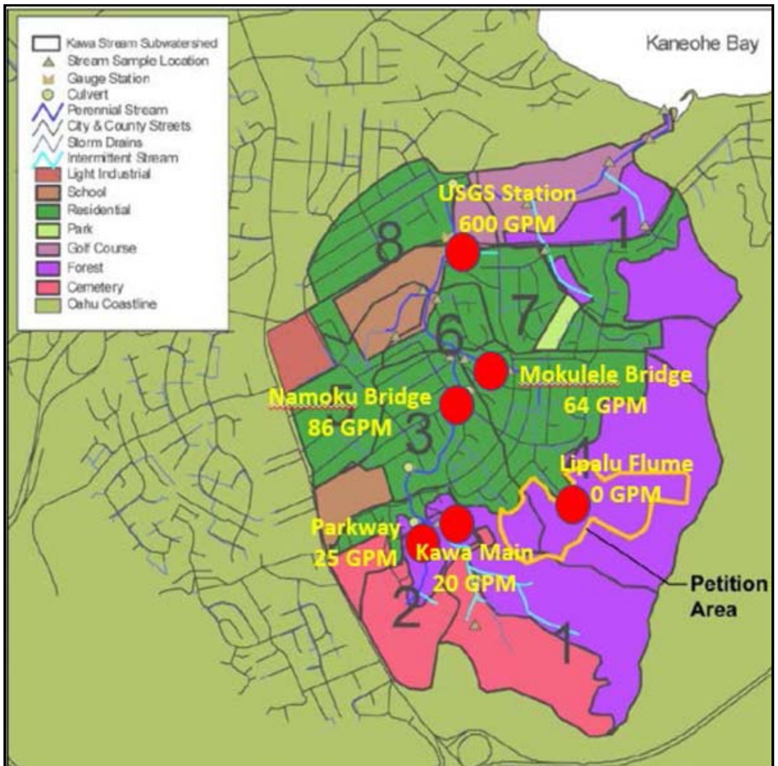


Exhibit 3.22 Flow Rates at Monitoring Sites

A seepage run conducted in the residential basin (Cascade Spring) measured spring flow of 5 gpm at the slope below HMP's existing maintenance facility; 2 gpm from the buried culvert draining HMP's existing cemetery and receiving groundwater input; and about 8 gpm of perched groundwater inflow across the course of the small tributary flowing northeast from the spring and culvert behind the Parkway residential recreational center.

In addition, water samples collected during this and previous studies from various monitoring locations throughout the watershed after several days with no rain reflected water quality of perched groundwater rather than the water quality of stormwater runoff from rainfall.

Flow Monitoring Data

A flume was installed within the drainageway serving the Lipalu watershed about 200 feet mauka of the improved Lipalu Street catchment basin to allow continuous monitoring of stormwater flow in this ephemeral drainageway. Manual and tipping rain gauges were also installed on the ridgeline to record rainfall that falls along the ridgeline at the Petition Area between December 2017 and February 2018. The volume of stream and runoff flow for Kāwā Stream was obtained from the USGS gaging station located mauka of Kāne'ohe Bay Drive during this timeframe. During the 71-day monitoring period, runoff was measured at the Lipalu flume on nine days.

It should be noted that monitoring for the flume was terminated on February 18, 2018 due to a large storm event that partially destroyed the flume. The flume recorded a water level of over 4.55-feet shortly before it collapsed. A three-foot high level in the flume is associated with a flow rate of 80.4 cfs, or over 36,000 gallons per minute. It is likely that the peak flow volume during this intense storm was on the order of 200 cfs. The flow measured at the USGS gaging station rose from 10 cfs to 1,000 cfs during the initial intense period of rainfall from this storm. The one-hour, 100-year design storm event for the Kāneʻohe area is around 4.5 inches/hour.

Table 3.4 summarizes the percentage of rainfall that ended up as runoff during nine storm events at the USGS gaging station and the Lipalu flume. The largest storm during the monitoring period was the February 18th major storm. The highest one-hour rainfall total associated with this event was 2.51 inches. The highest 10-minute rainfall intensity measured during this storm was 0.57 inches, which fell at the beginning of this storm event.

An average of 40% of the rainfall that fell within the Kāwā watershed during these nine storm events ended up as runoff discharged within Kāwā Stream at the USGS gaging station. Within the smaller Lipalu watershed, an average of 5.4% of rainfall discharged from this section of the Petition Area during these storm events ended up as runoff in the Lipalu flume. During the nine storm events recorded, only approximately 1.2% of the total runoff discharged from the Kāwā Stream watershed originated from the forested Lipalu watershed area monitored by the flume.

Table 3.4
Summary of Runoff Percentages from Areas

Storm Date: Time Start	Storm Date: Time End	Storm Event Rainfall Total (Inches)	Percentage of Storm Event Rainfall-Runoff at USGS Gauge[1]	Percentage of Rainfall Runoff at Lipalu Flume[2]	Percentage of Storm Runoff Originating from Project's Watershed
12/19/17: 16:40	12/21/18: 2:00	2.72	13.5%	0.0%	0.0%
12/26/17: 10:30	12/27/17: 0:00	3.07	64.2%	4.4%	0.5%
1/27/18: 13:00	1/27/18: 18:30	1.27	30.8%	0.9%	0.2%
2/4/18: 20:30	2/5/18: 0:00	0.36	33.1%	1.4%	0.3%
2/5/18: 6:30	2/5/18: 19:00	1.24	70.6%	10.8%	1.2%
2/7/18: 12:30	2/7/18: 19:15	0.60	12.1%	4.6%	2.9%
2/14/18: 7:00	2/14/18: 20:00	1.68	29.2%	8.2%	2.2%
2/17/18 21:00	2/18/18 5:00	2.00	67.3%	7.2%	0.8%
2/18/18 12:00	2/19/18 1:00	6.72	73.1%	**Flume Damaged**	-
Average Rainfall-Runoff Coefficient			**40.1%**	**5.4%**	**1.2%**

1 Watershed Acreage Contributing to USGS Kāwā Stream Gauge = 723.2 Acres
2 Watershed Acreage Contributing to Lipalu Flume = 56 Acres
Source: Element Environmental LLC, 2018

3.7.2 Project Impacts and Mitigation

No Action Alternative

No adverse impacts to surface water resources present in the Petition Area are anticipated under the No Action Alternative. Existing topographic conditions would be maintained because no grading or other site improvements would occur. Stormwater runoff would continue to discharge from the Lipalu watershed and smaller western watershed area of the Petition Area generally following existing ephemeral drainageway paths. Stormwater would continue to discharge from the Petition Area into the City's drainage system and eventually enter Kāwā Stream. Current runoff volumes associated with these drainageways would continue.

Proposed Action

Proposed cemetery expansion improvements would change existing drainage patterns within the site, but would not adversely impact surface water resources. The establishment of the Cultural Preserve would have minimal effect on existing drainage patterns because no major site improvements are planned. The area with the well and seep on the western end of the site would not be used for cemetery burial space, therefore, no grading or filling would occur or significantly impact this particular site.

Grading activities required for cemetery expansion would significantly alter the present topographic condition of the site by cutting and filling large areas of the site as previously discussed in Chapter 2. These changes would alter current drainage patterns and drainageway routes. The most significant change would occur in the western end of the Petition Area where a hillside would be cut.

Planned grading improvements would not change the overall watershed boundaries, allowing runoff to continue flowing to lower areas of site basins. The project would change topographic conditions within portions of these watersheds (e.g. Lipalu watershed). Grading plans are designed to create a more level site with sloped grades of less than 20%, which is an improvement because portions of the site currently have areas with much steeper grades. Therefore, the velocity of runoff would be reduced by less steep grades. The existing City catchment basins at the end of Ohaha Place and Lipalu Street would continue to serve as drainage discharge points from the site.

The installation of turf grass over the majority of the area to be used for cemetery space would slow the velocity of runoff and result in improved groundwater infiltration and decreased sediment transport. Remaining runoff would be detained by future retention/detention basins, allowing sediments and nutrients to settle before eventually discharging into the City's drainage system and Kāwā Stream.

Retention/detention basins capturing and treating runoff generated from the cemetery would be designed for a 100-year frequency, one-hour duration storm event. Based on this design criteria, runoff generated during storm events less than the 100-year storm event (4.5 inches per hour) would be retained on-site in detention/retention basins having a beneficial impact (reduced) on discharge volumes. Design plans would be coordinated with the City for review and approval during the project's design phase. Therefore, no mitigative measures are required. Drainage improvements are discussed in further detail in Chapter 5.

3.8 WATER QUALITY

A water quality study was prepared for the project by E2 and is included in Appendix I. This study updates a water quality study prepared in 2009 for previously proposed cemetery expansion plans. The primary purpose of this updated study is to evaluate project water quality impacts to Kāwā Stream.

Impaired Waters Background

The Federal Clean Water Act (CWA) of 1972 establishes a regulatory framework to protect the nation's surface water resources. The CWA requires states to conduct a bi-annual surface water quality assessment. Surface water bodies violating State standards must be reported pursuant to §303(d) of the CWA. The resulting list of impaired water bodies is usually referred to as the "303(d) list." The 303(d) list provides information on the pollutants impairing stream water quality. Additionally, the list identifies priorities for Total Maximum Daily Load (TMDL) development. TMDL is a regulatory term in the CWA and describes the maximum pollutant amount a waterbody can receive, while meeting water quality standards. TMDL is used as a planning tool for restoration and protection activities, with the ultimate goal of attaining or maintaining water quality standards (Townscape, Inc., 2012).

The TMDL development process identifies the causes of pollution and calculates the maximum daily pollutant amount that can enter a waterbody without violating water quality standards. TMDL calculations are performed for both point and non-point source pollutants. Point sources may include industrial discharge or municipal storm water drainages. Non-point source pollutants may include pollutants carried by rainfall or stream flow. The calculated maximum pollutant loads are then divided and assigned among the identified pollution sources.

The State Department of Health assesses several types of water quality parameters including nutrients, turbidity, total suspended solids (TSS), bacteria, heavy metals, pesticides, herbicides and other potentially harmful substances. In Koʻolaupoko streams, excess pollutants are mostly nutrients, turbidity, and TSS (Townscape, Inc., 2012). The following is a brief overview of these three major sources of pollution.

- **Nutrients** in a water quality context refers specifically to nitrogen and phosphorous, two essential substances for the growth of aquatic biota. At an elevated level, nutrients cause accelerated growth of phytoplankton, leading to an increase in turbidity.
- **Turbidity** refers to the cloudiness of water. High turbidity levels are considered unfavorable in a stream because it hampers sunlight from reaching the stream bottom, which in turn inhibits the growth of aquatic biota.
- **Total Suspended Solids** is a measure of particulate matter in water, usually as a result of dissolution of solid particles from eroded soils.

<u>State Water Quality Standards</u>

Kāwā Stream is classified by the State DOH as a Class 2 inland water body. Per HAR §11-54-03, the objective of this classification is to protect the use of these waterbodies for recreational purposes; the support and propagation of aquatic life; agricultural and industrial water supplies; shipping; and navigation (State of Hawai'i, 2011). These standards are outlined in Table 3.5. Per HAR 11-54-5.2, the wet season is the period between November 1 through April 30 while the dry season occurs from May 1 through October 31.

Table 3.5
State Water Quality Standards (Chapter 11-54-5.2, HAR)

Parameter	Geometric Mean Not to Exceed		Not to Exceed More Than 10%		Not to Exceed More Than 2%	
	Wet	Dry	Wet	Dry	Wet	Dry
Total Nitrogen (ug N/L)	250.0	180.0	520.0	380.0	800.0	600.0
Nitrate + Nitrate (ug [NO3+NO2] – N/L)	70.0	30.0	180.0	90.0	300.0	170.0
Total Phosphorus (ug P/L)	50.0	30.0	100.0	60.0	150.0	80.0
Total Suspended Solids (mg/L)	20.0	10.0	50.0	30.0	80.0	55.0
Turbidity (N.T.U.)	5.0	2.0	15.0	5.5	25.0	10.0
pH	5.5 – 8.0					
Source: State Department of Health, 2014						

3.8.1 Existing Conditions

3.8.1.1 Kāwā Stream

Kāwā Stream is currently listed on the DOH's 2016 303(d) list. Kāwā Stream was initially included on the DOH's list due to results of a study on stream water quality and the relationship between measured pollutant loads and State water quality standards (Burr, 2002). Initial TMDL were established by this study for nutrients (nitrogen and phosphorous) and sediments. The study concluded excess nitrogen was the most common pollutant in the watershed while excessive phosphorous and sediment loading occurred only during storm events.

The estimated largest source area for nitrogen and sediment loads measured were residential areas and cemetery lands, whereas the dominant source for phosphorous were from forest land and residential areas. The study concluded the pollutants could enhance unwanted algae growth within Kāwā Stream, and impact coral reef resources in receiving waters of Kāne'ohe Bay. TMDL developed were updated in 2005 and include nutrients (nitrogen and phosphorous) and TSS. Kāne'ohe Bay is also listed on the 2004 303(d) list for nutrients, nitrates/nitrites, NH4 (ammonia), turbidity, *chlorophyll a* and enterococci. Kāne'ohe Bay provides important habitat for freshwater and marine species of importance to subsistence, commercial and cultural uses.

Estimate of Kāwā Stream Loads

The current impact of Total Nitrogen (TN), Total Phosphorous (TP), Nitrate plus Nitrite (N+N) and Total Suspended Solids (TSS) loads discharging from the watershed into Kāwā Stream was estimated using stream flow and water quality data collected at the Kāwā Stream USGS station. Linear regression models estimated the relationship between streamflow rate and nutrient and TSS delivery during a 71-day monitoring period (December 2017 to February 2018).

A total of 304 million gallons of water flowed past the Kāwā Stream USGS station during the monitoring period. An estimated 256.8 tons of TSS, 2.9 tons of TN, and 1.3 tons of TP were entrained in the water passing the gauging station during this period. The vast majority of sediment and nutrient loads during the monitoring period were carried in Kāwā Stream during nine storm events. Table 3.6 summarizes streamflow and the estimated mass of TN, TP, and TSS associated with each storm event.

Table 3.6
USGS Kāwā Stream Gauge - Streamflow and Estimated Nutrient and Sediment Loads

Storm Date/Time Start	Storm Date/Time End	Time Interval Streamflow (gal)	Mass of TSS (kg)	Mass of Total N (kg)	Mass of Total P (kg)
12/19/17: 17:00	12/21/18: 5:00	8,387,379	624	41	3
12/26/17: 10:30	12/27/17: 0:00	39,200,912	20,998	286	104
1/27/18: 13:00	1/27/18: 18:30	7,876,324	3,906	56	19
2/4/18: 20:30	2/5/18: 0:00	2,466,395	634	14	3
2/5/18: 6:30	2/5/18: 19:00	17,629,921	12,247	144	61
2/7/18: 12:30	2/7/18: 19:15	1,664,682	111	8	1
2/14/18: 7:00	2/14/18: 20:00	10,110,376	2,416	58	12
2/17/2018 21:00	2/18/2018 5:00	26,728,954	15,565	202	77
2/18/2018 12:00	2/19/2018 1:00	96,911,874	172,127	1,354	853
Total Storm Flow and Mass		**210,976,816**	**228,628**	**2,162**	**1,134**
Percentage of Flow/Constituent Mass, Rainfall Events		69.30%	98.10%	83.20%	98.10%
Percentage of Flow/Constituent Mass, Noon 2/18/18 Rainfall Event		31.90%	73.90%	52.10%	73.90%
Total Flow/Mass of Constituents in Kawa Stream, 12/11/17 to 2/20/18		304,270,034	232,966	2,599	1,155
Source: Element Environmental LLC, 2018					

While 69% of stream flow occurred during these nine storm events, 98% of TSS and phosphorous loads and 83% of TN load occurred during these events. The USGS has observed that a single storm event may deliver the equivalent of years and even decades of pollutant loads received by coastal waters under extreme weather conditions. This phenomenon has been observed in the Kāwā watershed.

The intense rainfall event beginning around noon on February 18, 2018 accounted for about 74% of TSS yield, TP load, and over 52% of TN load measured over the entire monitoring period (Exhibit 3.23). Water flow at the Kāwā Stream USGS station rose 100-fold (from 10 to 1,000 cfs) in a 15-minute period during this storm. The resulting stream flow likely scoured unhardened portions of drainageways and Kāwā Stream leading to changes in the size, shape, and composition of the channel. Therefore, it can be concluded by data collected that the vast majority of sediment and nutrient loads entering Kāne‘ohe Bay from Kāwā Stream does occur during these significant storm events.

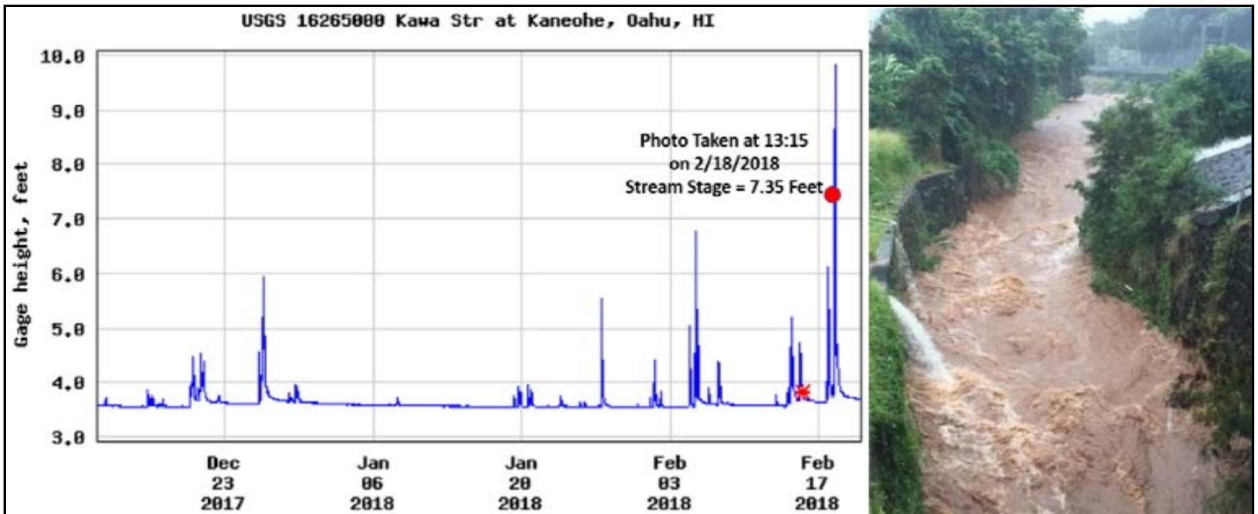


Exhibit 3.23 Graph of Kāwā Stream Gage Height and Photo During February 18th Storm
Source: Element Environmental LLC, 2018

Lipalu Watershed Load Contribution

The smaller Lipalu watershed area within the larger Kāwā watershed contributes nutrients and suspended solids to Kāwā Stream from within the Petition Area. The Lipalu flume set up in the existing ephemeral drainageway provides information on storm runoff volumes along with nutrient and TSS loads. The contribution of streamflow, total suspended solids and nutrients generated from the Lipalu watershed, where much of the cemetery's expansion would occur, is summarized on Table 3.7. The flow data and mass estimates of nutrient and suspended sediments for the large storm event on February 18 are not accurate because the flume collapsed, but do show that the volume of runoff from this single storm dwarfed the volume of runoff generated during the previous eight runoff events.

Table 3.7
Lipalu Flume Streamflow and Estimated Nutrient and Sediment Loads

Flow Date / Time Start	Flow Date / Time End	Event Rainfall (inches)	Time Interval Streamflow (gal)	Mass of TSS (kg)	Mass of Total N (kg)	Mass of Total P (kg)	Notes
12/26/2017 4:36	12/26/2017 20:01	3.72	206,339	2,710	8.4	0.8	Less than 0.1" within 72hrs
1/27/2018 13:56	1/27/2018 14:36	1.03	17,126	225	0.7	0.1	Less than 0.1" within 72hrs
2/4/2018 21:24	2/4/2018 21:43	0.36	7,874	103	0.3	0.0	Less than 0.1" within 48hrs
2/5/2018 6:32	2/5/2018 16:49	1.24	202,757	2,663	8.3	0.8	
2/7/2018 13:23	2/7/2018 17:24	0.6	41,912	551	1.7	0.2	
2/14/2018 7:24	2/14/2018 17:19	1.6	208,783	2,742	8.5	0.8	Less than 0.1" within 48hrs
2/15/2018 4:33	2/15/2018 13:01	0.89	219,222	2,880	9.0	0.9	
2/17/2018 18:24	2/18/2018 7:24	2.26	542,017	7,120	22.2	2.1	
Total Measured Flow			**1,446,030**	**18,994**	**59.1**	**5.7**	
2/18/2018 12:24	2/18/2018 14:20	6.95	2,563,491	33,672	104.8	10.1	**Flow Exceeded Flume Boundaries, Data Not Accurate**
Source: Element Environmental LLC, 2018							

The measured volume of runoff generated from this undeveloped, forested watershed represents approximately 0.71% of the total water flow measured at the USGS gaging station on Kāwā Stream during the same monitoring period. However, the total suspended solid load leaving this area represents about 31.3% of the TSS load measured at the USGS gaging station due to the extremely high TSS levels measured in the runoff at the flume. This forested watershed also contributed 4.8% and 1.9%, respectively, of the total nitrogen and total phosphorus mass measured at the USGS gaging station.

This data shows that the undeveloped forested portion of the Petition Area experiences a high level of erosion and sediment runoff contributing a significant amount of TSS into Kāwā Stream. A notable amount of nutrients are also discharged from this undeveloped area. Furthermore, large single storm events can contribute massive amounts of TSS and nutrients overwhelming totals resulting from other smaller rainfalls. Such large storms have a significant impact on Kāwā Stream and its water quality.

3.8.1.2 Water Quality Sampling Results

Water quality sampling was collected from several sources within the Petition Area and surrounding area between December 2017 and February 2018 to characterize Kāwā Stream and other water sources. Analysis to detect the presence of pesticides and formaldehyde within water resources was also conducted. Existing water quality characteristics were determined through analysis of data from the USGS Kāwā Stream gauging station located mauka of Kāneʻohe Bay Drive, existing water quality studies, and sampling conducted.

Stream water samples were obtained primarily from two sites; 1) the USGS Kāwā Stream station; and 2) a small groundwater fed tributary entering Kāwā Stream behind the Parkway subdivision recreation center. The USGS Kāwā Stream station receives ground and storm water input from the entire watershed mauka of Kāneʻohe Bay Drive. The Parkway site receives ground and storm water input from existing portions of HMP and the adjacent residential community.

Perched ground water samples were gathered primarily from two sites: 1) a small spring (Cascade Spring) located below the HMP maintenance yard; and 2) the well located in the northwest end of the Petition Area. Samples were also obtained at the Lipalu flume installed in the ephemeral drainageway leading to the catchment basin at the end of Lipalu Street.

Average concentrations of TN, TP, TSS, and N+N from data sources examined are summarized in Table 3.8. Analyzed collectively, the sampling data suggests groundwater dominant baseflow within Kāwā Stream can be characterized by relatively low concentrations of TP (0.04-0.11 mg/L) and TSS (4.9-12 mg/L), with intermediate concentrations of TN (0.95-1.7 mg/L) and somewhat elevated concentrations of N+N (0.70-1.29 mg/L).

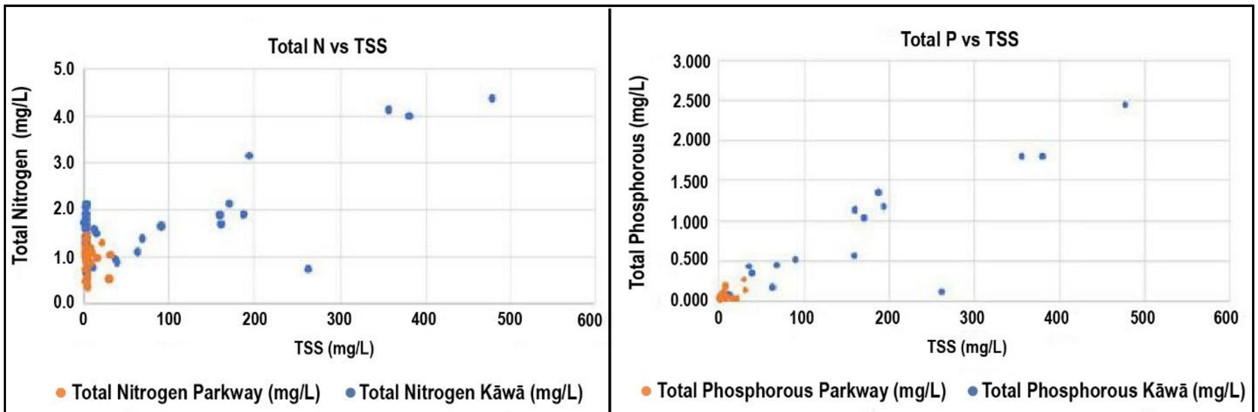
Samples comprised predominantly of stormwater runoff tend to have somewhat elevated concentrations of TP (0.11-1.04 mg/L), elevated concentrations of TSS (96.5-3,470 mg/L), elevated concentrations of TN (1.45-10.8 mg/L), and comparatively lower concentrations of N+N (0.25-0.40 mg/L).

The relationship between nutrient concentrations (TN, TP, N+N) and total suspended solids (TSS) at the USGS Kāwā Stream site and the Parkway site samples were visualized through scatterplot graphs. These graphs are shown in Exhibits 3.24 and 3.25. The data plotted on the left side of these variation diagrams (TSS from 0-25 mg/L) represent stream samples that predominately originated from perched groundwater input, while the higher TSS concentration data represent samples composed predominately of storm water runoff.

Table 3.8
Water Quality Characteristics

Location	Flow Regime	Total Phosphorous mg/L	Total Nitrogen mg/L	Nitrate plus Nitrite mg/L	Total Suspended Solids mg/L	Sample Count
Perched Groundwater[1]	Groundwater Dominant[6]	0.11	1.7	1.29	12.1	5
Bayview Golf Course[2]	Groundwater Dominant	0.04	1.45	1.09	2.6	24
Bayview Golf Course	Runoff Dominant[7]	0.11	0.73	0.40	262.0	1
Kāwā Stream – USGS[3]	Groundwater Dominant	0.07	0.95	0.70	7.6	2
Kāwā Stream – USGS	Runoff Dominant	0.90	2.10	0.25	189.2	22
Parkway[4]	Groundwater Dominant	0.04	1.07	0.79	4.9	26
Parkway	Runoff Dominant	0.37	1.04	0.38	96.5	7
Lipalu Flume[5]	Runoff Dominant	1.04	10.8	0.25	3,470	2

[1] Samples from Well, Cascade Spring, and Maintenance Culvert. Source: Element Environmental 2018.
[2] Samples from site 1,000 feet north and downstream of USGS Kāwā Stream station. Source: Oceanit 2002.
[3] Source: Element Environmental 2018, USGS monitoring data 2017 - 2018, Oceanit 2002.
[4] Source: Element Environmental 2018, Oceanit 2002, DOH monitoring data 1999 - 2000
[5] Source: Element Environmental 2018
[6] Groundwater if conductance >200 µS/cm or TSS < 20 NTU.
[7] Runoff impacted if conductance < 200 µS/cm or TSS > 20 NTU.
Source: Element Environmental LLC, 2018



Total Nitrogen vs Total Suspended Solids **Total Phosphorous vs Total Suspended Solids**

Exhibit 3.24 Graph of TSS Data with TN and TP at Sampled Sites
Source: Element Environmental LLC, 2018

Exhibit 3.24 illustrates a positive relationship between TN and TSS concentrations for samples graphed. The pattern shown indicates TN concentrations generally increase as TSS concentrations rise. This pattern suggests groundwater dominant samples, possessing lower TSS concentrations, also have comparatively lower nitrogen concentrations. Elevated nitrogen concentrations result from the presence of stormwater runoff in samples. Exhibit 3.24 also illustrates a positive relationship for TP concentrations that generally increase as TSS concentrations rise. This relationship suggests phosphorous may be present in solids transmitted to the stream during runoff events.

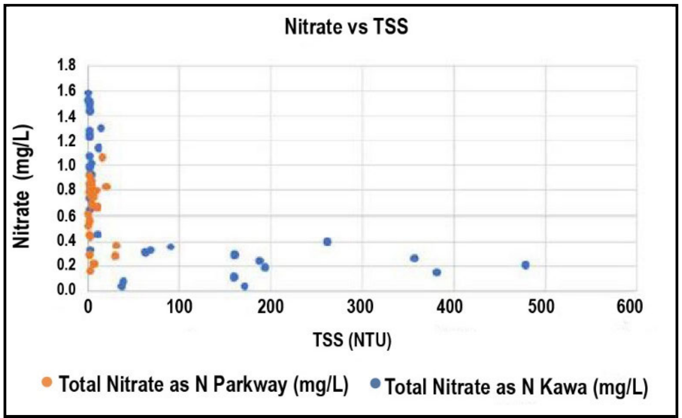


Exhibit 3.25 Graph of N+N with TSS Data at Sampled Sites
Source: Element Environmental LLC, 2018

Exhibit 3.25 shows the relationship between N+N and TSS, indicating a negative relationship between both constituents as N+N concentrations generally decline as TSS increases. This pattern suggests groundwater, which generally has lower TSS concentrations, is the primary source of nitrates to Kāwā Stream.

Examined collectively, these graphs illustrate that samples from the USGS Kāwā Stream station and the Parkway site follow similar variation trends. This suggests nutrient and TSS contributions to Kāwā Stream from the existing HMP cemetery area are not elevated compared to contributions to this stream from the lower urbanized portions of the watershed. Although HMP lands are only a portion of the larger watershed, the pattern may indicate existing areas of HMP do not contribute high nutrient concentrations to Kāwā Stream affecting its water quality.

The flume samples provide an understanding of pollutant concentrations in surface runoff water flowing downslope from the Petition Area and surrounding undeveloped forested areas. The TP, TN, and TSS concentrations from this area are significantly higher than samples taken from elsewhere within the watershed, including the Parkway monitoring site that receives runoff from the existing HMP cemetery.

Exhibit 3.26 Photo of Turbid Runoff at Flume on February 5, 2018

Exhibit 3.26 is a photo showing the turbid, chocolate-brown runoff that passed through the flume during a storm event. The TSS concentrations present in the runoff from this undeveloped forestland is particularly elevated compared to concentrations measured elsewhere. The elevated concentrations may partially reflect the higher amounts of rainfall and rainfall intensity required to initiate flow within this forested watershed.

3.8.1.3 Pesticide and Formaldehyde Analysis

A total of 42 stream and groundwater samples were collected and analyzed by E2 for Glyphosate, Diuron, and 2,4-D using enzyme-linked immunosorbent assay (ELISA) to address impacts from herbicides and pesticides. The USGS also collected a water sample from Kāwā Stream in February 2017 as part of an Interagency Pesticide Monitoring Initiative with the State Department of Agriculture.

The presence of Glyphosate, commonly known as Roundup, was analyzed since it is the most widely used herbicide, accounting for about 25% of the global herbicide market. Given its widespread use, Glyphosate tends to be ubiquitous in the environment and in food supplies. Diuron and 2,4-D were analyzed given the presence of these pesticides in a sample collected from the USGS Kāwā Stream station. Diuron is an herbicide spray used for selective weed control in certain crops and nonselective weed control in non-cropland areas. This herbicide may be applied to soil prior to weed emergence to control susceptible seedlings. 2,-4D is one of the oldest and most widely available herbicides globally, and can be found in numerous commercial lawn herbicides. Over 1,500 herbicide products contain 2,4-D as an active ingredient.

Background on Pesticides in Surface Waters

Other agencies and organizations have tested surface waters for pesticides since 1999 in streams on Oʻahu and Kauaʻi. The various studies have detected concentrations of these three pesticides (diuron, 2,4-D, and glyphosate) in Hawaiʻi's streams. It should be noted that these pesticides are not always detected, and that the detected values present are at trace levels, typically in the low to mid-part per trillion concentration levels. Table 3.9 provides a summary of the results from these studies.

In order to put the detected pesticide concentrations in Hawaiian streams in perspective, concentration levels of glyphosate have been measured in common beers and wines sold in Germany and the United States. The concentration levels of glyphosate in beers and wines are typically a couple of orders of magnitude higher (part per billion levels) than the levels detected in Hawaiian streams (see Table 3.9). The German Federal Institute for Risk Assessment also concluded that the highest glyphosate concentrations detected in German beer (30 parts per billion) do not constitute a risk to human health. An adult would need to drink 1,000 liters of beer in a single day for glyphosate levels to pose a health risk.

Table 3.9
Detected Concentrations from Streams Compared with Beers and Wines

Pesticide	Detected Concentration Range (ng/L)	Detection Frequency	Detection Limit (ng/L)	Number of Samples	Locations Where Pesticide Was Detected
Diuron	10 – 180	23%	10	30	Waikele and Mānoa Streams
Diuron	20(E) - 70	13%	40	24	Waikele and Mānoa Streams
Diuron	88	100%	5	1	Kāwā Stream
2,4-D	90 – 100	10%	80	30	Waikele and Mānoa Streams
2,4-D	80 - 90	4%	60	24	Waikele Stream
2,4-D	208	100%	62	1	Kāwā Stream
Glyphosate	30 – 110	43%	20	7	**O'ahu:** Mānoa Stream; **Kaua'i:** Hanalei Taro Field, Mana Plain Agricultural Ditch
Glyphosate	70 - > 4,000	60%	75	55	**O'ahu:** Mānoa, Honoululi, Kaupuni and Wai'alae Streams; **Kaua'i:** Hanamāulu, Hanapēpē, Mahaulepu, Mana Plain Agricultural Ditch
Comparison of Glyphosate Concentrations Measured in Domestic and Foreign Beers and Wines					
Glyphosate	460 – 29,700	100%	200	14	14 Most Popular Beers Sold in Germany
Glyphosate	380 – 196,000	95%	380	112	Domestic and imported Beers purchased in Philadelphia, Pennsylvania
Glyphosate	2,600 – 29,000	100%	380	30	Red (cabernet, merlot) and white (chardonnay, pinot grigio) wine purchased in Philadelphia, Pennsylvania
Source: Element Environmental LLC, 2018					

Pesticides Sampling Results

Glyphosate was the most commonly detected pesticide with concentrations detected in 15 of 42 samples gathered. Diuron was detected in 7 of the 42 samples analyzed, while 2,4-D was only detected in a single sample. Table 3.10 summarizes the concentration levels of pesticides detected in these 42 samples along with the frequency of detection.

Pesticides were most commonly detected in turbid, runoff dominated samples where TSS concentrations tended to be elevated. This pattern suggests the source of detected pesticides are pesticide contaminated sediments that may be transported to Kāwā Stream during rainfall events. Pesticides may also be located in alluvial deposits adjacent to the stream where these pesticides are already present. Pesticides in these deposits may become resuspended in stream waters through the scouring of deposits during periods of high stream flow.

Table 3.10
Pesticides Concentrations Detected

Location	Flow Regime	Glyphosate		Diuron		2,4-D		Sample Count
		Detect Range (ng/L)	Detect Frequency	Detect Range (ng/L)	Detect Frequency	Detect Range (ng/L)	Detect Frequency	
Perched Groundwater[1]	Groundwater Dominant	121 – 1,072	25%	1 J	13%	<1,000	0%	8
Kāwā Stream	Groundwater Dominant[2]	772	10%	<1	0%	<1,000	0%	10
Kāwā Stream	Runoff Dominant[3]	90 – 1,836	89%	4 – 6 J	22%	3,050	11%	9
Parkway	Groundwater Dominant	<1	0%	<1	0%	<1,000	0%	4
Parkway	Runoff Dominant	343 – 2,831	43%	1 – 1,293	29%	<1,000	0%	7
Lipalu Flume	Runoff Dominant	<1	0%	14 – 21 J	50%	<1,000	0%	4

J: Estimated value
[1] Perched groundwater includes samples collected from Cascade Spring, Maintenance Culvert, and Plantation Well
[2] Groundwater if conductance >200 µS/cm or TSS < 20 NTU.
[3] Runoff impacted if conductance < 200 µS/cm or TSS > 20 NTU.
Source: Element Environmental LLC, 2018

The detected concentration levels of glyphosate at the Kāwā Stream monitoring site, which receives runoff from the entire watershed, are generally similar at the Parkway monitoring site that receives runoff from the existing cemetery. This suggests that the input of glyphosate into the stream from HMP's cemetery is broadly similar to the input of glyphosate from lower residential communities that provide runoff to the stream. The trace concentrations of Diuron detected may reflect residual pesticide input to the stream from prior agricultural usage of the area, based upon the detection of this pesticide in runoff from the flume sampling the currently undeveloped Lipalu watershed.

Exhibit 3.27 compares the relationship between turbidity and glyphosate concentration. The graph illustrates this relationship for samples obtained for this project and those obtained in other studies from drainage ditches and streams on O‘ahu and Kaua‘i. Although variation is apparent, stream samples containing over 0.5 parts per billion glyphosate are generally moderately to highly turbid (>50 NTU). This pattern observed aligns with findings of other studies indicating that glyphosate is

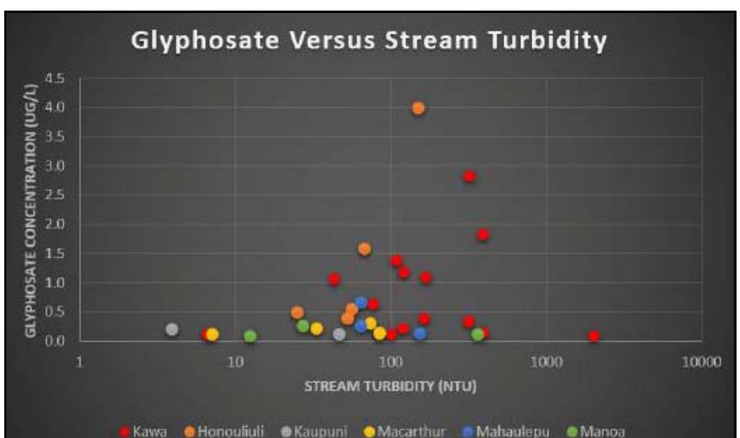


Exhibit 3.27 Glyphosate vs Stream Turbidity
Source: Element Environmental LLC, 2018

commonly detected in stream bed sediments, supporting the suggested conclusion that glyphosate may be found in Kāwā Stream from the runoff related resuspension of contaminated sediments.

The total mass/volume of glyphosate entering Kāwā Stream from runoff sampled related to the February 5, 2018 storm event was estimated through analysis of glyphosate concentrations in Kāwā Stream USGS station samples from this event. Glyphosate was detected in concentrations ranging from 120 to 1,098 ng/L. Concentrations measured in these samples were extrapolated across the duration of the storm event. The estimated total mass of glyphosate in the roughly 17.6 million gallons of runoff produced during the storm event is estimated to be 12.9 grams, or 7.6 milliliters (less than a tablespoon), of glyphosate. Therefore, it can be concluded that glyphosate concentrations detected in Kāwā Stream are minimal, especially given its comparatively greater presence in beers and wines.

Formaldehyde Sampling Results

Formaldehyde is a chemical that has been used as part of the modern embalming process for burials to temporarily prevent the decomposition of a body. Therefore, water samples were collected and analyzed to detect the presence of formaldehyde to address potential concerns with its leaching into perched groundwater from the veteran's and HMP existing cemeteries.

Four samples were collected from a small spring (Cascade Spring) located outside of the HMP property in the hillslope situated below HMP's maintenance yard and at the well located at the northwestern corner of the cemetery expansion site. Formaldehyde was not detected in any of these samples at an analytical detection limit of 5 parts per billion.

3.8.2 Potential Project Impact and Mitigation

No Action Alternative

Under the No Action Alternative, the Petition Area would continue to contribute nutrients and suspended solids to Kāwā Stream through rainfall generated runoff. The area would remain undeveloped, and heavily vegetated with exposed soils from the lack of ground cover (e.g. grass) due to sunlight blocked by tree cover. This would continue to provide opportunities for continued erosion allowing soils and material to be transmitted to Kāwā Stream by runoff.

The data collected from the water quality study conducted shows that a majority of nutrient loads and suspended solids enter Kāwā Stream through runoff generated by occasional significant storm events. Such large storm events contribute significant amounts of TSS from undeveloped forestland and exposed soil resulting in very turbid, chocolate-brown colored runoff within drainageways that eventually enter Kāwā Stream. These elevated nutrient and suspended solid concentrations discharged from large storms would continue to have a significant impact on Kāwā Stream water quality, which eventually discharges into Kāne'ohe Bay.

Pesticide concentrations present in stormwater runoff would remain similar to existing conditions. Pesticides such as Glyphosate would continue to be transmitted to Kāwā Stream by the scouring of alluvial deposits where residual pesticides may be present. However, Glyphosate concentrations in Kāwā Stream should continue to be minimal, given study conclusions that glyphosate concentrations are generally minimal in stormwater samples.

Diuron would continue to be detectable in water resources being introduced from runoff occurring within the Petition Area. The 2,4-D concentrations would likely remain minimal under this alternative because cemetery landscaping operations requiring usage of this herbicide would remain similar to existing conditions. Formaldehyde would not be present in area groundwater due to existing HMP and veteran cemetery operations.

Proposed Action

Proposed cemetery expansion improvements would change existing site conditions from an undeveloped forested area to a predominantly landscaped grass area that is maintained by HMP staff for burial plots. The site's topographic conditions would change to sloped grades of less than 20%, which is an improvement over existing conditions because portions of the site currently have areas with much steeper grades. The volume and velocity of runoff would be reduced by less steep grades within the site, improving opportunities for water to infiltrate instead of discharging. Proposed turf grass landscaping would also slow the flow of site runoff, improving ground infiltration and reducing runoff volumes.

Retention/detention basins capturing and treating runoff generated from the cemetery would be designed for a 100-year frequency, one-hour duration storm event (4.5 inches per hour). Therefore, runoff from rainfall rates lower than the 100-year, 1 hour event would be retained by detention/retention basins constructed under the Proposed Action.

Proposed retention/detention basins would reduce sediment and nutrient loads by treating the first flush of runoff from high-intensity rainfall events. The exact quantity of sediments and nutrients reduced on an annual basis is dependent on multiple factors including the timing, size (rainfall amount), and intensity of specific rainfall events as well as the infiltration capacity of the detention/retention basins ultimately installed.

As a result, project improvements are expected to have an overall beneficial impact on water quality associated with Kāwā Stream along with the eventual discharge point at Kāneʻohe Bay. Both Kāwā Stream and Kāneʻohe Bay are listed as 303(d) impaired waters. The prior TMDL study for Kāwā Stream determined that excess nitrogen was the most common pollutant in the watershed, while excessive phosphorous and sediment loading occurred during storm events. The water quality study conducted for this project supports this TMDL study findings, and further documents how large storm events contribute a significant amount of TSS into the stream, primarily associated with undeveloped forested areas. This project would improve Kāwā Stream's water quality and TMDL by reducing stormwater discharges, TSS, and nutrients within this watershed area. The detention/retention basins would reduce TSS and nutrient discharges, and the landscape grass would allow increased rainfall infiltration, especially during smaller rainfall events.

Herbicide, and to a lesser extent pesticide, usage may occur as a result of landscaping maintenance activities associated with cemetery expansion area. Appropriate measures would be taken to ensure such herbicide and pesticide use does not result in adverse water quality impacts. These methods would involve usage in compliance with manufacturer directions and avoidance of application during windy and rainy conditions.

Existing pesticide concentrations and discharges from the Petition Area would be reduced under the Proposed Action. Pesticides were most commonly detected in turbid, runoff dominated samples where TSS concentrations tended to be elevated, and project improvements would significantly improve this condition from occurring within the site. With the extensive grading improvement planned at the site, the trace concentrations of pesticides such as Diuron detected that may be potentially located in alluvial deposits adjacent to drainageways may become buried within fill material or removed as part of excess material from cutting activities. These pesticides may still be present within the Petition Area from its prior historic use for agriculture and ranching activities.

Glyphosate concentrations generated from the project should not have a significant impact on water quality. Detected concentration levels of glyphosate from the larger watershed serving the existing Veterans and HMP cemetery are broadly similar to the input of glyphosate from lower residential communities discharging runoff into the stream. Thus, glyphosate discharges from the cemetery expansion area should be similar, relatively small, and not have an impact on water quality. Runoff data collected from a volume of about 17.6 million gallons produced during a storm event was estimated to have less than a table spoon of glyphosate. Therefore, impacts from glyphosate concentrations that may be detected in Kāwā Stream would continue to be minimal, especially given its comparatively greater presence in beers and wines.

Based upon the sampling results for Formaldehyde, this chemical would continue to not be an issue with the cemetery expansion, and would not impact the stream’s water quality.

The Cultural Preserve would have minimal effect on existing runoff volumes and water quality because no major site improvements would occur within the preserve area. Runoff from this site would thus continue to experience some erosion and discharges that include TSS and nutrients because of the undeveloped forested area similar to that occurring under the No Action Alternative.

Proposed Mitigative Measures

The project would have a beneficial long-term effect on water quality by reducing runoff volumes, velocity and the amount of TSS and nutrients discharged into drainageways and Kāwā Stream. Therefore, no mitigative measures are proposed to address long-term effects.

However, short-term construction related activities could have an impact on water quality associated with the discharge of sediment from grading activities. Design plans will include BMPs for implementation to address mitigating such effects and plans would be coordinated with the City for review and approval during the project's design phase. Such mitigative measure were previously discussed in Chapter 2 along with Section 3.1.2 (Soils).

In summary, BMPs implemented to minimize impacts to soils would address water quality and effects on Kāwā Stream. 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) would also be prepared. BMPs would be incorporated as part of permit approval and development of the ESCP. Actual BMPs implemented would be determined during the project's design phase.