POHAKEA WATERSHED / MA‘ALAEA BAY
MAUI COUNTY, HAWAII
STORMWATER MANAGEMENT PLAN

Prepared for:

Maui Nui Marine Resource Council

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1.0 INTRODUCTION

At the request of Maui Nui Marine Resource Council (MNMRC), Maui Environmental Consulting, LLC (MEC) reviewed the Pohakea Watershed for current landscape conditions affecting water quality within Maʻalaea Bay. While this study focused on erosion and sediment transport caused by surface water flow during stormwater events, any on-site observations of nutrient, pathogen, or other pollutant sources, as well as any other land management practices that may be contributing to water quality degradation in Maʻalaea Bay or Maʻalaea Harbor were recorded. Department of Health Clean Water Branch (DOH CWB) Integrated Water Quality Reports (IWQR), Geographic Information System (GIS) data, local community expert information, and historical literature for the project were also reviewed in the preparation of this document. In addition, MEC proposed a water quality monitoring plan designed to better capture water quality trends throughout the Pohakea Watershed (Aerial) that may be contributing to impairments in Maʻalaea Bay.

2.0 PROJECT CHARACTERIZATION

2.1 Pohakea Watershed Location

The Pohakea Watershed is comprised of 87 different Tax Map Keys (TMK) in Maui County, Hawaii (TMK Map). Pohakea Watershed begins at approximately 4,600 feet at the summit of Hanaula within the West Maui Mountains. Along the coast, this watershed stretches from Kealia Pond and continues west past McGregor’s Point to the eastern ridge of Manawainui Gulch (project area). The makai portions of the watershed are approximately located between mile markers 4.5 and 9.25 along Honoapiʻilani Highway (or from just west of Papawai Point to just north of the intersection of Honoapi’ilani and Kuihelani Highways. Pohakea extends east to approximately mile marker 1.5 along North Kihei Road and the western edge of Kealia Pond. The entire area is part of the West Maui Mountains land formation and discharges into the western portion of Maʻalaea Bay (Location Map).

2.2 Pohakea Watershed Landscape and Major Drainageways

The approximately 5,268-acre watershed is composed of several different land formations. As stated above, the watershed begins at the summit of Hanaula within the West Maui Mountains at 4,616 feet above sea level. From here, the watershed flows south and east through several gulches that all discharge into Maʻalaea Bay or Maʻalaea Harbor. Hillslope is relatively steep at the upper portions of the West Maui Mountains, with grade leveling off considerably at approximately 400 feet and continuing to gradually drop along the coastal areas to the ocean (Quadrangle Map). Throughout this document the terms gulch and stream are used interchangeably.

2.2.1 Pohakea Gulch

As its name implies, the major landscape feature within the watershed is Pohakea Gulch. This deeply incised gulch flows almost due east, passing just south of the Hawaiian Cement Quarry located at the end of Kuihelani Road and continuing across Honoapiʻilani Highway via a

Figure 1. Aerial Map

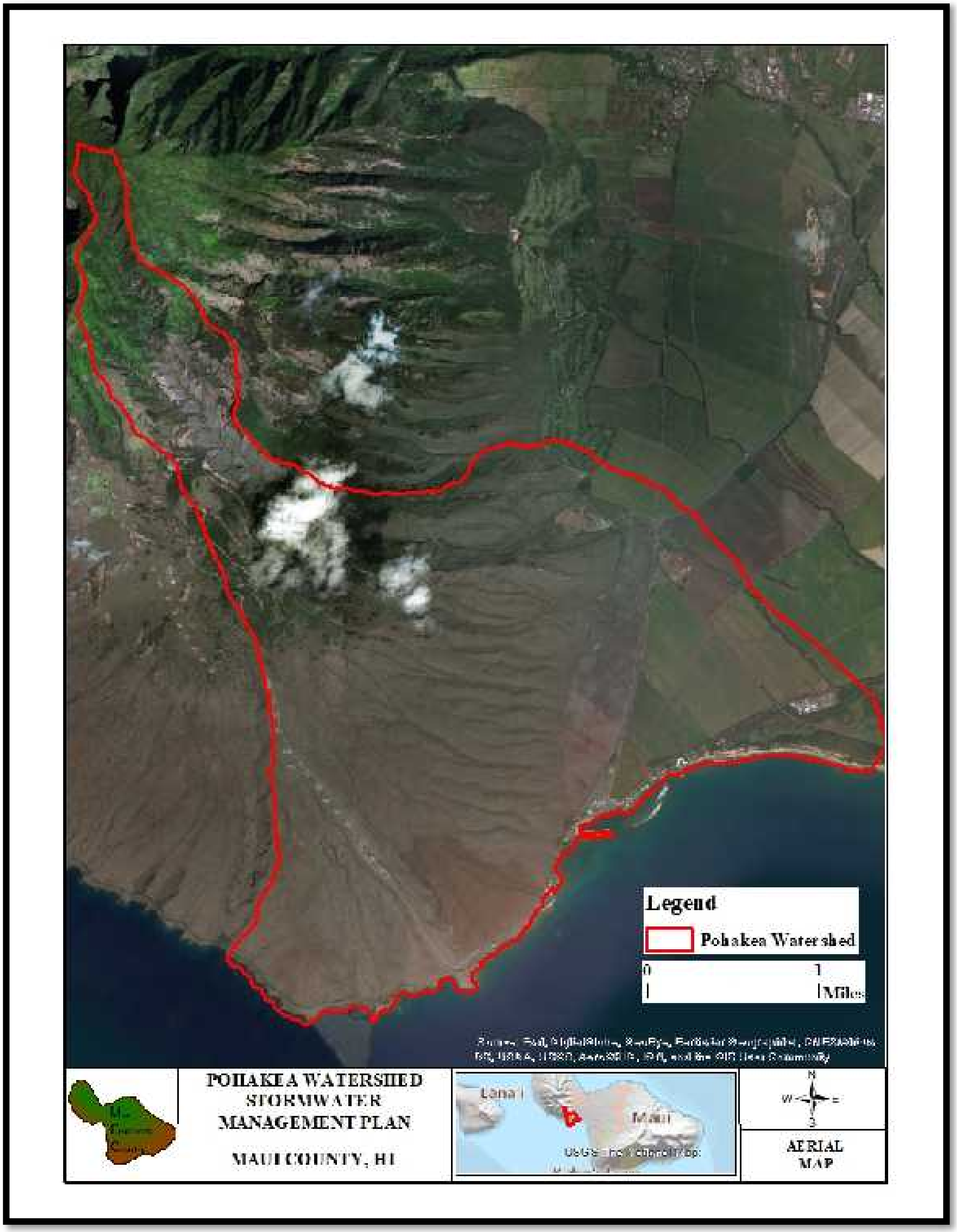


Figure 2. TMK Map

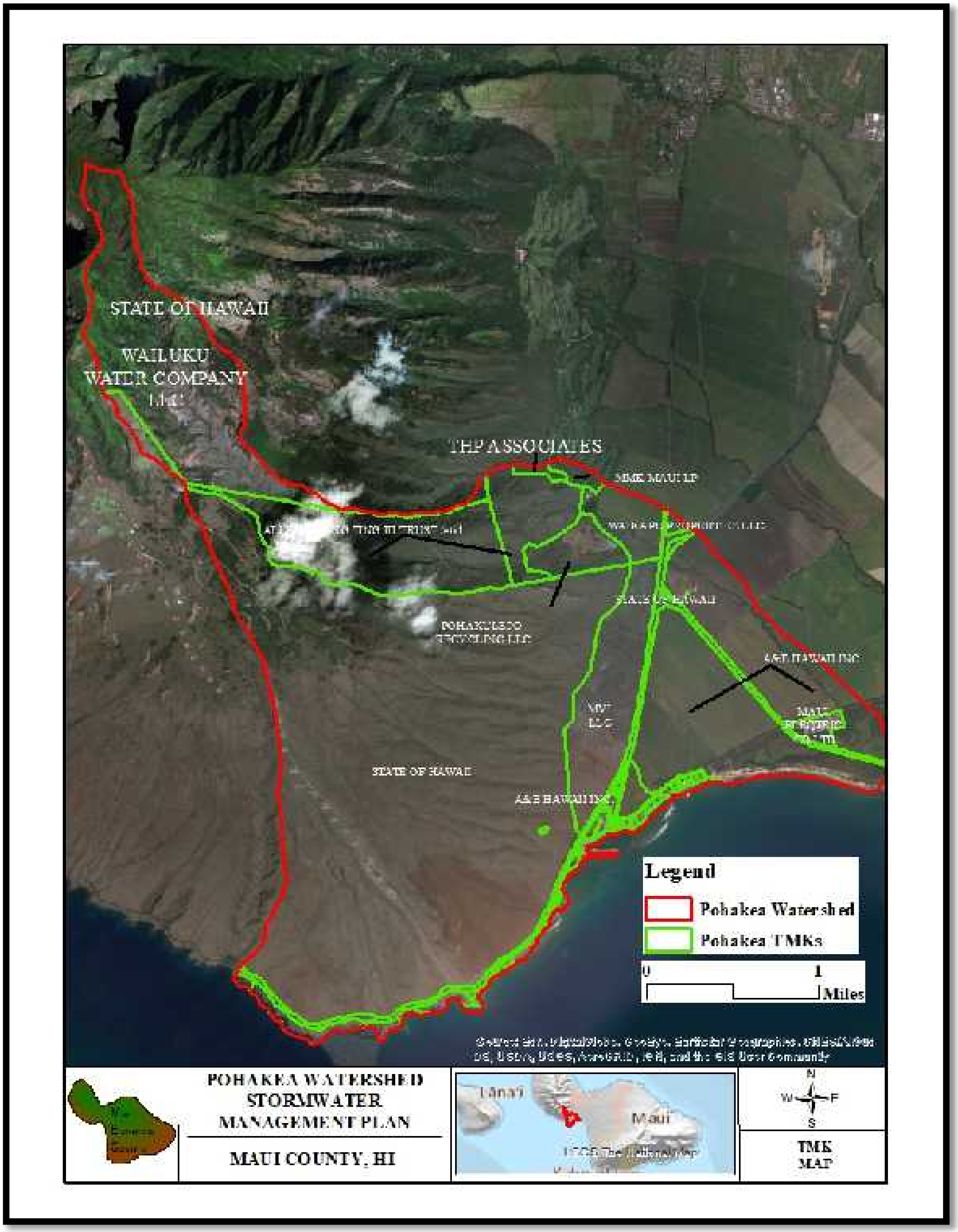
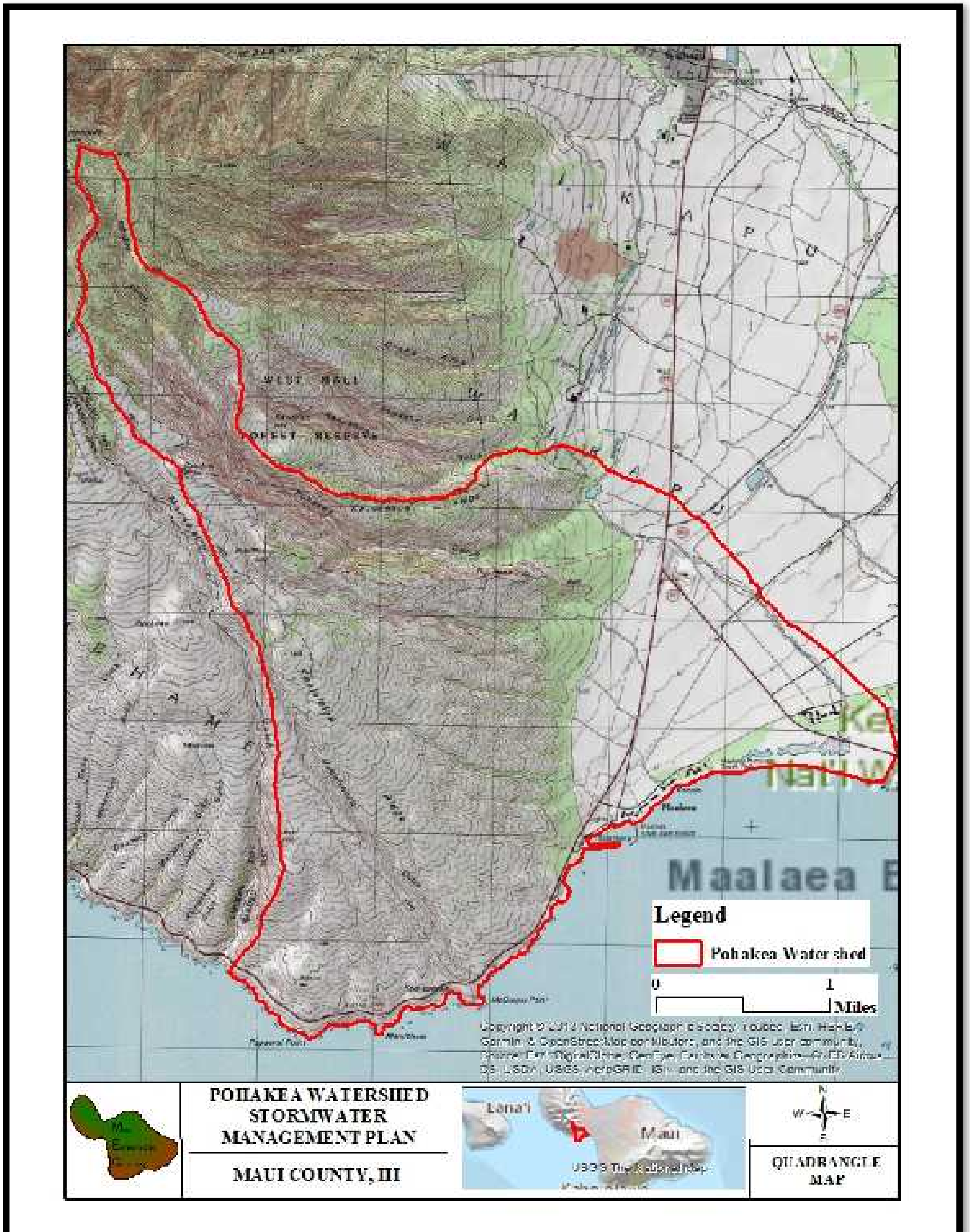


Figure 3. Location Map

Figure 4. Quadrangle Map



culvert system, north of the privately owned and now permanently closed Maui Construction and Demolition Landfill. Pohakea continues to flow through agricultural fields, paralleled by Maui Electric (MECO) powerlines before wrapping around the northern boundary of the oil powered 212.1 megawatt MECO Maʻalaea Powerplant. From here, Pohakea discharges into Kealia Pond National Wildlife Refuge and ultimately into Maʻalaea Bay.

2.2.2 Kanaio Gulch

Kanaio Gulch begins south of Pohakea Gulch at the base of Puʻu Moe at approximately 2,400 feet. The gulch flows east toward Honoapiʻilani Highway. Historically, this stream continued across the highway and through what is now fallow agricultural land before terminating at what is today Haycraft Beach Park. Currently, the stream passes under the highway via culvert, and is then diverted into a box-cut concrete lined ditch (Waiheʻe Makai Ditch) on the makai side of Honoapiʻilani Highway. From here, Kanaio flows southwest to a confluence with an unnamed gulch that also crosses the highway via culvert. Flow from both systems and two additional unnamed ditches connected by culvert under the highway, continue south and east within Waiheʻe Makai Ditch. This section of the flow way has steep, nearly vertical walls before discharging into a detention basin mauka of Hauʻoli Street and the Maui Island Sands Resort. This detention basin has recently failed. Water from both Kanaio and the unnamed gulches then passes under Hauʻoli Street via culvert, passing through a concrete lined drainageway in between Maui Island Sands Resort and the Maʻalaea Banyans before discharging into Maʻalaea Bay (Discharge Locations Map).

2.2.3 Maʻalaea Gulch

Maʻalaea Gulch is located south of the unnamed gulch associated with Kanaio Gulch mentioned above. Maʻalaea gulch begins at approximately 1,800 feet, flowing east towards Honoapiʻilani Highway. From here, the gulch enters a culvert and remains underground until it discharges into Maʻalaea Harbor. In addition to Maʻalaea gulch, at least three other small unnamed gulches flow east to the highway before entering culvert systems that discharge into Maʻalaea Harbor makai of the intersection of Honoapiʻilani Highway and Maʻalaea Road.

2.2.4 Malalowaiaole Gulch

Malalowaiaole Gulch originates at approximately 2,000 feet. This gulch is at the eastern flank of Kealaloloa Ridge. This ridge is home to the Kaheawa Wind Power wind farm and its associated access road. Malalowaiaole Gulch flows southeast towards the base of the dirt access road. From here, the system enters large culverts as it passes under the dirt road before continuing along the Honoapiʻilani Highway where it again enters a culvert system before finally discharging into coastal waters east of McGregor Point.

Beyond Malalowaiaole Gulch, three unnamed gulches discharge into coastal waters through culvert systems under Honoapiʻilani Highway. One discharges east of Manuohule Point and the other two flank the Papawai land formation, located at approximately 381 feet, discharging into coastal waters on either side of Papawai Point. Additional culverts exist west of Malalowaiaole Gulch where gullies and gulches run under the highway. Due to the unsafe conditions caused by heavy traffic and narrow road shoulders associated with the Pali, MEC staff did not record GPS positions of these culverts.

2.2.5 Waiheʻe Ditches

In addition, Waiheʻe Mauka Ditch runs north to south along the base of the West Maui Mountains, where steep hills transition to relatively flat coastal lands. This ditch discharges into Pohakea Gulch before ultimately flowing into Kealia Pond. A second ditch, also named Waiheʻe Ditch, is referred to as Waiheʻe Makai Ditch in this report for clarity. Waiheʻe Makai Ditch historically flowed along the makai side of Kuihelani Highway, wrapping around the landfill before crossing under North Kihei Road and continuing on the makai side of Honoapiʻilani Highway. The ditch now appears to begin along the highway and continue south, connecting with Kanaio Gulch and three unnamed ditches before continuing on through the failed detention basin mentioned in Section. 2.2.2 above before ultimately discharging into Maʻalaea Bay.

2.3 Stream Designations

As listed above, there are four major streams associated with the Pohakea Watershed (Major Drainage Ways Map). Moving north to south, these include Pohakea, Kanaio, Maʻalaea, and Malalowaiaole. Additional unnamed gulches also exist, and ditching associated with historical agricultural practices is also present on the landscape. All of these streams, unnamed gulches and ditches have ephemeral flow regimes. Even Pohakea Gulch which is the largest conveyance in the watershed, typically only flows during stormwater events.

2.4 Surrounding Watersheds

There are three watersheds surrounding the Pohakea Watershed (Watershed Boundary Map). These include Ukumehame to the north and west, Papalaua to the west, and Waikapu to the east. Ukumehame and Papalaua reside within the Lahaina District while Pohakea and Waikapu Watersheds reside within the Wailuku District.

2.4.1 Papalaua Watershed

This watershed is smaller than Pohakea at approximately 3,323 acres. Papalaua begins at the western boundary of Pohakea and continues west along the coast for roughly 2.5 miles. It rises to its terminus at approximately 3,700 feet along the Hanaulauiki Ridge on its western boundary and Kealaloloa Ridge on its eastern boundary. While relatively short in reach, eight different gulches exist within the Papalaua Watershed. They include from west to east: Papalaua, Manawaipueo, Kamaohi, Opunaha, Mokumana, Makahuna, Kaalaina and Kamanawai gulches. All eight gulches are ephemeral and flow south-southwest.

2.4.2 Ukumehame Watershed

The Ukumehame Watershed is just slightly smaller than the Pohakea Watershed at approximately 5,637 acres. It begins at the western edge of the Papalaua Watershed and

Figure 5. Major Drainage Ways Map

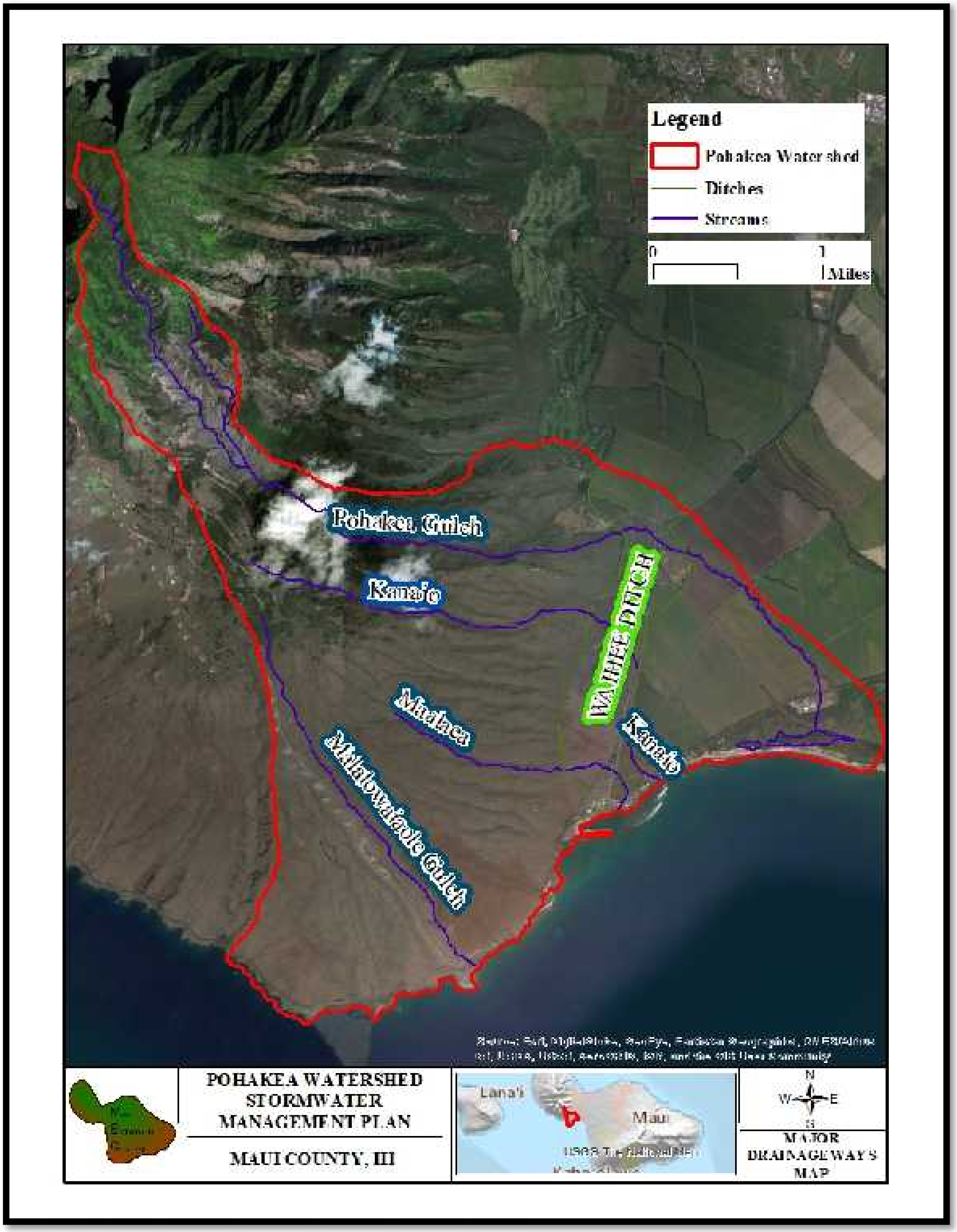


Figure 6. Discharge Locations Map

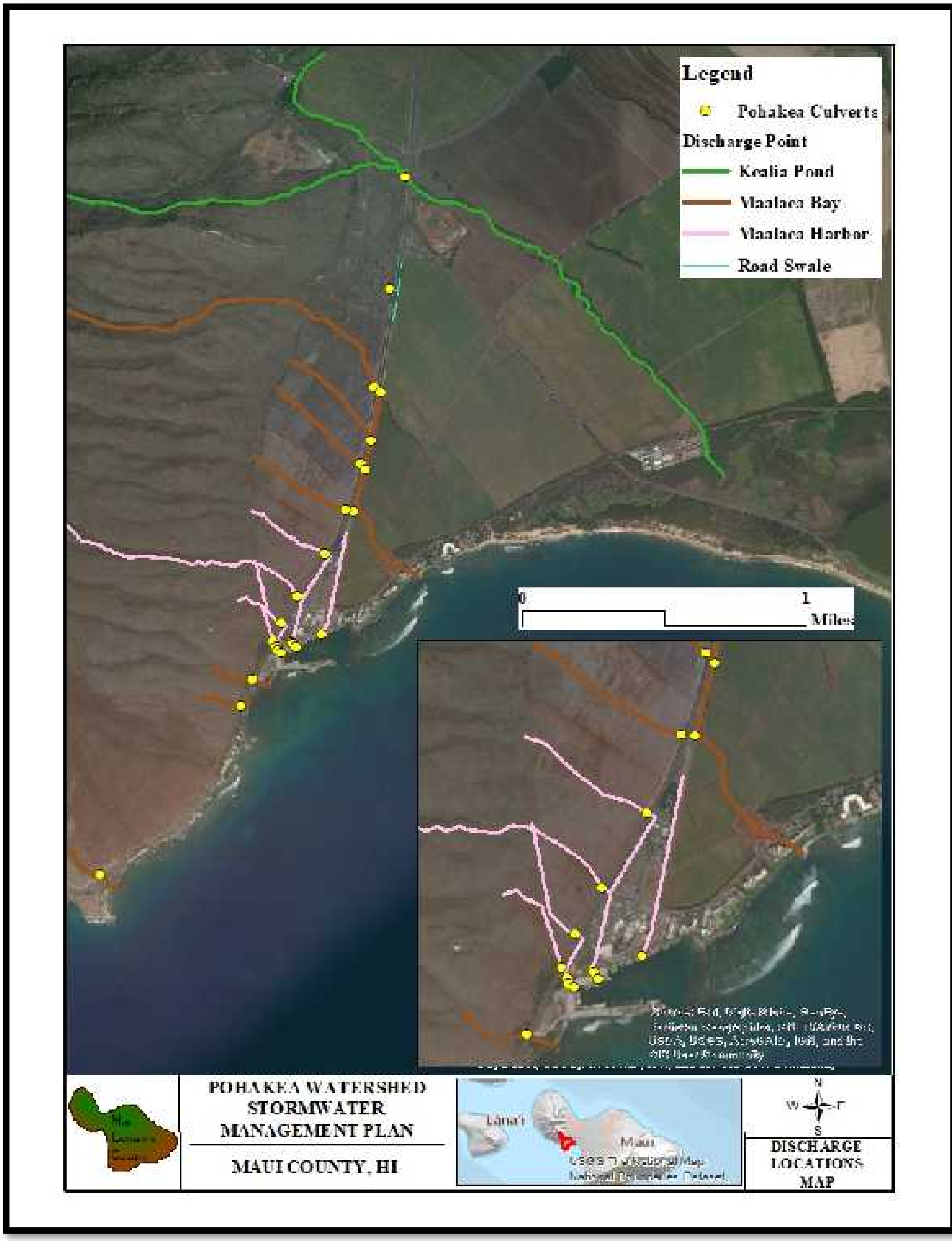
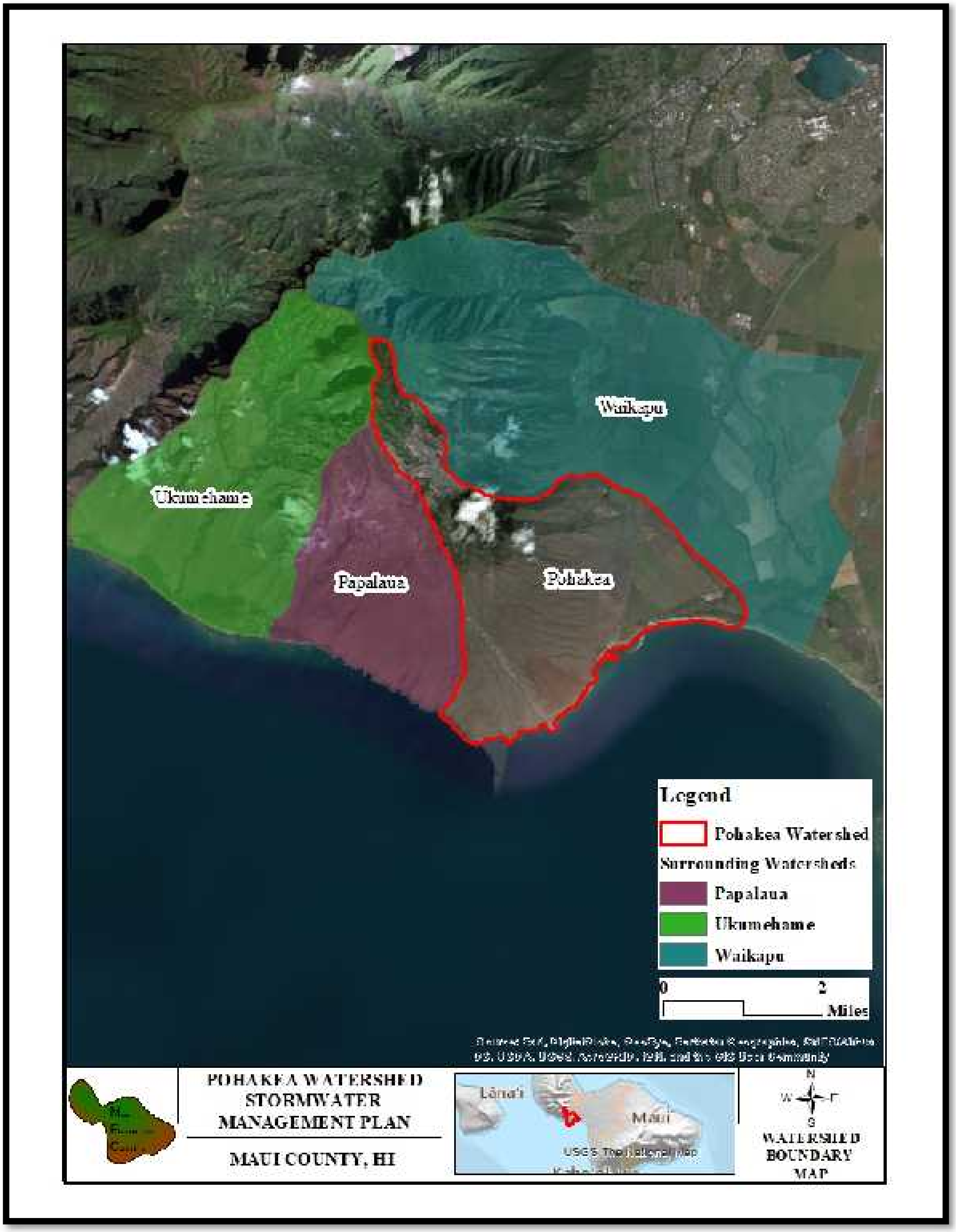


Figure 7. Watershed Boundary Map



extends along the coastline roughly 2.8 miles. It rises above both the Papalaua and Pohakea Watersheds ending at the 4,000-foot ridge separating it from the Waikapu Watershed flowing east on the opposite side of the West Maui Mountains. Six gulches exist within the Ukumehame Watershed. All are ephemeral and generally flow southwest. They include from west to east: Kailiili, Ukumehame, a small gulch associated with Pu‘u Kauoha, Makiva, and Hanaula gulches.

2.4.3 Waikapu Watershed

The Waikapu Watershed is the largest of the three watersheds surrounding Pohakea Watershed at approximately 11,167 acres. It is located east of the Pohakea Watershed. Along the coastline it extends from the eastern boundary of Pohakea less than a mile before heading north - northeast into the central isthmus of Maui. Near the Central Maui Base Yard, this watershed heads back towards the West Maui Mountains and the Kapilau Ridge before climbing to meet the Ukumehame Watershed. Five streams exist within the Waikapu Watershed. They include the Waikapu Stream, Waikapu Tributary, Ooawa Kilika Gulch, Paleaahu Gulch, and Kaonohua Gulch. Ooawa Kilika, Paleaau and Kaonohua converge at the Waihe‘e Mauka Ditch mentioned above. From here the system continues flowing east before converging with Waikapu Tributary. The flow way is referred to as Paleaahu Gulch for the remainder of its run as it discharges into Kealia Pond and ultimately into Ma‘alaea Bay. Waikapu stream is considered perennial while the rest of the streams are ephemeral, conveying flow only during storm events.

2.5 Marine Environments

The coastal waters offshore from the Pohakea Watershed are protected by various federal and state agencies (Marine Environments Map). The Hawaiian Humpback Whale Sanctuary extends
Along the Maui coastline north from Lipoa Point to its southern boundary offshore from Cape Hanamanioa and just beyond Ahihi Kinau Natural Area Reserve. The sanctuary spans half of the ‘Alalakeiki Channel in between Maui and Kaho‘olawe, completely encompassing the ‘Au‘au and Kalohi Channels in between Maui and Lana‘i and Lanai and Moloka‘i respectively, as well as most of the Pailolo Channel separating Maui and Moloka‘i. Within three miles of the entire shoreline of the island of Maui, a State of Hawaii Department of Natural Resources Division of Aquatic Resources Marine Managed Area exists and places a prohibition on the use of lay nets (DLNR DAR 2017).

Coral reef exists directly offshore extending west from McGregor Point beyond the coastal boundary of the watershed. Coral reef begins east of Haycraft Park and extends to Kealia Pond and beyond (Coral Reef Map). Benthic habitat is comprised of “pavement” or exposed rock horizontal with the sea floor with many crevices or joints, aggregate reef, aggregate patch reef, rock, rubble, sand, and scattered coral and rock composites (Benthic Habitat Map) (NOAA, 2007).

Figure 8. Marine Environments

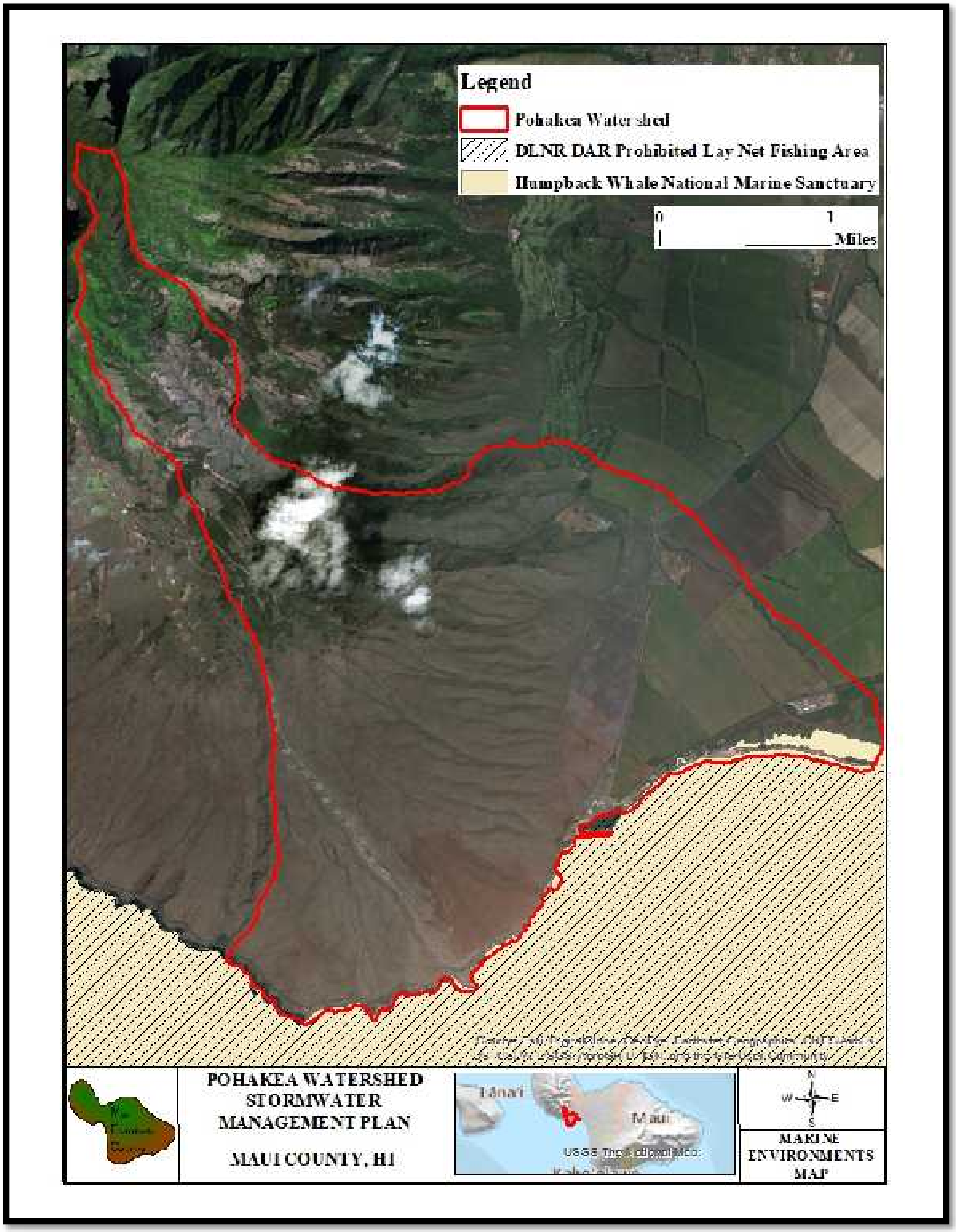


Figure 9. Pohakea Coral Reef Map

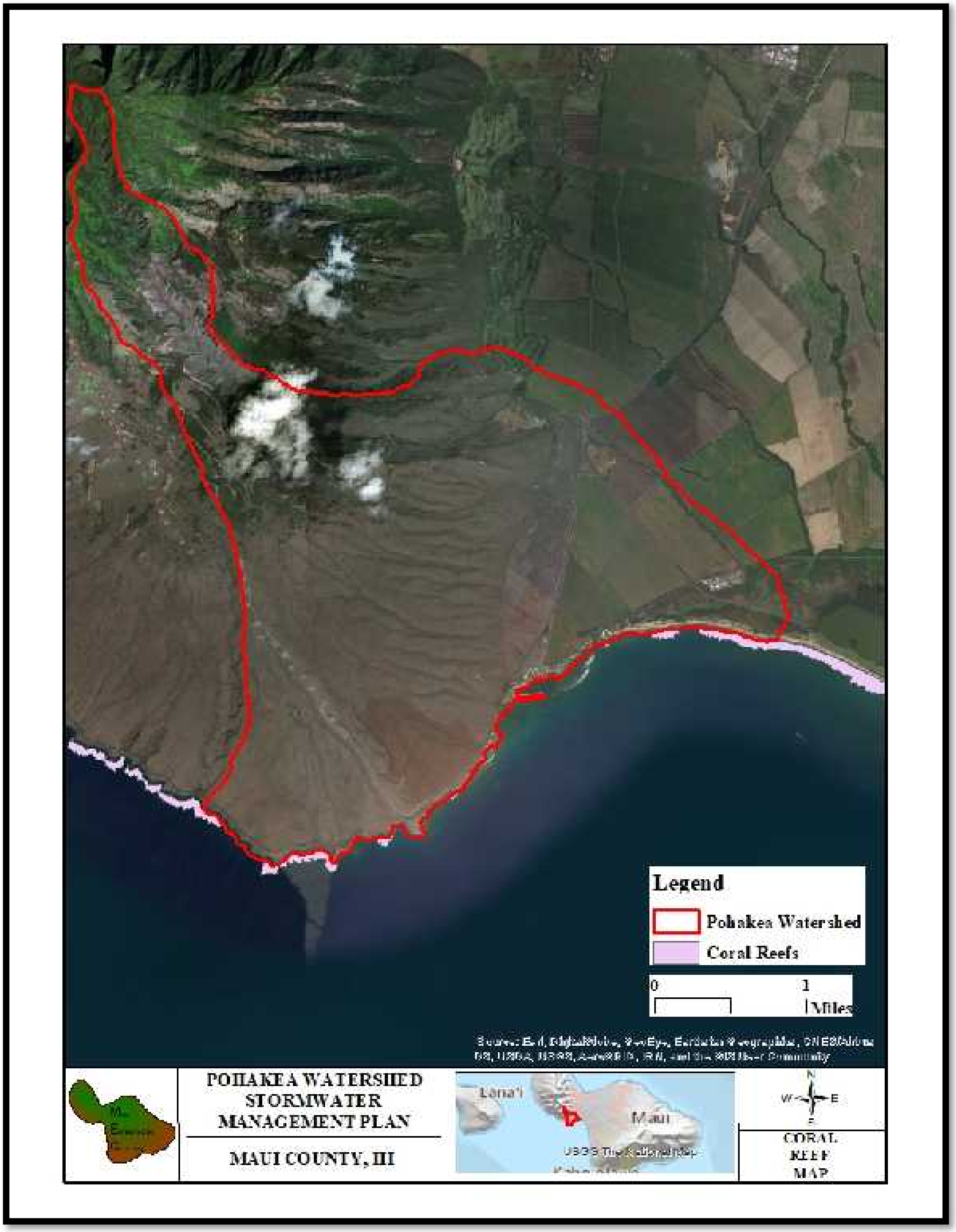
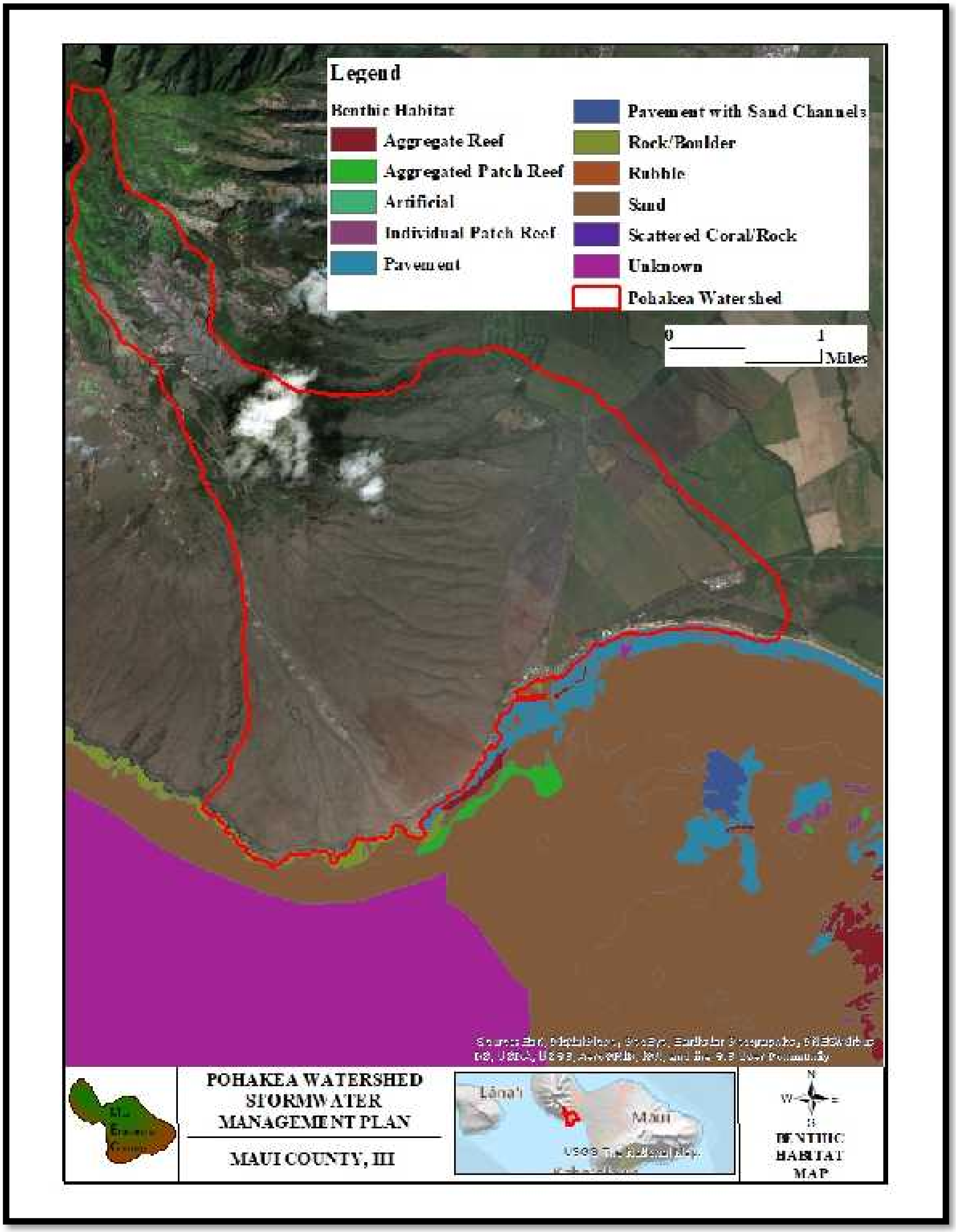


Figure 10. Pohakea Benthic Habitat Map



2.6 Land Use Districts

Three land use districts exist within the boundary of the Pohakea Watershed. The largest district being conservation lands at approximately 3,873 acres (Land Use District Map). This section of the watershed stretches from the summit of Hanaula within the West Maui Mountains, completely encompassing the western border of the watershed and the coastline, ending at the small coastal neighborhood along Ma‘alaea Bay Place. From here, conservation lands head north following the mauka side of the aforementioned Waihe‘e Mauka Ditch. Agricultural lands make up 25 percent of the watershed. These lands are now largely comprised of fallow sugar cane fields. Urban land represents a relatively small portion within the watershed and is comprised of the business district associated with Ma‘alaea Harbor. State land use boundaries were compiled by the State Land Use Commission and were most recently updated in 2014.

Table 1. Pohakea Watershed Land Use Districts

Land Use District	Acres	Percent
Conservation	3873.36	73.53
Agriculture	1317.23	25.00
Urban	77.44	1.47

2.7 Land Use Classifications

State land use and land cover data consists of historical land use and land cover classifications that were based on the manual interpretation of 1970’s and 1980’s aerial photography. There are 21 possible categories of cover type. Within the Pohakea Watershed boundary, six land cover types exist. These include Mixed Rangeland, Cropland and Pasture, Shrub and Brush Rangeland, Evergreen Forest Land, Non-forested Wetland, and Residential. Mixed Rangeland is the largest land cover type, making up nearly half of the watershed (Land Use Classification Map).

Table 2. Pohakea Watershed Land Use Classifications

Land Cover	Description	Acres	Percent
33	Mixed Rangeland	2480.80	47.09
21	Cropland and Pasture	1044.25	19.82
32	Shrub and Brush Rangeland	932.69	17.70
42	Evergreen Forest Land	707.72	13.43
62	Non-Forested Wetland	72.72	1.38
11	Residential	29.85	0.57

Figure 11. Pohakea State Land Use Districts Map

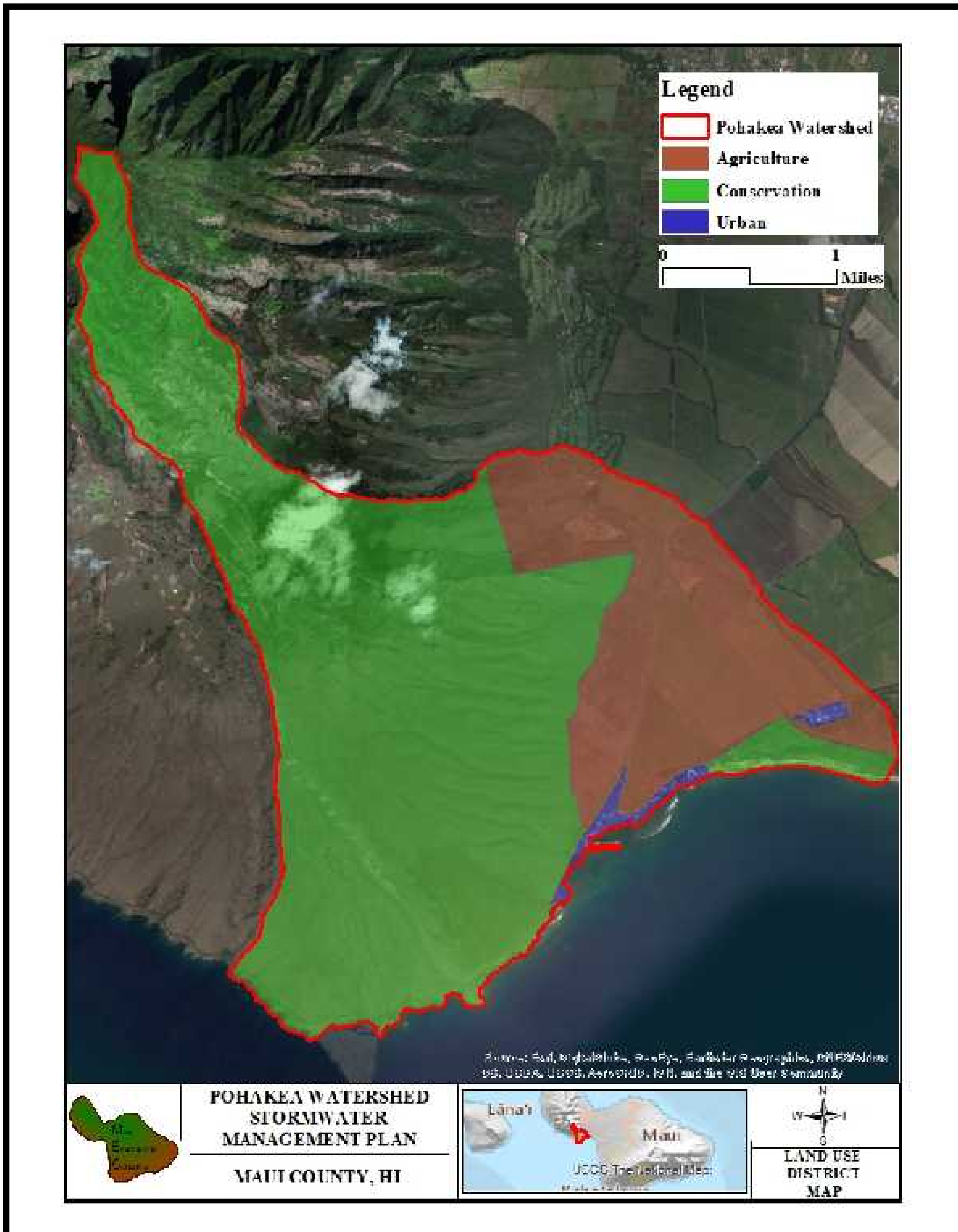
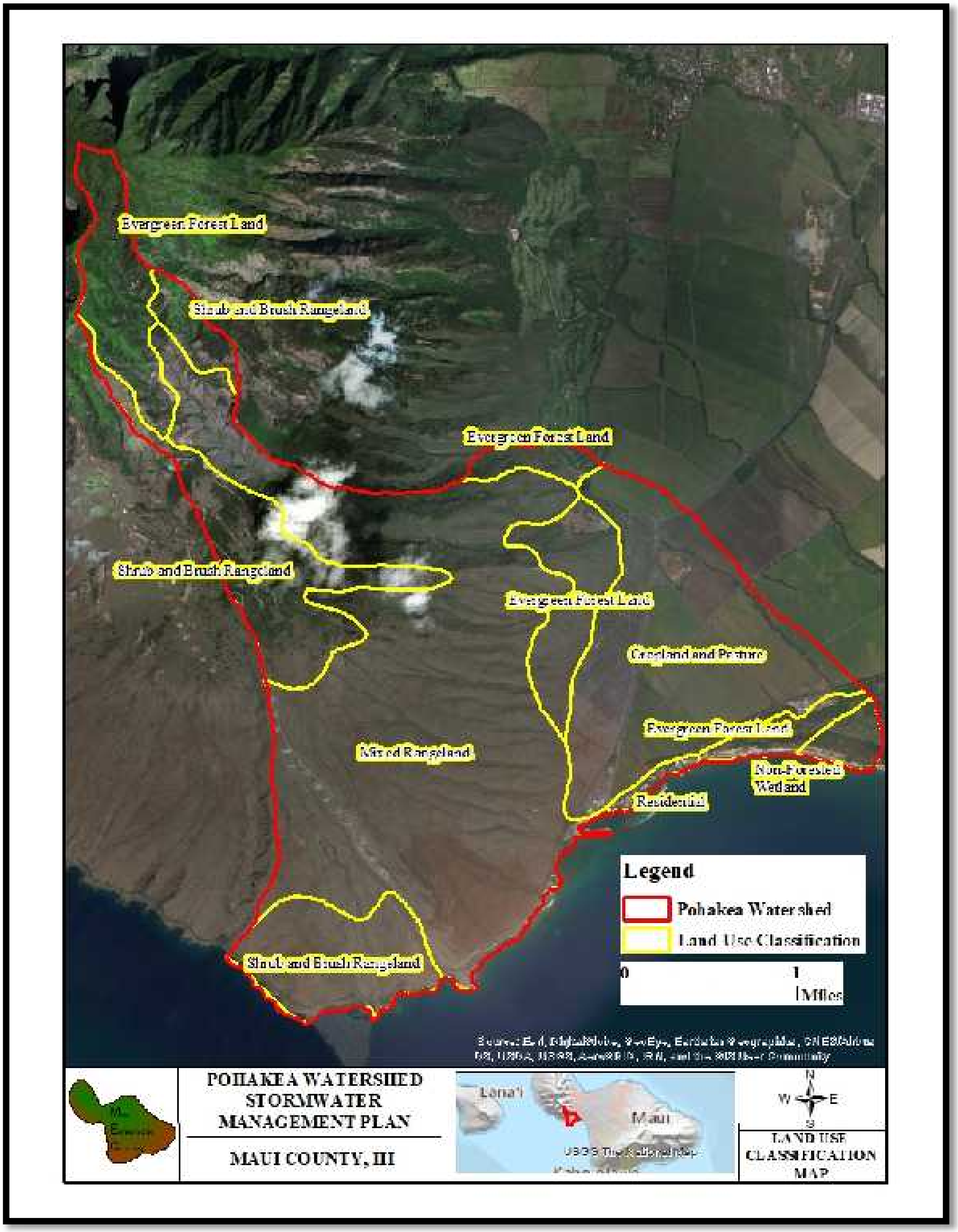


Figure 12. Pohakea State Land Use Classifications Map



2.8 Soils

Based on the USDA/NRCS Soil Survey for Maui County (Version 15, October 3rd, 2017), 19 soil types are mapped within the Pohakea Watershed (Soils Map). Listed below are the soil types found within Pohakea Watershed and general descriptions of their characteristics.

Table 3. Pohakea Watershed Soils

Soil Symbol	Soil Name	Mean Annual Precipitation (inches)	Elevation (feet)	Slope (percent)	Drainage Class	Runoff Class	Frequency of Flooding
BS	Beaches	10 to 75	0 to 10	1 to 5	Excessively Drained	Very Low	Frequent
CPI	Cinder Pit	NA	NA	NA	NA	NA	NA
EsB	Ewa Silty Clay	15 to 30	0 to 150	3 to 7	Well Drained	Medium	None
EtB	Ewa Cobbly Silty Clay	15 to 30	0 to 150	3 to 7	Well Drained	Medium	None
KMW	Kealia Silt Loam	10 to 41	0 to 260	0 to 1	Poorly Drained	Negligible	Frequent
NAC	Naiwa Silty Clay Loam	45 to 95	600 to 3,030	13 to 45	Well Drained	High	None
OFC	Olelo Silty Clay	60 to 10	1,430 to 3,420	15 to 50	Well Drained	High	None
OMB	Oli Silt Loam	30 to 40	1,000 to 2,250	3 to 10	Well Drained	Medium	None
PpB	Pulehu Silt Loam	10 to 35	0 to 300	3 to 7	Well Drained	Low	Occasional
PrB	Pulehu Cobbly Silt Loam	10 to 35	0 to 300	3 to 7	Well Drained	Medium	Occasional
PsA	Pulehu Clay Loam	10 to 50	0 to 300	0 to 3	Well Drained	Low	Rare
PtA	Pulehu Cobbly Clay Loam	10 to 35	0 to 300	0 to 3	Well Drained	Low	Occasional
PtB	Pulehu Cobbly Clay Loam	10 to 35	0 to 300	3 to 7	Well Drained	Medium	Occasional
W	Water	NA	NA	NA	NA	NA	NA

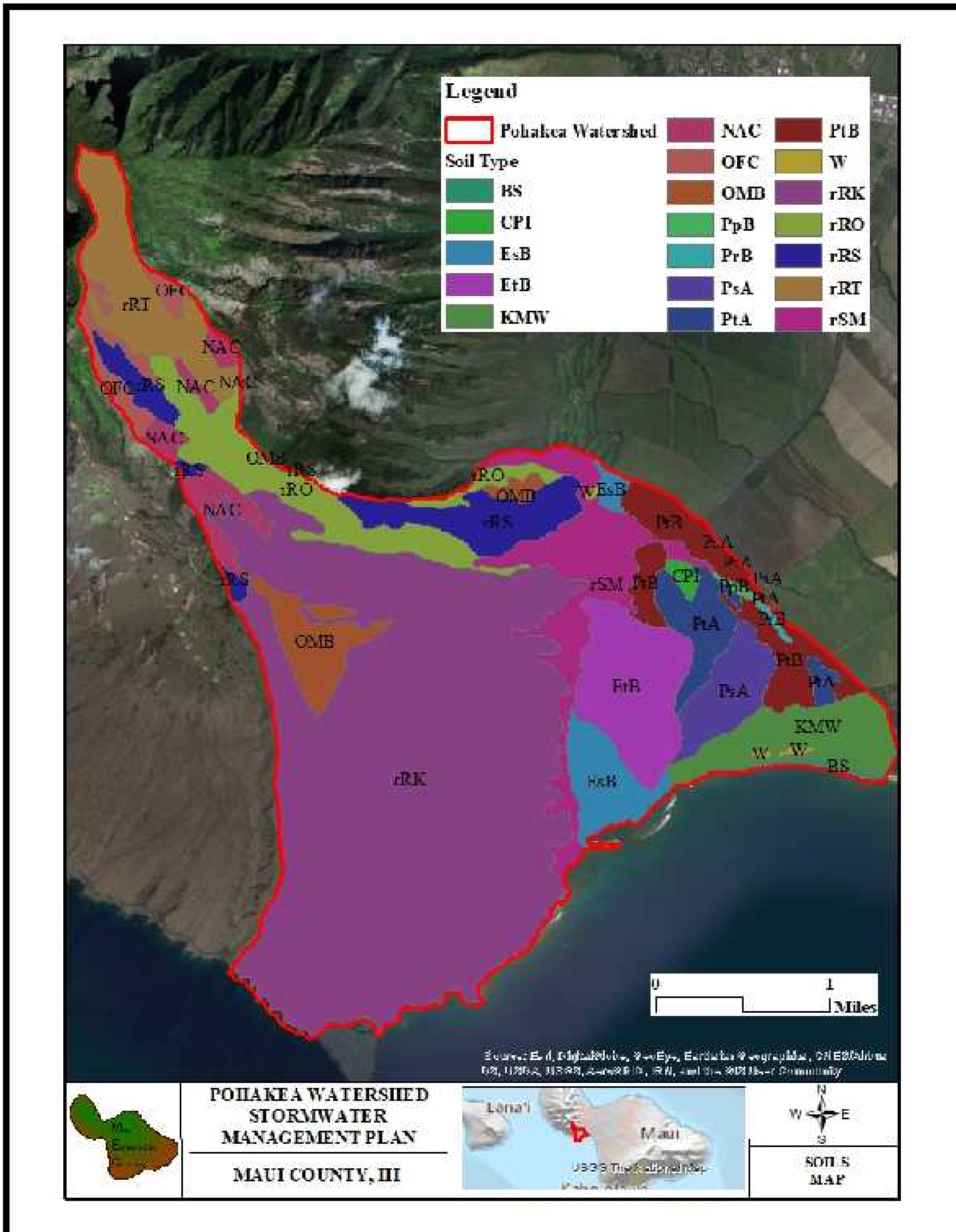
Soil Symbol	Soil Name	Mean Annual Precipitation (inches)	Elevation (feet)	Slope (percent)	Drainage Class	Runoff Class	Frequency of Flooding
rRK	Rock Land	15 to 60	0 to 6,000	0 to 70	Well Drained	Very High	None
rRO	Rock Outcrop	10 to 175	0 to 10,000	5 to 99	Well Drained	Very High	None
rRS	Rough Broken and Stony Land	20 to 200	0 to 4,000	40 to 70	Well Drained	Very High	Frequent
rRT	Rough Mountainous Land	NA	0 to 6,000	50 to 99	Well Drained	Very High	None
rSM	Stony Alluvial Land	10 to 50	0 to 1,000	3 to 15	Well Drained	Medium	Frequent

As seen in the Soils Map, rRK – *Rock Land* is the dominant soil type within the Pohakea Watershed. This soil type is considered well drained with very high runoff potential. This soil type was formed during pahoehoe lava flows. Pahoehoe flows are associated with low volume and low flow eruption events. Because these flows are slow, individual pahoehoe toes form along the flow, developing a smooth unbroken skin that cools by the air. Pahoehoe flows are therefore often characterized as smooth lava as opposed to aʻa which is considered rough lava (Carr, 1980). The parent material for Rock Land is basalt with silty clay loam found between zero to four inches of the surface, silty clay located between four to eight inches deep, and bedrock from eight to 20 inches of the surface. The restrictive feature is lithic bedrock and is usually encountered within four to ten inches of the surface. Depth to the water table is typically greater than 80 inches.

Similar soil types with high runoff potential include rRO – *Rock Outcrop*, rRS – *Rough Broken and Stony Land*, rRT – *Rough Mountainous Land*, and rSM – *Stony Alluvial Land* and are found throughout the upper and middle ranges of the watershed where slopes are steepest. NAC – *Naiwa Silty Clay Loam* and OFC – *Olelo Silty Clay* are also found in the upper reaches of the Pohakea Watershed and have high runoff potential.

One hydric soil is found within the Pohakea Watershed boundary. KMW – Kealia Silt Loam is associated with Kealia Pond which experiences frequent flooding and ponding. This soil type is found in tidal marshes and salt flats. The parent material is alluvium over beach sand. From the surface to three inches deep, this soil type consists of silt loam. Silt loam exists from three inches to 27 inches. Beyond 27 inches, fine sandy loam exists. This poorly drained soil has a depth to restrictive feature of over 80 inches. Depth to water is typically 12 to 42 inches depending on seasonal fluctuations in rainfall.

Figure 13. Pohakea Soils Map



3.0 POTENTIAL SOURCES OF POLLUTION

Sediment, nutrient, and other pollutant sources associated with the Pohakea Watershed were assessed using field observations made during three field events occurring on July 26th, July 27th, and August 29th, 2018. In addition, the Nonpoint Source Pollution and Erosion Comparison (NSPECT) model was used to identify pollutant hot spots for the watershed to better understand these sources at a landscape level.

3.1 Field Observations

Maui Environmental Consulting, LLC (MEC) staff canvassed the watershed to identify and photo-document sources of sediment and areas with high erosion potential due to both natural and anthropogenic circumstances. Specifically, when looking for evidence of erosion, MEC recorded observations of head cuts, bare ground, rills and channels on the soil surface. In addition, failed Best Management Practices, failed or non-functioning infrastructure, and improper or outdated land management strategies were also documented. The Pohakea Watershed was divided into four distinct areas including Mauka/Conservation Lands, Mid-Level Ag Lands, Commercial and Urban Lands, and Kealia Pond. Within each of these areas, several locations and situations were identified as having appreciable sources of sediment vulnerable to erosion during high stormwater events. While some of the vulnerable areas are present within two or more of the delineated areas, (examples being unimproved roadways and powerline corridors) management actions/recommendations will be similar across the different landscapes, but dictated by specific conditions at each site such as slope, rainfall, water availability, equipment access, etc. The four areas and their respective stormwater management issues are discussed below.

3.1.1 <u>Mauka/Conservation Lands:</u>

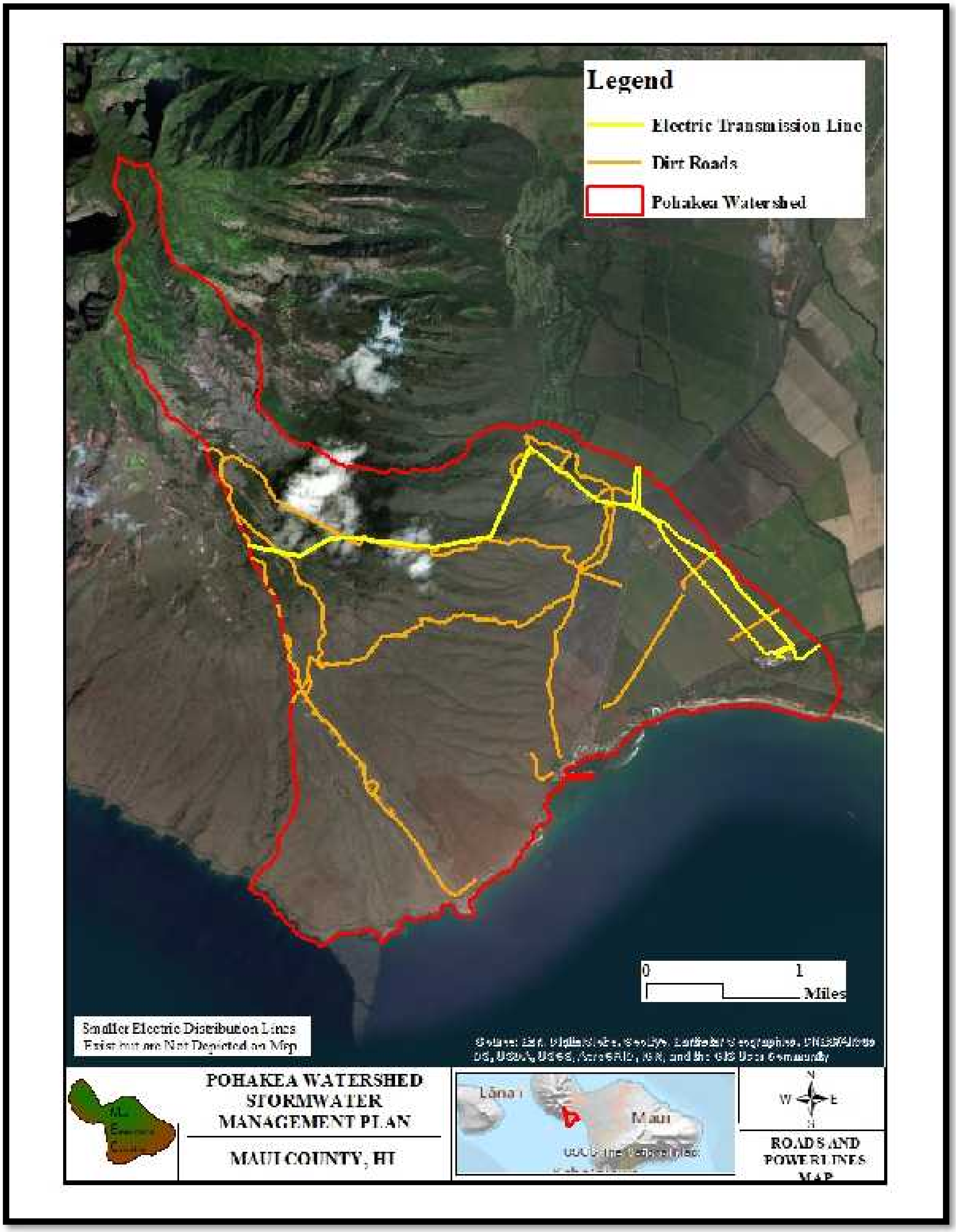
3.1.1.1 Unimproved Roads

Historic land uses in this area (primarily cattle ranching) have left behind an extensive network of unimproved and unmaintained agricultural roadways. Some roadways are deeply incised into the landscape, an indication of long-term sediment loss and erosion. Water bars (berms constructed across roadways designed to channel water off of the road) and kickouts (channels which convey water away from the road), have failed in many places. Disused and unmaintained roadways are acting as stormwater conveyance mechanisms during rain events, and are channeling stormwater and sediment into adjacent gulches (Roads and Powerlines Map).

3.1.1.2 Powerline Corridors

There are a number of powerline corridors associated with transmission and distribution power lines. The status of these lines is unknown, but downed lines, and aging poles were observed at several locations. In addition, recently burned areas were observed directly below transmission corridor power lines. The powerline access roads for these corridors were observed to be in various states of disrepair, and the clearing of vegetation from under and around the power lines has created bare areas which, like agricultural roads act as stormwater and sediment conveyances (Roads and Powerlines Map).

Figure 14. Pohakea Roads and Transmission Powerlines



3.1.1.3 Wind Farm Road

While the access road leading up to the windmills is well engineered and well maintained, there were several areas observed where erosion was causing undermining of the road surface, and loss of the gravel overlay.

3.1.1.4 Land Slides

It was observed that native scrub habitat was being lost as topsoil sloughed off and ‘mini’ landslides were occurring. Steep slopes combined with a groundcover predominance of non-native/invasive plant species have caused structural failures of topsoil layers when the soil becomes over saturated with water and sloughs off of the rocky underlying bedrock. A gradual loss of native habitat as non-native species encroach seems to increase this sloughing process leaving behind a series of ‘badlands’ - areas of exposed bedrock that can support little to no vegetation. Invasive species observed in association with these landslides included Common Ironwood (*Casuarina equisetifolia*), Buffalo Grass (*Brachiaria mutica*), and Molasses Grass (*Melinis minutiflora*). There may be a correlation between these landslides and the presence of Common Ironwood trees. Additional studies should be conducted to identify whether invasive species are contributing to these large losses of soil.

3.1.2 Mid-Level Ag Lands

3.1.2.1 Head Cuts along highway

Substantial loss of sediment was observed along the upstream side of the highway where stream flow was directed underneath the highway through box drains and culverts. The constriction point created by these culverts, possibly due to their being undersized, has led to extensive head cutting within the stream channel and loss of many tons of sediment material during times when the streams flow. Head cuts occur when stream force is directed downward due to a constriction of flow (in this case a road culvert), and creates a sheer bluff or cliff known as the knickpoint. The head cutting observed was ‘active’ in that more stream channel incision, loss of floodplain connectivity, and loss of sediment at an exponential rate will continue and worsen as the knickpoint migrates further upstream each time the stream flows.

3.1.2.2 Hawaiian Cement Quarry

Hawaiian Cement Quarry is located at the base of Pohakea Gulch, just before the land begins to level out and the gulch converges with the Waiheʻe Mauka Ditch. This quarry is mining aggregate materials from what appears to be a large ancient debris flow deposit which came down from Pohakea Gulch. The Stream now flows around the quarry site, splitting into two rivulets skirting along the north and south sides of the excavation site and rejoining just downslope of the quarry. The Waiheʻe Mauka Ditch skirts along the eastern edge of this excavation.

3.1.2.3 Landfill

Operations at the Pu’u Hele Cinder Pit Quarry began during WWII. The cinder from this puʻu was used to create military and service roads throughout the island. In 1996 the resulting pit became a privately-owned construction dump named the Maui Demolition and Construction

Landfill. In September of 2016, the landfill reached height restrictions and was subsequently closed. Pohakea Stream Gulch skirts along the edge of the now closed and capped landfill. While a detailed survey of this site was not conducted due to lack of land owner permission, there is presumably a potential for sediment or other materials to leach into the stream and/or groundwater from this site.

3.1.2.4 Waihe‘e Ditches

There are two historic irrigation ditches, both named ‘Waihe‘e Ditch’ (for purposed of this report, they are referred to as Waihe‘e Mauka Ditch and Waihe‘e Makai Ditch). These ditches historically brought irrigation water from Waihe‘e Stream to irrigate fields throughout the central isthmus.

The Waihe‘e Mauka ditch is evident in the northern portion of the watershed until it converges with Pohakea Gulch. The remaining portion of the original Waihe‘e Mauka Ditch runs essentially north/south at the inflection point between the mountains and the relatively flat plain. A reservoir located at the southern end of the Kahili Golf Course appears to be the terminus of the actively used portion of the Waihe‘e Mauka Ditch. While the ditch was observed to be dry within the project area, during high rain events, it could discharge additional sediment laden stormwater into Pohakea Stream. It is assumed a control structure exists at the aforementioned reservoir associated with Kahili Golf Course but due to access restrictions, MEC was not able to confirm this. A well-defined channel does exist coming from the reservoir and leading to a confluence with Pohakea Stream just east of the Hawaiian Cement Quarry. The original Mauka Ditch pathway continues along the inflection point where the steep West Maui Mountains meet fallow agricultural lands and is no longer an obvious conduit for water except during high flow rain events, or possibly when excess water from the ditch is directed into it. It is now being utilized as a powerline corridor that terminates near the intersection of Honoapiilani Highway and Ma‘alaea Road (By the old Buzz’s Wharf building). This corridor is severely eroded at its southern end where it intersects with the highway and is an active sediment transport pathway. It was likely a major transport mechanism responsible for large amounts of sediment observed washing onto and across the highway, and down into the parking area near the boat ramp at Ma‘alaea during the recent storm in September 2016.

The Waihe‘e Makai Ditch has also been altered from its original extent. The ditch is an armored, box-cut channel beginning along Honoapi‘ilani Highway flowing south, severing Kanaio Gulch from its original course, becoming a more natural, unarmored system after receiving water from three additional unnamed gulches that are routed via culvert under the highway. At the confluence of this ditch with the third unnamed gulch on the makai side of the highway, the system turns southeast, losing its concrete lining and continuing through the failed detention basin mentioned in Section. 2.2.2 above before ultimately discharging into Ma‘alaea Bay.

3.1.2.5 Sugar Cane Ag Roads

The legacy of agricultural roads continues downslope into areas of the landscape that were actively cultivated with sugar cane until late in 2016. While these fields are now fallow, they still contain primarily sugar cane regrowth. Unimproved agricultural access roads, especially at stream crossings are a potential sediment source whenever the streams flow.

3.1.2.6 Fire Breaks

A recent brush fire within the fallow sugar cane fields whose ignition source was a car fire on the highway has prompted the plowing of firebreaks along the perimeters of the fields wherever they are adjacent to a roadway. These firebreaks leave an area devoid of vegetation approximately 20 yards wide and could be a source of sediment loss during rain events.

3.1.2.7 MECO Powerline Corridors

Powerline corridors were generally placed to traverse sugar cane fields along stream riparian corridors, ditches, and other areas where they wouldn't interfere with cultivation activities. These locations are potential flow paths during storm events, so any activities such as the repair or replacement of lines or poles require access and construction activities within these sensitive areas. MECO staff reported the loss of several utility poles to flood waters associated with high flows in Pohakea Stream during one recent field event. Evidence of heavy equipment use, tree removal, and earthmoving associated with utility pole replacement was observed within these areas.

3.1.2.8 MECO Maʻalaea Powerplant

Pohakea Stream runs along the eastern edge of the MECO Maʻalaea Powerplant where it discharges into Kealia Pond. The riparian zone of Pohakea Stream is also utilized as an electricity transmission corridor crossing the surrounding fallow agricultural lands. MECO staff reported power poles being undermined by heavy flows within Pohakea during recent storm events.

In addition, evidence of surface water discharge was observed as rills and gullying were apparent in the wetland areas adjacent to the facility. Observations during storm events are needed to determine the amount of flow produced during these events at the outfall of Pohakea Stream into Kealia Pond. MECO also has a NPDES permit for stormwater associated with industrial activity, which likely discharges directly into Kealia Pond during heavy rainfall events.

3.1.2.9 Kahili Golf Course

The Kahili Golf Course is primarily located north of Pohakea Watershed. However, the Waiheʻe Mauka Ditch runs along the entire eastern boundary of the golf course before discharging into a reservoir located just north of the Hawaiian Cement Quarry within the Pohakea Watershed. While a control structure was not observed leading from this reservoir, the Waiheʻe Mauka Ditch is well defined below this catchment and discharges into Pohakea Gulch just east of the Hawaiian Cement Quarry. Pohakea ultimately discharges into Kealia

Pond and Ma‘alaea Bay. Golf courses can be a source of nutrient runoff from fertilizers. Kahili Golf Course was not contacted as part of this stormwater management plan and course turf management BMPs were not assessed.

3.1.2.10 Fallow Pastures

All of the streams within the project area are ephemeral and are considered losing or disappearing streams because water is infiltrated into the aquifer as it flows downstream. This results in generally more water volume upstream than downstream, and is characterized by deep gulches and canyons upstream and relatively small rivulets and stream channels downstream. As the streams discharge out of the West Maui Mountains, they flow onto a broad gently sloping plain between the base of the mountains and the mauka side of the highway. In many cases these streams disperse into a network of smaller stream channels similar to a river delta. While these streams may not flow for years at a time, large storm events such as those that occurred in September and December of 2016 cause substantial flows into this area. This plain was historically used for sugar cane cultivation, but this appears to have ceased some time ago, and the area now is used for horse and cattle grazing or remains fallow. There may also be feral ungulate grazing in this area although no evidence was observed. This landscape is significantly degraded with numerous areas devoid of vegetation, and is dominated by invasive grasses and weeds. There is evidence of sheet flow across these barren patches and the entire landscape is a significant contributor of sediment to the streams flowing through it. An extensive survey was not conducted because of a lack of landowner permission, but the landscape was observed from neighboring lands owned by the State and from the Lahaina Pali Trail right of way.

3.1.3 Commercial and Urban land

3.1.3.1 Stream Diversions

The cut off reach of Kanaio Stream that was diverted into the armored channel (Waihe‘e Makai Ditch) running parallel to the Highway, still exists as a dry gulch that continues through fallow sugar cane fields from the highway until it terminates in the field mauka of Haycraft Beach. It is likely that this stream once flowed into wetlands in the vicinity of Haycraft. Further investigation of the historic hydrologic conditions in this area are recommended to inform potential restoration activities.

3.1.3.2 Dirt Lots and Parking Lots

Vacant lots and dirt parking lots are found in the areas adjacent to the harbor. While some of these areas have been improved with a gravel overlay, many are simply bare compacted earth which can easily be transported to the nearby ocean by wind and rain. In particular, the paid parking located near the Pacific Whale Foundation embarkation area and the parking areas at the west (towards Lahaina) end of the harbor are bare dirt right next to the ocean.

3.1.3.3 Ma‘alaea Triangle Parking Lot

The parking lots that service the Ma‘alaea Triangle represent approximately 350,000 square feet of impervious surface. This area is a source of considerable urban stormwater runoff and its associated pollutants during rain events. While the drains are stenciled to indicate that they lead to the ocean, the stormwater entering them receives no treatment before being discharged directly into the harbor. Runoff from parking lots contains sediment as well as petrochemicals, heavy metals, trash, and other pollutants associated with urban runoff.

3.1.3.4 Failed Detention Basin

There is a failed detention basin mauka of Hauʻoli Street and the Maui Island Sands Resort. Constructed following the major storms in September and December of 2016, this detention basin receives the flows from Kanaio Stream as well as several other unnamed streams representing a significant concentration point of stormwater flow from the landscape within the project area (Discharge Locations Map). Based on the observed failure, it is assumed the basin's size and construction are inadequate to handle the substantial flows it receives. This is evidenced by extensive head cutting and channel incision above the basin, and a breached control structure that divides the basin. This structure is a compacted earth and gravel berm that was intended to temporarily detain stormwater, and gradually release it through PVC stand pipes directed into the lower portion of the basin. The breach occurred at the center of this berm, directly in line with the point at which the stream enters the basin, indicating a high flow stream event which punched through the control structure carrying gravel and sediment material under Hauʻoli Street, down a concrete lined channel, and into the ocean between Maui Island Sands Resort and the Maʻalaea Banyans. This basin, its associated head cut, and the failed control structure, all represent sediment sources in the flow path waiting for the next storm to be transported to the ocean each time the stream flows.

3.1.3.5 Car Washes and Condo Impervious Surfaces

The roads, parking lots and buildings associated with the oceanfront resorts and condominiums along Hauʻoli Street represent a significant area of impervious surface. Runoff from these areas increases the volume of stormwater runoff flowing into the ocean, and, is a significant contributor of sediment as well as petrochemicals, heavy metals, trash, and other pollutants associated with urban runoff. Swimming pool backwash and car washing areas were also observed discharging directly into the channelized stream which flows into the ocean. There are likely additional sources of nutrient pollution within the landscaped areas of these condominiums.

3.1.4 <u>Kealia Pond</u>

Kealia Pond and its surrounding wetlands are extremely important for preventing pollution from entering the ocean. The ecological function of Kealia Pond as a wetland provides numerous ecosystem services acting as both a nutrient sink and buffer against stormwater runoff pollution entering the ocean. Pollution from Pohakea Stream is likely contained within Kealia Pond. Within the wetland, biological processes have the ability to capture and convert dissolved and suspended nutrients contained in stormwater into harmless atmospheric nitrogen gas. While there are certainly limits to the capacity for Kealia Pond to handle large amounts of sediment and stormwater pollutants, it is fortunate that Pohakea and the adjacent Waikapu Streams discharge into the pond instead of directly into the ocean. That said, it is likely that sediment deposits in Kealia are gradually filling in the pond, and further study of the sediment dynamics of the system are warranted. Sediment laden stormwater captured in Kealia is regularly discharged at the pond's outfall into Maʻalaea Bay and the ocean.

3.2 Water Quality Data

In an effort to identify water quality trends over time, MEC reviewed the Final 2016 State of Hawaii Department of Health (DOH) Clean Water Branch (CWB) Integrated Water Quality Report (IWQR) as well as the Final 2018 IWQR for water quality data specific to the Pohakea Watershed. In addition, the Maui Ocean Center provided data on several stormwater discharge events flowing into Maʻalaea Harbor.

3.2.1 Clean Water Act Sections 303(d) and 305(b)

The Hawaii State Department of Health (DOH) is obligated by the Clean Water Act (CWA) Sections (§) 303(d) and 305(b) to report on the State's water quality on a two-year cycle. The CWA §305(b) requires states to describe the overall status of water quality statewide, and the extent to which water quality provides for the protection and propagation of a balanced population of shellfish, fish, and wildlife, and allows recreational activities in and on the water. The CWA §303(d) requires states to submit a list of waters that do not attain applicable water quality standards, plus a priority ranking of impaired waters for Total Maximum Daily Loads (TMDL) development based on the severity of pollution and the uses of the waters.

The IWQR informs the public on the status of marine and inland (streams and estuaries) water bodies and serves as a planning document to guide other CWA programs. The Final 2016 IWQR incorporates data collected from November 1, 2013 to October 31, 2015 to provide an updated snapshot of water body conditions throughout the state and carries over the assessment results from previous IWQRs. In addition, the Final 2018 IWQR report incorporates data collected from November 1st, 2015 to October 31st, 2017. These documents can be found on the DOH CWB website:
(http://health.hawaii.gov/cwb/clean-water-branch-home-page/integrated-report-and-total-maximum-daily-loads/)

Impaired waters—waters that do not meet the State's water quality standards (WQS)— in the IWQR may be targeted for further monitoring activities to develop TMDLs, to plan and evaluate CWA §319 nonpoint source (NPS) pollution control projects and set requirements for National Pollutant Discharge Elimination System (NPDES) permits and §401 Water Quality Certifications (WQCs). The IWQR not only identifies areas in need of restoration but serves as a baseline to validate the State's efforts to improve water quality and eventually delist impaired waters that have been rehabilitated.

3.2.2 2018 State of Hawaii Integrated Water Quality Report - Clean Water Act §305(b) Assessments and §303 (d) List of Impairments

In the most recent finalized Integrated Water Quality Report (Hawaii Department of Health, 2018), three water quality monitoring stations are listed by the DOH CWB that fall within the Pohakea Watershed boundary (Water Quality Monitoring Map). They include Maʻalaea Beach, Maʻalaea Boat Harbor Station, Maʻalaea Small Boat Harbor. At this time, only Maʻalaea Beach is being sampled. No DOH CWB water quality data is being collected in the harbor and data reported for these two sites in the 2016 Final and 2018 Final IWQRs have been carried over from previous assessments and are likely over ten years old according to DOH staff.

3.2.2.1 HI058731 - Maʻalaea Beach (Haycraft Beach) is currently listed in the 2016 Final IWQR report for turbidity and chlorophyll-a impairments. In the 2018 Final IWQR report, this site is listed for enterococcus as well as turbidity and chlorophyll-a. No attainment/impairment status is offered in either report for Total Nitrogen, Nitrate+Nitrite, Ammonium, or Total Phosphorus. The site has been given low priority status for the development of a Total Maximum Daily Load (TMDL) for these parameters.

3.2.2.2 HIW00082 - Maʻalaea Boat Harbor Station is not currently being sampled. Data from previous IWQR reports has been carried over and the station continues to be listed in both the 2016 Final IWQR report and the Final 2018 IWQR for Total Nitrogen, Nitrate+Nitrite, Turbidity and Chlorophyll-a impairments. No attainment/impairment status is offered in either report for Enterococcus, Ammonium, or Total Phosphorus. The site has been given low priority status for the development of a Total Maximum Daily Load (TMDL) for these parameters. As stated above, no water quality testing is currently being conducted in Maʻalaea Harbor and DOH CWB data used for these determinations is likely over ten years old.

3.2.2.3 HI00140 - Maʻalaea Small Boat Harbor is not currently being sampled. Data from previous IWQR reports has been carried over and the station continues to be listed in both the 2016 Final and 2018 Final IWQR reports for Turbidity and Chlorophyll-a impairments. No attainment/impairment status is offered in either report for Enterococcus, Total Nitrogen, Nitrate+Nitrite, Ammonium, or Total Phosphorus. The site has been given low priority status for the development of a Total Maximum Daily Load (TMDL) for these parameters.

Figure 15. Pohakea Watershed Water Quality Monitoring Map

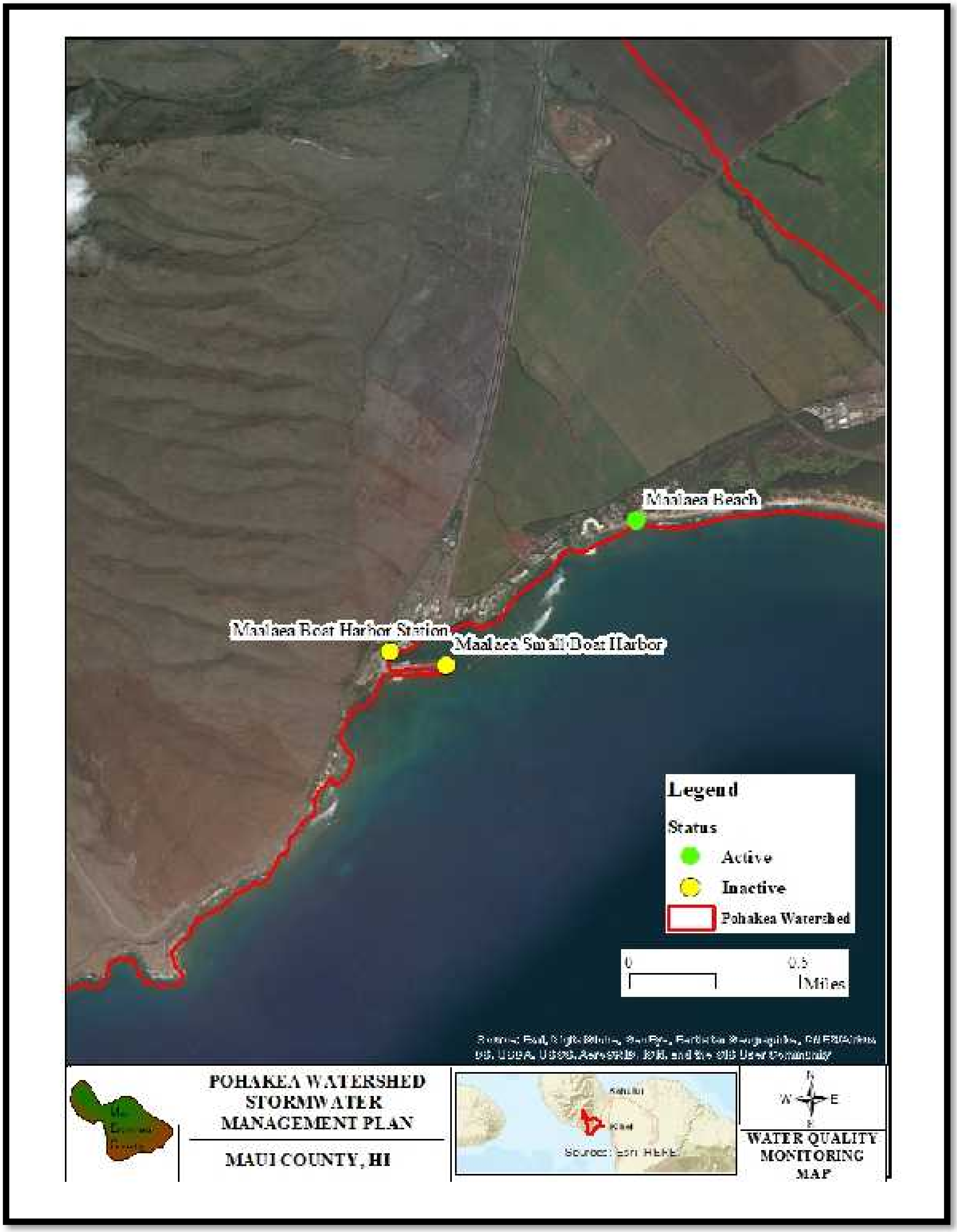


Table 4. Pohakea Watershed Water Quality Stations and Impairments for the 2016 Final and 2018 Final Integrated Water Quality Reports

Final 2016 Integrated Water Quality Report								
Station	Water Body ID	Water Quality Parameters						
		Enterococcus	TN	Nitrate+Nitrite	Ammonium	TP	Turbidity	Chlorophyll-*a*
Maʻalaea Beach	HI058731	A	--	--	--	--	N	N
Maʻalaea Boat Harbor Station*	HIW00082	--	N	N	--	--	N	N
Maʻalaea Small Boat Harbor*	HIW00140	--	--	--	--	--	N	N
Final 2018 Integrated Water Quality Report								
Station	Water Body ID	Water Quality Parameters						
		Enterococcus	TN	Nitrate+Nitrite	Ammonium	TP	Turbidity	Chlorophyll-*a*
Maʻalaea Beach	HI058731	N	--	--	--	--	N	N
Maʻalaea Boat Harbor Station*	HIW00082	--	N	N	--	--	N	N
Maʻalaea Small Boat Harbor*	HIW00140	--	--	--	--	--	N	N

N indicates that the water quality standard was not attained
A indicates that the water quality standard was attained.
*Site is not currently sampled and data have been carried over from previous reports

Turbidity measurements in exceedance of water quality standards can be caused by sediment laden water discharging from freshwater streams and/or from the resuspension of sediment cause by tidal or wave action within coastal waters. Increased sedimentation and nutrient loading on the extensive offshore reef complex threatens the health of the reef ecosystem. Sediments deposited by one storm event can be subsequently re-suspended. Recent studies have demonstrated that increases in sediment discharges from watersheds associated with poor land-use practices can impact reefs over 100 km from shore, and that ecosystem-based management efforts that integrate sustainable activities on land, while maintaining the quality of coastal waters and benthic habitat conditions, are critically needed if coral reefs are to persist (Richmond, et al., 2007).

In addition to nutrient testing, DOH tests for algae in coastal waters. Testing for algal growth is conducted by measuring chlorophyll-*a* concentrations in the water. Chlorophyll-*a* is the most abundant type of chlorophyll within photosynthetic organisms and gives plants their green color. Higher concentrations generally indicate poor water quality. Abundance of algal growth is maintained by high nutrient concentrations.

3.2.3 Maui Ocean Center Stormwater Data

MOC has collected water quality data during three storm events at the western most culvert discharging into Maʻalaea Harbor (Stormwater Sampling Map and Table 5). The parameters assessed by MOC include total nitrogen (TN), nitrate + nitrite (NO_3+NO_2), ammonium-nitrogen (NH_4), total phosphorus (TP) and Total Suspended Solids (TSS) along with a suite of other parameters used to assess water quality. Data from these three events show relatively high amounts of sediment and nutrients entering the harbor during heavy rainfall.

To further analyze the nutrient data collected by MOC, MEC subtracted nitrate + nitrite and ammonium-nitrogen from total nitrogen to determine the amount of organic nitrogen present in the stormwater. Below we discuss these parameters and what they indicate with regards to land use and water quality concerns.

Total nitrogen is equal to the sum of organic nitrogen, ammonia, and inorganic nitrogen. It should be noted that the term ammonia refers to two chemical species which are in equilibrium in water (NH3, un-ionized and NH4+, ionized). Ammonia and ammonium forms of N are usually only elevated near sources of human or animal waste discharges. Nitrate + nitrite nitrogen is also known as inorganic nitrogen. Inorganic nitrogen is typically associated with the use of fertilizers for agricultural operations, golf courses, and residential lawn maintenance. Organic nitrogen can originate from various sources including organic fertilizers, detritus, human and animal waste, and algae in the water column (Wall, 2013). When too much nitrogen is present in water, algae blooms can occur. These blooms reduce dissolved oxygen that fish and other aquatic and marine organism need to survive. Some types of algae are toxic and can cause respiratory issues, rashes, neurological impairments, and stomach or liver illness. In addition, high levels of nitrates in drinking water can cause illnesses such as blue baby syndrome in infants and can even result in death (Beaudet, et al., 2014).

When testing wastewater Kjeldahl-nitrogen is generally applied as a measure. The TKN value (Total Kjeldahl Nitrogen is the sum of organic nitrogen compounds and ammonium nitrogen (TKN = org-N + NH4-N [mg/L]) nitrogen mainly occurs in wastewater in this form. After biological wastewater treatment, it mainly occurs as oxidized nitrite (Scott, 2012).

Figure 16. Stormwater Sampling Map

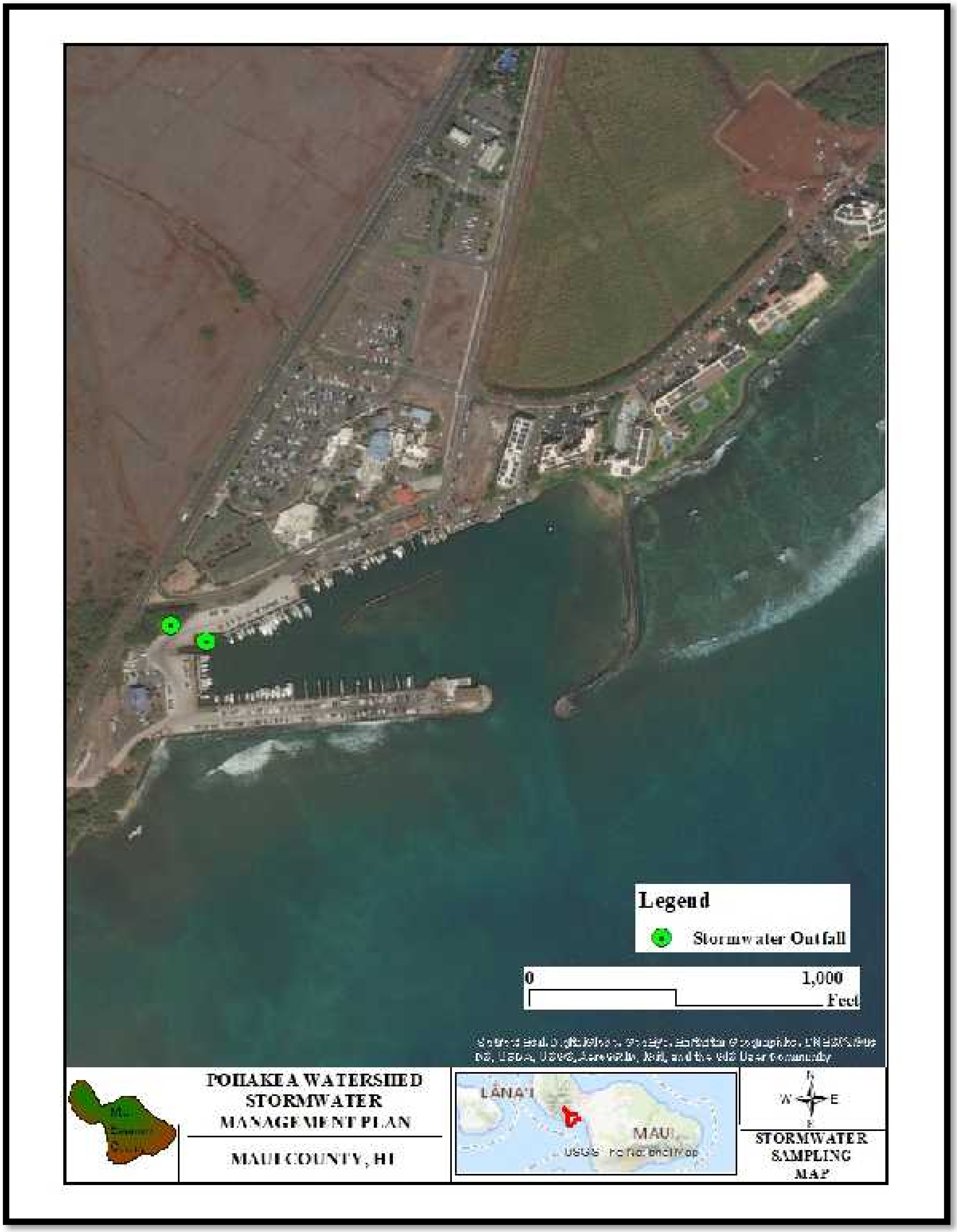
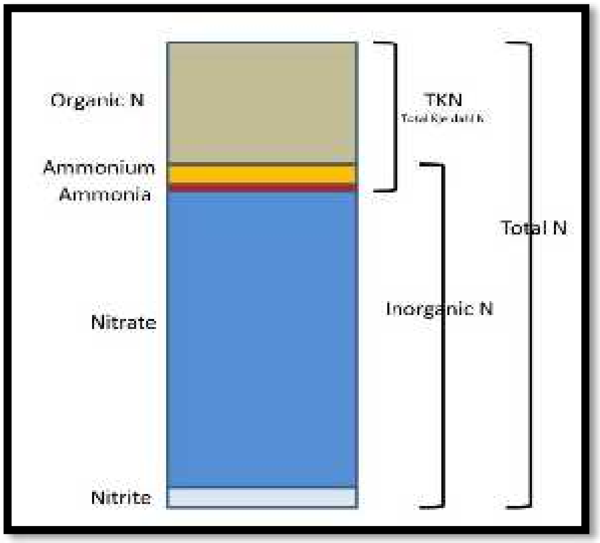


Figure 17. Total Nitrogen and Nitrogen Components in Surface Water



In most surface waters, the dominant forms of Nitrogen (N) are Nitrate and Organic Nitrogen. Where streams occur near agricultural production or biological wastewater treatment facilities, the Nitrate form of N is usually substantially higher than organic N. Nitrate levels are typically low in forested and grassland environments, therefore organic N is typically found in much higher amounts than Nitrates in more natural landscapes.
Ammonia and ammonium forms of N are usually only elevated near sources of human or animal waste discharges (Wall, 2013).

Total phosphorus is found in agricultural fertilizers, manure, and organic wastes in sewage and industrial wastewater. An abundance of phosphorus in surface waters can lead to an abundance of plankton and algae that consume large amounts of dissolved oxygen and may ultimately lead to eutrophication within the system. Too much phosphorus can also be detrimental to human health, causing kidney damage and osteoporosis. Phosphorus and orthophosphates are not typically very mobile in stormwater. Phosphorus fertilizers typically enter streams with sediment transport and increase as TSS increases (Oram, 2014).

Table 5. Maui Ocean Center Storm Drain Sampling Results for Nutrients and Sediment

MAUI OCEAN CENTER STORM DRAIN SAMPLING RESULTS FOR NUTRIENTS AND SEDIMENT							
October 2017 STORMWATER RUNOFF WATER QUALITY RESULTS							
Sample Location	**Total Nitrogen (TN)**	**Nitrate + Nitrite [NO3- & NO2-]**	**Ammonia Nitrogen [NH4+]**	**TKN (Organic Nitrogen + Ammonia N)**	**Total Phosphorous (TP)**	**Orthophosphate [PO4-3]**	**Total Suspended Solids (TSS)**
	µg-N/L	**µg-N/L**	**µg-N/L**	**µg-N/L**	**µg-P/L**	**µg-P/L**	**mg/L**
01-A W. Drain	3772.10	1820.20	38.52	1951.90	82.08	34.07	25972
01-C W. Drain	1566.00	406.90	116.96	1159.10	205.98	170.36	5318

December 2017 STORMWATER RUNOFF WATER QUALITY RESULTS							
01-A W. Drain	1451.10	814.37	127.18	636.73	188.94	167.88	392
01-B W. Drain	319.22	183.63	13.59	135.59	27.88	21.68	3736
01-D W. Drain	362.64	166.82	61.35	195.82	27.26	21.06	1756
01-E W. Drain	367.54	157.58	50.99	209.96	30.66	21.68	1456
February 2018 STORMWATER RUNOFF WATER QUALITY RESULTS							
01-C W. Drain	759.88	300.45	135.17	459.43	92.92	71.24	5063
01-A W. Drain	714.36	132.37	125.36	581.99	150.22	136.29	467
01-B W. Drain	712.96	131.67	155.48	581.29	157.97	151.77	452

Due to the high concentration of ammonia, organic nitrogen, total phosphorus, and orthophosphates observed in samples taken from the stormwater culvert, MEC speculates that sewage may be mixing with stormwater before being discharged into the harbor. MOC has additional data collected at several locations throughout the harbor. While data from these locations are not provided in this report as they do not specifically pertain to stormwater, nutrient trends are similar with high nutrient concentrations for both inorganic and organic nitrogen and ammonia, total phosphorus and orthophosphates. Upon preliminary review these data suggest sewage wastewater is a concern throughout the year and not just during storm events.

Several abandoned cesspools are associated with the Ma'alaea Harbor. In addition, several homeless encampments exist in the culvert system below Honoapi'ilani Highway. Feral ungulate feces, human feces, decomposing vegetation, agricultural fertilizer, golf courses, and other sources of nutrients may also be causing or contributing to the high nutrient concentrations observed in this stormwater. Appendix B Water Quality Monitoring Plan provides methods for determining the source of these nutrients in the stormwater. Specifically, by distributing testing locations throughout the watershed at locations where pollutants are believed to originate, and by testing groundwater, stormwater, and coastal surface water, this plan aims to tease out the various sources of pollutants entering Ma'alaea Bay and Ma'alaea Harbor. In addition, by testing for a suite of nutrient species, the origin of these pollutants can be better understood as discussed in detail above.

3.3 Point Source Pollution including NPDES and UIC Wells

As stated above, the 2016 Final 2018 Final IWQR reports indicate that Maʻalaea coastal waters are not meeting Hawaii State water quality standards for Total Nitrogen, Nitrate+Nitrite, Turbidity and Chlorophyll-*a*. In addition, Enterococcus levels were elevated above water quality standards in the Final 2018 report. Nutrients may enter coastal waters through various mechanisms including shallow waste water injection wells, septic systems, cesspools, effluent discharge, and the improper use of fertilizers on agricultural lands, golf courses, residential lawns and resort landscapes. An injection well can be considered a point source, whereas discharges from cesspools and septic systems are usually accounted for as nonpoint sources of pollution. Stormwater runoff from conservation lands; agricultural or industrial land uses; and urban, resort, and rural development can transport nonpoint source pollution to the ocean. Point Source pollution is addressed and regulated through the National Pollution Discharge Elimination System. Non-point source pollution is typically addressed through the formation of a Watershed-Based Plan approved by the DOH CWB and the EPA.

3.3.1 National Pollutant Discharge Elimination System

The discharge of pollutants from point sources is generally regulated through the National Pollutant Discharge Elimination System (NPDES). The Clean Water Act prohibits discharge of pollutants to Waters of the US except in compliance with an NPDES permit. The Hawaii Department of Health, Clean Water Branch is delegated authority for issuance of general and individual NPDES permits. The NPDES program requires permits for the discharge of "pollutants" from any "point source" into "waters of the United States." The terms "pollutant", "point source", and "waters of the US" are found at Code of Federal Regulations (CFR) Chapter 40 Part 122.2. Point source means any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel, or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture or agricultural stormwater runoff (See §122.3).

Stormwater runoff from construction sites greater than one acre discharging to Class A waters are regulated point sources under the State's General NPDES Permit for stormwater associated with construction activity. Discharges of stormwater associated with industrial activity to Class AA waters require an individual NPDES permit. Table 6 below lists the NPDES permits that exist within the Pohakea Watershed boundary.

Table 6. NPDES Permits within the Pohakea Watershed

Name	Permit Number	Address	Permit	Type	Issued:	Expires:
Maʻalaea Small Boat Harbor Improvements, Ferry System & Utility and Pier	HIR10D757	101 Maʻalaea Boat Harbor Road, Wailuku, HI 96793	General Permit	Form C: stormwater associated with construction activities	12/9/2013	12/5/2018
Maui Ocean Center*	HI0021504	192 Maʻalaea Road, Wailuku, HI 96793	Individual Permit	Form 2C: Wastewater from existing operations	10/4/2013	10/3/2018 (extended)
Maʻalaea Generating Station	HIS000004	North Kihei Road Maui, HI 96753	Individual Permit	Form 2F: stormwater associated with industrial activity	12/16/2014	12/15/2019

*At the time of this report, Maui Ocean Center is currently requesting a NPDES permit modification to increase their wastewater daily discharge volume of effluent from 1.2 million gallons per day to 2.8 million gallons per day. Interim discharge volumes were approved on September 20th, 2018.

This study did not review water quality data associated with individual NPDES permits or their associated discharges within the watershed as these entities are actively regulated by the DOH and permit exceedances have been developed by the regulatory agency to ensure Hawaii water quality standards are being adhered to. As a condition of their NPDES permit, these entities are required to report any exceedance of their permit limitations.

Maui Ocean Center has the only Individual NPDES permit authorizing daily direct discharges of wastewater to surface waters within the Pohakea Watershed. The DOH has noted the lack of mixing within the harbor and has determined that the MOC effluent discharge assists in the mixing of harbor water with coastal water from Maʻalaea Bay. From January of 2016 to December of 2017, MOC had two effluent limitation violations, both for inorganic nitrogen (Nitrate+Nitrite). MOC has recently requested a NPDES permit modification to increase their wastewater daily discharge volume from 1.2 million gallons per day to 2.82 million gallons per day – an increase of 1.62 million gallons per day. Interim discharge volumes were approved on September 20th, 2018.

The Maʻalaea Small Boat Harbor has an Individual NPDES permit for stormwater and has no compliance issues to date.

The Maui Electric Company Maʻalaea Power Generating Facility has a General NPDES permit for stormwater. The facility has experienced several effluent exceedances from January of 2016 to December of 2017. In 2016 they measured exceedances in September and December for stormwater discharge at Outfalls 002 and 003. Parameters in exceedance included Total Nitrogen, Total Phosphorus, Nitrate+Nitrite, Total Copper, Total Nickel, and Total Zinc.

In 2017, MECO recorded outfall exceedances in January, March, twice in April, and in July at either Outfall 002 and/or Outfall 003 for various parameters including Total Phosphorus, Total Nitrogen, Nitrate+Nitrite, Total Copper, Total Nickel, and Total Zinc.

3.3.2 Injection Wells

An injection well (IW) is a bored, drilled or driven shaft, or a dug hole, whose depth is greater than its largest surface dimension; an improved sinkhole; or a subsurface fluid distribution system used to discharge fluids underground (40 CFR Part 144.3). Injection wells and cesspools are regulated by the USEPA under the authority of the Underground Injection Control (UIC) program, as provided by Part C of the Public Law 92-523, the Safe Drinking Water Act (SDWA) of 1974. DOH administers a separate UIC permitting program under state authority.

Fifteen injection well UIC permits exist within the Pohakea Watershed boundary (NPDES and UIC Map). Of these, 13 are used for sewage and two are used for industrial wastewater. These wells are relatively shallow in depth and it is widely believed that sewage wastewater effluent from these wells is making its way through the porous substrate and mixing with nearshore coastal waters, promoting algal growth and having deleterious effects on the environment (Dollar 2011). Table 6 below lists these wells and provides information on their permit number, operator and location within the Pohakea Watershed.

Figure 18. NPDES, UIC, and Cesspool Locations within the Pohakea Watershed

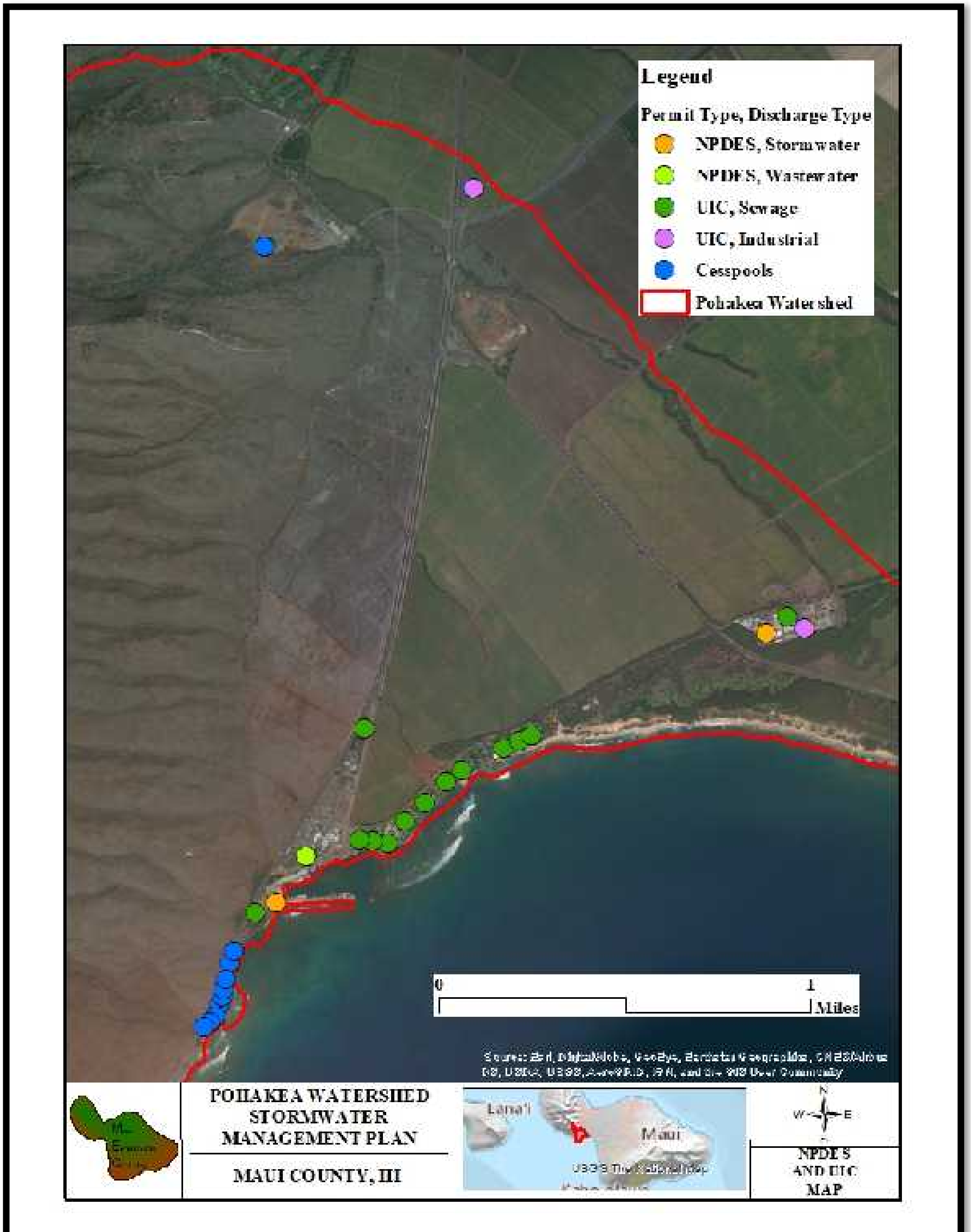


Table 7. UIC Permits within The Pohakea Watershed

Permit Number	Operator	TMK	Discharge Type	Well Classification	Location
UM-2818	HR Bio Petroleum Maʻalaea Facility	Not Listed	Industrial	Class V, Subclass AB	Not Listed
UM-1592	Maʻalaea Power Plant	2-3-8-005-025	Industrial	Class V, Subclass AB	North Kihei Road, Maʻalaea, Wailuku, Maui
UM-2412	Maʻalaea Generating Station, Maui Electric Company	2-3-8-005-025	Sewage	Class V, Subclass E	North Kihei Road, Maʻalaea, Wailuku, Maui
UM-1870	Makani A Kai Condominium	2-3-8-014-001	Sewage	Class V, Subclass AB	300 Hauʻoli St., Maʻalaea, Wailuku, Maui
UM-1871	Hono Kai Resort Condominium	2-3-8-014-002	Sewage	Class V, Subclass AB	280 Hauʻoli St. Maʻalaea, Wailuku, Maui HI 96793
UM-1863	Kanai A Nalu Condominium	2-3-8-014-004,2-3-8-014-005	Sewage	Class V, Subclass AB	250 Hauʻoli St.,Maʻalaea,Wailuku,Maui 96793
UM-1272	Maʻalaea Banyans Condominium	2-3-8-014-011	Sewage	Class V, Subclass AB	190 Hauʻoli St. Wailuku, Maui

Permit Number	Operator	TMK	Discharge Type	Well Classification	Location
UM-1345	Island Sands Condominium	2-3-8-014-015	Sewage	Class V, Subclass AB	150 Hauʻoli Street, Wailuku, HI 96793
UM-1327	Lauloa Resort Condominium	2-3-8-014-016	Sewage	Class V, Subclass AB	100 Hauʻoli St., Wailuku, Maui
UM-1273	Maʻalaea Kai Condominium	2-3-8-014-021	Sewage	Class V, Subclass AB	70 Hauʻoli St., Maʻalaea, Wailuku, Maui
UM-1329	Milowai Maʻalaea Condominium	2-3-8-014-022	Sewage	Class V, Subclass AB	50 Hauʻoli St. Wailuku, Maui
UM-1235	Maʻalaea Yacht Marina Condominium	2-3-8-014-024	Sewage	Class V, Subclass AB	30 Hauʻoli St., Wailuku, Maui
UM-1864	Maʻalaea Mermaid Condominium	2-3-8-014-026	Sewage	Class V, Subclass AB	Hauʻoli St., Maʻalaea, Wailuku, Maui
UM-2625	Maʻalaea Small Boat Harbor	2-3-6-001-051	Sewage	Class V, Subclass AB	Not Listed
UM-1954	Maʻalaea Triangle Wastewater Treatment Facility	2-3-6-001-001	Sewage	Class V, Subclass AB	Maʻalaea Rd & Honoapiilani Hwy

3.4 Nonpoint Source Pollution

3.4.1 Cesspools

Cesspools are of particular concern throughout Maui County. These underground regions are used for the disposal of human waste, where untreated sewage is discharged directly into the ground, leakage from which can contaminate oceans, streams, and ground water by releasing disease-causing pathogens and nitrates.

Residential areas, including the homes located along Maʻalaea Bay Place are served by onsite waste disposal systems, such as individual residential cesspools or septic tanks. DOH and USEPA databases indicate that the island of Maui has several thousand individual small septic or small cesspool wastewater systems. Figure 18 depicts the locations of cesspools within the Pohakea Watershed boundary.

Leaching from these cesspools may be contributing to the high levels of enterococcus and nutrients observed within Maʻalaea. Once in the water, nutrients such as nitrogen and phosphorus can cause algae blooms as well. As stated earlier, high Chlorophyll-*a* values act as evidence of these algae blooms. Due to the fact that enterococcus levels are not attaining water quality standards, pathogens from these cesspools may be making their way into coastal waters in appreciable amounts.

3.4.2 Agricultural Lands

Agricultural lands may provide a nonpoint source for sediment, pathogens, and nutrient pollution. Within the Pohakea Watershed, fallow agricultural plots associated with the now defunct HC&S sugar operation are situated on gently sloping fields east of Honoapiʻilani Highway. Pohakea Gulch and the Waiheʻe Ditches flow through these agricultural lands. In addition, several dirt roads are located within these fallow fields. Sediment from agricultural fields, and roads can make its way into gulches and ditches during stormwater events, ultimately being transported to Kealia Pond and Maʻalaea Bay. Nutrients used for fertilizer such as nitrogen and phosphorus can be transmitted to coastal waters along with sediment. Likewise, bacteria associated with domestic and feral ungulates can be swept off the landscape by stormwater sheet flow.

3.4.3 Landscaped Golf Courses, Resorts and Residential Communities

Several landscapes throughout the Pohakea Watershed are unnatural, requiring irrigation and fertilizer to exist. The Kahili golf course and the numerous condominiums along Hauʻoli Street have manicured grassed lawns and are examples of these unnatural landscapes. When fertilizers are placed in the soil they can be transferred to the ocean by both surface water and ground water. During heavy rainfall, stormwater can carry these nutrients from their source to the ocean through gullies, gulches, stormwater drains and other surface water conveyances. In addition, nutrients can be absorbed into the aquifer and make their way to coastal waters through groundwater flow.

3.4.4 NSPECT Modeling

NSPECT is an informative spatial tool developed by the National Oceanic Atmospheric Administration (NOAA) Coastal Services Center (CSC) for watershed managers and planners (Eslinger, 2012). It is a GIS-based application that models potential water-quality impacts from non-point source pollution and erosion. The model inputs include soil maps from U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), Soil Survey Geographic Database, 30m Digital Elevation Maps (DEMs) from the United States Geological Survey (USGS), annual precipitation from the Parameter- elevation Regressions on Independent **S**lopes Model (PRISM) group, and Coastal Change Analysis Program (CCAP) land cover. Each land cover type has an associated impervious surface co-efficient. Data from each of these sources was downloaded and clipped to the boundary of the Pohakea Watershed and processed using ArcGIS software.

MEC ran the NSPECT model for sediment, nitrogen and phosphorus delivery throughout the Pohakea Watershed. The model provides estimates of both accumulated sediment and nutrients in the gullies and gulches making their way towards the ocean and localized sediment and nutrient contributions based on the model inputs listed above.

It should be noted that NSPECT has known limitations with accuracy and precision when modeling for erosion in wet, steep slopes like those in the upper reaches of the Pohakea Watershed. This is due, in part, to a lack of available data collection from inaccessible mountainous areas. Inputs to NSPECT, such as rainfall days and soil erosion factors, are often very different throughout the landscape being modeled and may not be accurately represented by the input data. In addition, general CCAP designations can skew data. As an example, CCAP data used in this effort designates the fallow sugar cane fields as “Cultivated Land” and does not consider that while this land is agricultural, the bulk of this portion of the watershed is not actively being farmed. MEC recognizes that there are other models available, namely InVEST, and that there are trade-offs between cost-efficiency and higher accuracy (more robust modeling methods and procedures can be costly and time-intensive).

For these reasons, MEC will not discuss quantitative data resulting from the modeling effort in this report but instead has included the results of the NSPECT modeling exercises for localized sediment, nitrogen and phosphorus as figures (Localized Sediment, Nitrogen, and Phosphorus Maps). These figures are offered as qualitative data serving as visual representations of the various sediment and nutrient sources as water flows toward coastal waters. Load estimates for the various pollutants affecting water quality in Maʻalaea Bay and Maʻalaea Harbor were purposefully not calculated or modeled in the Pohakea Stormwater Management effort.

The Localized Sediment Map depicts several areas within the watershed where sediment transport is particularly high. In the lower reaches of the watershed, where the slope of the West Maui Mountains changes from being extremely steep into the various gulches and gullies ultimately leading to the coastline, localized sediment availability is high. In addition, Pohakea,

Figure 19. NSPECT Localized Sediment Map

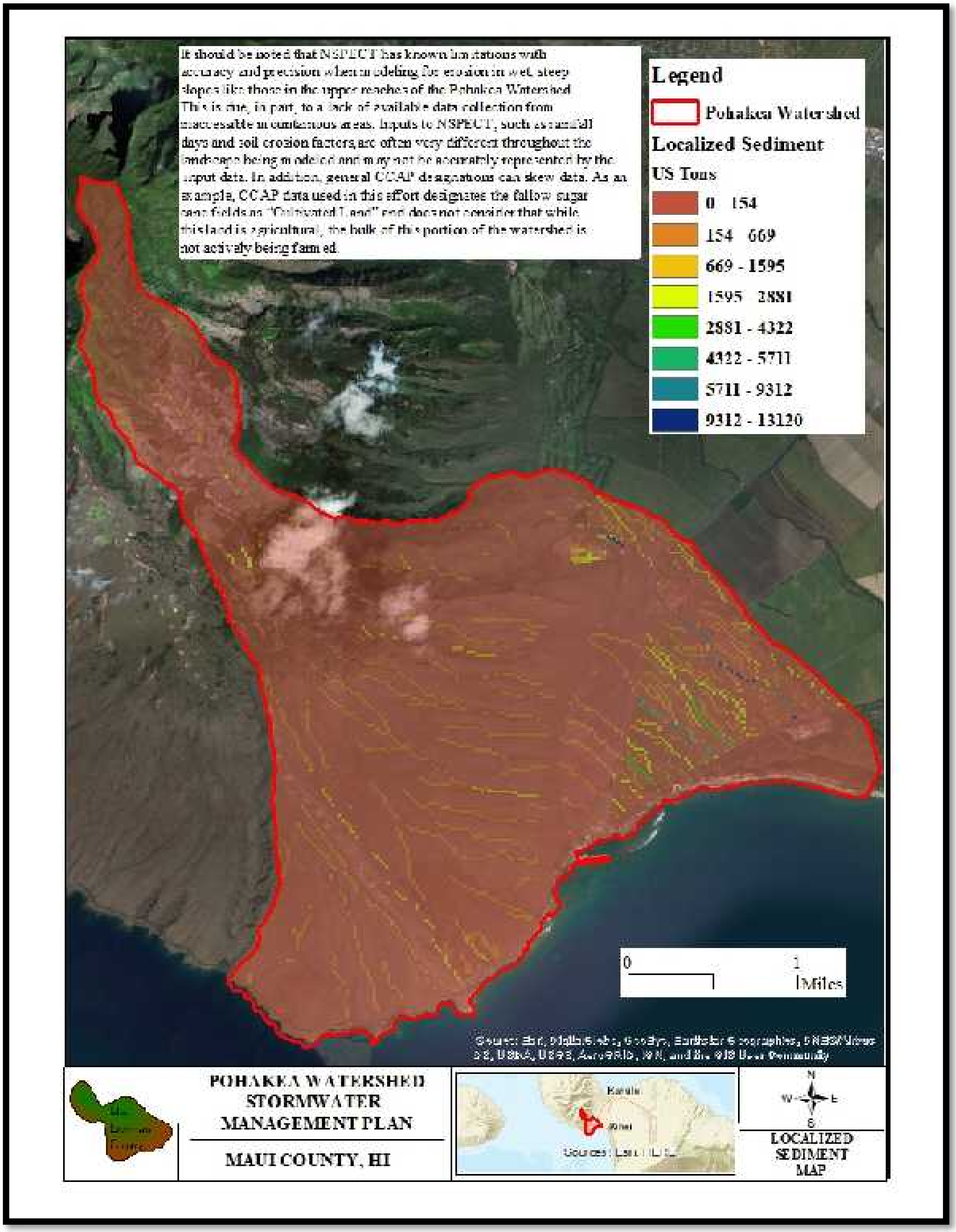


Figure 20. NSPECT Localized Nitrogen Map

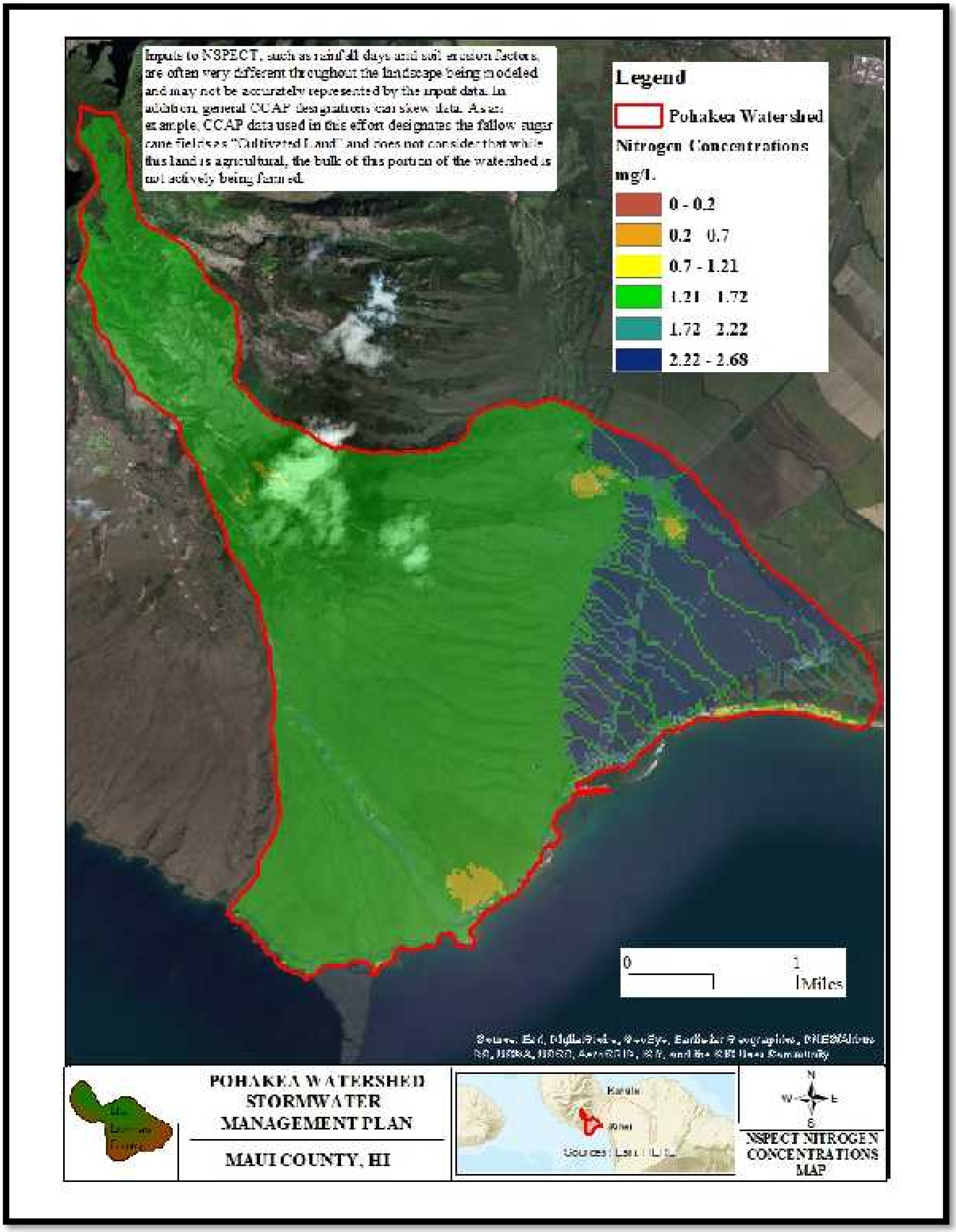
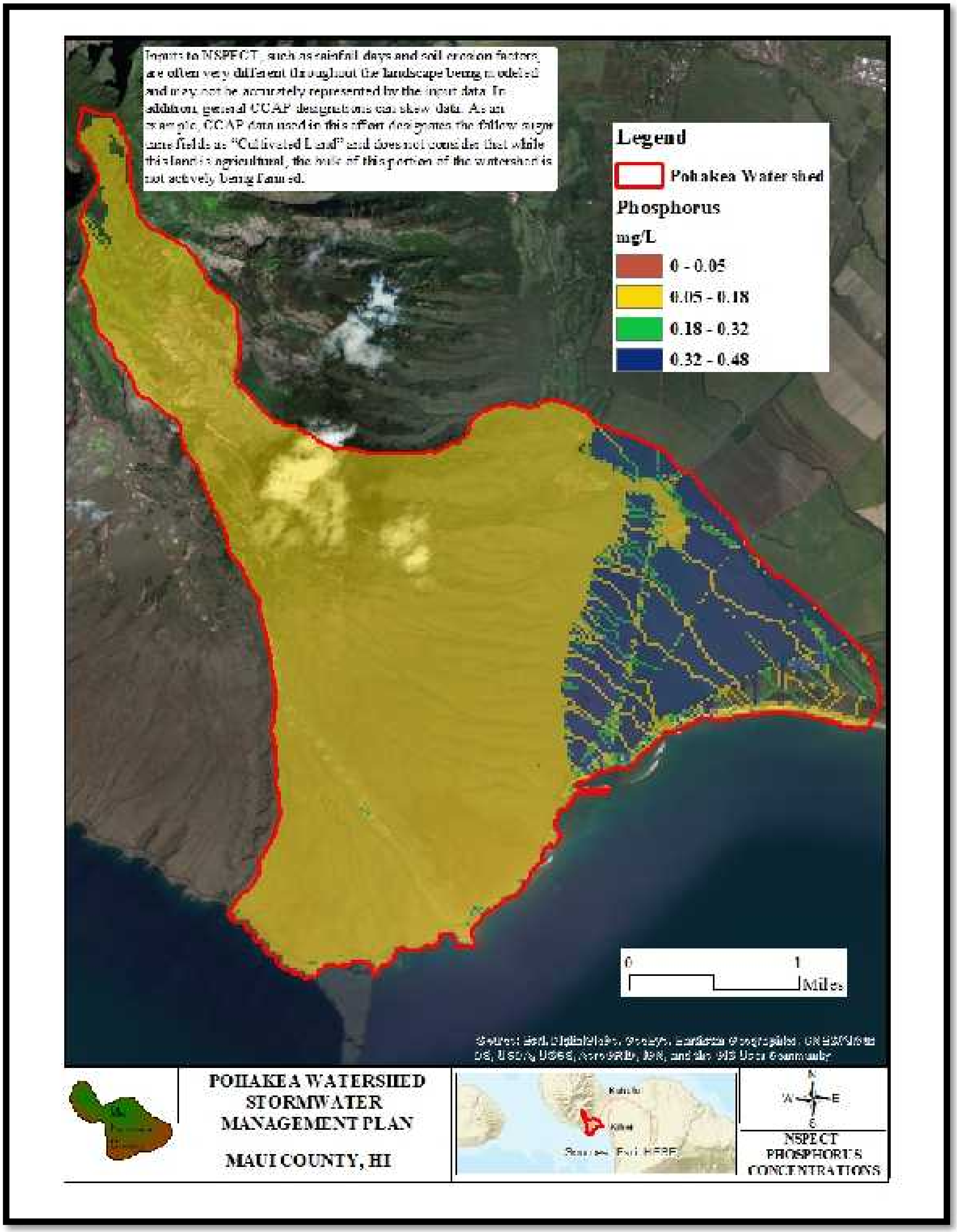


Figure 21. NSPECT Localized Phosphorus Map



Kanaio, and Maʻalaea Streams running through the agricultural lands and the Hawaiian Cement Quarry are listed as elevated areas of localized sediment. The NSPECT model does not consider anthropogenic changes to the watershed and therefore, the hydrologic impacts of the Waiheʻe Mauka and Makai Ditches with regard to these streams are not accounted for in the model.

The Localized Nitrogen and Phosphorus Maps model for nutrient concentrations records high amounts in those land uses associated with agriculture and the highly developed land associated with the Maʻalaea condominiums, business district, and harbor. As stated above, the NSPECT model does not consider anthropogenic changes to the watershed and therefore, the hydrologic impacts of the Waiheʻe Mauka and Makai Ditches with regards to these streams are not accounted for in the model.

4.0 MANAGEMENT PROJECTS AND STRATEGIES

The Pohakea watershed is characterized by long periods of up to several years with little to no rainfall. Discharge from gulches and gullies into Maʻalaea Harbor and Maʻalaea Bay rarely occur. Unfortunately, when stormwater events do occur, the potential for flash floods, and very large stormwater volumes is possible within this watershed. The occurrence of these extreme flooding events is only likely to increase as weather patterns change due to climate change. Any stormwater mitigation measures and restoration activities must be engineered to handle the high flow events that will eventually occur.

In addition, extremely limited water quality data exists for the watershed. As stated earlier, the DOH CWB currently only monitors at one location within the entire 5,268-acre area, at Haycraft Beach. While this location is important as a public park providing fishing, swimming, and other recreational activities, no stream outfalls exist at this location. For this reason, the Pohakea Water Quality Monitoring Plan was created for the Pohakea Watershed and is included as Appendix B to this stormwater management plan. At a minimum, if none of the other management projects and strategies listed below are implemented, the Pohakea Water Quality Monitoring Plan (or portions of this plan) should be implemented to narrow existing data gaps in water quality issues affecting the watershed and to better determine where sediment and nutrient pollution is occurring throughout the watershed. The following sections provide projects and strategies designed to address specific land use issues known to occur or observed in the field during this study. Stakeholders in the watershed are encouraged to collaborate on and actively participate in the implementation of these projects. Load reduction estimates for each of these projects were purposefully omitted from the Pohakea Stormwater Management Plan and are outside the scope of this effort.

4.1 Mauka/Conservation Lands

4.1.1 Unimproved Roads

The miles of poorly maintained and disused former agricultural roads are major sources of sediment transfer and pathways for channeling stormwater runoff into stream gulches. A comprehensive inventory of the Pohakea Watershed’s roads should be conducted to determine stakeholder access needs and roads that are candidates for decommissioning or repair. Closing

roads using structural methods (barriers) such rocks, logs, or vetiver plantings can capture sediment and attenuate runoff. The roads observed in upland areas are severely compacted, and the soils have lost most, if not all, of their stormwater infiltration capabilities. In coordination with landowners and potential road users, disused, and unnecessary or redundant roadways should be identified for decommissioning, and roads likely to stay in use improved using water bars, sediment traps and BMPs to minimize downslope transport of eroded sediments such as the BMPs found in the document entitled: Unpaved Road Standards for Caribbean and Pacific Islands.
See: https://dcrm.gov.mp/wp-content/uploads/crm/2017IslandUnpavedRoadStandards.pdf

Roads for stabilization and closure should be prioritized based on 1) public use needs, 2) slope, 3) percentage of sand, silt, clay, and stone, 4) erosion and infiltration rates, and 5) likelihood of transport to streams/gulches based on models developed by Ramos-Scharron in 2009. Other agricultural roads on Maui have been decommissioned based on the following criteria:

1. Roads with high levels of erosion and deep ruts that render them dysfunctional as a road.
2. Those roads which have clearly not been used for at least two years.

Mauka roadways in Pohakea that are contributing to sloughing and landslides should be prioritized as well as those that are directly contributing sediment and stormwater into gulches.

Lines of vetiver can be planted on contours across disused roads. These lines serve to interrupt and spread stormwater flows, capture sediment, and infiltrate water safely into the ground. As plants mature, and especially if coupled with stones or other physical barriers, they effectively delineate a road as decommissioned. It is important to conduct stakeholder engagement with any potential road users such as fire crews, rangers, illicit dirt bikers, hunters, hikers, etc. to help select sites and ensure potential users understand the purpose of the road closure barriers and plants so they are left intact. Signage can also be useful to convey this information.
Table 7 below provides a sample budget for decommissioning roads based on similar projects in West Maui. Note that this sample budget is for the decommission of 1,000 feet of roadway with the use of vetiver and native plants and assumes an average of one vetiver row per 100 feet. In addition, it assumes volunteers will be used for digging and planting, that no ungulate fencing will be installed and that site access via 4x4 truck is available.

Table 8. Sample Budget for Decommissioning Dirt Roads Using Vegetation

Item	Cost $
Installation Supplies:	
Plants, equipment, and irrigation supplies	7,500
Surveying and site prep	2,000
Transportation and fuel	1,200
Total:	10,700
Maintenance:	
Initial watering and establishment (first 2 months)	3,200

Item	Cost $
Adaptive management/maintenance	800
Total:	4,000
Monitoring:	
Supplies (tape measures, erosion posts)	500
Soil lab tests	500
Monitoring transportation and fuel	2,400
Total:	3,400
Staff:	
Project management; volunteer coordination, and outreach	8,000
Technical/design consulting	4,000
Monitoring overall effectiveness	2,400
Total:	14,400
Contingency costs (15%)	4,875
Project TOTAL	**$37,375**

Based on initial monitoring results from similar projects, the above project can capture and retain approximately10-15 tons of sediment in one year (CORAL unpublished data). Projects should be coordinated with existing restoration activities being conducted in the area. Potential partners include Maui Cultural Lands, West Maui Mountains Watershed Partnership, and DLNR.

4.1.2 Powerline Corridors

Similar to the recommendations for unimproved roadways, the extent to which access is needed and vegetation must be controlled or removed from powerline corridors should be assessed. Disused or inactive corridors should be decommissioned, and active corridors managed to minimize disturbance of native vegetation while still maintaining corridor safety and access requirements. An assessment of where utilities can be place underground should also be conducted (see MECO Powerline Corridors section below).

4.1.3 Wildfires

Extremely windy conditions and aging infrastructure make powerline corridors vulnerable ignition sources for wildfires. During field observations, a recently burned area associated with a mauka powerline corridor was observed, as well as a number of downed lines, and aging powerline poles. While a wildfire prevention and mitigation strategy is beyond the scope of this document, the loss of vegetation and subsequent erosion resulting from wildfires is well documented in this area, and every effort should be made to prevent their occurrence in collaboration with Maui Electric Company.

The Hawaii Wildfire Management Organization is a 501(c)(3) non-profit working in Hawaii to protect the environment from wildfire damage. Their goals are to prevent wildfires, mitigate for their impacts, aid in post-fire recovery, and to provide for a collaborative environment. In

2016, they made the following movie discussing the recent Ma‘alaea wildfires and their effects on water quality in the watershed:
(https://www.youtube.com/watch?time_continue=18&v=ZtsG5fP-Z9Y)

After fires are extinguished, restoration activities should be coordinated and targeted to quickly stabilize newly burned areas with appropriate planting. Techniques such as hydro mulching with native plants, which have been piloted in West Maui by the Pu‘u Kukui Watershed Preserve (https://www.puukukui.org/) have potential application in this regard, but further refining of the methods is needed within dry land contexts as well as further study of the overall ecological response of plant communities and vegetation regrowth following fires in this particular area.

4.1.4 Wind Farm Road

While the access road leading to the windmills is in excellent condition, incorporating good use of road management BMPs, overall road performance and erosion prevention could be improved in a number of places along its stretch. The steep grade of this road makes it an ideal candidate for the strategic planting of vetiver and native plants at kickouts and water bars which would have the added advantage of preventing imported (expensive) gravel aggregate from washing off the roadway into adjacent gulches. Vetiver, when planted on road kickout contour lines (The line joining equal elevation points along a surface), can trap sediment and prevent it from being conveyed into the stream gulch. It can also effectively filter and sink water flowing off of the road, thereby meeting road maintenance goals without compromising sediment mitigation objectives. This technique has been successfully piloted and refined in West Maui where the presence of either of two specific factors was deemed to lead to the most overall success of the method: 1) High maintenance capacity to remove accumulated material in a timely manner, and 2) a steep grade of the road combined with aggressively cut water bars to create ample ‘freeboard’ or storage space for accumulated material to gather. Both of these conditions are present along the wind farm access road.

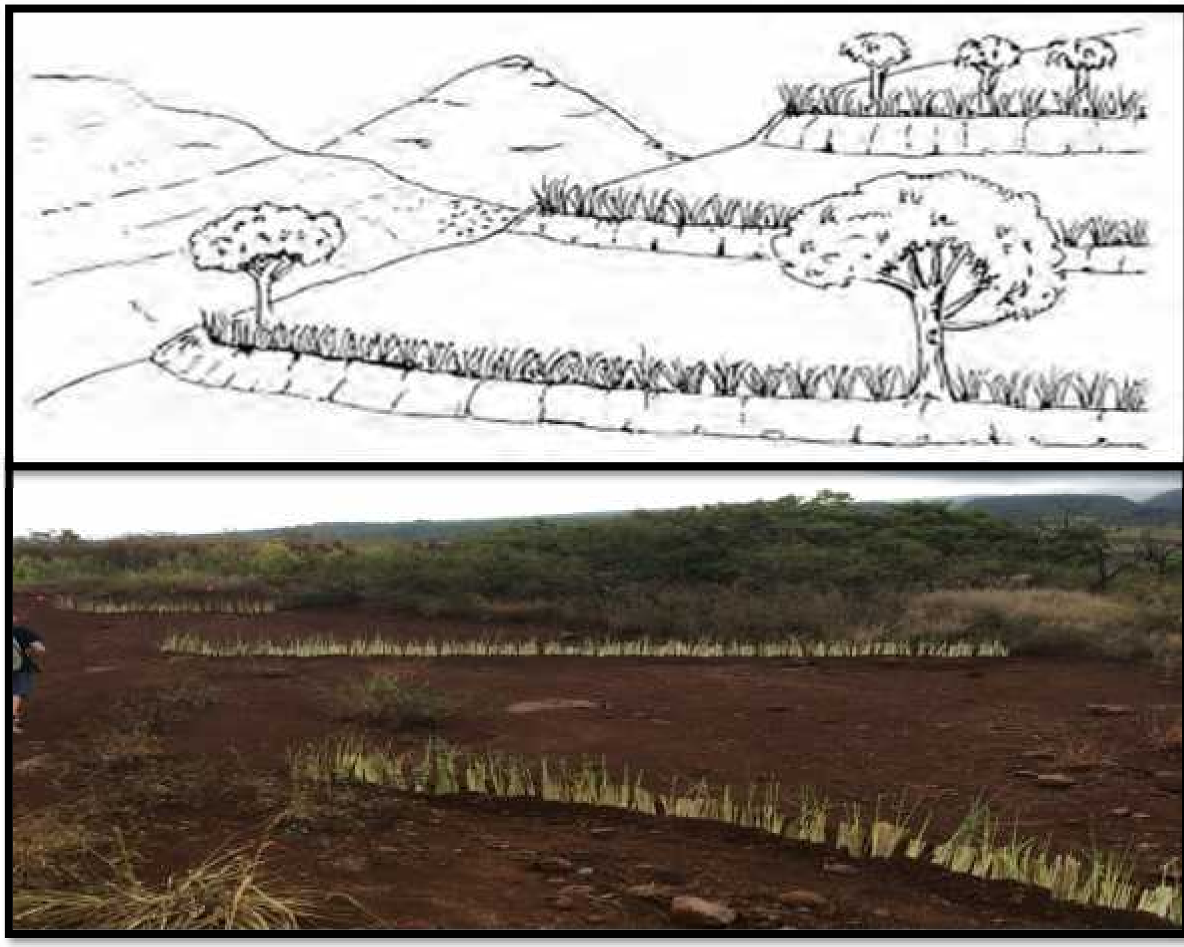
4.1.4.1 Detention Structure at the Bottom of the Wind Farm Road

Located at the bottom of the wind farm access road is a parking area that could accommodate a detention structure. This structure would detain stormwater flowing down Malalowaiaole Gulch and allow sediment as well as any roadway aggregate to settle out of suspension instead of being discharged into the ocean (See figure 6. Discharge Locations Map). Culverts currently directing this flow under the Honoapi’ilani Highway represent a bottleneck or constriction point in the stormwater flow that could be retrofitted to accommodate a stand pipe or other control structure that would increase stormwater retention times before discharge.

4.1.5 Land Slides

While the scale of this problem is extensive, attempts to mitigate the loss of topsoil and native vegetation caused by sloughing and mini landslides should be piloted in mauka areas adjacent to major gulches. Preserving high quality functional native habitat should be a priority. Drawing upon lessons learned from projects conducted in Hawai‘i and other high islands in the Pacific, a better understanding of the geologic processes causing this problem is needed. Hillslope stabilization methods could be employed at strategic locations in mauka lands that are vulnerable to landslides. The NRCS Practice 601 for vegetative barriers is offered as an example: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_010398.pdf) This practice involves planting vetiver or other suitable vegetation on contour to stabilize actively eroding hillslopes, capture sediment, and to promote the infiltration of stormwater sheet flow into the ground so that it does not move laterally across the landscape. This practice consists of planting rows of vegetation along contour lines with vertical distances of six feet between lines. This practice also has the potential to allow for the reintroduction of Hawaiian native plants and trees which can be planted behind the vegetation rows as a suitable soil base accumulates.

Figure 22. Examples of Contoured Vegetative Barriers



Vegetative Barriers (such as vetiver) planted on contour for topsoil protection and sediment runoff capture (USDA NRCS Practice 601)

4.2 Mid-level Ag Lands

4.2.1 Head Cuts Immediately Mauka of Highway

Due to the substantial and ongoing losses of sediment observed at head cuts just mauka of the highway, head cut stabilization is a priority recommendation for preventing sediment loss within the project area. Head cut stabilization is accomplished by either 1) excavating the actively eroding knickpoint (cliff) and incised stream banks to substantially reduce the slope, or 2) by filling in the incised channel below the knickpoint having the same result.

Both these methods serve to reduce stream flow velocity which prevents further scouring and erosion, however filling in the channel is not possible in these cases due to the presence of the highway just below the head cuts. Along the newly reshaped stream channel slope, boulders are used to create riffle pools which further reduce stream flow velocity and allow one pool to fill up before spilling into the next. Head cut stabilization and restoration is greatly enhanced by including native plants to further prevent erosion and maintain the new channel shape.

There are at least four sites that are candidates for head cut repair in Pohakea. They range in height from 1-2 meters, to over 8 meters high. The larger head cuts will require substantially more excavation in order to be effectively stabilized and restored, and costs will increase concurrently. Due to the flashy nature of the Pohakea Watershed characterized by long periods with little to no rain punctuated by substantial and damaging stormwater flows, any head cut stabilization or stream channel reshaping must be engineered to handle these high flow events.

It is also important to address the underlying initial causes of the head cuts. In these cases, it appears that the constriction points created by the box drains and culverts where stream flow is directed under the highway are significantly undersized, and cause water to back up, creating head cut conditions. An example of a head cut repair can be found here:
(http://geographicconsulting.com/2017/02/14/head-cut-repair-stabilizing-reforesting-stream-banks-bed-st-croix/)

Figure 23. Examples of Head Cutting and Stabilization

An example of a head cut stabilization project in, St. Croix in the US Virgin Islands. The initial head cut (above) is very similar to those observed in Pohakea. The stabilized St. Croix project head cut (below), which uses step pools, boulders, and incorporates native plants, represents a possible solution for the Pohakea head cuts (Horsley Whitten, 2017).

For illustrative purposes, the budget for the above referenced project is outlined below.

Table 9. Example Budget Using the Head Cut Stabilization Project in St. Croix Shown Above

Head Cut Stabilization Budget	
Task Description	Cost ($)
Site Topographic Survey and Preliminary Design	12,700
75% Engineering Design Plans	13,500
Permitting	25,000
Construction Plans	13,800
Construction Administration	13,650
Construction Oversite	42,350
Construction:	
Mobilization	13,700
Site Clearing and Grubbing	15,000
Excavation and Hauling	38,000
Fine Grading and Compaction	20,200

Head Cut Stabilization Budget	
Task Description	Cost ($)
3/4-inch Stone	4,000
12-inch Stone	5,500
Boulders	28,850
Fencing and Gate	6,750
Erosion Control	5,000
Landscaping	12,000
Watering and Plant Replacement	3,000
Total Implementation Cost	$260,300
Total Project Cost	$273,000

Due to the relatively high expense associated with head cut stabilization, and therefore the unlikelihood that these problems will be addressed in a short time frame, MEC recommends that monitoring at known head cut locations begin immediately so that continued soil loss can be quantified and documented. Monitoring of continued head cutting can be accomplished by inserting rebar vertically into the soil at the current extent (bank width and reach) of the head cutting and then in standardized increments moving up the stream channel. In this manner, after stormwater events, soil loss could be quantified based on how much soil has been lost in between rebar posts.

4.2.2 Quarry

The Hawaiian Cement Quarry is positioned at a vulnerable location on an existing debris flow. While an extensive survey of the site is not included within this report, it is essential that best management practices are implemented in and around the quarry to prevent loss of alluvium deposits to the surrounding streams and gulches. One area in particular observed was the entry and exit point to the quarry, where heavy trucks have to cross a portion of the Waiheʻe Mauka Ditch. This area should be managed to prevent sediment loss from the road surface and from trucks entering and exiting the facility.

Quarrying activities in this area could have synergies with stormwater mitigation goals. For example, quarries and mines are required to have a ‘closure plan’ in place that details the effective lifespan of the operation, and includes the details of closure and landscape reclamation requirements. This quarry is well positioned to receive flows from Pohakea Stream, and could be redesigned as a stormwater detention/infiltration facility once the quarrying activities reach the end of their effective lifespan. The following is an example of a quarry converted into a stormwater facility and public park:
https://csengineermag.com/article/converting-a-degraded-quarry-into-a-community-asset/)

Earthmoving, excavation, and hauling of excavated material represents a significant portion of the total cost associated with construction of a stormwater detention or infiltration facility. It could be possible to coordinate excavation and earthmoving needs with stormwater detention needs such that today's borrow pits and fill excavation sites could be tomorrow's stormwater detention basins.

4.2.3 Landfill

Verification of the use of landfill capping best management practices is recommended as well as further study of the portion of Pohakea Stream that runs along the edge of the landfill to ensure this area will not be undermined during a sizeable storm event when the stream flows.

4.2.4 Waiheʻe Ditch System

The hardened channel of the Waiheʻe Makai Ditch that runs adjacent to the highway collects substantial roadside rubbish and should be more effectively maintained as the bulk of this material is likely to end up in the ocean during a high flow event. It is unclear if the ditch itself is part of any existing roadside cleanup efforts, but it could be incorporated into 'Adopt a Highway' programs, volunteer efforts from organizations like Malama Maui Nui, Maui County and/or Department of Transportation litter control efforts. Organizations that regularly do 'Beach Cleanups' could be encouraged to clean up this channel as an alternative, and keeping this channel free of rubbish will likely have a far greater impact than waiting until this garbage makes its way downstream to the Ocean and onto beaches in Maʻalaea.

The Waiheʻe Mauka Ditch pathway that is now being utilized as a powerline corridor is severely eroded and is an active sediment transport pathway during high flow events. This corridor was the source of mud flows running onto Honoapiʻilani Highway during recent storm events. This road represents a significant source delivering sediment into Maʻalaea Harbor and should be targeted for restoration activities. Restoration methods to capture and retain sediment suitable for this area are similar in nature to those found above (See Unimproved Ag Roads and Landslides sections).

The ditch pathway is approximately 9,000 feet long from its last assumed functioning reservoir to the terminus at the highway near Maʻalaea Harbor. To install a suite of implementation projects along this entire length (utilizing the budget numbers associated with road decommissioning cited above, the total cost would be ~ $336,375.00.

4.2.5 Sugar Cane Ag Roads

Now that sugar cane is not actively being cultivated in the area, an assessment of the current necessity and future needs of dirt agriculture roads should be conducted (see ag roads section above). Locations where agriculture roads parallel or cross the stream gulches provide areas where erosion can occur and can often act as a sediment source for stormwater moving through the watershed. Because several years may pass between major storm events, and these gulches and stream corridors remain dry for long periods of time, personnel should be educated on best management practices when working in riparian corridors or near wetlands so that when major events do occur, soil loss is not exacerbated by these daily operations or periodic construction activities.

4.2.6 Fire Breaks

While preventing the spread of brush fires within the formerly cultivated sugar cane fields is important, the observed practice of ripping/plowing the field edges near the road 1) Does not appear to provide a long-term effective fire break because regrowth of sugar cane biomass was observed within the plowed areas less than one month after planting, and 2) the bare areas are potential sediment sources during rain events. Plowing should be combined with sowing a suitable cover crop. The ideal crop would provide an effective firebreak by not creating excessive biomass, be dense growing to prevent sugar cane regrowth, and ideally be a nitrogen fixing legume that could nourish degraded soils. A suitable cover crop or crops should be chosen through collaboration with Natural Resources Conservation Service (NRCS) technical specialists. Guidance for cover crop uses in Hawaii can be found at the link below.
https://cms.ctahr.hawaii.edu/soap/Resources/Sustainable-and-Organic-Topics/cc-gm

4.2.7 MECO Powerline Corridors

Extreme caution must be exercised when conducting maintenance and repair in transmission and distribution powerline corridors because they are often sited within and adjacent to stream riparian corridors. Grading and grubbing activities must be conducted in a way that ensures that sediment deposits are not left in the regular flow path or floodways of streams to be transported downstream during stormwater events. Stream beds should not be overly disturbed and spoil piles or other loose material should be relocated well out of reach the stream flood plain. While riparian corridors may provide linear pathways for utilities offering minimal impacts to available agricultural lands, these same areas are prone to flooding and can cause additional maintenance and safety issues in the long term for utility companies. For example; when utility poles are installed in damp soils, they are more prone to rot and can fall over in high winds or saturated soils. As stated earlier, this was recently the case along Pohakea Stream when several utility poles had to be replaced after being undermined by heavy flows within the riparian corridor.

Relocating this infrastructure away from stream corridors to follow agricultural roads instead will lower maintenance costs for utility companies while enabling farmers to partner with utility companies to share the cost of road maintenance. Wherever possible powerlines should be installed underground. Although initially more expensive, underground utilities are an important part of creating a resilient infrastructure as they don’t blow over in storms and are less likely to spark wildfires. Underground utilities could also potentially have less impact on sediment transfer as the corridors do not require the same level of vegetation removal and maintenance as above ground lines and poles. Hawaii Revised Statute § 269-27.6 (https://law.justia.com/codes/hawaii/2013/title-15/chapter-269/section-269-27.6) requires that new installations of transmission lines are assessed by the Public Utilities Commission (PUC) to determine the merits of underground versus above ground installation. Factors that must be considered in this decision process include:

- Overall benefits outweigh costs
- Public sentiment
- Government requirements
- Funds availability
- Environmental impacts
- Tourism industry impacts

The PUC and the above mechanism could be a potential avenue to explore for lessening the overall negative impacts from sediment transfer caused by improperly placed powerline corridors.

4.2.8 MECO Facility

While this site does have a NPDES stormwater permit, a detailed survey of the MECO Power generation facility is recommended because there are most likely opportunities to mitigate the site's potentially large stormwater footprint through bioretention or other Low Impact Design (LID) techniques. An assessment could also ensure that any other surface discharges are properly treated through appropriate management practices before being released into Pohakea Stream and/or Kealia Pond. The area where Pohakea Stream discharges into the pond should be assessed for sediment transport. There are plans to construct an earthen berm around the southern end of the facility in 2019 to contain stormwater runoff.
http://gokihei.org/environment/meco-meeting-regarding-proposed-detention-basin-at-maalaea

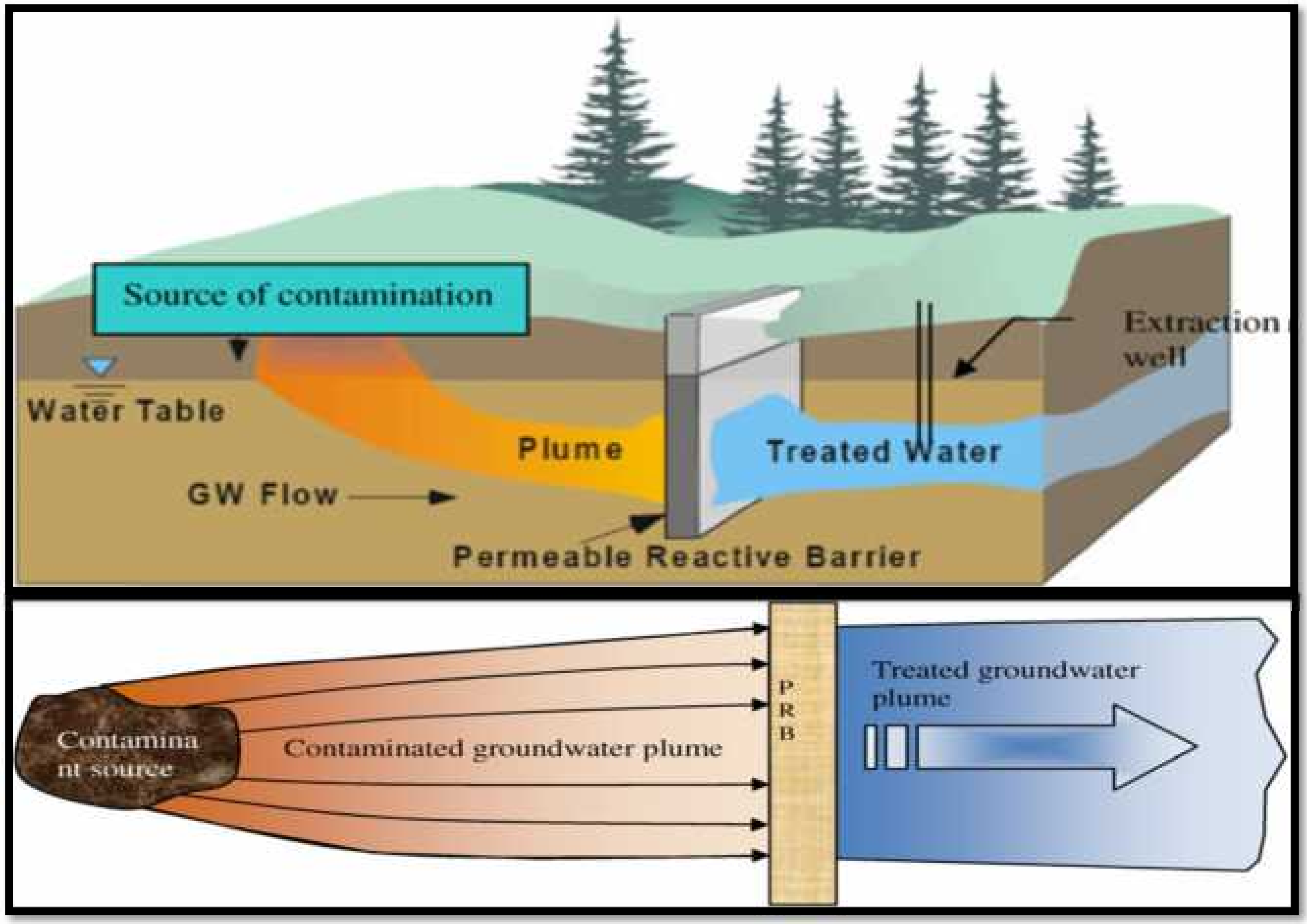
4.2.9 Kahili Golf Course

While a relatively small portion of the golf course falls within the project area, there are numerous turf management BMPs that can effectively reduce nutrient stormwater runoff and groundwater pollution on golf courses. Recent examples successfully piloted in West Maui include:

4.2.9.1 Nutrient Curtain

The Permeable Reactive Barrier (a.k.a. 'nutrient curtain') is constructed by excavating a trench approximately three feet wide, and four feet deep and long enough to bisect the groundwater moving through the area. It consists of a mix of hardwood chips, sand, sawdust, and activated charcoal (a.k.a. 'biochar'). This precise mixture converts nitrogen pollution contained in the groundwater into atmospheric nitrogen effectively filtering pollutants from groundwater passing through. This process requires no maintenance once installed and has a long effective lifespan because charcoal lasts for hundreds of years when buried in the soil (charcoal makes up a substantial portion of ancient archaeological sites in the Amazon Basin as well as Pacific Islands). There may be a slight loss in nutrient removal efficiency when the woodchips eventually break down (10-15 years), but the system will still function well beyond this time horizon.

Figure 24. Nutrient Curtain (Permeable Reactive Barrier) Example



A sample budget for a nutrient curtain 40’ long x 4’ wide x 4’ deep is included for illustrative purposes (depth is dependent upon depth to groundwater and may be more or less):

Table 10. Sample Budget for Nutrient Curtain Installation

Item	**Cost**
Site planning and design	$4,000
Excavation	$3,000
Materials (biochar, woodchips, sand, and sawdust)	$5,000
Construction management and oversight	$3,000
TOTAL	**$15,000**

4.2.9.2 Floating Treatment Wetland (FTW)

A floating treatment wetland (FTW) can improve the pollution treatment effectiveness of a wet retention pond. An FTW consists of a floating raft of buoyant material that is deployed on the surface of the pond, on which aquatic plants are grown hydroponically. Plant roots take up nutrients to support plant growth. The roots hanging down in the water column provide an ideal habitat for denitrifying bacteria. These bacteria remove nitrogen from the water and convert it into nitrogen gas which bubbles out of the water and is released into the atmosphere.

Figure 25. Floating Treatment Wetland Examples

Costs vary widely depending upon the overall size and complexity of the floating treatment wetland. Assuming volunteer labor is used to assemble the wetland, a small (8’ x 8’) version of a floating treatment wetland can be constructed for less than $1000. Kahili Golf Course greens managers should be partnered with to implement this nutrient reduction strategy. Detailed instructions for creating a FTW can be found at the link below.
https://coral.org/wordpress/wp-content/uploads/2017/11/2017_Maui_CaseStudies_FloatingTreatmentWetlands_Final.pdf

4.2.10 Fallow Pastures and the Proposed Spencer Homes Agricultural Subdivision

The part of the Pohakea Watershed landscape containing fallow pastures located between the base of the West Maui Mountains and the highway form a relatively gently sloped plain. Currently, this area is slated to become the Spencer Homes Agricultural Subdivision. This land has significant potential to mitigate sediment transport to the ocean through a number of restoration activities. There has been public support for Maui County to acquire this land in an effort to curb additional development and to provide opportunities to address fire and stormwater issues within the watershed.

During high flow events millions of gallons of stormwater pour down out of the West Maui Mountains and onto this plain. Restoration measures would have the collective goal to slow, detain, filter, and permeate into the ground as much of this stormwater as possible. There may be existing structures in this area such as old reservoirs associated with irrigation infrastructure and the Waihe‘e Mauka Ditch running along the base of the mountains that could be repurposed or renovated to serve as detention infrastructure. Ideally, detention infrastructure would be decentralized with multiple practices installed using a ‘treatment train’ approach whereby the collective impact of the overall stormwater treatment system is greater than the sum of its individual components.

An example of this approach would be several smaller detention basins and infiltration structures along a stream reach instead of one massive basin at the bottom of the stream. This method effectively spreads out the overall treatment burden, as well as the risk of failure or a practice becoming overwhelmed (such as what occurred at the failed detention basin near the bottom of Kanaio Stream). Practices that could be used to accomplish optimal infiltration of stormwater include both ‘hard’ engineered methods such as detention basins as well as ‘soft’ methods such as vegetated bioswales and filter strips. Examples include, but are not limited to:

- High flow diversions that channel excessive stormwater out of a stream and into a suitable treatment system in the floodplain.
- In stream detention basins
- Off stream detention basins
- Stream channel restoration: geoengineering solutions that serve to restore stream/gulch functionality by reconnecting the stream with the adjacent flood plain.
- Infiltration wells (aka dry wells) and trenches are structures designed to rapidly infiltrate stormwater.

4.2.10.1 Multi-Pond System

A dry land multi-pond system such as this example from Los Angeles County, California would be ideal to attenuate high flows coming down the streams in the Pohakea Watershed. High flows would be diverted out of streams into a series of stepped ponds that would remain dry most of the year.

Figure 26. Multi-Pond Systems

4.2.10.2 Detention Basins in Series

Example of a detention system from Wahikuli, West Maui that combines a high flow diversion coupled with a series of infiltration basins designed to slow filter and sink stormwater safely into the ground.

Figure 27. Detention Basins in Series

4.2.10.3 Large Single Detention Basins

Detention basins function by allowing for high flows from the stream to enter the basin, where sediment settles out as water infiltrates into the ground. Overflows pass through a stand pipe and there are additional failsafe mechanisms in case the basin becomes overwhelmed by excessive stormwater. Access roads associated with the basin allow for periodic removal of sediment with heavy equipment.

Large detention basins can be engineered to function as recreational facilities or green spaces. Few people visiting the Saturday Swap meet at UH Maui College realize that they are shopping within a stormwater detention and management system. This is an excellent example of a multi-use stormwater facility with multiple user beneficiaries. Other examples have combined stormwater detention with sports fields, golf courses, public parks, or other green spaces**.**

Figure 28. Large Single Detention Basins

4.2.10.4 Stormwater Wells

The underlying geology in Pohakea Watershed consists of layers of volcanic deposits; some containing rapidly cooled lava that is brittle and highly porous, while other deposits are denser as a result of having cooled more slowly. Dense layers do not allow water to rapidly percolate, while the less dense, porous layers promote surface water infiltration into the aquifer. This latter geology has the potential to infiltrate significant amounts of water provided engineered wells and trenches are suitably high enough above underlying groundwater tables and the bottoms of wells and trenches can access enough porous (less dense) strata to allow water to permeate through the soil. Infiltration wells, trenches, or French drains are all designed to convert surface water into groundwater by sinking excess stream flows safely into the ground. Acting like a 'reverse well', this approach has the added benefit of effectively recharging freshwater aquifers.

4.2.10.5 Stormwater Infiltration (Dry) Wells

These wells are **s**imilar in construction to a cesspool. This open-bottomed well structure is installed surrounded by gravel and wrapped in a geotextile cloth to prevent fine sediment from clogging the well, which would reduce infiltration performance over time. Stormwater is directed into the well where it drains effectively into the ground. Infiltration wells can be as simple as a pit filled with rubble or as complex as a prefabricated concrete structure. UIC permits are typically required for the installation of infiltration wells.

Figure 29. Stormwater Infiltration Well

4.2.10.6 Infiltration Trench or French Drain

This structure is similar to a well except that it is configured as a long trench filled with gravel or a perforated pipe which spreads water over a larger area. Excess stream water could be directed into a trench, provided the water did not contain significant fine sediment particles which might eventually clog the system.

4.3 Commercial and Urban land

4.3.1 Stream Diversions

Kanaio Stream is currently diverted into the Waiheʻe Makai Ditch that runs parallel to the highway. Downstream from the highway, about 2,000 feet of the Kanaio Stream pathway is still visible winding its way through the fallow sugar cane field. Before it was diverted, this stream likely discharged into a wetland area in the vicinity of Haycraft Beach. This disconnected portion of Kanaio Stream would be a good candidate for stream channel restoration, and reestablishment of pre-alteration flow regimes. Coupled with appropriate infiltration and detention BMPs, restoration of this essentially 'dead reach' would have the added benefit of reducing flow volumes currently directed into the previously mentioned failed detention basin.

Figure 30. Example of a Restored Stream Reach

Example of a restored stream reach that incorporating course woody debris, native plants (both which increases nutrient uptake), and stepped pools constructed with boulders (that slow down the erosive forces of the water).

Figure 31. Example of a Stream Channel Restoration

Stream channel restoration and stabilization projects usually include step pools and rip rap to reduce erosive action and increase infiltration.

Costs vary widely with stream restoration projects, and are most dependent upon site access, proximity and cost of aggregate materials (sand, boulders, etc.), and quantities needed to fill the incised stream channel. A study in North Carolina (an early adopter of stream restoration methods) found an average cost of $242.12 per linear foot of stream restored (Templeton, 2008).

While the costs are likely significantly higher in Maui, this figure is included for illustrative purposes. In many cases, the largest proportion of the costs of stream channel restoration is associated with temporarily diverting stream flow around the area being restored to allow access by heavy equipment. In the case of Kanaio Stream, the stream is already diverted, essentially eliminating this expense. This also could allow a longer-term phased approach to restoration activities conducted in the disconnected stream channel. The existing stream channel (makai of the highway) is approximately 2,000 feet in length, and from its terminus in the fallow sugar cane field, it is approximately another 1,500 feet to the wetlands associated with Kealia Pond (near to Haycraft Beach Park at the end of Hauʻoli Street. Presumably, Kanaio Stream historically flowed into these wetlands, which likely extended beyond their present-day boundaries. Using the costs cited above, an estimate to restore the entire 3,500 feet would be $847,420. It may be that these costs would be substantially lower than this figure due to the fact that the Kanaio Stream channel still exists makai of the highway, the stream is ephemeral and rarely flows, and because there is one property owner throughout the restoration footprint.

4.3.2 Dirt Lots and Parking Lots

Dirt parking lots in the vicinity of the harbor should be targeted for improvement. At the very least, they should be improved with gravel, pervious pavers, or another suitable substrate. Ideally, they should be curbed, and all runoff directed into low impact design elements such as bioretention to capture and infiltrate stormwater. The paid parking across from Buzz's Wharf is too close to the ocean, and should be eliminated, and the compacted soil revegetated and restored.

4.3.3 Maʻalaea Triangle Parking Lot

There is ample space within this lot to incorporate a suite of Low Impact Design (LID) systems to treat stormwater discharging off the parking lot. These include systems such as curb cuts, vegetated bioswales, rain gardens, and pervious paving options.

The Florida Aquarium in Tampa, Florida incorporated an 'eco parking lot' design that turned an existing decaying urban landscape into a low impact design demonstration 'exhibit' complete with a map and interpretive signs at each of the different LID components. The parking lot was a partnership with the City of Tampa, and was meant to demonstrate the aquarium's commitment to ocean and bay protection.
http://www.ekisticsdesignstudio.com/2014/florida-aquarium/)

Figure 32. Examples of Low Impact Design (LID) Stormwater Treatment in Parking Lots

Retrofits such as this curb cut and biofiltration garden could easily be incorporated into the Maʻalaea Triangle parking lot, potentially as a community project with volunteers. Estimated material costs associated with a curb cut/biofiltration installation that is approximately 300 square feet in size are below. There are approximately 38 such sites within the Maʻalaea Triangle parking lot representing a total footprint of 11,400 square feet.

Table 11. Maʻalaea Triangle Parking Lot Low Impact Development Implementation Cost Estimates

Technical design/ infiltration test, plan and oversight:	$500
Volunteer coordination:	$500
Cement work:	$750
Native plants:	$300
Soil and compost:	$300
Transportation/hauling	$300
TOTAL (per site):	**$2,650**
***TOTAL (for all 38 sites):**	**$100,700**

* If all sites were done at once, there would likely be cost savings associated with economies of scale.

The 38 locations suitable for curb cuts and biofiltration are areas where the grade of the planted area contained within the curbs could be lowered by digging out and hauling away the existing soil (ideally to a maximum depth of four feet if possible), backfilling with a suitable compost topsoil mix at a lower grade than the surrounding pavement, and planting the area with native plants allows stormwater running off the parking lot to enter the planted area and infiltrate into the ground. Irrigation infrastructure is already in place for the majority of these sites.

4.3.4 Failed Detention Basin

The recent failure of the detention basin mauka of Hauʻoli Street and the Maui Island Sands Resort suggests that the structure is undersized and poorly engineered to handle the potentially large flow volumes the structure receives. This basin should be reconstructed to accommodate additional flow volumes based on the combination of 100-year storm events flowing downhill from each of its several receiving waters.

An engineering assessment and redesign of the failed basin is a high priority recommendation because the basin is the only stormwater mitigation practice in a system that receives flows from Kanaio Stream and several other unnamed streams via the Waiheʻe Makai Ditch. This represents a significant portion of the catchment area within the project area that is currently not receiving any stormwater treatment before discharge to the ocean. The site would be an ideal candidate for a large multi-use sports field or other green space that could also serve to retain stormwater during high flow events. As discussed in Section 4.2.9.3 above, stormwater infrastructure can be a community asset instead of a liability. Detention structures need not be limited to large holes with tall fences around them.

4.3.5 Cesspools at Maʻalaea Harbor and Residences along Maʻalaea Bay Place

Both within the harbor at Buzz's Wharf and at the small neighborhood of homes found at the southern end of the Harbor, individual on-site disposal systems such as cesspools or septic tanks are being used for wastewater. These systems are a known source of nutrient contamination to groundwater and the ocean. There is currently a small scale 'package plant' wastewater treatment system located at the corner of the Honoapi'ilani Highway and the southern harbor entrance/exit road. While the capacity of this treatment plant is unknown, its close proximity to these homes makes it ideal infrastructure to receive the waste streams from these homes. All of the homes in this neighborhood fall within 1000 feet of the treatment plant. While a gravity fed wastewater collection system is likely not feasible in this site due to rocky terrain and the presence of a large gulch which would need to be crossed, a smaller scale E-1 or other low-pressure system could be utilized. The advantage of this system is that smaller diameter piping can be installed just 1 foot below the ground, and can be routed following the landscape's natural topography. In this case the highway right of way would be the logical path for the collection system. For information about the E-1 system, see; https://eone.com/sewer-systems/products/grinder-pumps

4.3.6 Condominium Injection Wells

Private injection wells associated with condominiums along Hauʻoli Street are a source of nutrient transport to the nearshore areas of Maʻalaea Bay. As in the case above, the presence of an existing treatment plant built to process the Maʻalaea Village's wastewater (Maʻalaea Triangle Wastewater Treatment Facility) (see Injection Wells section above) begs the question of the feasibility of connecting these condos to a central treatment system. While the capital costs of connection to central treatment are high, the ongoing maintenance of ten aging individual treatment systems and their associated injection wells is an ongoing financial burden to condominium owners.

4.3.7 Car Washes and Condo Impervious Surfaces

The condominiums along Hauʻoli Street have numerous locations where polluted runoff discharges into stream outfalls and directly into the ocean. Sources observed included; swimming pool backwash water, runoff from parking lots, car wash stations, and tool and equipment wash down sites. A number of potential sites suitable for bioretention or other low impact design (LID) retrofits to treat polluted water were also observed. A full LID assessment of the Maʻalaea Condos is recommended to determine those sites best suited for LID retrofits. These projects could be developed and installed in collaboration with condo residents and Maʻalaea community groups.

4.3.8 Maʻalaea Harbor Boat Maintenance Facility

The small boat yard operation located near the boat ramp at Maʻalaea is a potential source for chemical pollutants. Marinas and boat yards are known sources for potentially harmful pollutants including heavy metals such as coper based ablative paints, solvents, and fiberglass residues associated with sanding and scraping of boat hulls. Appropriate BMPs are essential at this facility due to its close proximity to the harbor.

4.3.9 Maʻalaea Harbor Oyster Colonies

As filter feeders, oysters are capable of pumping large volumes of water through their gills every day. This process removes nutrients like nitrogen and phosphorus from the water while improving water clarity, removing algae and promoting other life in the harbor. MNMRC is actively pursuing an oyster project in the harbor. MEC fully supports this project.

5.0 FUTURE CHANGES TO POHAKEA WATERSHED

The Pohakea Watershed Management Plan is provided to identify and offer management strategies for the various stormwater related sources of pollution including sediment, nutrients, pathogens, and other chemicals currently being transported within the Pohakea Watershed project boundary. MEC conducted several field events to canvass representative land uses throughout the watershed. In addition, research was conducted on various fronts to determine past, current, and future conditions that should be addressed to properly manage stormwater related issues to water quality affecting the watershed, Maʻalaea Harbor, Maʻalaea Bay, and ultimately the various channels and open ocean surrounding South Maui.

The watershed begins at the summit of Hanaula within the West Maui Mountains at 4,616 feet above sea level. From here, the watershed flows south and east through several gulches that all discharge into Kealia Pond, Maʻalaea Bay or Maʻalaea Harbor. Hillslope is relatively steep at the upper portions of the West Maui Mountains, with grade leveling off considerably at approximately 400 feet and continuing to gradually drop along the coastal areas to the ocean.

The approximately 5,268-acre watershed is currently composed of three different land use designations. The largest land use in conservation land, with large tracts of agricultural land occurring at lower elevations. The Maʻalaea Urban Corridor exists along the coastline and is comprised of the Maʻalaea Triangle and its associated shops, restaurants, and the Maui Ocean Center, the Maʻalaea Harbor, and the condominiums along Hauʻoli Street.

5.1 Proposed Changes to Pohakea Watershed

In addition to the land uses described above and those observed in the field, several major changes are slated to occur within the Pohakea Watershed in the near future. If these land uses are realized, they will have the potential to positively or negatively impact the watershed depending on how they are implemented.

5.1.1 Proposed Spencer Homes Agricultural Subdivision

As stated earlier, the fallow agricultural land mauka of Honoapiʻilani Highway has been proposed for development as low-density agricultural estates. Development of this land may result in additional stormwater discharge as more impervious surfaces are created to accommodate roads, houses and other structures.

This land is ideally situated for the implementation of a suite of projects that would benefit the Pohakea Watershed. These projects have been discussed in detail in Section 4 of this plan and include everything from head cut repair to detention basins to ideal locations for stormwater wells. In addition to providing locations for these projects, this parcel is situated in a highly accessible location along the highway, making it an ideal candidate site for parks and greenspace. Lastly, due to high winds and dry conditions, this area is prone to wildfires. Regardless of the type of any future land use, development should include stormwater detention and fire mitigation measures at the watershed scale and not be limited to individual project footprints.

5.1.2 Maui Ocean Center Interim Effluent Discharge Increase from 1.2 Million Gallons Per Day to 2.82 Million Gallons Per Day

As part of their recent NPDES permit renewal application, Maui Ocean Center has requested to more than double their daily discharge to 2.82 million gallons of effluent directly into Ma'alaea Harbor. The permit renewal application can be viewed at:
http://eha-web.doh.hawaii.gov/wpc-viewer-static/permits/HI0021504/20180409.Contents%20of%20CD-RENEWAL%20APPLICATION_signed-HI%200021504.pdf

Currently, the DOH CWB does not collect water quality data within the harbor and the nearest water quality samples are collected at Haycraft Beach three quarters of a mile northeast of the Ma'alaea Harbor discharge culvert. Additional studies should be conducted to determine what if any impacts to harbor and near shore coastal water quality may result from this increased effluent discharge. The following modifications to daily discharge became effective on September 20th, 2018. Upon commencement of the final effluent limitations, the interim effluent limitations shall no longer be valid.

Table 12. MOC Interim Effluent Daily Discharge for Sediment and Nutrients

MOC Daily Discharge into Ma'alaea Harbor	
Effluent Discharge Type	Permitted Discharge Amount (Pounds per Day)
Total Suspended Solids (Final)	235.2
Total Nitrogen*	11.76
Ammonia Nitrogen*	1.69
Nitrate+Nitrite Nitrogen*	3.85
Total Phosphorus*	1.76

*Single Sample Maximum

All State of Hawaii NPDES permits can be viewed at:
http://eha-web.doh.hawaii.gov/wpc-viewer/

In issuing the permit modification for the flow increase, the DOH determined that the increased flow can be allowed in keeping with state anti-degradation policy. 11-54-1.1 (B) General Policy of Water Quality Antidegradation states: "Where the quality of the waters exceed levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water, that quality shall be maintained and protected unless the director finds, after full satisfaction of the intergovernmental coordination and public participation provisions of the state's continuing planning process, that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located. In allowing such degradation or lower water quality, the director shall assure water quality adequate to protect existing uses fully. Further, the director shall assure that there shall be achieved the highest statutory and regulatory requirements for all new and existing point sources and all cost-effective and reasonable best management practices for nonpoint source control.”

As stated earlier, DOH CWB has identified a lack of circulation within the harbor as being of detriment to the water quality. They have observed that the discharge from MOC improves circulation and that additional discharge will further promote circulation of water in Ma‘alaea Harbor with the coastal waters of Ma‘alaea Bay. While water quality testing in the harbor is not presently being conducted by the DOH, MOC does collect water quality data within the harbor as a requirement of their permit twice per year. In addition, MEC has proposed monthly water quality sampling locations inside Ma‘alaea Harbor and in Ma‘alaea Bay in the Pohakea Watershed Water Quality Monitoring Plan attached as Appendix B.

5.1.3 Transition from Fallow Sugar to Diversified Agriculture

Agricultural lands make up 25 percent of the watershed. These lands are now largely comprised of sugar cane fields that have been fallow since 2016. Agricultural roads and other infrastructure associated with these unused fields continues to deteriorate. In addition, the perimeters of these fields have been tilled and grubbed to provide fire breaks where these fields come in close proximity to roads and other developments. As stated earlier, unused roads, unplanted fire breaks, and fallow agricultural lands provide sediment sources for erosion during stormwater events.

A transition to diversified agriculture within these lands will once again anchor these soils in place while ensuring that farming infrastructure like roads, stream crossings, and fire breaks are actively managed using proper BMPs. Actively farmed land in the form of diversified agriculture has the potential to provide food for local communities and is generally a preferred land use to development. Stormwater BMPs could also work in conjunction with diversified agricultural activities. For example, captured stormwater could be stored and used for the irrigation needs of crops.

5.1.4 MECO Onsite Retention Basin

MECO is in the process of developing an unlined earthen retention basin expected to significantly reduce the amount of stormwater effluent discharge from their Ma’alaea Powerplant facility. This retention basin is estimated to be in operation by the first quarter of 2019 and may address many of the General NPDES stormwater exceedances discussed in Section 3.3.1 above. As this stormwater discharges directly into Kealia Pond before ultimately making its way into Ma’alaea Bay, this retention basin may significantly improve water quality as well as fish and wildlife habitat within the wildlife refuge and along the coast in areas in close proximity to the power generation facility. Conversely, by retaining this stormwater onsite, any pollution normally discharged during storm events has the potential to percolate into the groundwater through the unlined earthen retention basin. Sampling of stormwater within the retention basin should occur to properly characterize water quality before it enters aquifer as groundwater.

5.2 Priority Management Projects and Strategies

MEC has reviewed the various sources of stormwater pollution within the Pohakea Watershed. Table 13 below summarizes the projects and strategies that if implemented, will benefit water quality throughout the Pohakea Watershed and coastal waters of Maʻalaea Harbor and Maʻalaea Bay. Priority Status for each project was determined foremost by direct need for action to address water quality concerns within the watershed. Feasibility, current or future status, cost, access and ownership constraints, examples of past successes in other locations, and other issues were also considered when making the recommendations within the Pohakea Watershed. Load reduction estimates were not calculated for individual projects and is outside the scope of this effort. It should be noted that while some projects have been given low priority status, they may be inexpensive to execute and can be implemented quite readily. Likewise, other projects which have been given high priority status due to their known impacts to water quality within the watershed, may be quite expensive and not easily implemented given permitting, engineering, ownership and various other constraints. Finally, the Pohakea Stormwater Management Plan is not a watershed-based plan, in that it lacks models of current loading estimates and estimates of project load reductions, as well as many of the various other elements needed in a watershed-based plan. This document was created as a reference for the MNMRC to better understand water quality issues in the Pohakea Watershed and to provide a list of implementation projects that will address the various pollutants affecting water quality in Maʻalaea Harbor and Maʻalaea Bay.

Table 13. Prioritized Stormwater Management Projects for the Pohakea Watershed

Pohakea Watershed Stormwater Management Projects	
Priority Level	Description
Conservation Lands	
Medium	Unimproved Dirt Road Stabilization/Closure
High	MECO Powerline Corridors/Wildfire Suppression in Conservation Lands
Low	Wind Farm Road BMPs
Low	Landslide Mitigation
Mid-Level Agricultural Lands	

Pohakea Watershed Stormwater Management Projects	
Priority Level	Description
High	Engage with Maui County Regarding Spencer Parcel as Catchment and Greenspace
High	Install Head Cut Monitoring Infrastructure and Engage the Dept of Public Works
Low	Discuss BMPs with the Hawaiian Cement Quarry
Low	Landfill Study
High	Waiheʻe Mauka Ditch and Dirt Road Stabilization
High	Waiheʻe Makai Ditch Cleanup
Low	Maintain Agricultural Roads
Medium	Vegetate Bare Soil Associated with Sugar Cane Fire Breaks
Low	MECO Powerline Corridor BMP Study in Agricultural Lands
Low	Kahili Golf Course Nutrient Catchment
Commercial and Urban Land	
High	Implement Water Quality Monitoring Plan - Especially within Maʻalaea Harbor and West Maʻalaea Bay
Low	Restore Kanaio Stream Pathway
High	Repair Failed Detention Basin
Medium	Gravel or otherwise Improve Dirt Lots at Maʻalaea Harbor
Medium	Maʻalaea Triangle Parking Lot LID Improvements
Medium	Maʻalaea Condominium Injection Well Review (Ongoing)
High	MECO Powerplant Retention Basin (Ongoing)
High	Cesspool Study for Maʻalaea Harbor and the Maʻalaea Place Neighborhood
Low	Maʻalaea Condominium Impervious Surfaces LID Improvements

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APPENDIX A

PHOTO DOCUMENT

Section 1 Conservation Lands
Unimproved Roads:

Road Channelization

Erosion and Discharge from Road

Road Channelization

Exposed Soil Along Road

Exposed Soil Along Road

Exposed Soil Along Road

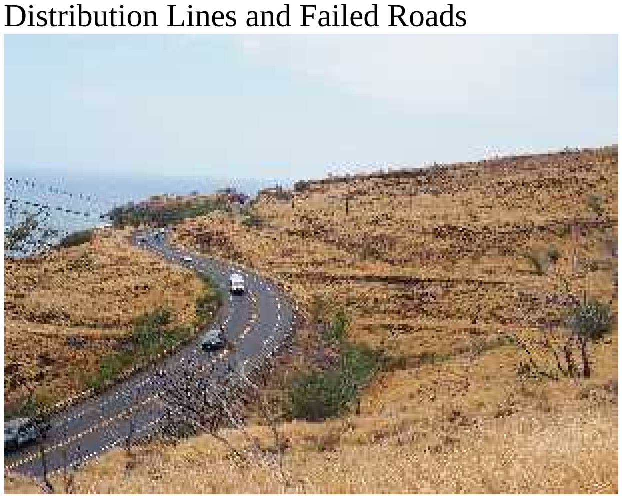
Section 1 Conservation Lands
Powerline Corridors and Wildfires:

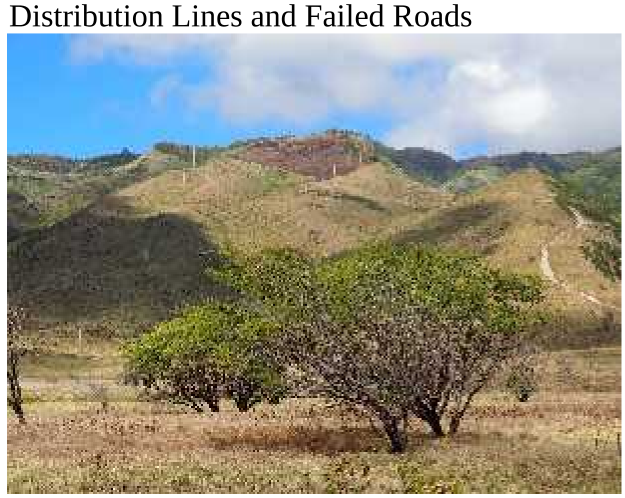

Downed Communications Lines


Fire Lines Associated with Powerlines


Distribution Lines and Failed Roads


Distribution Lines and Failed Roads


Transmission Lines along the Pali


Transmission Corridor and Evidence of Fire

Section 1 Conservation Lands
Wind Farm Road:

Water Bars and Kickouts

Well Maintained Road with Swale

Gravel Loss at Kickouts

Erosion

Channelization and Gravel Loss in Swale

Gravel Loss in Swale

Section 1 Conservation Lands

Landslides:

Loss of Vegetation

Loss of Vegetation

Soil Loss and Remaining Vegetation

Land Slide into Gulch

Bare Ground Areas

Bare Ground and Native Vegetation

Section 2 Mid-Level Agricultural Lands
Agricultural Roads and Fire Breaks:


Fallow Agricultural Land


Ag Roads and Fire Breaks


Fire Breaks


Ag Road with Fire Break

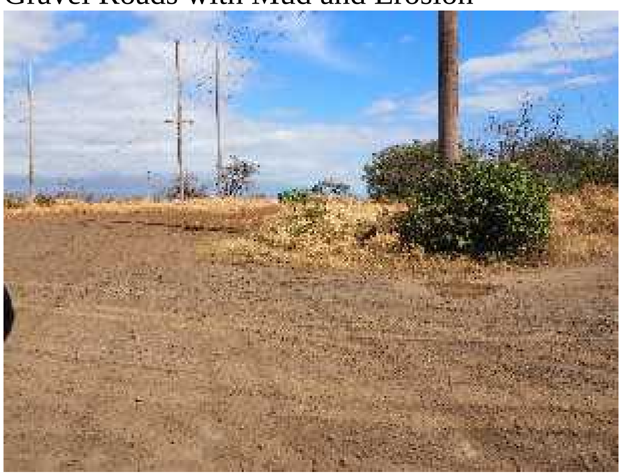

Agricultural Road


Old Sugar Cane Piled Near Ma‘alaea Stream

Section 2 Mid-Level Agricultural Lands
Hawaiian Cement Quarry:

Gravel Roads with Mud and Erosion

Gravel Roads Near Ditches



Gravel Roads Near Ditches

Gravel Piles Near Entrance

Well Maintained Gravel Roads

Evidence of Fire Near Entrance

Section 2 Mid-Level Agricultural Lands

Head Cutting:


Head Cutting


Channelization


Channelization


Head Cutting


Head Cutting


Culvert Backwall and Head Cutting

Section 2 Mid-Level Agricultural Lands
Sediment and Vegetation in Culverts:


Sediment in Culverts


Sediment and Gravel in Culverts


Sediment and Gravel in Culverts


Vegetation at Entrance to Culvert


Extent of Vegetation at Entrance to Culvert


Sediment and Gravel at Culvert Entrance

Section 2 Mid-Level Agricultural Lands

Waiheʻe Makai Ditch:


Waihe‘e Makai Ditch – Armored and Box Cut


Rubbish in Ditch


Vegetation and Rubbish in Ditch


Discharge Pathway Toward Ma‘alaea Bay


Unnamed Ditch


Confluence with Unnamed Ditch

Section 2 Mid-Level Agricultural Lands
Ma‘alaea Stream Mauka of Honoapi‘ilani Highway:


Sugar Cane Push Piles Near Gulch


Extent of Erosion


Highly Eroded Stream Channel


Sugar Cane Push Piles Near Gulch


Highly Eroded Stream Channel


Evidence of Severe Erosion

Section 2 Mid-Level Agricultural Lands

Waihe'e Mauka Ditch and MECO Distribution Line Access Road:


Channelization and Erosion


Channelization and Erosion


Failed Road with Channelization and Erosion


Failed Road with Channelization and Erosion


Failed Road with Channelization and Erosion


Gravel Piles Near Highway

Section 2 Mid-Level Agricultural Lands

MECO Transmission Corridor and Pohakea Gulch Through Agricultural Lands:


Transmission Corridor Next to Pohakea


Road Crossing Pohakea Lacking BMPs


Bank Cutting within Pohakea


Vertical Stream Banks within Pohakea


Exposed Stream Banks within Pohakea


Wrack Lines and Eroded Bank within Pohakea

Section 3 Commercial and Urban Lands
Water Quality Monitoring:


Maʻalaea Triangle Outfall


Culverts Discharging into Harbor


Culverts Discharging into Harbor


Culverts Discharging into Harbor


Culvert Outfall to Harbor


Substantial Sediment Deposition in Culvert

Section 3 Commercial and Urban Lands
Maʻalaea Harbor Dirt Lots:


Dirt Lots with No BMPs in Place


Dirt Lots with No BMPs in Place


Dirt Lots with No BMPs in Place


Dirt Lots with No BMPs in Place


Dirt Lots with No BMPs in Place Next to Harbor


Dirt Lots with No BMPs in Place

Section 3 Commercial and Urban Lands
Failed Detention Basin:


Sand Bags at Failed Control Structure


Sand Bags at Channel Outfall to Detention Basin


Eroded Sidewalls


Sand Bags at Channel Outfall to Detention Basin


Failed Control Structure


Sand Bags Under Hau'oli Street

APPENDIX B

POHAKEA WATERSHED

WATER QUALITY MONITORING PLAN

POHAKEA WATERSHED / MA‘ALAEA BAY
MAUI COUNTY, HAWAII
WATER QUALITY MONITORING PLAN

Prepared for:

MAUI NUI MARINE RESOURCE COUNCIL

PO BOX 331204
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November 2018

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Contents

Figures

Tables

1.0 INTRODUCTION AND PURPOSE

The Pohakea Stormwater Management Plan was developed to include the 5,268-acre planning area designated by the State of Hawaii as the Pohakea Watershed. The watershed begins at the summit of Hanaula within the West Maui Mountains at approximately 4,616 feet above sea level. From here, the watershed flows south and east through several gulches that all discharge into Kealia Pond, Maʻalaea Bay or Maʻalaea Harbor. Hillslope is relatively steep at the upper portions of the West Maui Mountains, with grade leveling off considerably at approximately 400 feet and continuing to gradually drop along the coastal areas to the ocean (Quadrangle Map).

The streams within Pohakea Watershed are ephemeral and are considered losing or disappearing streams because water is infiltrated into the aquifer as it flows downstream. This results in generally more water volume upstream than downstream, and is characterized by deep gulches and canyons upstream and relatively small rivulets and stream channels downstream. While the downstream reaches of these streams may not flow for years at a time, and discharges from gulches and gullies into Maʻalaea Harbor and Maʻalaea Bay are infrequent, when stormwater events do occur, the potential for flash floods, and very large stormwater volumes is possible within this watershed. The overall goal of this monitoring plan is to capture water quality samples from these two primary inputs of water (stormwater runoff flows, and subsurface groundwater flows, and to understand potential pollution sources within the watershed, and their water quality impacts to nearshore marine water quality over time.

The primary sources of water quality pollution carried by storm water runoff are sediment and nutrients such as phosphorus and nitrogen. While all the streams, gulches and gullies within the Pohakea Watershed are ephemeral, during major rain events these systems discharge large volumes of stormwater and facilitate erosion throughout the landscape. These stormwater flows overload infrastructure causing flooding in the urban areas near coastal waters. Because this methodology was developed to identify sources of pollution and not the amounts of each pollutant, flow measurements are not specifically mentioned in this water quality monitoring methodology. Flow measurements can be incorporated if loading or load reduction estimates are required at a later time.

State standards for water quality are not being met for enterococcus, Chlorophyll-*a* and turbidity at the one site currently being monitored by the Hawaii Department of Health (DOH) Clean Water Branch (CWB). In addition to surface water discharges into Ma'alaea Harbor and Ma'alaea Bay, it has been suggested that significant groundwater discharge occurs in nearshore coastal waters in the form of submarine seeps and springs throughout the coastal portions of the watershed. The development of a water quality monitoring methodology provides an opportunity to collect additional data throughout the watershed so that implementation projects can be employed to address water quality problems.

At the request of Maui Nui Marine Resource Council (MNMRC), Maui Environmental Consulting, LLC (MEC) has created the Pohakea Watershed / Maʻalaea Bay Stormwater Management Plan, outlining numerous implementation projects designed to reduce the amount of sediment and nutrient pollution entering the gullies and gulches that discharge into Kealia Pond, Maʻalaea Bay and Maʻalaea Harbor. In an effort to collect baseline data on surface and ground water throughout the watershed, and to identify sources of pollutants, the following water quality monitoring methodology has been developed. While this methodology is being proposed to obtain baseline water quality data, it is meant as a living document that can be further developed to monitor the success of implementation projects as they are executed.

2.0 METHODOLOGY

MEC suggests monitoring marine surface water, stormwater, and subsurface ground water within the Pohakea Watershed. For surface water, monthly samples should be taken from the various coastal locations depicted in the Pohakea Proposed Water Quality Monitoring Map below. In addition, samples should be collected from the stream and gulch locations when stormwater flow is occurring. Groundwater samples should be collected monthly in conjunction with coastal water sampling and whenever possible, also be collected during stream and gulch discharge events. Local rain gauges should be referenced after storm events to categorize each storm event and to correlate rainfall amounts to observed flows in the watershed.

2.1 SURFACE WATER SAMPLING LOCATIONS

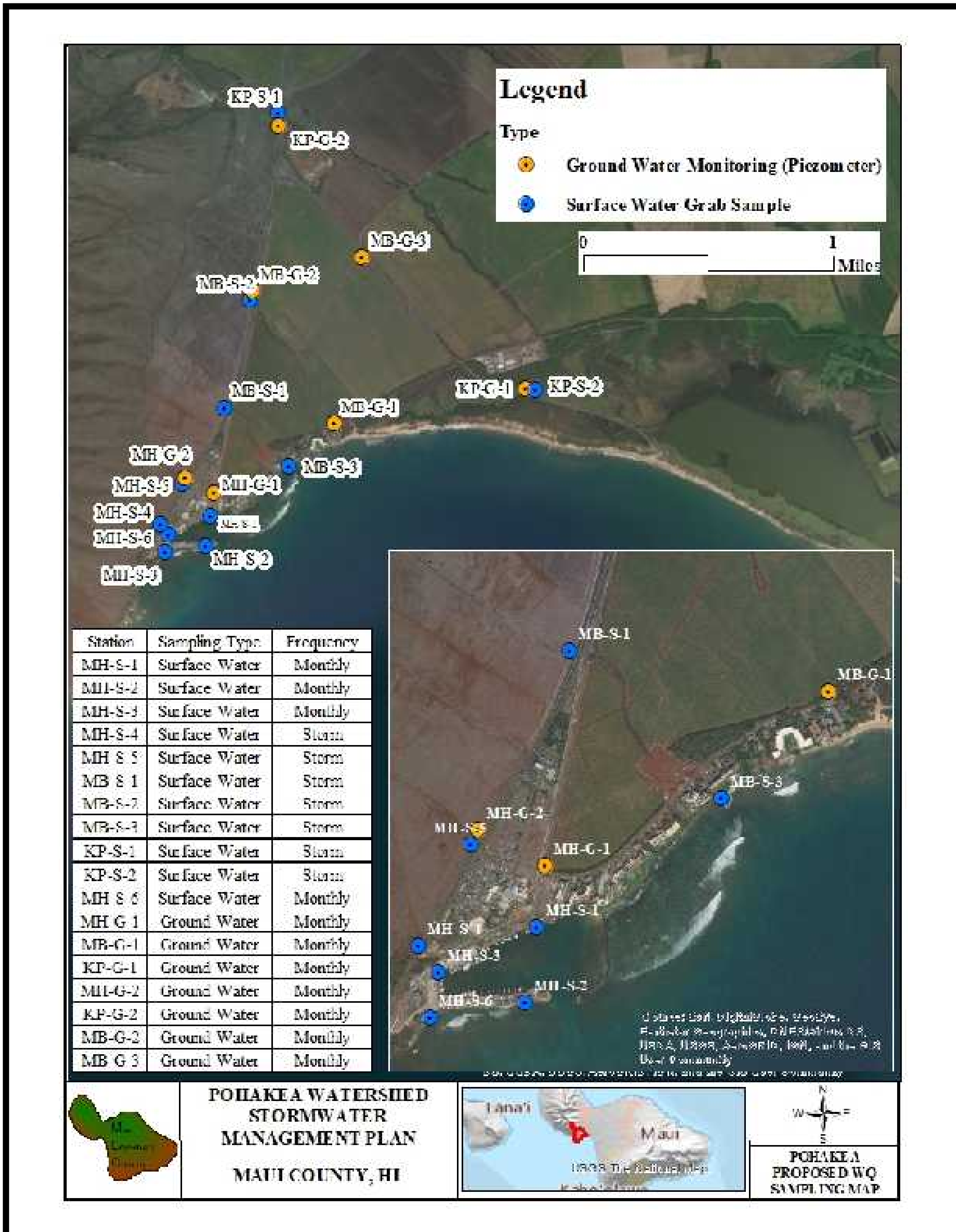
A total of 11 surface water monitoring stations were chosen to characterize water quality within the Pohakea Watershed discharging into Kealia Pond, directly into Maʻalaea Bay, and stormwater entering Maʻalaea Harbor (Pohakea Watershed Proposed Water Quality Monitoring Stations). Four occur within Ma’alaea Harbor and should be sampled on a monthly basis and the other seven should be sampled during stormwater discharge events.

To capture stormwater entering Kealia Pond, sampling locations were proposed at the Pohakea Stream culvert crossing under Honoapiilani Highway and at the Pohakea Stream outfall into the Pond just makai of the MECO power generating facility.

To capture data on water discharging from Kanaio Stream and the numerous unnamed gulches and gullies crossing under Honoapiʻilani Highway and flowing directly into Maʻalaea Bay, three stormwater surface water sampling locations were proposed. One mauka of the highway at the large unnamed gulch that flows under the highway to converge with the Waiheʻe Makai Ditch and the rerouted pathway for Kanaio Stream, one on the mauka side of Honoapiʻilani Highway where Kanaio is rerouted via culvert to the Waiheʻe Makai Ditch, and one sampling location at the concrete lined drainageway in between Maui Island Sands Resort and the Maʻalaea Banyans makai of Hauʻoli Street.

To capture data on water discharging into Maʻalaea Harbor, six stormwater surface water sampling locations have been proposed. Two are mauka of Honoapiʻilani Highway where the Maʻalaea Stream and a major unnamed gulch cross under the highway and discharge directly into the harbor. Two marine surface water stations have been proposed within the harbor. One at the outfall for the stormwater drains servicing the impervious surfaces associated with the Maʻalaea Triangle commercial district and Maʻalaea Road at the east end of the harbor and one near the small boat launch at the western end of the harbor. A sampling location has been proposed directly beyond the entrance to the harbor. A final sampling location is proposed outside the harbor near the Maʻalaea Bay Place residences west of the harbor. As stated earlier, the four sampling locations occurring in and around the harbor should be sampled monthly while the remaining two locations associated with the culverts discharging into the harbor should be sampled when stormwater flow occurs.

Figure 1. Pohakea Watershed Proposed Water Quality Monitoring Stations



Station	Sampling Type	Frequency
MH-S-1	Surface Water	Monthly
MH-S-2	Surface Water	Monthly
MH-S-3	Surface Water	Monthly
MH-S-4	Surface Water	Storm
MH-S-5	Surface Water	Storm
MB-S-1	Surface Water	Storm
MB-S-2	Surface Water	Storm
MB-S-3	Surface Water	Storm
KP-S-1	Surface Water	Storm
KP-S-2	Surface Water	Storm
MH-S-6	Surface Water	Monthly
MH-G-1	Ground Water	Monthly
MB-G-1	Ground Water	Monthly
KP-G-1	Ground Water	Monthly
MH-G-2	Ground Water	Monthly
KP-G-2	Ground Water	Monthly
MB-G-2	Ground Water	Monthly
MB-G-3	Ground Water	Monthly

2.2 Ground Water Sampling Locations

A total of seven ground water monitoring stations have been proposed in order to collect water quality samples of ground water throughout the Pohakea Watershed. Ground water samples will be collected via installed piezometers. These devices allow for sample collection and ground water level monitoring. A depiction of a typical piezometer installation is included as Figure 2 below. Placement of these piezometers was designed to collect representative samples from locations in the Pohakea watershed potentially affecting nearshore coastal water quality associated with Kealia Pond, Maʻalaea Bay, and within Maʻalaea Harbor.

2.3 Sample Parameters and Frequency

MEC proposes sampling for the following parameters:

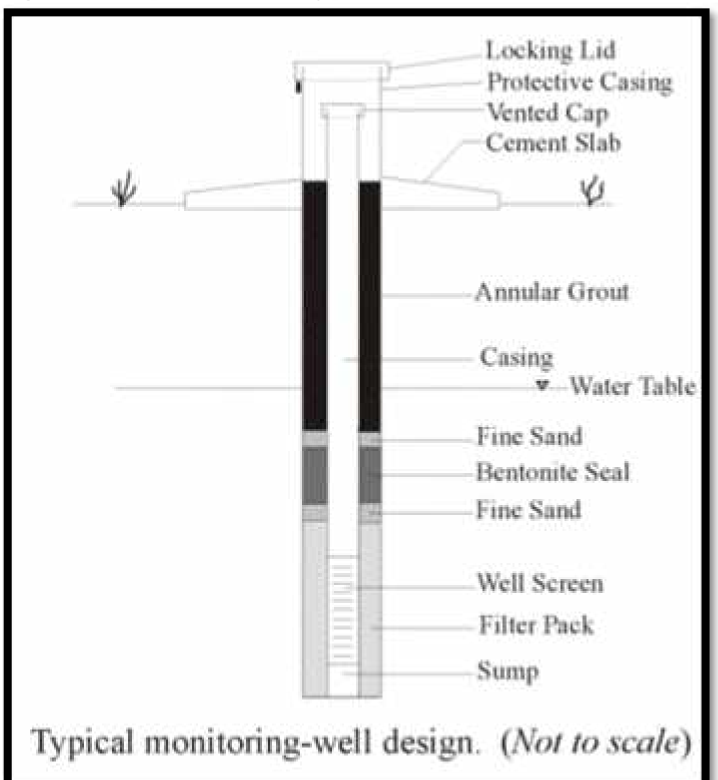
<u>In Situ Sampling Parameters:</u>

Temperature	pH
Salinity/Conductivity	Turbidity
Dissolved Oxygen	

<u>Laboratory Sampling Parameters:</u>

Total Nitrogen	Nitrate+Nitrite
Total Phosphorus	Ammonia Nitrogen
Orthophosphates	Total Suspended Solids

Figure 2. Depiction of a Typical Piezometer Installation



Due to the ephemeral nature of the streams and gulches that exist within the Pohakea Watershed, many of the sampling locations proposed in this water quality monitoring plan will require sampling during storm events when stormwater discharge is occurring. Table 1 below details the sampling type and frequency at each of the locations proposed.

Table 1. Pohakea Watershed Proposed Water Quality Monitoring Sites and Sampling Frequency

Station	Sampling Type	Frequency	Station	Sampling Type	Frequency
MH-S-1	Surface Water	Monthly	MH-G-1	Ground Water	Monthly
MH-S-2	Surface Water	Monthly	MB-G-1	Ground Water	Monthly
MH-S-3	Surface Water	Monthly	KP-G-1	Ground Water	Monthly
MH-S-6	Surface Water	Monthly	MH-G-2	Ground Water	Monthly
MH-S-4	Surface Water	Storm	KP-G-2	Ground Water	Monthly
MH-S-5	Surface Water	Storm	MB-G-2	Ground Water	Monthly
MB-S-1	Surface Water	Storm	MB-G-3	Ground Water	Monthly
MB-S-2	Surface Water	Storm			
MB-S-3	Surface Water	Storm			
KP-S-1	Surface Water	Storm			
KP-S-2	Surface Water	Storm			

In an effort to generate quality-assured coastal water-quality data, and to provide this data to DOH CWB and other interested entities, a Quality Assurance Project Plan (QAPP) should be prepared for this water quality monitoring methodology (at the harbor and coastal sites at a minimum) to ensure this data is able to assist the DOH CWB and that the data can be included in their beach monitoring Program. Fortunately, a QAPP already exist for the Hui O Ka Wai Ola monitoring program to ensure Standard Operating Procedures (SOPs) such as sample depths, proper equipment usage, labeling, sample chain of custody etc., are being met and data is being collected, compiled, and reported accurately. As an active member of the Hui O Ka Wai Ola, the Maui Nui Marine Resource Council understands the importance of SOPs when sampling water and should continue to implement water sample collection procedures as spelled out in the existing QAPP.