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Mā‘alaea Watershed Management Plan
Maui County, HI
Draft Report 2023

Prepared For:
Maui County
Office of Innovation and Sustainability
And
State of Hawaii
Department of Health
Clean Water Branch

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ACKNOWLEDGEMENTS

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ACRONYMS

AURORA	Autonomous Unmanned Remote Monitoring Robotic Airship
A&B	Alexander & Baldwin, LLC
BLNR	Board of Land and Natural Resources
BMPs	Best Management Practices
BOD5	5-day Biological Oxygen Demand
CCAP	Coastal Change Analysis Program
COM	County of Maui
CWA	Clean Water Act
CWB	Clean Water Branch
CDUA	Conservation District Use Application
CFR	Code of Federal Regulations
DAR	Department of Aquatic Resources
DEM	Digital Elevation Model
DHHL	Department of Hawaiian Home Lands
DLNR	Division of Land and Natural Resources
DOFAW	Division of Forestry and Wildlife
DOH	Department of Health
EPA	Environmental Protection Agency
FTW	Floating Treatment Wetland
GIS	Geographic Information Systems
HAR	Hawaiʻi Administrative Rule
HDOH	Hawaiʻi Department of Health
HOKWO	Hui O Ka Wai Ola
HRS	Hawaiʻi Revised Statutes
IKONOS	Greek for Image – commercial earth observation satellite
InVEST	Integrated Valuation of Ecosystem Services and Trade-offs
IR	Integrated Water Quality Reports
IW	Injection Well
IWS	Individual Wastewater System
KDMP	Kīhei Drainage Master Plan
KPNWR	Keālia Pond National Wildlife Refuge
LID	Low Impact Design/Development
LLC	Limited Liability Company
LULC	Land Use and Land Cover
MEC	Maui Environmental Consulting, LLC
MECO	Maui Electric Company
MNMRC	Maui Nui Marine Resource Council
MS	Microsoft
MWMP	Māʻalaea Watershed Management Plan
N	Nitrogen
NDMC	National Drought Mitigation Center
NDR	Nutrient Delivery Ratio
NFWF	National Fish and Wildlife Foundation
NOAA	National Oceanic and Atmospheric Administration
NO3 + NO2	Nitrate + Nitrite

NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NRCS	Natural Resources Conservation Service
NTU	Nephelometric Turbidity Unit – unit used to measure turbidity
OHWM	Ordinary High-Water Mark
PRCP	Polluted Runoff Control Program
PUC	Public Utility Commission
QAPP	Quality Assurance Project Plan
R-factor	Rainfall erosivity
RUSLE2	Revised Universal Soil Loss Equation – Version 2
SDWA	Safe Drinking Water Act
SDR	Sediment Delivery Ratio
SOPs	Standard Operating Procedures
STEPL	Spreadsheet Tool for Estimating Pollutant Loads
STV	Statistical Threshold Value
SWCD	Soil and Water Conservation District
TMDL	Total Maximum Daily Load
TMK	Tax Map Key
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
UIC	Underground Injection Control
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
USLE	Universal Soil Loss Equation
VB	Visual Basic
WBUS	Water Bodies of the United States
WOTUS	Waters of the United States
WQC	Water Quality Certification
WQS	Water Quality Standard

1.0 EXECUTIVE SUMMARY

A watershed is an area of land in which all sources of water discharge into a common waterbody such as a lake, river, stream, wetland, estuary, bay, or ocean. The types of activities, management measures, and practices that are conducted on the land within a watershed impact the quality of the receiving waterbodies. Watershed management plans are developed to protect natural resources and improve water quality by characterizing watersheds, identifying sources of pollution and impacted natural resources, engaging stakeholders, quantifying pollutant loads, and identifying and implementing management measures and best management practices to reduce sources of pollution.

Watershed planning efforts have been expanding across the island of Maui. In 2019 the Southwest Maui Watershed Management Plan was approved, and the same with the Pōhākea Watershed Plan in 2023. The Waikapū and Waiakoa Watersheds – together referred to as the Māʻalaea Watersheds - converge in Mauiʻs central isthmus, and bridge the gap between the two previsouly approved plans. Collectively these plans can work together to achieve water quality goals for the entirety of southwest Maui.

Reaching elevations of approximately 4,400 feet in the West Maui Mountains the Waikapū Watershed extends to the southeast and covers an area of 10,393 acres. The Waiakoa Watershed encompasses 35,331 acres, including the summit of Haleakalā at 10,023 feet. It extends northwest until its boundaries meet with the Waikapū Watershed. All but one of the streams within the Māʻalaea Watershed are ephemeral, flowing only during stormwater events, and their waterways drain into Keālia Pond and the coastal waters of Māʻalaea Bay. Agriculture and Conservation land use districts make up the majority of the land area. Urban and rural land use districts comprise just over 6% of the area for each watershed.

Land management plays an important role in maintaining healthy coastal waters. Coral reefs are important culturally, economically, and ecologically. Traditionally, the ocean is relied upon as a source of sustenance both physically and spiritually. Used for canoeing, diving, fishing, limu gathering, ceremonial purposes, and so much more, Native Hawaiians have a strong connection to the sea. Residents and visitors alike rely on the coastal waters for recreational opportunities, and commercially they support tourism enterprises. To manage the land is to protect the water, and all who live, work, and recreate within the watersheds will benefit from measures to reduce pollution.

According to the Hawaiʻi Department of Health (DOH) Final 2020 and Final 2022 Integrated Water Quality Reports (IR) submitted to the Environmental Protection Agency (EPA) and Congress pursuant to Clean Water Act Section 303(d), the coastal waters of Waikapū and Waiakoa watersheds are listed as impaired for several parameters including total nitrogen, nitrate+nitrite, ammonium, turbidity, and chlorophyll-a at one or more sampling locations. The sampling locations within the Māʻalaea watersheds also lack adequate data for assessment of at least one water quality standard.

The goal of the Māʻalaea Watershed Management Plan is to identify the various sources of pollution within the watershed and to provide best management practices that will protect the water resources within the planning area. In considering the environment, economy, and community, this Plan aims to learn from the past and provide solutions that will restore and preserve the watershed into the future.

2.0 INTRODUCTION AND PURPOSE

The Māʻalaea Watershed Management Plan bridges the gap between two existing, EPA-approved watershed plans - The Pōhākea Watershed Plan to the west and The Southwest Maui Watershed Plan to the southeast. Composed of Waikapū and Waiakoa Watersheds, the land area totals 45,724 acres and spans from elevations of approximately 4,400 feet in Mauna Kahālāwai to the summit of Haleakalā at 10,023 feet. Both watersheds converge in the isthmus of Maui and discharge into Keālia Pond and the coastal waters of Māʻalaea Bay. Upon completion of this Plan, all aquatic resources flowing from the southeast peaks of Mauna Kahālāwai and the southwest peaks of Haleakalā to the shorelines stretching from Makena Beach to beyond McGregor's Point will be included in a watershed plan.

2.1 Building Partnerships

2.1.1 <u>Community Outreach</u>

A major step in the watershed planning effort is to engage stakeholders and gather public input. Large landowners within the watershed boundaries were contacted via phone or email and invited to participate in outreach events. Meetings were held in May, June, July, and September 2023 to inform the community of the plan, to identify common values among individuals, and to better understand issues or concerns regarding water resources. Implementation and execution of this plan will be a collaborative effort among all entities. Updates to the Plan will be posted on mauiwatershed.org, and questions and comments are also available through online outlets.

2.1.2 <u>Partnerships with other Federal Agencies, Non-Government Organizations, Local Government, and Local Landowners and Businesses</u>

In March of 2021, the National Fish and Wildlife Foundation (NFWF) published the Hawaiʻi Conservation Business Plan that highlights strategies and resources required to achieve desired conservation outcomes. The Business plan follows the framework set forth by State of Hawaiʻi's Sustainable Hawaiʻi Initiative that aims to protect 30% of priority watershed forests and establish 30% of nearshore waters as marine management areas by 2030 to increase freshwater security capacity, invasive species control, and native species restoration (NFWF, Hawaiʻi Conservation Business Plan).

Waiakoa Watershed was listed as a focal watershed forest with the 10-year goal of improving watershed condition and function in the Kamehamenui fence unit by:

1) Increasing the native plant cover from 10% – 35%
2) Establishing five endangered plant species
3) Increasing native species diversity from zero to five species per acre

Kīhei's coral reef system was listed as a focal reef with the 10-year goal of maintaining high coral cover and building resiliency by:

1) Increasing the proportion of reef building species by 10%
2) Increasing herbivore fish biomass by 35%
3) In the event of a disturbance, such as a bleaching event(s), recover coral cover significantly faster than comparison sites

Watershed protection is essential in sustaining Hawaiʻi's ecological, economic and cultural resources that provide critical habitats for native flora and fauna both on land and at sea. As with all watershed management work, the study could only be undertaken with the community and landowners as partners. Major landowners and stakeholders associated with the study area include Maui County, the State of Hawaiʻi, Department of Land and Natural Resources, United State Fish and Wildlife Service, Keālia Pond National Wildlife Refuge, Mahi Pono, Wailuku Water Company, Alexander & Baldwin, LLC (A & B), Department of Hawaiian Homelands (DHHL), Haleakalā Ranch, Kula Ranch, Māʻalaea C&D Landfill Condominium, and the Von Tempsky Ranch.

2.1.3 Key Stakeholders

Community support and cooperative action are key components in waterhsed planning efforts. As required by EPA nonpoint source pollutant control (Section 319) grant requirements, appropriate stakehoders within the community were engaged to gather concerns, seek input, and share information regarding water resources within the Māʻalaea Watersheds. Stakeholders were tasked with determining how to best manage the watershed in ways that satisfy environmental health, human health, and economic interests. The entire community falling within the watershed boundaries is potentially affected by the implementation projects proposed in this Plan.

Key stakeholders in the Māʻalaea Watershed Management Plan include but are not limited to Maui County,West, Central, and Olinda – Kula Soil and Water Conservation Districts, Department of Land and Natural Resources (DLNR) – Division of Forestry and Wildlife, DLNR – Division of Aquatic Resources, DLNR – Division of Boating and Ocean Recreation, Keālia Pond National Wildlife Refuge, Maui Nui Marine Resource Council, Maui Environmental Consulting, LLC, Maui Surfrider Foundation, Hui O Ka Wai Ola, United States Army Corps of Engineers (USACE), Environmental Protection Agency, U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration, Hawaiʻi Tourism Authority, Maui County Fire Department, Hawaiʻi Department of Transportation, Maui Visitor's Bureau, Maui Tourism Authority, Boat/Tour Companies, Coral Reef Alliance, Hawaiʻi Wildlife Fund, Maui Cultural Lands, Maui Electric Company, Alexander & Baldwin, LLC, Department of Hawaiian Homelands, Haleakalā Ranch, Kula Ranch, Māʻalaea C & D Lanfill and Condominiums, Mahi Pono, LLC, Haleakalā National Park, Von Tempsky Ranch, Nishikiʻs Market, the Sugar Beach Condos, Bayer, Alana Yurakanin, Andrea Kealoha, Kula Community Association, Leeward Haleakalā Watershed Partnership, County of Maui Parks Department, Puʻunene Heavy Industrial Subdivision, Wailuku Water Company/Hanaula Ranch, Mauna Kāhālawai Watershed Partnership, Kahili and King Kamehameha golf courses, Waikapū Properties, Waikapū Town, Kuihelani Solar, and others.

Working with Tova Callender of West Maui Ridge to Reef Initiative, MEC held meetings with individual entities and organizations. MEC reached out to stakeholders to provide and receive information on issues and concerns within the watersheds. Brief surveys were sent and available online to collect initial feedback on watershed concerns. The kickoff outreach event was held on May 30th, 2023 at the Keālia Pond National Wildlife Refuge. To accommodate upcountry community members, MEC presented at the Kula Community Association meeting on June 14th, 2023. To provide updates and progress of the Plan an interim meeting was held on July 25th, 2023, and a draft version of the Plan was shared with the Kula Community Association on July 31st, 2023. Final public presentations were given on September 18th, 2023 at the Waikapū Community Association meeting, and again at Keālia Pond National Wildlife Refuge on September 26th, 2023. From the restorative work being by Maui Nui Marine Resource Council, to water quality testing in the coastal waters by the Hui O Ka Wai Ola (HOKWO), to small business owners who rely on healthy and clean coastal waters for their business, MEC has identified stakeholders that have knowledge of existing programs and can serve as resources of information.

The Department of Health Clean Water Branch (CWB) Polluted Runoff Control Program (PRCP) and Maui County can also provide technical and financial assistance with project implementation. The following table was created to note key stakeholders and their role in the Māʻalaea Watershed Management Plan (MWMP) (Table 1. Stakeholder Capacity in the Māʻalaea Watershed Management Plan).

Table 1. Stakeholder Capacity in the Māʻalaea Watershed Management Plan

Stakeholders	Stakeholder Capacity				
	Stakeholders responsible for implementing the Plan	Stakeholders affected by Plan implementation	Stakeholders who can provide information on issues and concerns in the watershed	Stakeholders who have knowledge of existing programs and resources	Stakeholders who can provide technical and financial assistance in implementing the Plan
Olinda-Kula, West, and Central Maui Soil and Water Conservation Districts					**X**
Maui County	**X**	**X**	**X**	**X**	**X**
Hawaiʻi Department of Health Clean Water Branch Polluted Runoff Control Program			**X**	**X**	**X**
Hawaiʻi Department of Land and Natural Resources			**X**	**X**	**X**
U.S. Environmental Protection Agency			**X**	**X**	**X**

Stakeholders	Stakeholder Capacity				
	Stakeholders responsible for implementing the Plan	Stakeholders affected by Plan implementation	Stakeholders who can provide information on issues and concerns in the watershed	Stakeholders who have knowledge of existing programs and resources	Stakeholders who can provide technical and financial assistance in implementing the Plan
Rural Land Owners	**X**	**X**	**X**		**X**
Urban Land Owners	**X**	**X**	**X**		**X**
Small Businesses		**X**	**X**		**X**

2.1.4 Education and Outreach

Stakeholders representing diverse interests including local, state, and federal agencies; private landowners, nonprofit organizations, and community residents were invited to participate in the watershed planning effort. Public outreach meetings were held in May, June, July, and September 2023 to discuss the process and gather input. Information and updates were available on the www.mauiwatershed.org website.

2.1.5 Setting Goals and Identifying Stakeholder Concerns

As a result of reviewing water quality data, it has been determined that the primary source and most problematic pollutants are sediment and nitrogen species, including nitrate-nitrite and ammonia. Stakeholder concerns have included:

- Brown water events (Water Quality) including sediment, nutrients and pathogens
- Flooding impacts to traffic and businesses in North Kīhei
- Debris clogging stormwater infrastructure and damaging roads
- Piles of sediment near waterways
- Wetlands being smothered by sediment
- Impervious surfaces
- Feral ungulates and erosion
- Fire hazards
- Cultural site protection/preservation
- Keālia Pond salinity and aquatic bird habitat

2.1.6 Identify Possible Management Strategies

Management strategies were developed based on the land use types within the watershed. Most of the land in the Waiakoa Watershed is designated as agricultural land. While the same is true of Waikapū Watershed, conservation lands are also a dominant land use. Within conservation lands, efforts should focus on ungulate fencing and native forest rehabilitation.

3.0 WATERSHED CHARACTERIZATION

The Māʻalaea Watershed Management Plan is unique in that it includes two watersheds that extend mauka to makai on the slopes of both volcanic mountain formations that make up the island of Maui (Figure 1. Māʻalaea Watershed Boundaries). The Waikapū Watershed reaches elevations of 4,400 feet in the West Maui Mountains, or Mauna Kahālāwai, and the Waiakoa Watershed begins at the summit of Haleakalā at approximately 10,023 feet. The two watersheds converge in the central valley of Maui where their waterways drain into Keālia Pond and the coastal waters of Māʻalaea Bay. In this document, the Waikapū and Waiakoa Watersheds are collectively referred to as the Māʻalaea Watersheds.

The information provided in this section describes the current conditions of Waikapū and Waiakoa Watersheds. Watershed characterization helps identify and prioritize areas of concern, and likewise, areas of least concern. Throughout this document the terms gulch and stream are used interchangeably.

The Māʻalaea Watershed is comprised of 4,060 different Tax Map Keys. Of these, 268 occur in the Waikapū Watershed (Figure 2. Waikapū TMK Map) and 3,792 occur in the Waiakoa Watershed (Figure 3. Waiakoa TMK Map) in Maui County, Hawaiʻi, with the large landowners shown in the maps below (Figures 31-32. Large Landowner Maps).

Waikapū Watershed begins at approximately 4,400 feet at the summit of the West Maui Mountains. This watershed discharges directly into Keālia Pond. Major roads running through the makai portions of this watershed include Honoapiʻilani Highway, Kuihelani Highway, and North Kīhei Road (Figure 4. Waikapū Location Map). The approximately 10,393-acre watershed is composed of several different land formations. Hillslope is relatively steep at the upper portions of the West Maui Mountains, with grade leveling off considerably at approximately 1,000 feet and continuing to gradually drop along the coastal areas to the ocean (Figure 6. Waikapū Quadrangle Map).

The Waiakoa Watershed begins at approximately 10,000 feet at the summit of Haleakalā. Some streams in this watershed discharge into the eastern portions of Māʻalaea Bay while others first flow into Keālia Pond. Major roads running through the mauka portions of the watershed include Haleakalā Highway, Kekaulike Highway, and Kula Highway. Omaopio and Pūlehu Roads run mauka to makai, connecting upcountry to the central valley. Mokulele Highway runs north to south along the central isthmus and is the only major road associated with the makai portions of the Waiakoa Watershed (Figure 5. Waiakoa Location Map). The approximately 35,330-acre watershed is composed of several different land formations. Hillslope grade is fairly steep associated with the summit of Haleakalā, but decreases and eventually becomes relatively gradual in slope, continuing to gradually drop along the coastal areas to the ocean (Figure 7. Waiakoa Quadrangle Map).

Figure 1. Māʻalaea Watershed Boundaries

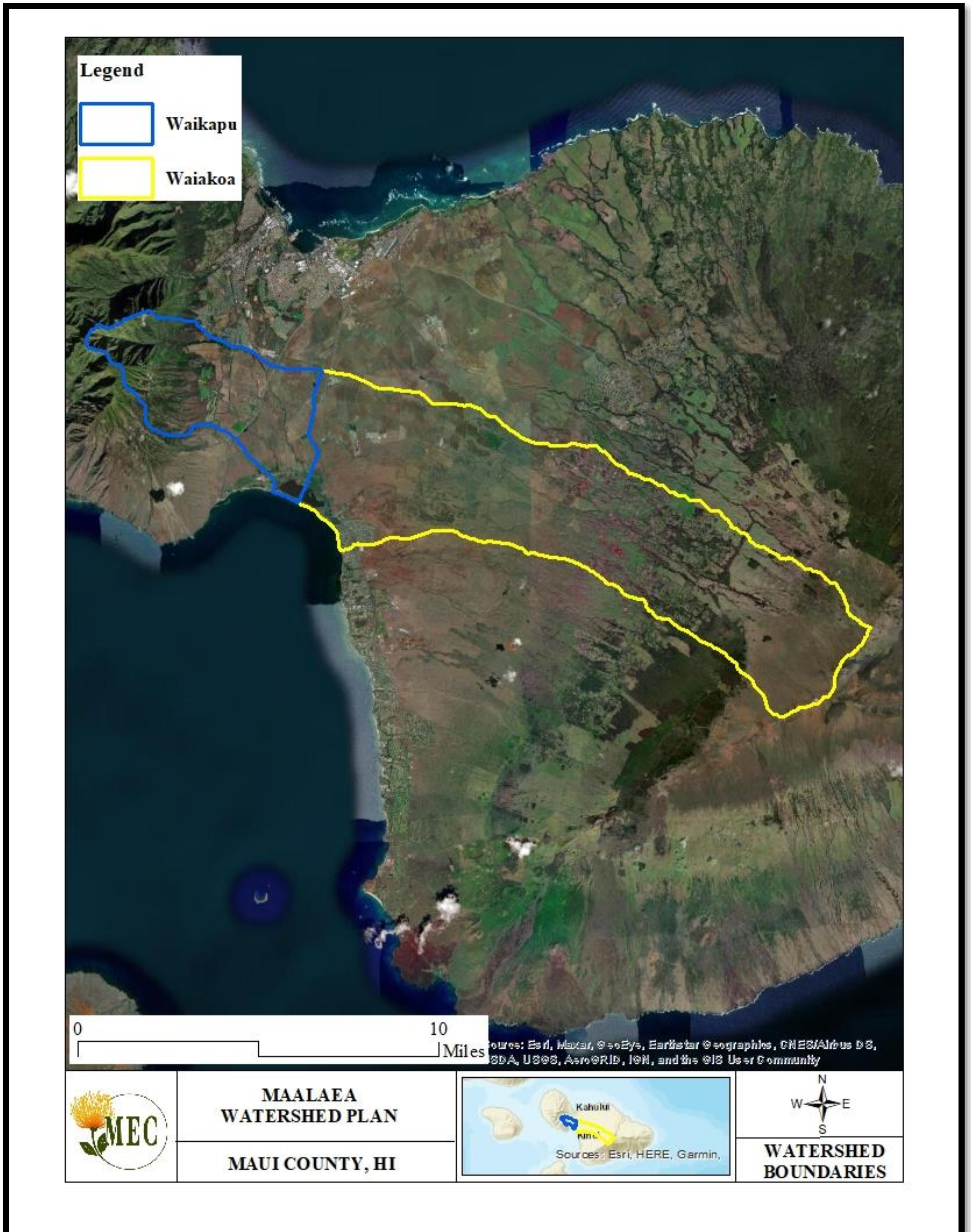


Figure 2. Waikapū TMK Map

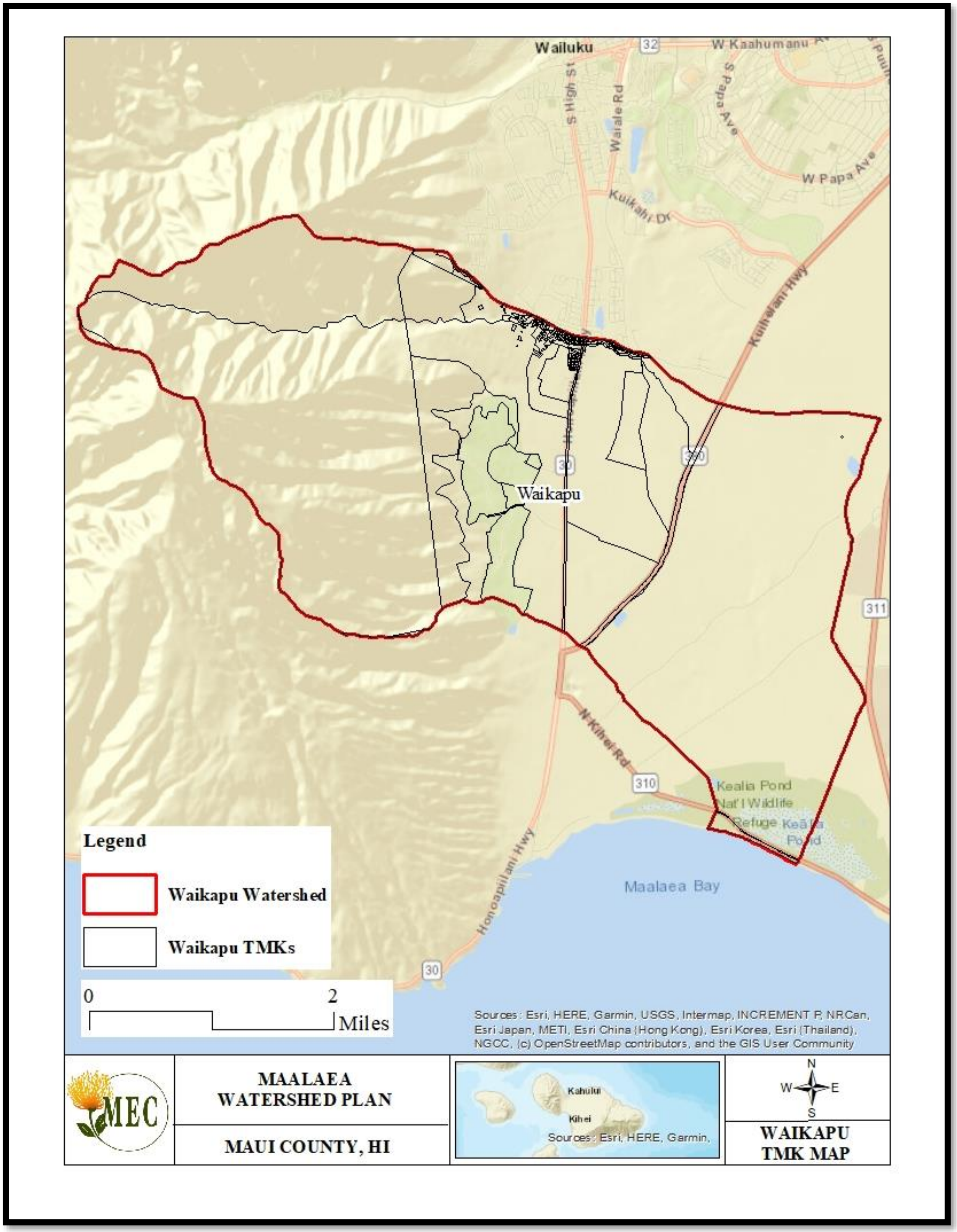


Figure 3. Waiakoa TMK Map

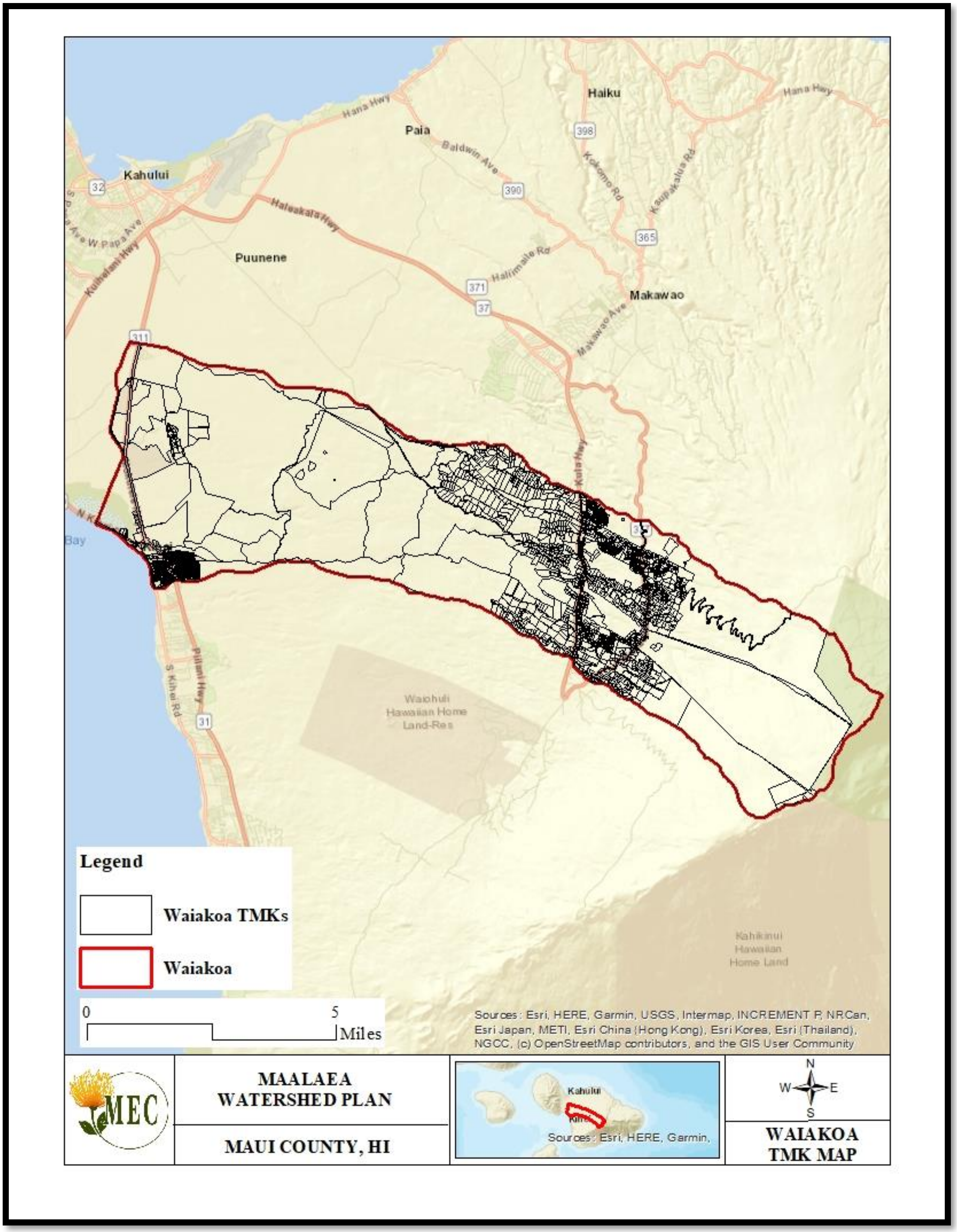


Figure 4. Waikapū Location Map

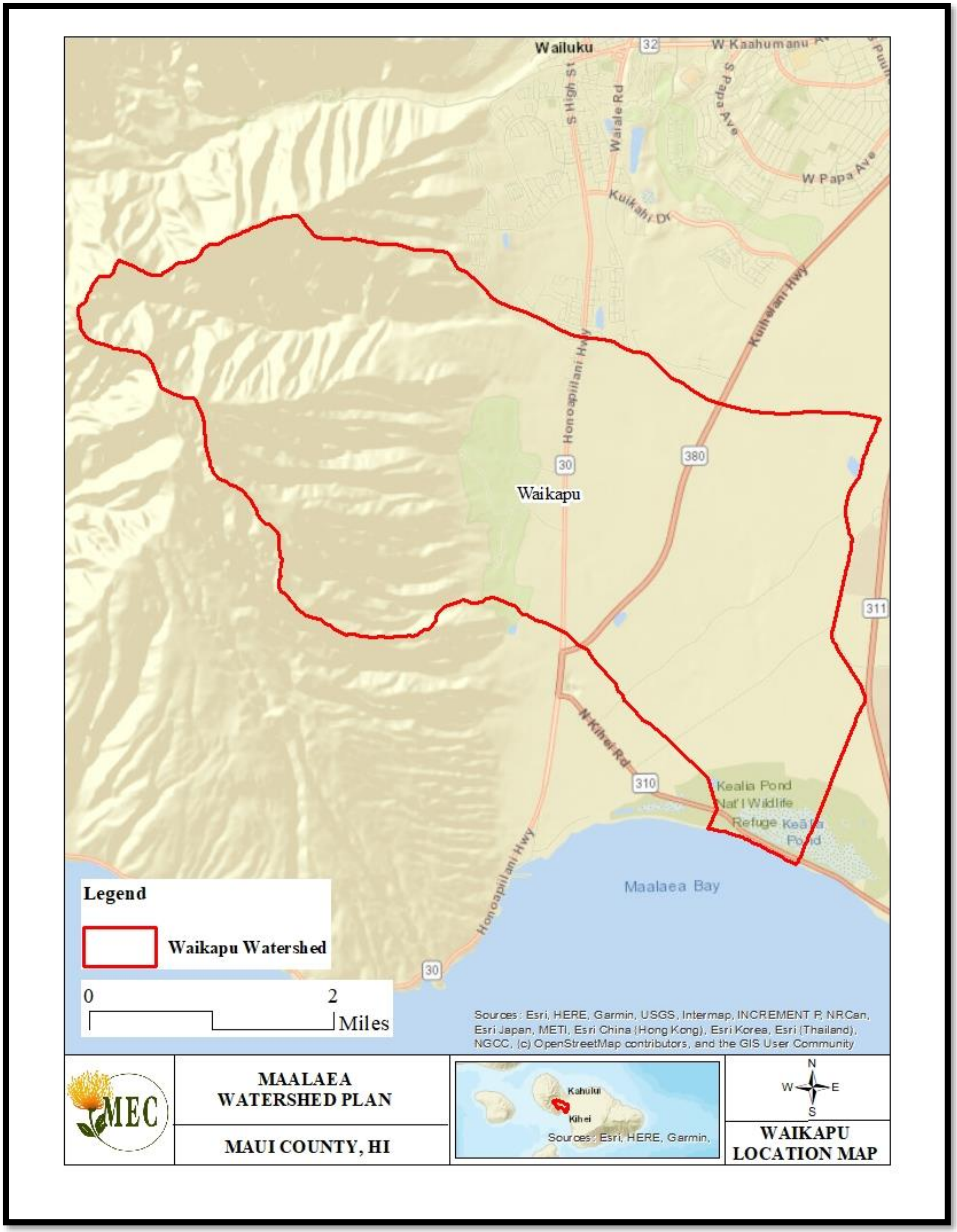


Figure 5. Waiakoa Location Map

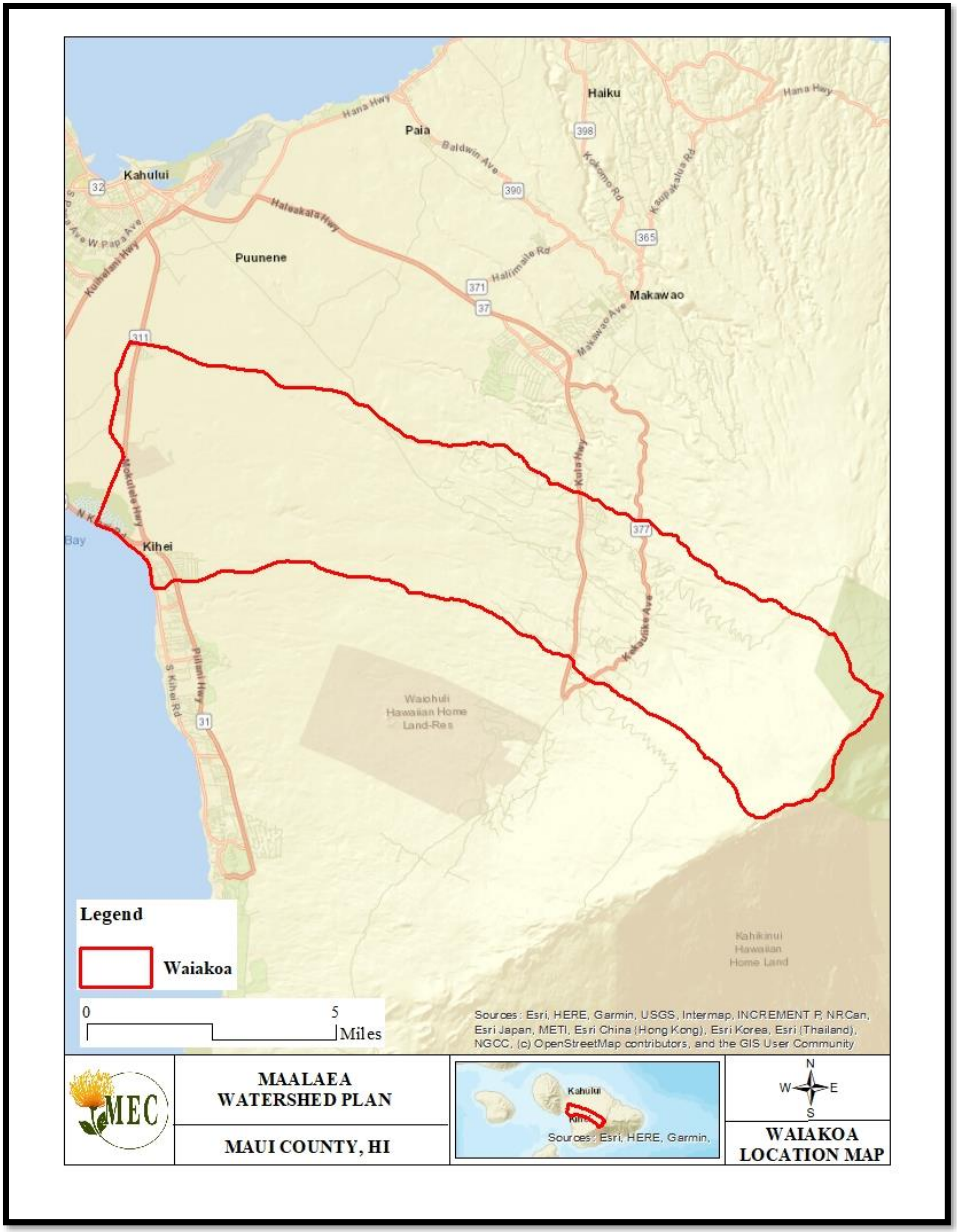


Figure 6. Waikapū Quadrangle Map

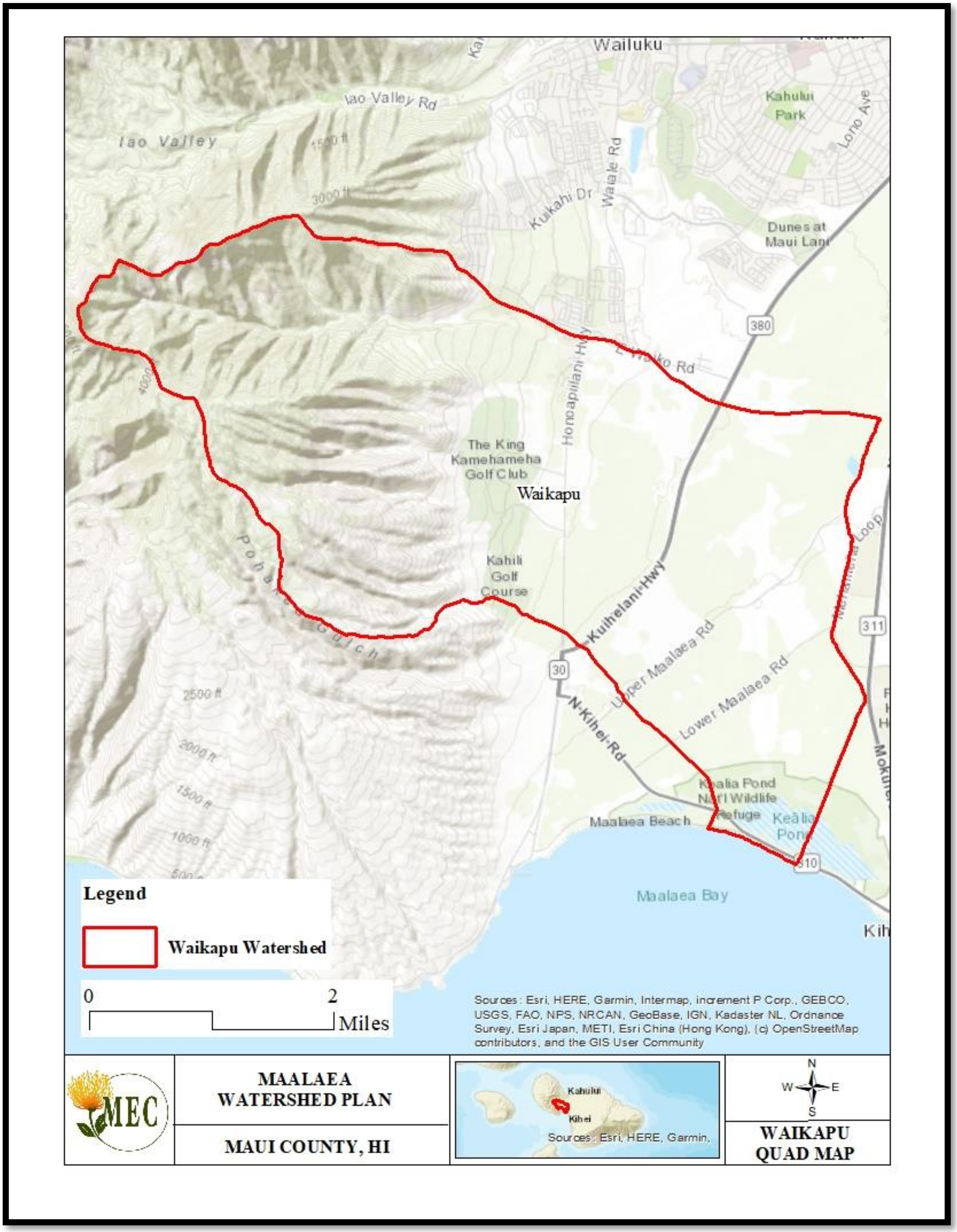
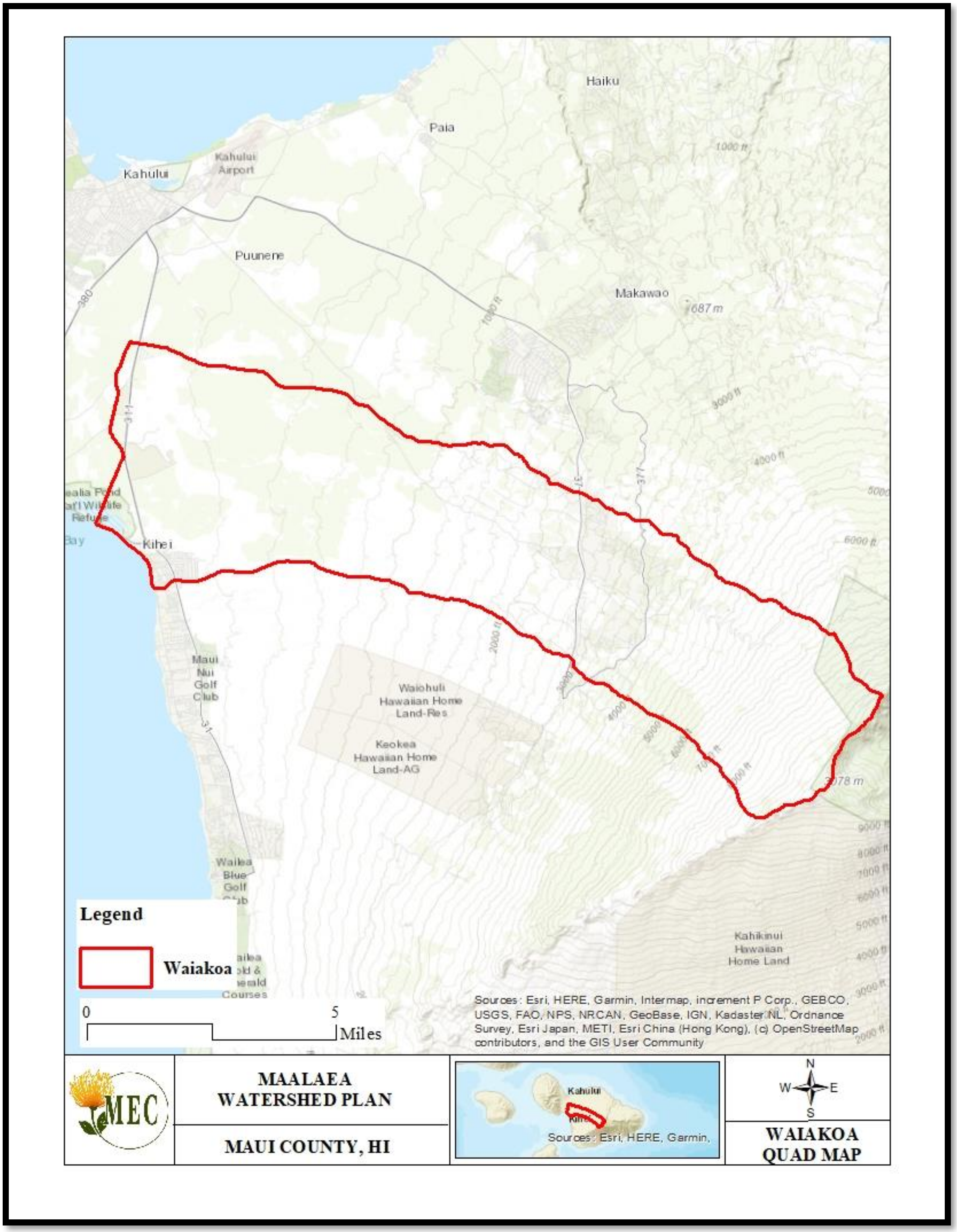


Figure 7. Waiakoa Quadrangle Map



3.1 Geology

The island of Maui is comprised of two steep volcanoes known as Haleakalā and the West Maui Mountains or Mauna Kahālāwai. Haleakalā stands at 10,023 feet, and the West Maui Mountains highest peak is at 5,788 feet. The two volcanoes are connected by a shallow isthmus where a lava flow from Haleakalā once met the base of the West Maui Mountains. The volcanic rocks of Maui are considered diverse and include basalts, gabbros, picritic basalts, nepheline basanites, basaltic andesites, andesites, and soda trachytes (Stearns and Macdonald, 1942). Lava types are Pahoehoe (smooth) flows that can form lava tubes, and A'a (rough), dense basalt that can form beds of clinkers (Stearns and Macdonald, 1942).

The West Maui Mountains are estimated to be 1.15 - 1.3 million years old and have been divided into three volcanic series: the Wailuku, Honolua, and Lahaina (Mink and Lau, 2006). The Waikapū Watershed spans from the coastal isthmus of Maui to the northwest into the West Maui Mountains, and is dominated by the Wailuku Volcanic Series. Composed primarily of pahoehoe and aʻa lava flows, the Wailuku series consists of tholeiite, olivine tholeiite, and oceanite with hawaiite and alkalic basalt found at upper grades. (Macdonald, et al. 1983). The mountain range spans approximately 18 miles and is deeply dissected by stream erosion.

The Waiakoa Watershed extends from the shores of the central valley eastward to the upper elevations of Haleakalā. At approximately 800,000 years old, Haleakalā is the youngest of the two volcaones of Maui, with its most recent eruption occurring as recent as the late 1700's (Mink and Lau, 2006). Being a relatively young mountain, Haleakalā has had less time to erode from wind and rain. It remains largely in the shape of a dome – a shape that is representative of the shield volcanoes that have formed the Hawaiian islands. Waiakoa Watershed is located almost completely within the Kula volcanic series comprised predominantly of Hawaiite with lesser amounts of ankaramite and alkalic olivine basalt (Stearns and Macdonald, 1942).

3.2 Topography

A spatial analysis of the USGS, Digital Elevation Model (DEM) shows that slope ranges from 0 to 78 percent within the planning area for Waikapū (Figure 8. Waikapū Slope Map). Steeper slopes are associated with higher elevations, along the steep ridges and sides of Waikapū Gulch, and along the steep banks of Ooawa Kilika, Paleaahu, and Kaonohua Gulches. Waiakoa is less steep, with slopes ranging from 0 to 28 degrees, with the steeper portions occurring at the upper reaches of Haleakalā (Figure 9. Waiakoa Slope Map).

Figure 8. Waikapū Slope in Degrees

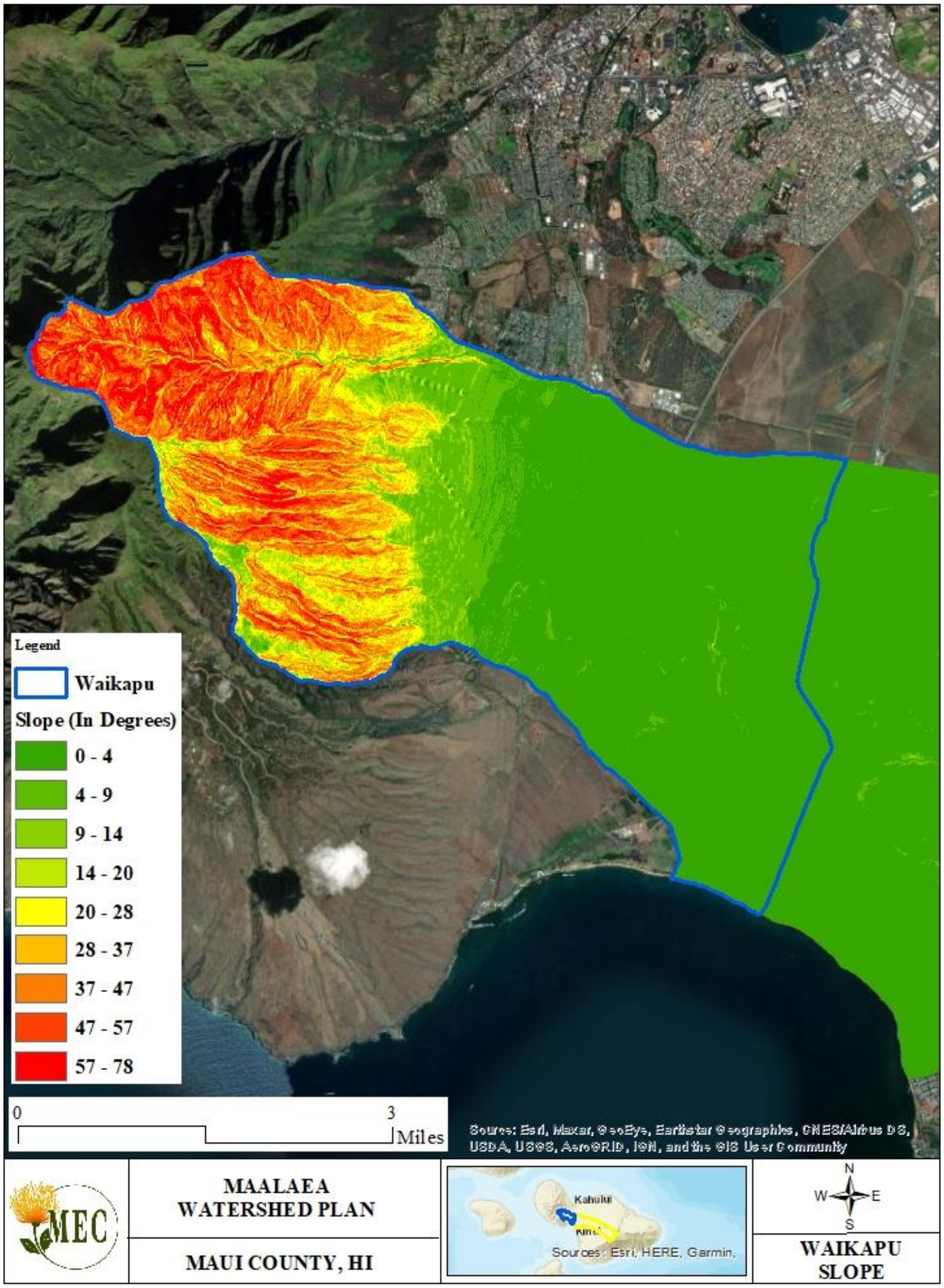
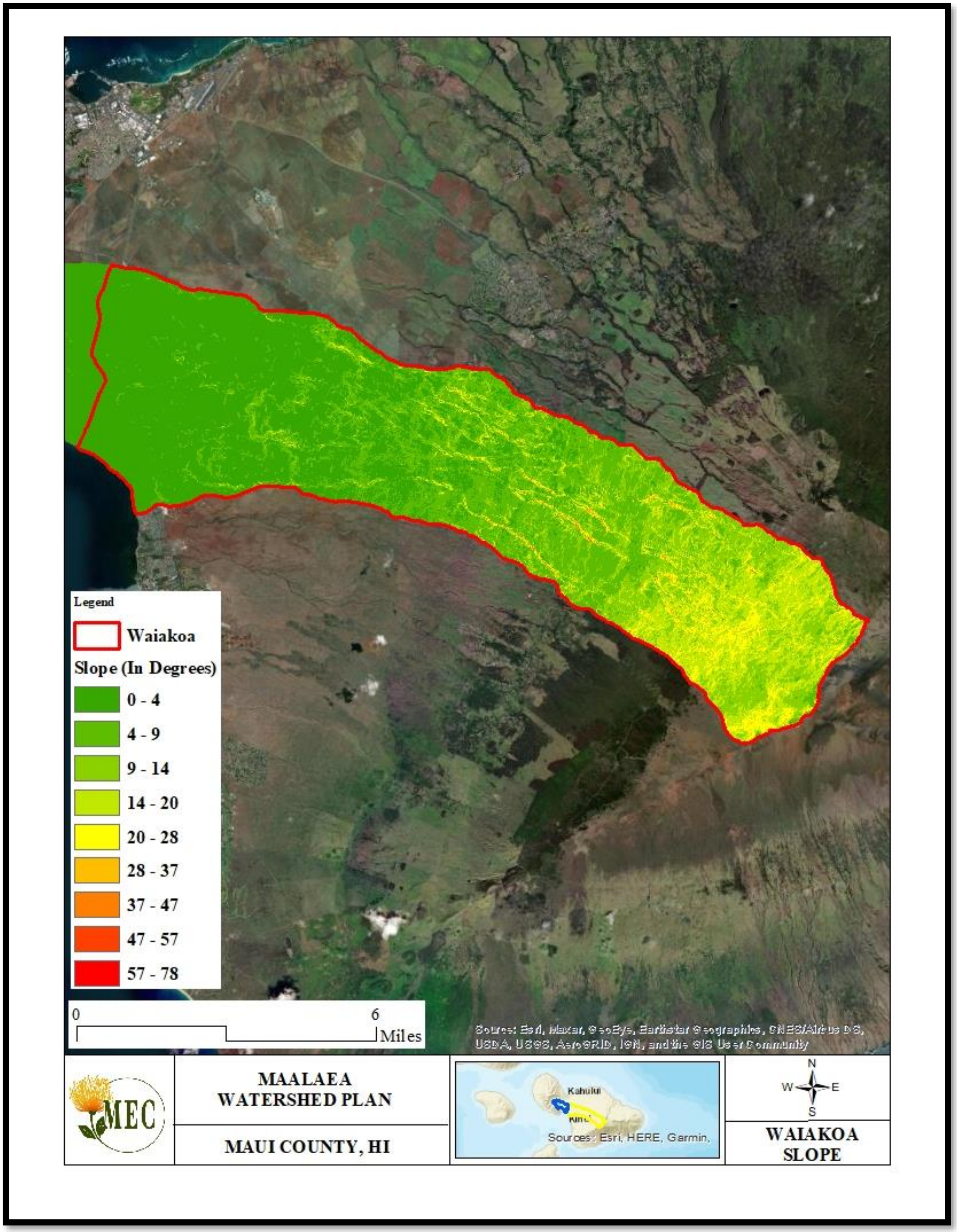


Figure 9. Waiakoa Slope in Degrees



3.3 Soils

Based on the USDA/NRCS Soil Survey for Maui County (Version 15, October 3rd, 2017), 30 soil types are mapped within the Waikapū Watershed (Figure 10. Waikapū Soils Map), and 54 soil types are mapped within the Waiakoa Watershed (Figure 11. Waiakoa Soils Map). Listed below are the soil types found within each watershed and general descriptions of their characteristics.

Table 2. Waikapū Watershed Soils

Soil Symbol	Soil Name	Mean Annual Precipitation (inches)	Elevation (feet)	Slope (percent)	Drainage Class	Runoff Class	Frequency of Flooding	Acreage	Percent of Watershed
AcA	Alae Cobbly Sandy Loam	14 to 19	20 to 380	0 to 3	Excessively Drained	Very Low	Occasional	6.18	0.06
BS	Beaches	10 to 75	0 to 10	1 to 5	Excessively Drained	Very Low	Frequent	11.39	0.11
EaA	Ewa Silty Clay Loam	16 to 23	0 to 240	0 to 3	Well Drained	Very Low	None	16.01	0.16
EcA	Ewa Cobbly Silty Clay Loam	15 to 20	0 to 10	0 to 3	Well Drained	Low	None	21.00	0.21
EsB	Ewa Silty Clay	17 to 25	0 to 320	3 to 7	Well Drained	Medium	None	59.23	0.58
GPI	Gravel Pits							35.88	0.35
IbB	Iao Cobbly Silty Clay	25 to 40	100 to 500	3 to 7	Well Drained	Medium	None	9.62	0.09
IcB	Iao Cobbly Silty Clay	25 to 40	100 to 500	7 to 15	Well Drained	Medium	None	403.39	3.94

Soil Symbol	Soil Name	Mean Annual Precipitation (inches)	Elevation (feet)	Slope (percent)	Drainage Class	Runoff Class	Frequency of Flooding	Acreage	Percent of Watershed
IcC	Iao Clay	32 to 41	390 to 870	7 to 15	Well Drained	Medium	None	40.54	0.40
JaC	Jaucas Sand	13 to 77	0 to 1,140	0 to 15	Excessively Drained	Low	Rare	1572.81	15.35
KMW	Keālia Silt Loam	10 to 41	0 to 260	0 to 1	Poorly Drained	Negligible	Frequent	264.22	2.58
NAC	Naiwa Silty Clay Loam	45 to 95	600 to 3,030	13 to 45	Well Drained	High	None	117.05	1.14
OFC	Olelo Silty Clay	60 to 10	1,430 to 3,420	15 to 50	Well Drained	High	None	12.88	0.13
OMB	Oli Silt Loam	30 to 40	1,000 to 2,250	3 to 10	Well Drained	Medium	None	117.19	1.14
PpA	Pūlehu Silt Loam	10 to 35	0 to 300	0 to 3	Well Drained	Low	Occasional	601.54	5.87
PpB	Pūlehu Silt Loam	10 to 35	0 to 300	3 to 7	Well Drained	Low	Occasional	239.57	2.34
PrA	Pūlehu Cobbly Silt Loam	10 to 35	0 to 300	0 to 3	Well Drained	Low	Occasional	120.21	1.17

Soil Symbol	Soil Name	Mean Annual Precipitation (inches)	Elevation (feet)	Slope (percent)	Drainage Class	Runoff Class	Frequency of Flooding	Acreage	Percent of Watershed
PrB	Pūlehu Cobbly Silt Loam	10 to 35	0 to 300	3 to 7	Well Drained	Medium	Occasional	373.21	3.64
PsA	Pūlehu Clay Loam	10 to 50	0 to 300	0 to 3	Well Drained	Low	Rare	460.42	4.49
PtA	Pūlehu Cobbly Clay Loam	10 to 35	0 to 300	0 to 3	Well Drained	Low	Occasional	144.00	1.41
PtB	Pūlehu Cobbly Clay Loam	10 to 35	0 to 300	3 to 7	Well Drained	Medium	Occasional	523.27	5.11
PZUE	Puuone Sand	20 to 30	50 to 350	7 to 30	Somewhat Excessively Drained	Medium	None	262.26	2.56
rRO	Rock Outcrop	10 to 175	0 to 10,000	5 to 99	Well Drained	Very High	None	937.07	9.15
rRR	Rough Broken Land	20 to 200	0 to 4,000	40 to 70	Well Drained	Very High	None	795.94	7.77
rRS	Rough Broken and Stony Land	20 to 200	0 to 4,000	40 to 70	Well Drained	Very High	Frequent	120.18	1.17

Soil Symbol	Soil Name	Mean Annual Precipitation (inches)	Elevation (feet)	Slope (percent)	Drainage Class	Runoff Class	Frequency of Flooding	Acreage	Percent of Watershed
rRT	Rough Mountainous Land	NA	0 to 6,000	50 to 99	Well Drained	Very High	None	2161.73	21.10
rSM	Stony Alluvial Land	10 to 50	0 to 1,000	3 to 15	Well Drained	Medium	Frequent	540.42	5.27
WvB	Wailuku Silty Clay	20 to 40	50 to 1,000	3 to 7	Well Drained	Medium	None	43.86	0.43
WvC	Wailuku Silty Clay	20 to 40	50 to 1000	7 to 15	Well Drained	Medium	None	234.49	2.29

*Precipitation data is associated with the USDA, NRCS soil descriptions.

The dominant soil type within Waikapū Watershed is rRt – Rough Mountainous Land. This soil type is found at the upper elevations, has steep slopes, and is well drained with very high runoff potential. Similar soil types include rRO – Rock Outcrop, rRR – Rough Broken Land, rRS – Rough Broken and Stony Land, and rRT – Rough Mountainous Land, 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. Together, these soils have high runoff potential and make up approximately 40% of the land area within Waikapū Watershed.

Figure 10. Waikapū Soils Map

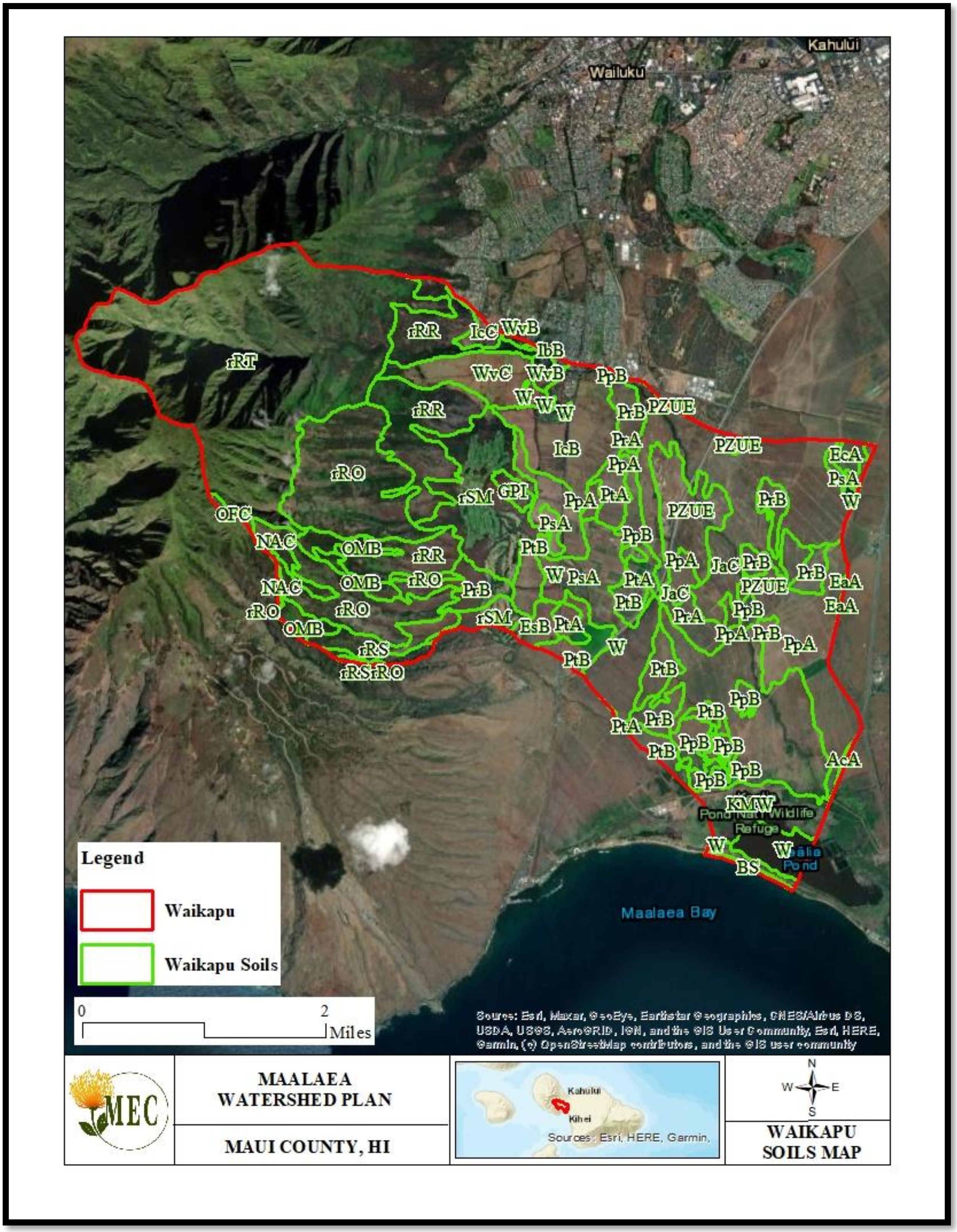


Table 3. Waiakoa Watershed Soils

Soil Symbol	Soil Name	Mean Annual Precipitation (inches)	Elevation (feet)	Slope (percent)	Drainage Class	Runoff Class	Frequency of Flooding	Acreage	Percent of Watershed
8	Lava Flows-Cinder Land Complex	15 to 30	6,560 to 13,680	2 to 40	Excessively Drained	Very Low	NA	2718.14	7.73
AaB	Alae Sandy Loam	13 to 19	10 to 450	3 to 7	Excessively Drained	Low	Occasional	579.76	1.65
AcA	Alae Cobbly Sandy Loam	14 to 19	20 to 380	0 to 3	Excessively Drained	Very Low	Occasional	660.82	1.88
AcB	Alae Cobbly Sandy Loam	14 to 20	90 to 400	3 to 7	Excessively Drained	Low	Occasional	186.88	0.53
BS	Beaches	10 to 75	0 to 10	1 to 5	Excessively Drained	Very Low	Frequent	22.53	0.06
DL	Dune Land	15 to 90	0 to 150	NA	NA	NA	NA	37.81	0.11
EaA	Ewa Silty Clay Loam	16 to 23	0 to 240	0 to 3	Well Drained	Very Low	None	596.64	1.70
EcA	Ewa Cobbly Silty Clay Loam	15 to 20	0 to 10	0 to 3	Well Drained	Low	None	376.40	1.07
EcB	Ewa Cobbly Silty Clay Loam	16 to 17	120 to 220	3 to 7	Well Drained	Medium	None	423.03	1.20
IaA	Iao Silty Clay	25 to 40	100 to 500	0 to 3	Well Drained	Low	None	0.25	0.00

Soil Symbol	Soil Name	Mean Annual Precipitation (inches)	Elevation (feet)	Slope (percent)	Drainage Class	Runoff Class	Frequency of Flooding	Acreage	Percent of Watershed
JaC	Jaucas Sand	13 to 77	0 to 1,140	0 to 15	Excessively Drained	Low	Rare	11.91	0.03
KDIE	Kaipoioi Loam	30 to 45	3,500 to 6,000	7 to 40	Well Drained	High	None	1790.65	5.09
KDVE	Kaipoioi Very Rocky Loam	10 to 175	0 to 10,000	7 to 40	Well Drained	High	None	265.37	0.75
KGKC	Kamaole Very Stony Silt Loam	15 to 25	1,500 to 2,300	3 to 15	Well Drained	Medium	High	2196.21	6.25
KGLC	Kamaole Extremely Stony Silt Loam	15 to 25	1,500 to 2,300	3 to 15	Well Drained	Medium	None	6.63	0.02
KMW	Keālia Silt Loam	10 to 41	0 to 260	0 to 1	Poorly Drained	Negligible	Frequent	207.75	0.59
KnaB	Keahua Cobbly Silty Clay Loam	15 to 25	600 to 1,500	3 to 7	Well Drained	Medium	None	714.15	2.03
KnaC	Keahua Cobbly Silty Clay Loam	15 to 25	600 to 1,500	7 to 15	Well Drained	Medium	None	1501.00	4.27
KnaD	Keahua Cobbly Silty Clay Loam	15 to 25	600 to 1,500	15 to 25	Well Drained	High	None	315.83	0.90

Soil Symbol	Soil Name	Mean Annual Precipitation (inches)	Elevation (feet)	Slope (percent)	Drainage Class	Runoff Class	Frequency of Flooding	Acreage	Percent of Watershed
KnB	Keahua Silty Clay Loam	15 to 25	600 to 1,500	3 to 7	Well Drained	Low	None	1101.14	3.13
KnbD	Keahua Very Stony Silty Clay Loam	15 to 25	600 to 1,500	1 to 25	Well Drained	Medium	None	1025.75	2.92
KnC	Keahua Silty Clay Loam	15 to 25	600 to 1,500	7 to 15	Well Drained	Medium	None	744.51	2.12
KncC	Keahua Silty Clay	15 to 25	600 to 1,500	7 to 15	Well Drained	Medium	None	106.67	0.30
KnhC	Keahua Cobbly Silty Clay	15 to 25	600 to 1,500	7 to 15	Well Drained	Medium	None	532.36	1.51
KnsC	Keahua Stony Silty Clay	15 to 25	600 to 1,500	7 to 15	Well Drained	Medium	None	327.88	0.93
KxaD	Kula Cobbly Medial Loam	25 to 40	2,000 to 3,500	12 to 20	Well Drained	Medium	None	1524.63	4.34
KxbE	Kula - Rock Outcrop Complex	25 to 40	2,000 to 3,500	12 to 40	Well Drained	Medium	None	125.63	0.36
KxC	Kula Loam	25 to 40	2,000 to 3,500	4 to 12	Well Drained	Low	None	78.34	0.22

Soil Symbol	Soil Name	Mean Annual Precipitation (inches)	Elevation (feet)	Slope (percent)	Drainage Class	Runoff Class	Frequency of Flooding	Acreage	Percent of Watershed
KxD	Kula Loam	25 to 40	2,000 to 3,500	12 to 20	Well Drained	Low	None	1293.13	3.68
LME	Laumaia Loam	35 to 70	5,500 to 8,000	7 to 40	Well Drained	Medium	None	1243.50	3.54
LMF	Laumaia Loam	35 to 70	5,500 to 8,000	40 to 70	Well Drained	Medium	None	506.26	1.44
LNE	Laumaia Extremely Stony Loam	35 to 70	5,500 to 8,000	7 to 40	Well Drained	Medium	None	2047.30	5.82
MuA	Molokai Silty Clay Loam	20 to 25	0 to 1,500	0 to 3	Well Drained	Low	None	39.36	0.11
MuB	Molokai Silty Clay Loam	20 to 25	0 to 1,500	3 to 7	Well Drained	Medium	None	7.66	0.02
PpA	Pūlehu Silt Loam	10 to 35	0 to 300	0 to 3	Well Drained	Low	Occasional	797.78	2.27
PpB	Pūlehu Silt Loam	10 to 35	0 to 300	3 to 7	Well Drained	Low	Occasional	499.38	1.42
PrA	Pūlehu Cobbly Silt Loam	10 to 35	0 to 300	0 to 3	Well Drained	Low	Occasional	613.52	1.74
PrB	Pūlehu Cobbly Silt Loam	10 to 35	0 to 300	3 to 7	Well Drained	Medium	Occasional	121.00	0.34

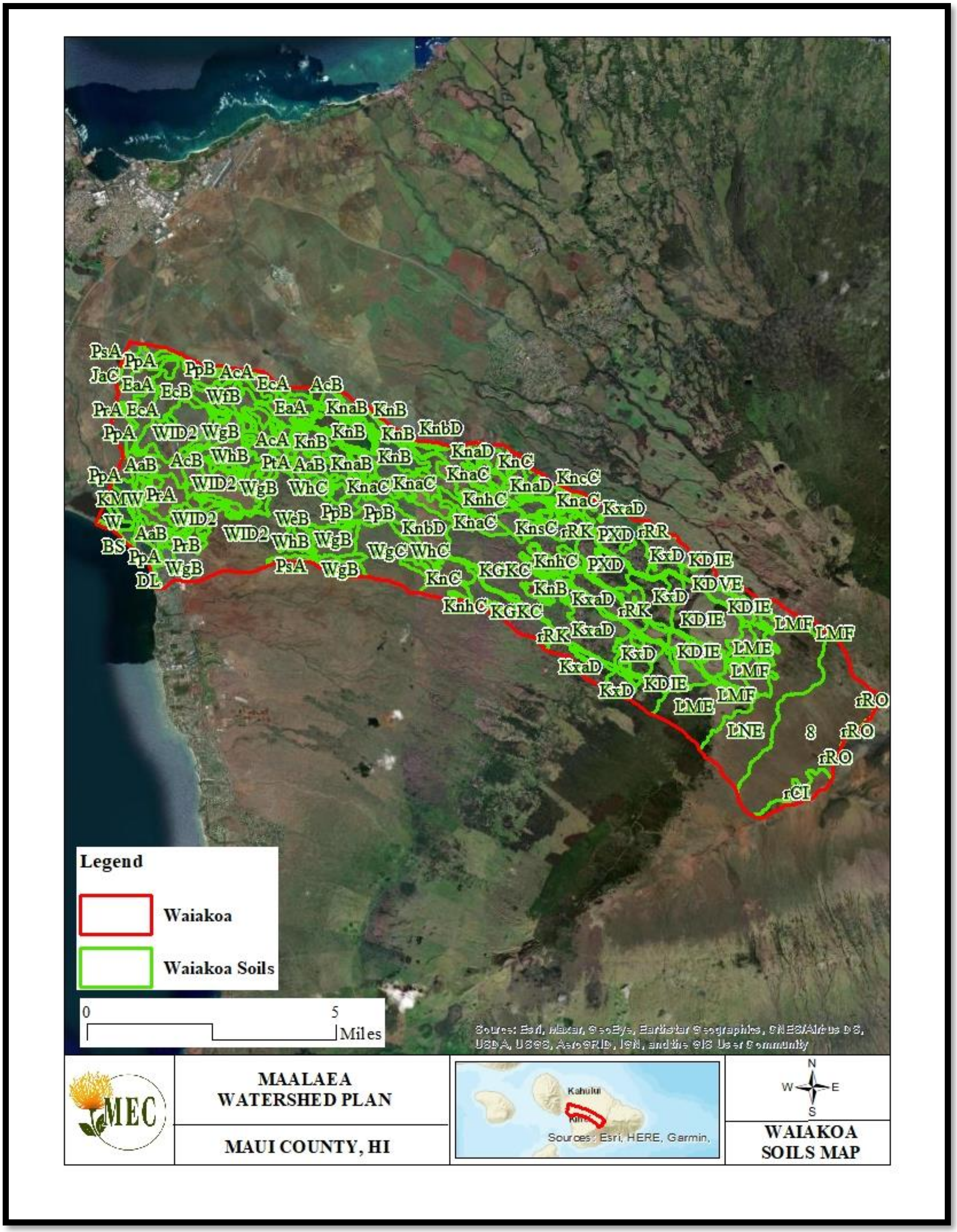
Soil Symbol	Soil Name	Mean Annual Precipitation (inches)	Elevation (feet)	Slope (percent)	Drainage Class	Runoff Class	Frequency of Flooding	Acreage	Percent of Watershed
PsA	Pūlehu Clay Loam	10 to 50	0 to 300	0 to 3	Well Drained	Low	Rare	202.44	0.58
PtA	Pūlehu Cobbly Clay Loam	10 to 35	0 to 300	0 to 3	Well Drained	Low	Occasional	212.85	0.61
PXD	Pane Silt Loam	30 to 50	2,000 to 3,500	7 to 25	Well Drained	Low	None	1093.81	3.11
rCI	Cinder Land	20 to 100	8,000 to 10,000	NA	NA	NA	NA	240.45	0.68
rRK	Rock Land	15 to 60	0 to 6,000	0 to 70	Well Drained	Very High	None	949.96	2.70
rRO	Rock Outcrop	10 to 175	0 to 10,000	5 to 99	Well Drained	Very High	None	10.66	0.03
rRR	Rough Broken Land	20 to 200	0 to 4,000	40 to 70	Well Drained	Very High	None	12.79	0.04
WeB	Waiakoa Silty Clay Loam	12 to 20	100 to 1,000	3 to 7	Well Drained	Medium	None	239.38	0.68
WeC	Waiakoa Silty Clay Loam	12 to 20	100 to 1,000	7 to 15	Well Drained	Medium	None	35.58	0.10
WfB	Waiakoa Cobbly Silty Clay Loam	12 to 20	100 to 1,000	3 to 7	Well Drained	Medium	None	120.75	0.34

Soil Symbol	Soil Name	Mean Annual Precipitation (inches)	Elevation (feet)	Slope (percent)	Drainage Class	Runoff Class	Frequency of Flooding	Acreage	Percent of Watershed
WgB	Waiakoa Very Stony Silty Clay Loam	14 to 21	100 to 1,000	3 to 7	Well Drained	Medium	None	1331.09	3.79
WgC	Waiakoa Very Stony Silty Clay Loam	16 to 21	750 to 1,150	7 to 15	Well Drained	Medium	None	802.62	2.28
WhB	Waiakoa Extremely Stony Silty Clay Loam	14 to 19	20 to 460	3 to 7	Well Drained	Medium	None	259.28	0.74
WhC	Waiakoa Extremely Stony Silty Clay Loam	17 to 19	460 to 1,280	7 to 15	Well Drained	Medium	None	249.05	0.71
WID2	Waiakoa Extremely Stony Silty Clay Loam	14 to 19	100 to 1,000	3 to 25	Well Drained	High	None	4055.99	11.53

*Precipitation data is associated with the USDA, NRCS soil descriptions.

There are 54 different soil types within Waiakoa Watershed that differ in clay, sand, and silt content and also in texture, slope, and aggregate size. The dominant soil type within Waiakoa Watershed is WID2 – *Waiakoa Extremely Stony Silty Clay Loam*. This soil has a depth of 20 to 40 inches and is well drained. The water movement in the most restrictive layer is moderately high, available water to a depth of 60 inches is low, shrink-swell potential is low, there is no zone of water saturation within a depth of 72 inches, the organic matter content in the surface horizon is about 2 percent, it does not meet hydric criteria, and it can be found on slopes that range from 3 to 25 percent (Soil Conservation Service, 2001).

Figure 11. Waiakoa Soils Map



3.4 Climate

The climate on the island of Maui is highly variable. Its proximity to the equator, steep volcanic peaks, and consistent trade winds, create subsidence inversions that greatly influence the weather patterns of the island (Giambelluca & Nullet, 1991). Orographic rainfall occurs on the windward side as the moisture from the ocean is uplifted and cools to form rain at upper elevations of the mountain, where the highest rainfall occurs. Rainfall decreases gradually toward the coastline as elevations descend. On windward sides of the mountains, northeasterly trade winds generate heavy rainfall while the leeward sides remain dry. Generally speaking, there is a wet winter season (October to April) and a dry summer season (May to September).

3.5 Precipitation

The Waikapū 390 rain gauge located at 20.8536 degrees latitude and -156.5088 degrees longitude with an elevation of 483 feet was used to represent rainfall within Waikapū Watershed. The Kula Branch Station rain gauge lies within Waiakoa Watershed at 20.75868 degrees latitude and -156.3211 degrees longitude at an elevation of 3125 feet. Rainfall data from the nearby Haleakalā Ranger Station rain gauge was also used to reference rainfall amounts for upper elevations of Waiakoa Watershed. It is located less than 2,000 feet, or 0.3 miles, to the north of the watershed boundary. Additional rainfall data was reviewed from GIS generated isohyets. Data used to generate the isohyets (Figure 13. Waikapū Rainfall Map and Figure 14. Waiakoa Rainfall Map) were pulled from the State of Hawaiʻi, Office of Planning Geographic Information System Data Portal.

To capture recent rainfall trends associated with the Māʻalaea Watershed, the last five years (2018-2022) of rainfall data from the Waikapū 390 station, Kula Branch Station, and Haleakalā Ranger Station were analyzed. The period-of-record began 16 August 1916 and continues through present day. Monthly and annual rainfall totals are displayed in the tables below. The island of Maui has experienced varying levels of drought conditions during the past five years, and rainfall amounts coincide with the drought conditions reported by NOAA's National Integrated Drought Information System. From 2018 until the end of 2022, drought conditions increased in both duration and intensity (U.S. Drought Monitor, 2023) (Figure 12. Maui Drought Conditions from 2018-2022).

Table 4. Waikapū 390 Rainfall by Month from 2018 to 2022

Month	Year				
	2018	2019	2020	2021	2022
January	0.05	2.56	1.37	5.61	0.32
February	8.92	6.49	2.95	1.75	0.00
March	2.19	0.75	1.89	4.51	0.07
April	4.89	No Data	1.6	0.07	0.12
May	1.85	1.24	0.85	0.07	0.02
June	0.05	0	0	0.02	0.06
July	0.67	0.08	0.01	0	0.04
August	1.34	0.44	0.01	0.24	0.16
September	4.36	0.01	0.21	0.02	0.34
October	2.11	0.29	0.36	0.12	0.62
November	2.73	0.28	0.09	0	0.3

Month	Year				
	2018	2019	2020	2021	2022
December	1.29	0.61	0	3.6	0.78
Totals	30.45	12.75	9.34	16.01	2.83

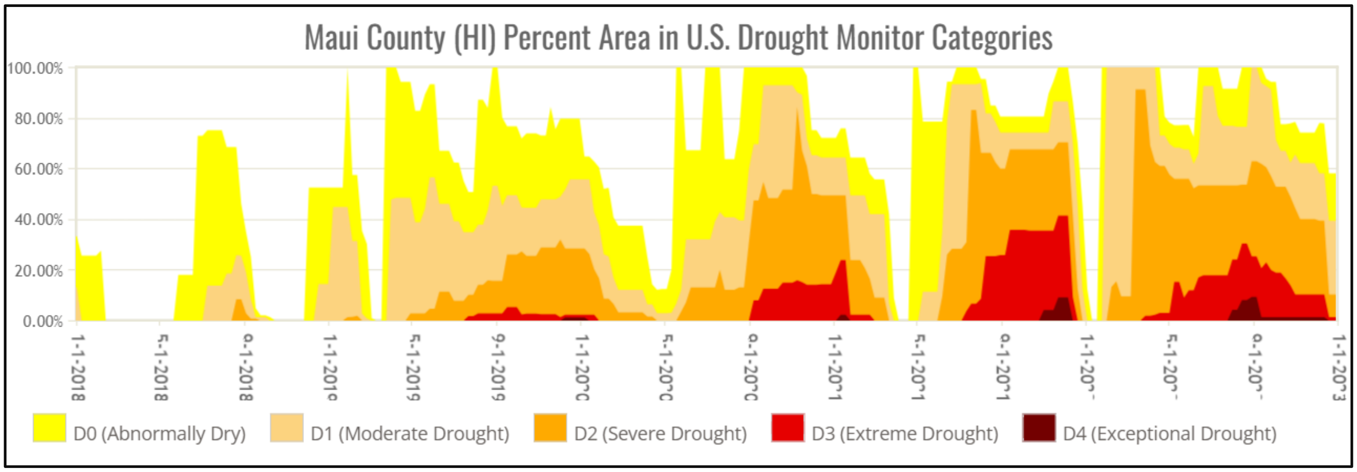
Table 5. Kula Branch Station Rainfall by Month from 2018 to 2022

Month	Year				
	2018	2019	2020	2021	2022
January	2.34	2.16	1.69	0.91	0.05
February	8.9	9.77	2.54	1.05	0.67
March	3.05	0.11	7.18	2.75	0.36
April	5.38	1.93	3.4	0.29	0.07
May	1.62	3.59	1.23	1.00	0.11
June	0.04	0.85	0.52	0.00	0.22
July	0.48	0.31	2.7	0.01	0
August	6.51	3.48	0.1	0.45	0.54
September	3.5	2.75	0.7	0.65	0.2
October	2.37	0.43	4.08	0.23	0.85
November	0.4	1.55	0.12	0.16	0.78
December	0.05	1.45	0.17	1.39	5.84
Totals	34.64	28.38	24.43	8.89	9.69

Table 6. Haleakalā Ranger Station Rainfall by Month from 2018 to 2022

Month	Year				
	2018	2019	2020	2021	2022
January	0.48	No Data	14.12	11.76	0.3
February	5.99	No Data	No Data	2.17	0.25
March	1.83	No Data	No Data	14.99	0.22
April	7.49	No Data	No Data	2.14	1.2
May	1.35	No Data	No Data	1.91	No Data
June	0.49	No Data	No Data	0.1	0.91
July	1.56	No Data	0.61	0.2	0.46
August	4.11	No Data	0.06	2.11	0.45
September	2.43	No Data	0.23	0.9	0.98
October	No Data	No Data	1.25	10.7	0.26
November	No Data	0	1.9	1.43	2.59
December	No Data	5.48	2.76	14.86	10.01
Totals	25.73	5.48	20.93	63.27	17.63

Figure 12. Maui Drought Conditions from 2018-2022



*The U.S. Drought Monitor is jointly produced by the National Drought Mitigation Center at the University of Nebraska-Lincoln, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration. Graph courtesy of NDMC.

Figure 13. Waikapū Rainfall Map

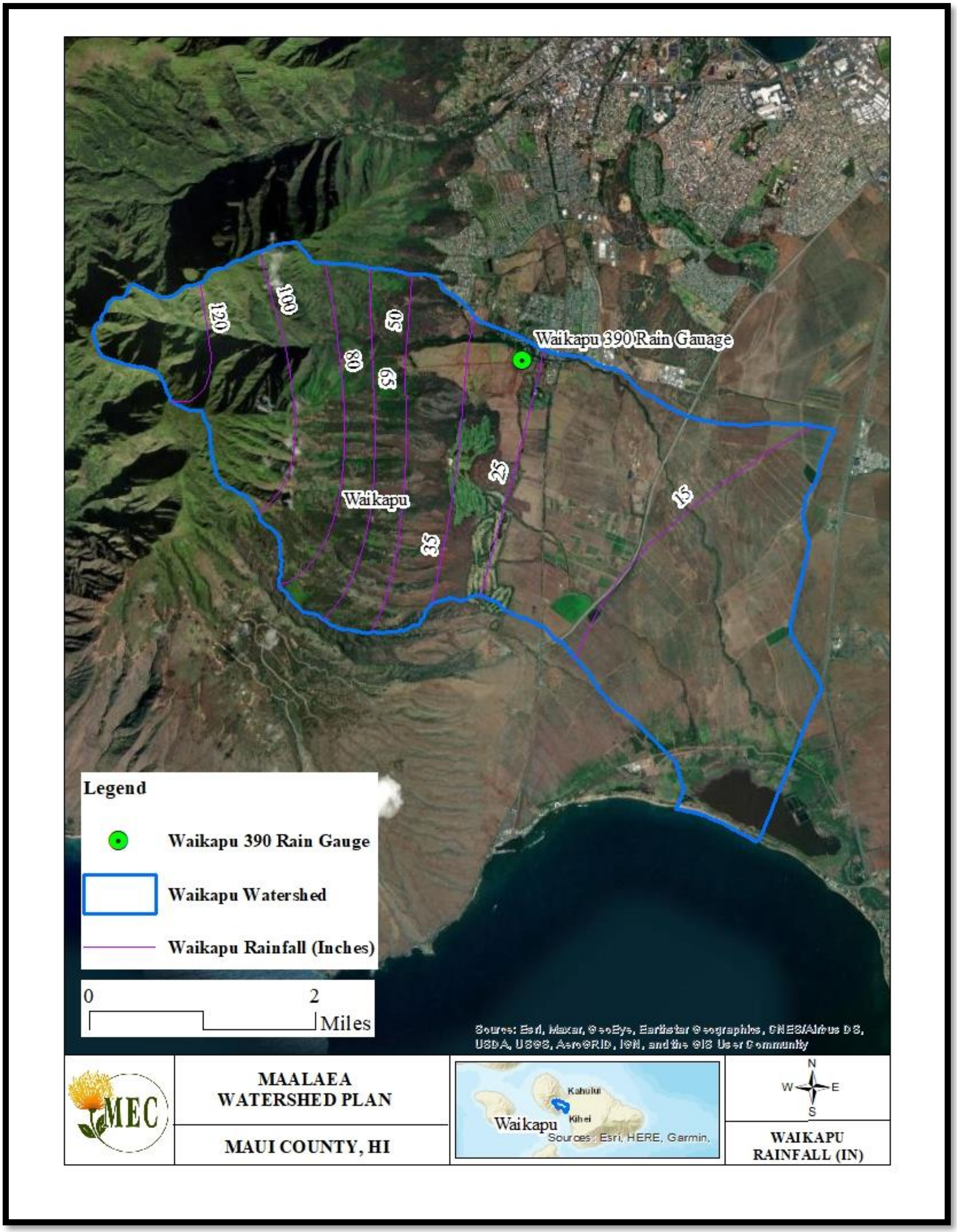
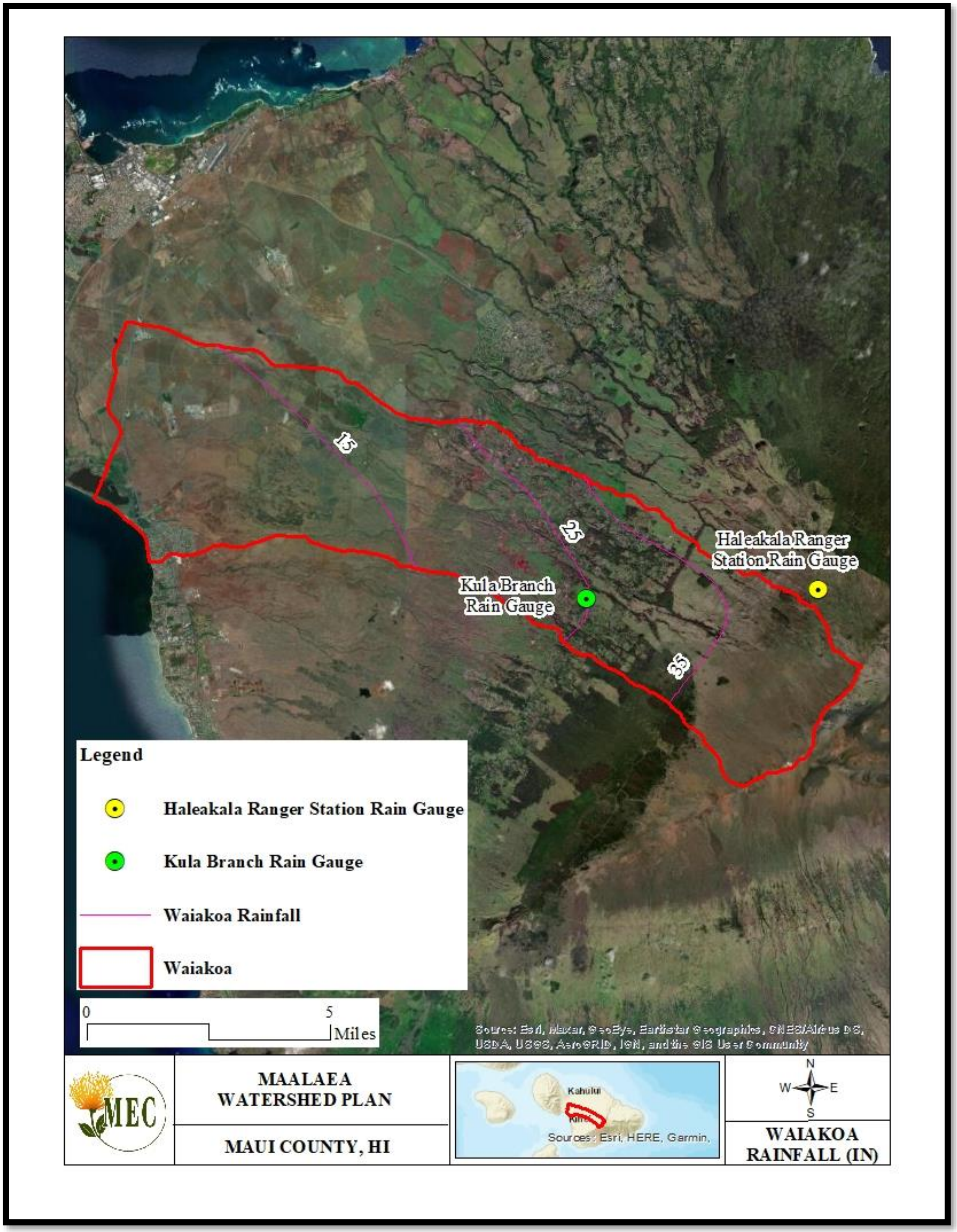


Figure 14. Waiakoa Rainfall Map



3.6 Hydrology

3.6.1 Surface Water: Māʻalaea Watershed Landscape and Major Drainageways

Table 7. Māʻalaea Watershed Streams

Watershed	Streams/Gulches	Classification
Waikapū	Waikapū	Perennial
	Ooawa Kilika Gulch	Ephemeral
	Paleaahu Gulch	Ephemeral
	Kaonohua Gulch	Ephemeral
Waiakoa	Pohaku o ka La Gulch	Ephemeral
	Pūlehu Gulch	Ephemeral
	Kolaloa Gulch	Ephemeral
	Waikapū	Ephemeral
	Keahuaiwi Gulch	Ephemeral
	Waiakoa Gulch	Ephemeral

3.6.1.1 Waikapū Watershed Streams

Waikapū Watershed consists of two major drainage ways, both of which are referred to as Waikapū Stream (Figure 15. Waikapū Streams and Wetlands Map). The northern-most Waikapū Stream originates at apporximately 3,300 feet in the West Maui Mountains and has several smaller tributaries that flow into it at upper elevations. It flows due east until it reaches Honoapiʻilani Highway at 400 feet of elevation, and then bends to the south where it discharges into Keālia Pond. This is the only perennial stream within the Māʻalaea Watersheds.

To the south exists several tributaries that flow into an ephemeral stream that is also named Waikapū Stream. The two northern most tributaries are referenced as Waikapū, and they merge into the main stream at approximately 440 feet of elevation. Moving to the south are Ooawa Kilika, Paleaahu, and Kaonohua Gulches, each of which merge into Waikapū Stream at approximately 400 feet of elevation. These gulches all join together into one stream at approximately 220 feet of elevation in between Honoapiʻilani Highway and Kuihelani Highway. The Waikapū Stream flows southeast into Keālia Pond.

3.6.1.2 Waiakoa Watershed Streams

The streams within Waiakoa watershed are all ephermeral (Figure 16. Waiakoa Streams and Wetlands Map). Pohaku o Ka La Gulch and Pūlehu Gulch originate at approximately 8,000 feet and 6,400 feet of elevation respectively. Pūlehu Gulch merges into Pohaku o ka La Gulch at approximately 4,400 feet and continues northwest into the central isthmus of Maui. The gulch makes a sharp bend to the south where it then flows into Keālia Pond. Makai of Mokulele Highway, this gulch is essentially a ditch as it passes through agricultural lands.

At approximately 8,000 feet Kalaloa Gulch begins flowing. It flows northwest before turning southwest. Like Pūlehu Gulch, Kalaloa enters a ditch system immediately west of Mokulele Highway before discharging into Keālia Pond.

Keahuaiwi Gulch begins at approximately 8,100 feet. This gulch runs generally west through Kula and agricultural lands before discharging into a narrow strip of land immediately north of the intersection of North and South Kīhei Roads. This swale is intended to discharge into the eastern boundary of Keālia Pond but often floods roads and condos associated with the area.

Waiakoa Gulch runs parallel to Keahuaiwi Gulch, originating at approximately 5,000 feet. This gulch also runs through Kula and agricultural lands before discharging into the Pacific Ocean just north of the Kīhei Canoe Club and just south of the intersection of South and North Kīhei Roads.

Figure 15. Waikapū Streams and Wetlands Map

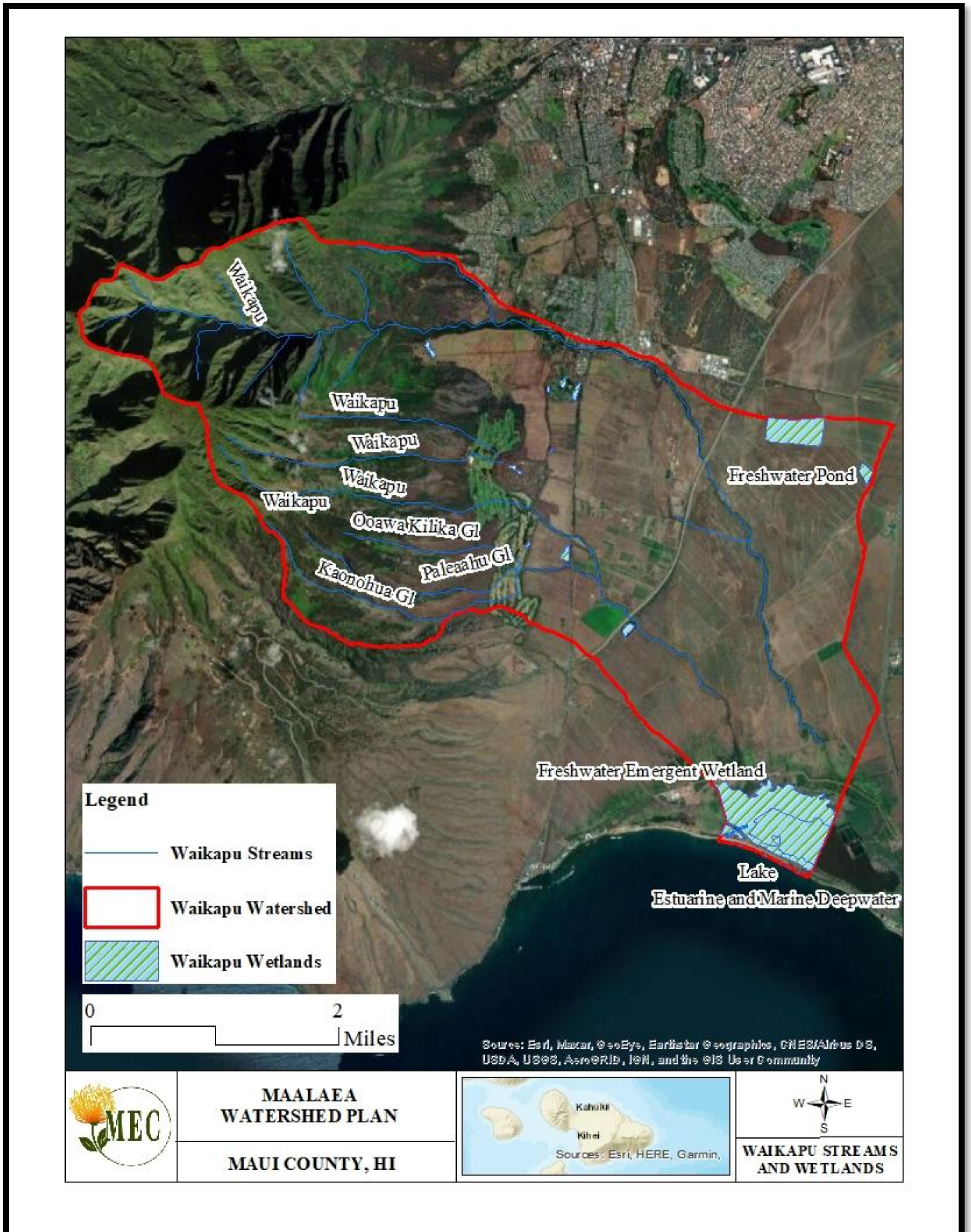
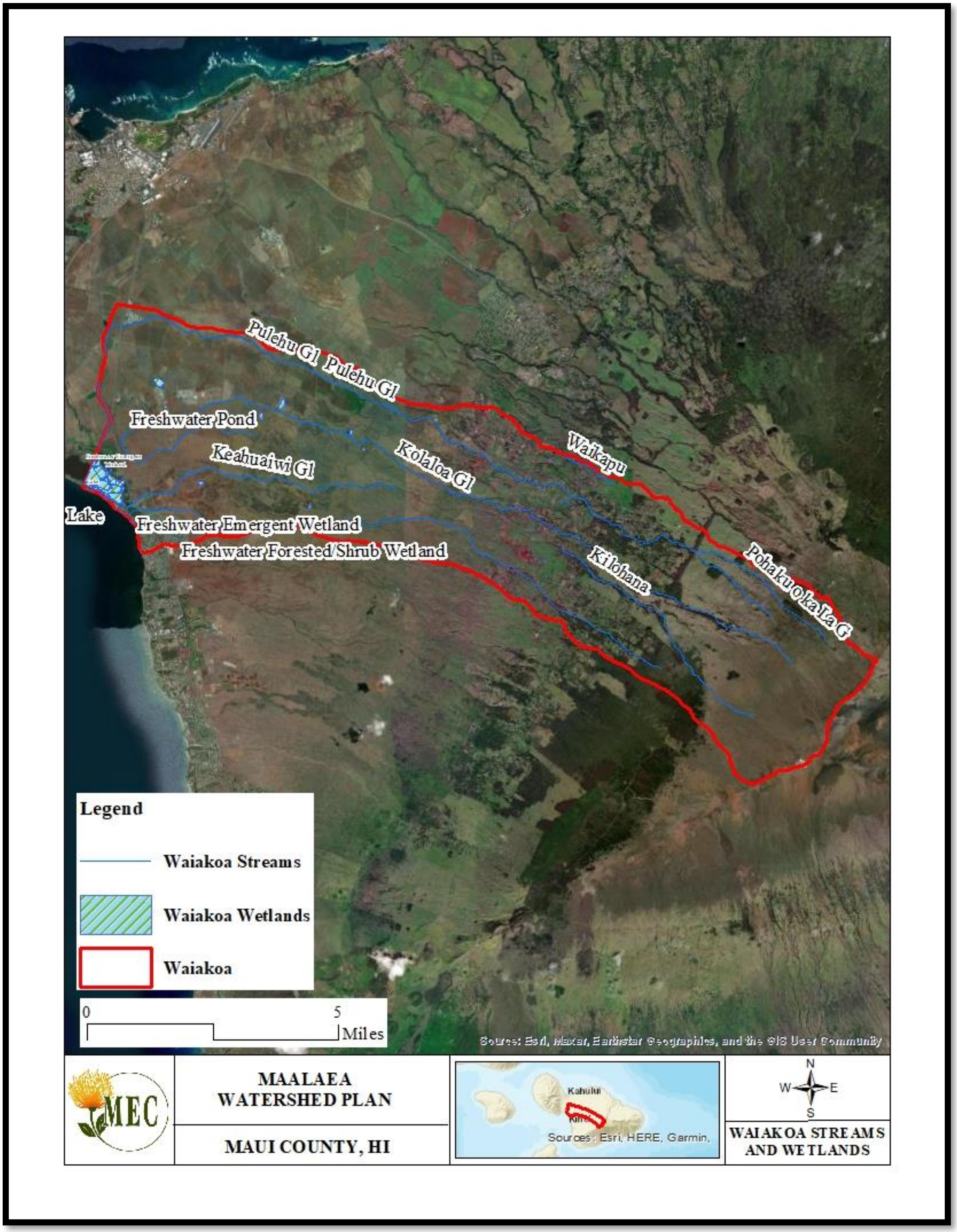


Figure 16. Waiakoa Streams and Wetlands Map



3.6.2 Surrounding Watersheds

There are five watersheds surrounding the Waikapū Watershed (Figure 17. Waikapū Surrounding Watersheds Map). These include ʻĪao to the north, Waiakoa to the east, Pōhākea to the south, Ukumehame to southwest, and small section of Olowalu along the western edge. Waiakoa Watershed is adjacent to Kalialinui to the north, Piinau, Manawainui Gulch, and Kipapa along the southeastern edge, Hāpapa to the south, and Waikapū to the west, and a small shared boundary with ʻĪao on the northwestern corner (Figure 18. Waiakoa Surrounding Watersheds Map). The major surrounding watersheds are discussed below.

3.6.2.1 ʻĪao Watershed

The ʻĪao Watershed is approximately 14,290 acres and borders the Waikapū Watershed to the north. Beginning in the highest peaks of the West Maui Mountains 5,788 feet, the ʻĪao Watershed extends in a northeasterly direction to the coastal waters of the north central valley of Maui. It encompasses the cities of Wailuku and Kahului almost entirely. The major streams of ʻĪao Watershed include ʻĪao, Puulio, and Kaiapaokailio.

3.6.2.2 Kalialinui Watershed

The Kalialinui Watershed is approximately 19,187 acres, and borders Waiakoa Watershed along its length to the north. It originates at an elevation of 9,300 feet on Haleakalā, and extends northwest to the northern coastlines of Maui's central valley. Three major streams/gulches exist within the Kalialinui Watershed. All are ephemeral and generally flow northwest. They include Kalialinui Gulch, Kaluapulani Gulch, and Waiale Gulch.

3.6.2.3 Hāpapa Watershed

The Hāpapa Watershed borders the Waiakoa Watershed along its southern boundaries. This watershed, along with Wailea and Mooloa Watersheds make up the Southwest Maui Watershed Plan approved in 2020. It spans 26,493 acres from the coastal waters of North Kīhei to the southeast where it reaches elevations of 9,400 feet on the slopes of Haleakalā. The four major streams within Hāpapa Watershed are Kulanihakoi Gulch, Waipuilani Gulch, Kēōkea Gulch, and Waimahaihai Gulch. Each of these streams are ephemeral and flow in a westerly direction into the coastal waters of Kīhei.

3.6.2.4 Pōhākea Watershed

The Pōhākea Watershed encompasses 5,268 acres, and is located directly southeast of the Waikapū Watershed. It begins at approximately 4,600 feet at the summit of Hanaula within the West Maui Mountains. Along the coast, this watershed stretches from Keālia Pond and continues west past McGregor's Point. The four major streams associated with the watershed are Pōhākea, Kanaio, Māʻalaea, and Malalowaiaole, all of which have ephemeral flow regimes. Pōhākea Gulch discharges into Keālia Pond and ulitmately into Māʻalaea Bay. This watershed plan was approved in 2023.

Figure 17. Waikapū Surrounding Watersheds

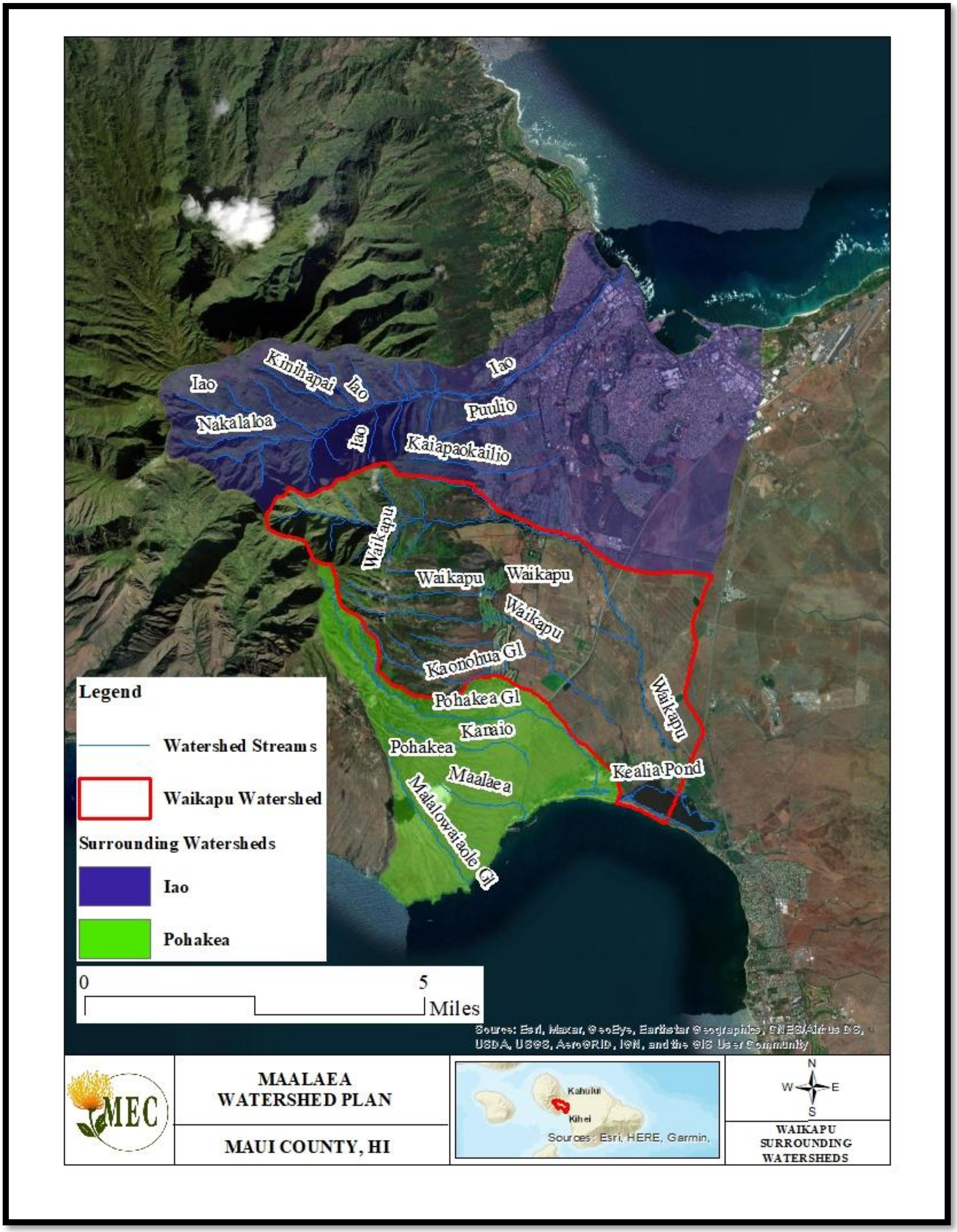
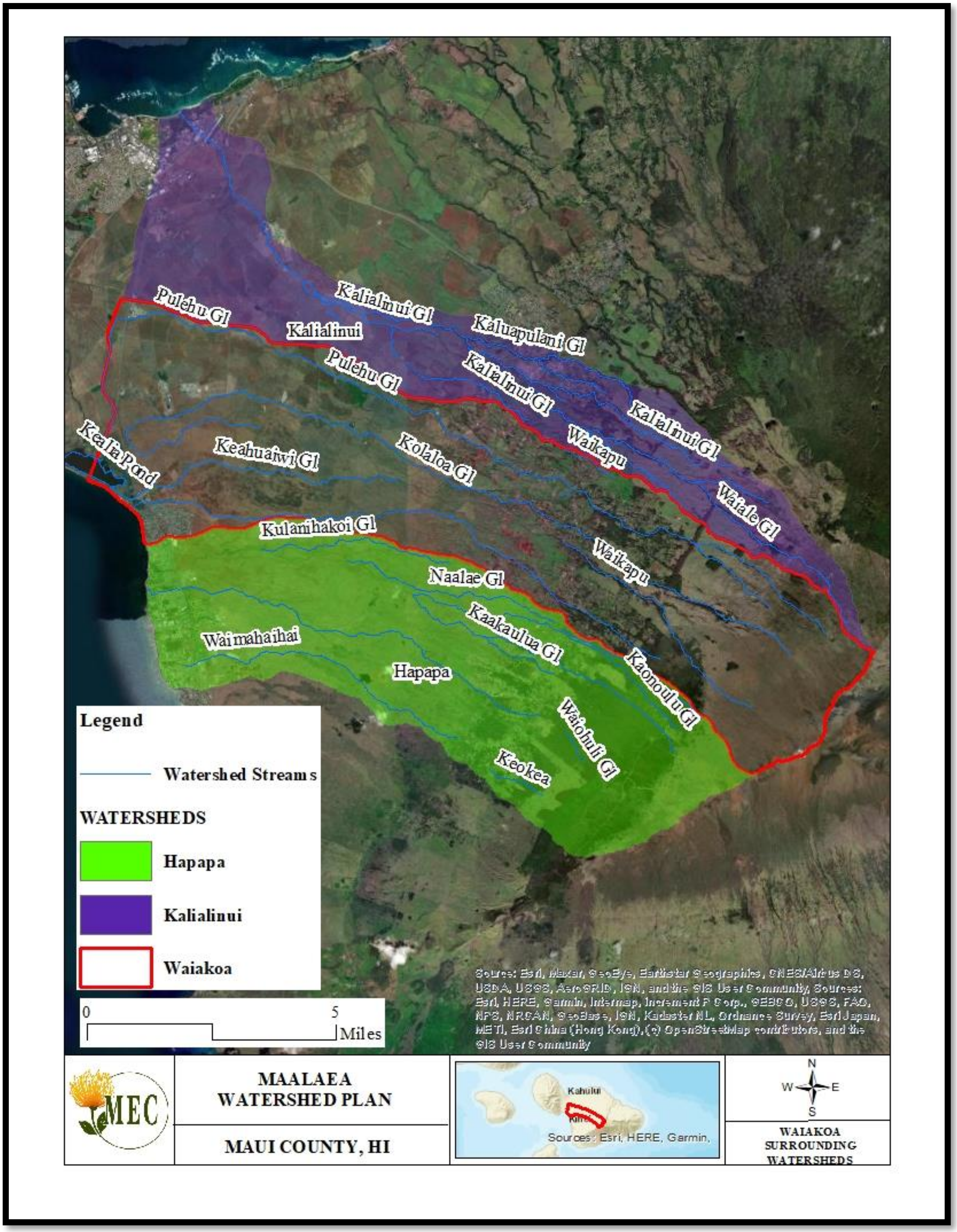


Figure 18. Waiakoa Surrounding Watersheds



3.7 Terrestrial Habitat

The Māʻalaea Watersheds are divided into four land use districts: conservation, agriculture, rural, and urban. Of those four districts, conservation lands make up 7,823.59 acres, or 17.1% of the combined project area. The remainder of the watersheds are designated as 76.7% agriculture, 3.3% rural, and 2.9% urban. Both Waikapū and Waiakoa Watersheds discharge into Keālia Pond National Wildlife Refuge (Figure 19. Waikapū Terrestrial Habitat Map and Figure 20. Waiakoa Terrestrial Habitat Map). The pond provides critical habitat for many endangered bird species. The refuge protects some of the last remaining native wetland habitat in the State. Feral ungulates such as axis deer, goats, and pigs can be found throughout the entire planning area. These animals, especially the uncontrolled population of axis deer, contribute greatly to land degradation associated with erosion. Axis deer are known to forage on native and endangered plant species which also results in further habitat loss for listed species of fauna.

The upper elevations of Waikapū watershed share a boundary with the West Maui Forest Reserve and provide a critical habitat for high densities of native vegetation. Within the montane wet ecosystem, endangered plants such as *Cytrandra oxybapha* (Haʻiwale) or *Remya mauiensis* (Maui remya) can be found. At lower elevations, the lowland dry ecosystems can provide habitat for endangered plants such as *Ctenitis squamigera* (Pauoa) and *Canavalia pubescens* (ʻāwikiwiki).

As the elevation climbs within Waiakoa Watershed, higher densities of listed species are present. Dense forests of *Metrosideros polymorpha* (ʻōhiʻa lehua) and *Acacia koa* (koa) exist at upper elevations, providing habitat for many species of endangered birds. Some of Hawaiʻi's rarest plants and animals occupy the watershed where its boundaries overlap with Haleakalā National Park. Most notably is the Silversword or *Argyroxiphium sandwicense ssp. macrocephalum* (ʻĀhinihina), an endemic and endangered plant found only on the summits of Hawaiʻi's volcanoes.

3.8 Benthic Habitat

The National Oceanographic and Atmospheric Administration (NOAA) has published benthic habitat data for the planning area. Vector boundaries of habitat areas were delineated by photo interpreting georeferenced color aerial photography, AURORA hyperspectral, and IKONOS satellite imagery. Overall accuracy of the major habitat classifications in these data is greater than 90%. Habitat boundaries are based on photo-interpretation of imagery of ground condition at the time the imagery was collected. Shore lines are subject to change over time due to natural erosion and vegetation growth processes. Habitat boundaries are subject to change over time due to population dynamics of the dominant biological communities. 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 (Figure 21. Waikapū Benthic Habitat Map and Figure 22. Waiakoa Benthic Habitat Map). Moving offshore aggregate reefs, aggregate patch reefs, and individual patch reefs are scattered along a sandy bottom (NOAA, 2007).

The coastal waters offshore from the Māʻalaea Watershed are protected by various federal and state agencies (Figure 23. Waikapū Marine Environments Map and Figure 24. Waiakoa 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 ʻĀhihi-Kīnaʻu Natural Area Reserve. The sanctuary spans half of the ʻAlalākeiki Channel in between Maui and Kahoʻolawe, completely encompassing the ʻAuʻau and Kalohi Channels in between Maui and Lanaʻi and Lanai and

Molokaʻi respectively, as well as most of the Pailolo Channel separating Maui and Molokaʻi. Within three miles of the entire shoreline of the island of Maui, a State of Hawaiʻi 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). Beginning at Haycraft Park, Coral reef exists directly offshore along the entire coastal boundary of the Waikapū Watershed. Moving southeast, coral reefs extend into the Waikoa Watershed coastline adjacent to Keālia pond and beyond (Figure 25. Waikapū Coral Reefs Map and Figure 26. Waiakoa Coral Reefs Map).

3.8.1 Aquatic and Marine Life

Both aquatic and marine life are abundant in the coastal ecosystems that receive inputs from the watershed lands, streams, and groundwater. The several streams and gulches within the Māʻalaea Watersheds discharge directly into Keālia Pond, which is one of the largest remaining wetlands on Maui. Hawaiian traditional and customary gathering rights, subsistence fishing, commercial and recreational fishing, and commercial recreational activities, such as snorkeling, diving, and whale-watching, depend on balanced aquatic ecosystems. These systems support aquatic life and wildlife, such as coral, Hawaiian stilts, Hawaiian monk seals, hawksbill turtles, green sea turtles (honu), humpback whales, etc. The entire coastline of the planning area is part of the Hawaiian Islands Humpback Whale National Marine Sanctuary.

Figure 19. Waikapū Terrestrial Habitat Map

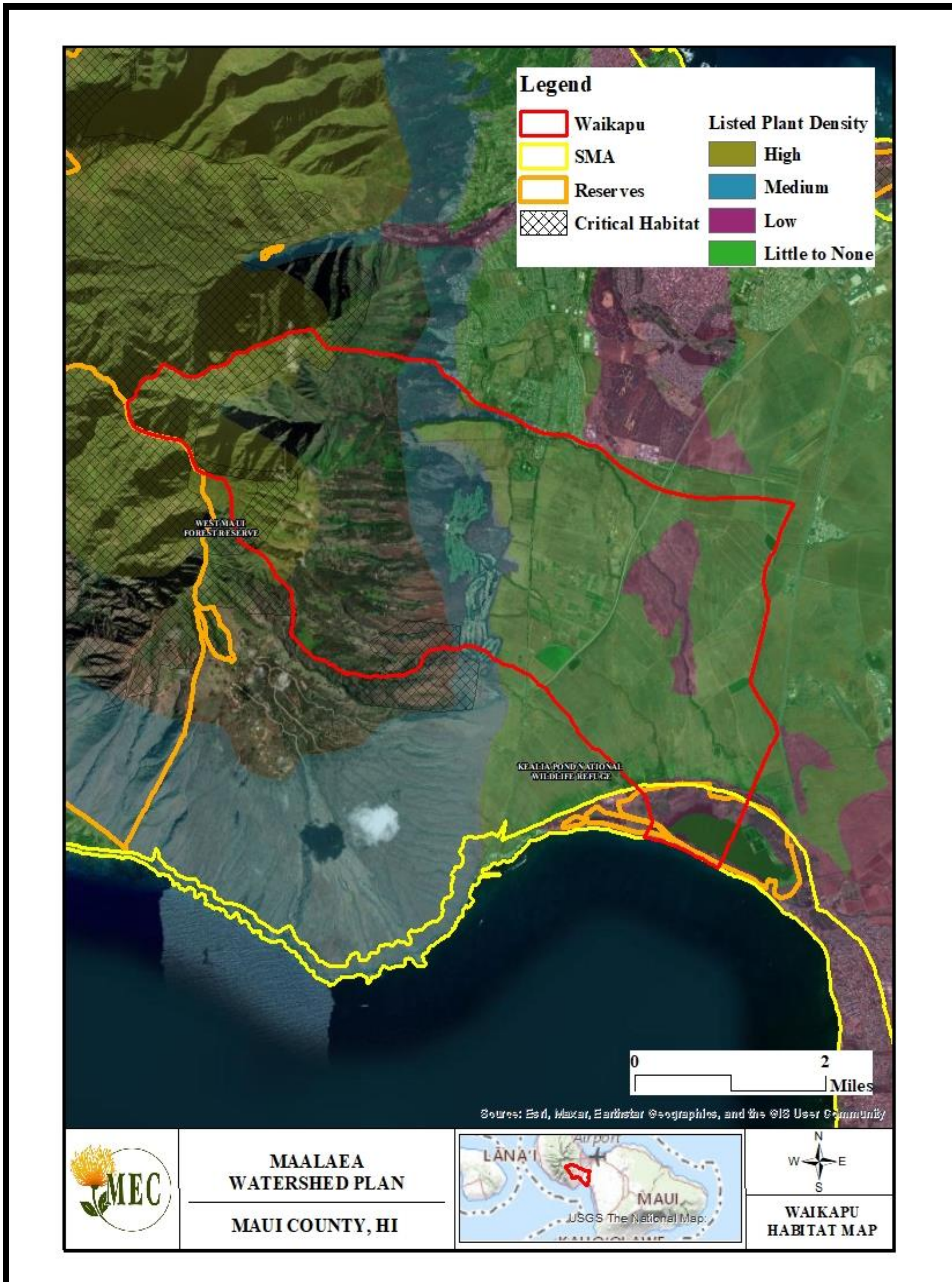


Figure 20. Waiakoa Terrestrial Habitat Map

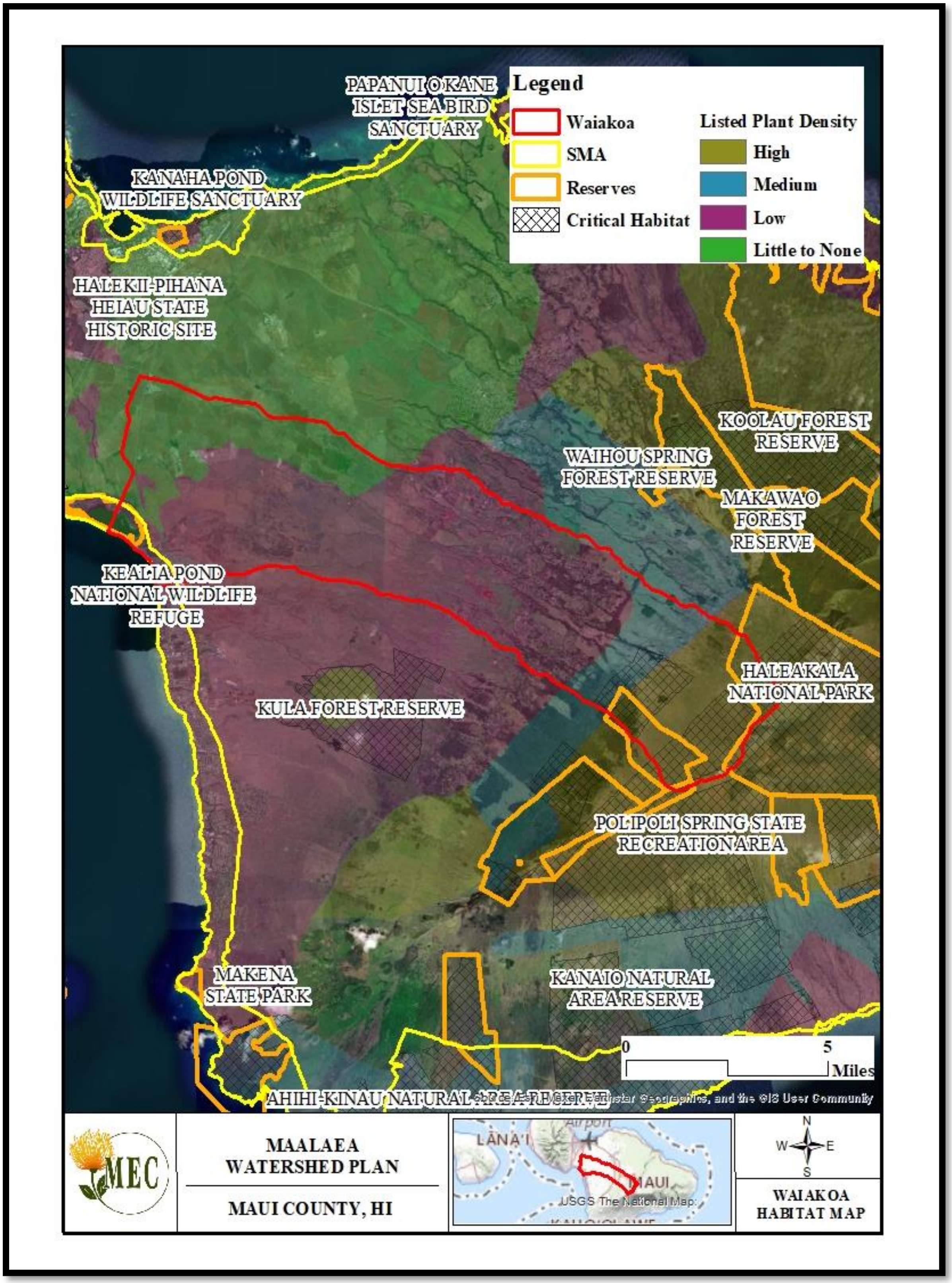


Figure 21. Waikapū Benthic Habitat

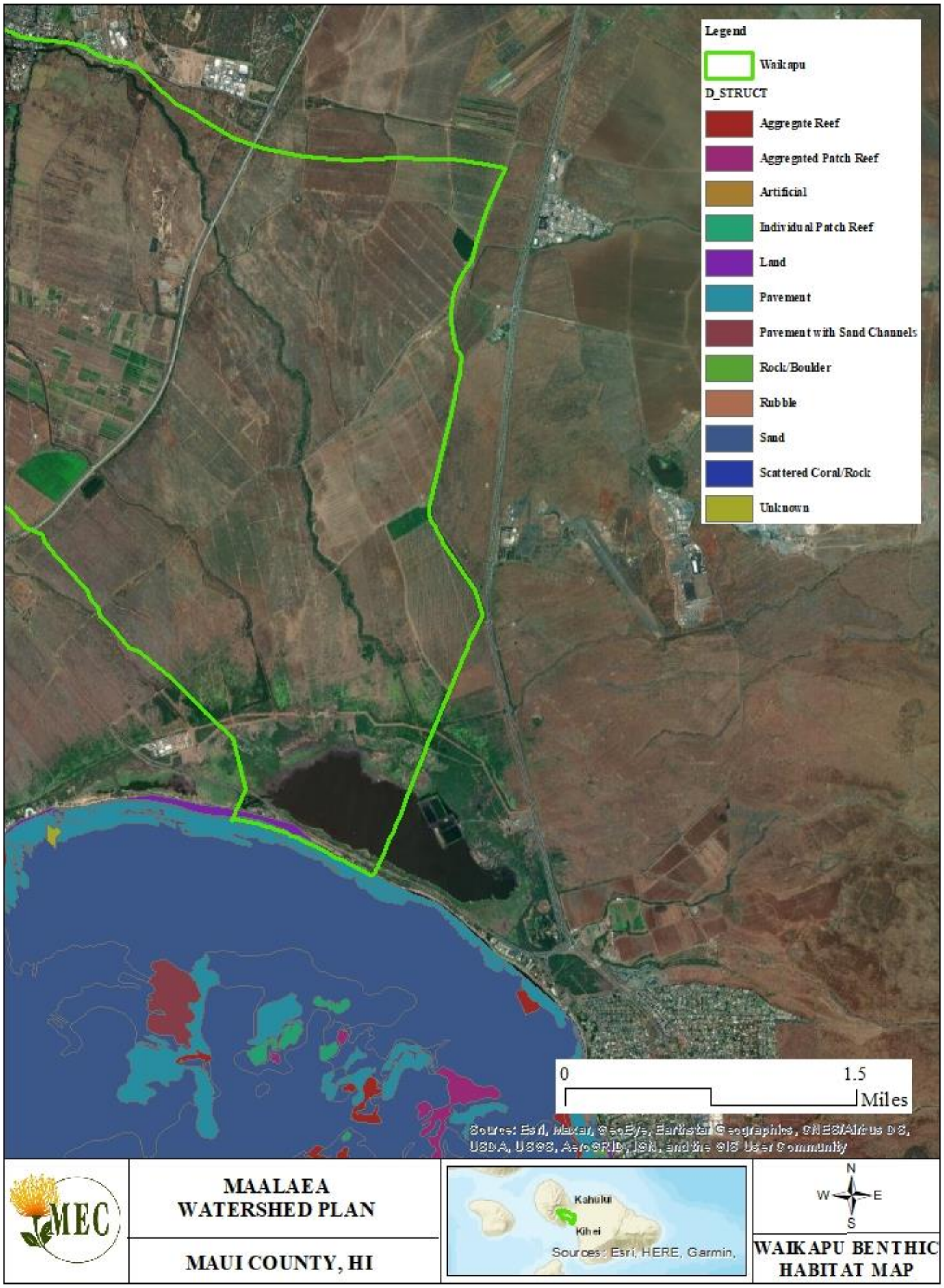


Figure 22. Waiakoa Benthic Habitat

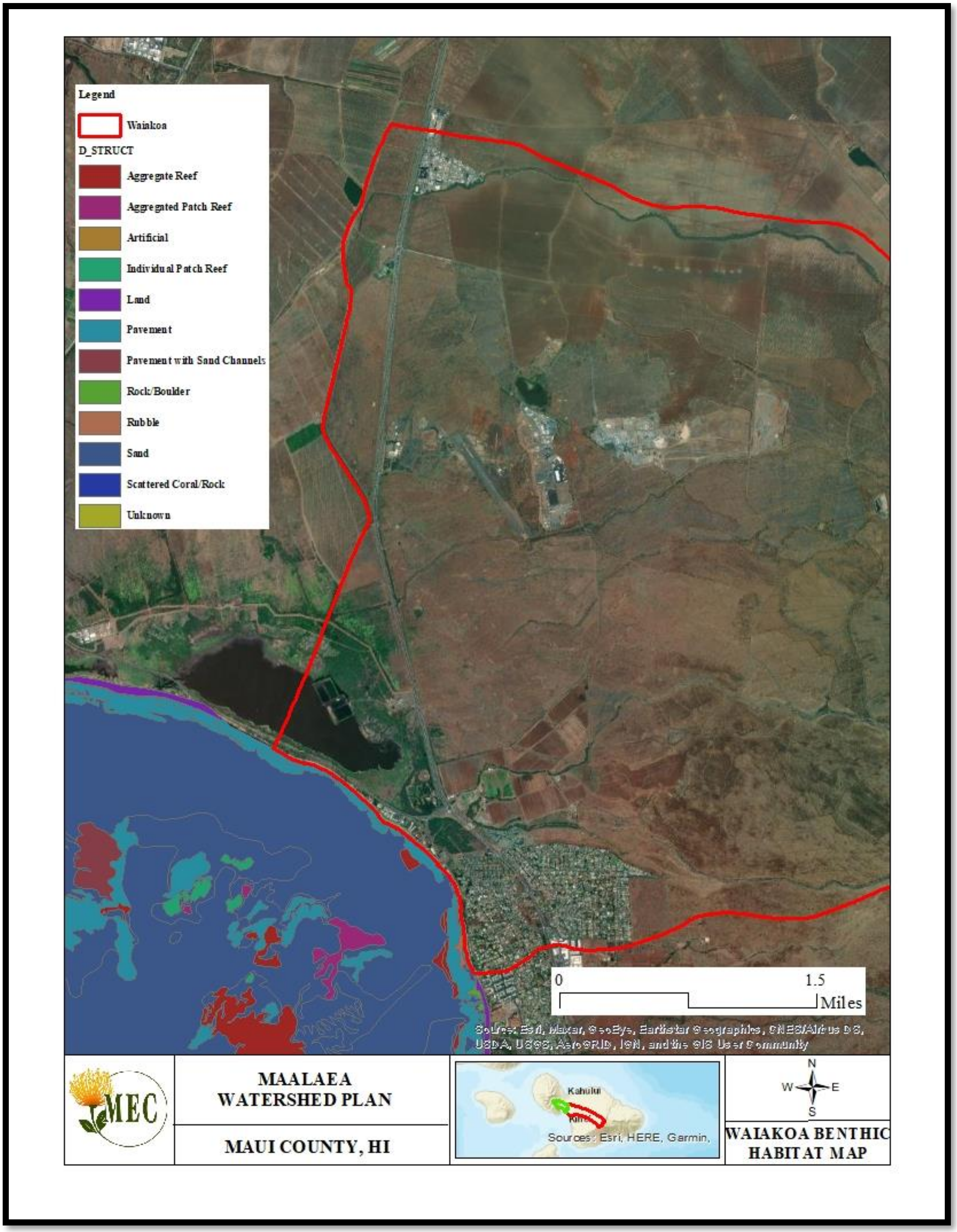


Figure 23. Waikapū Marine Environments Map

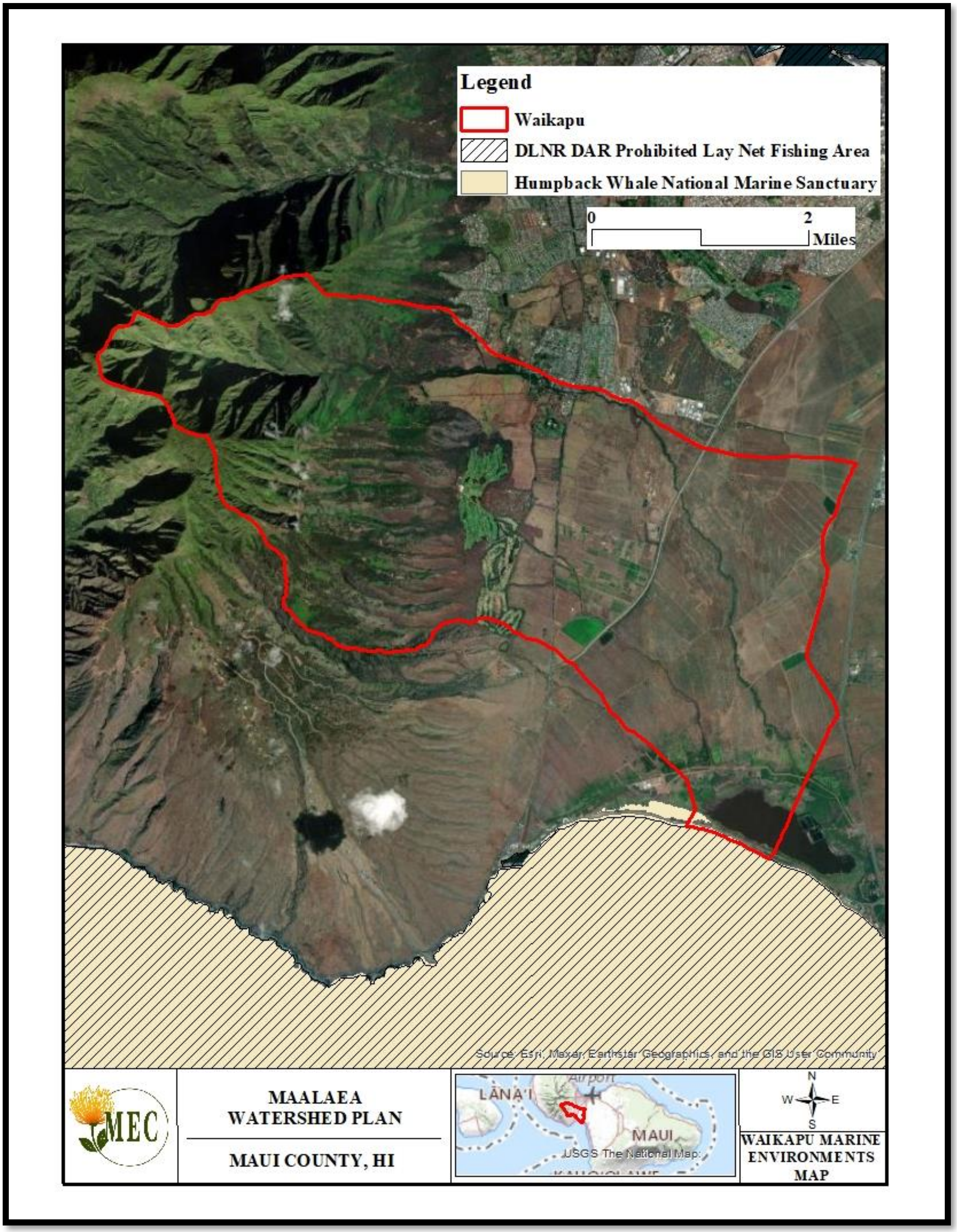


Figure 24. Waiakoa Marine Environments Map

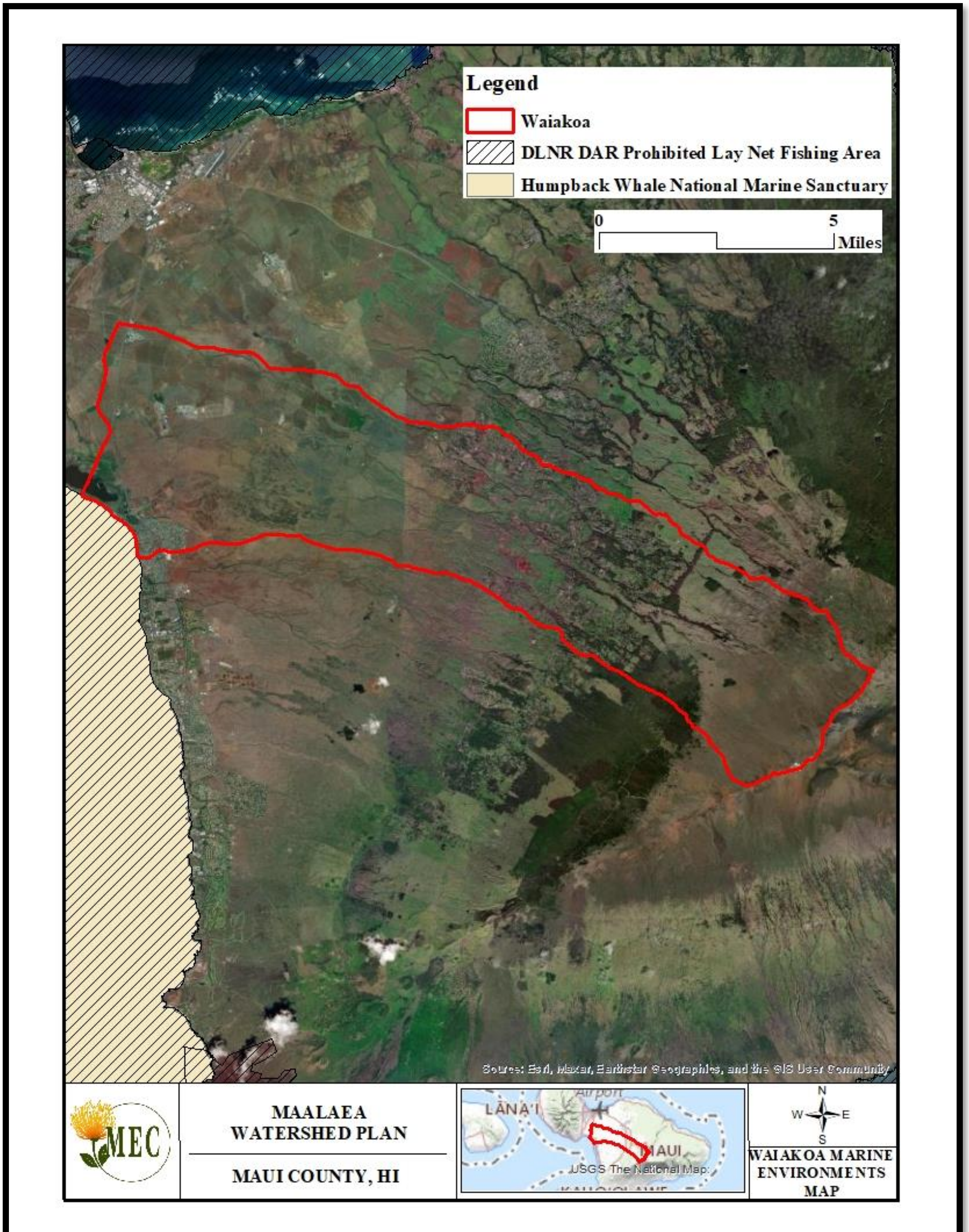


Figure 25. Waikapū Coral Reefs Map

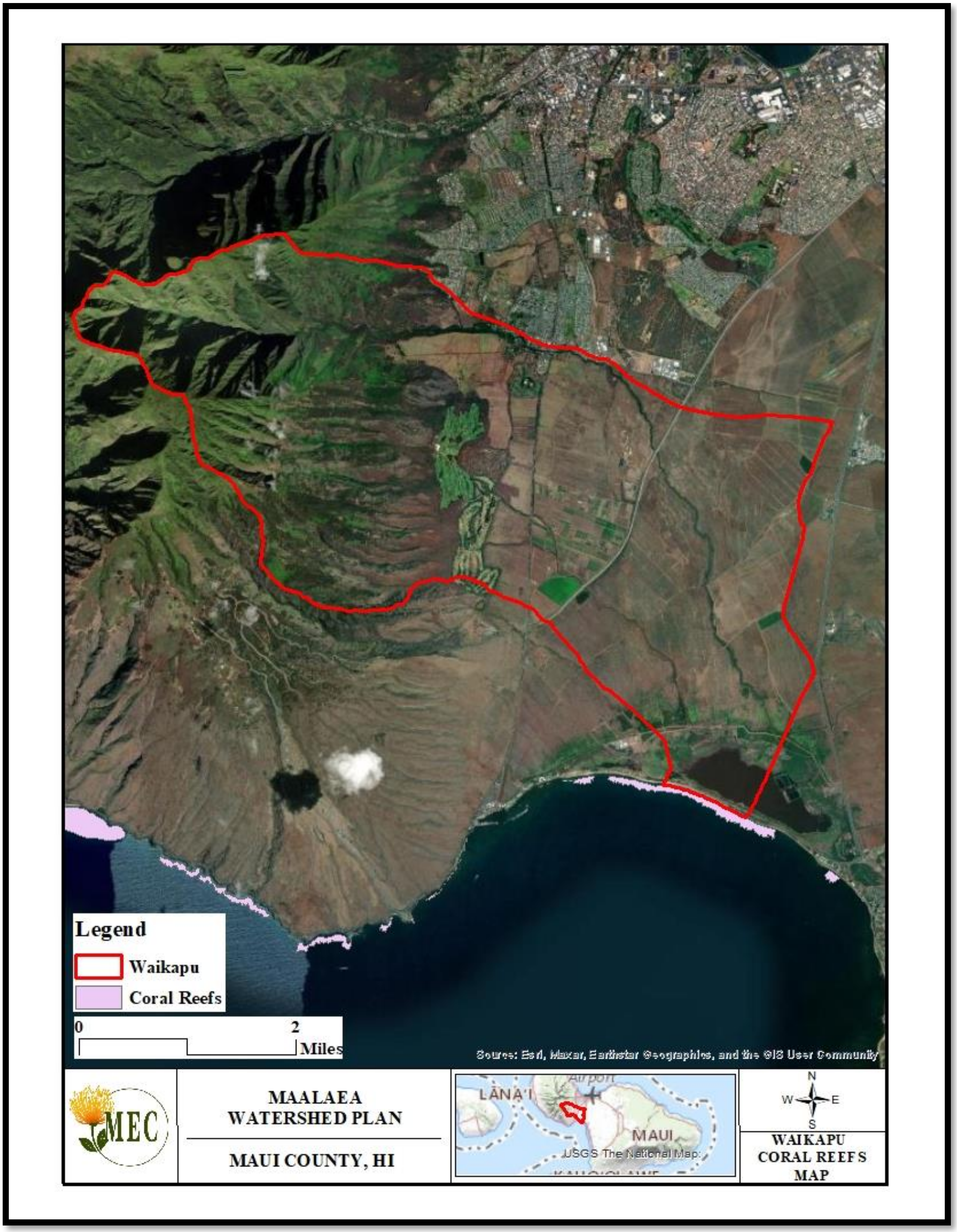
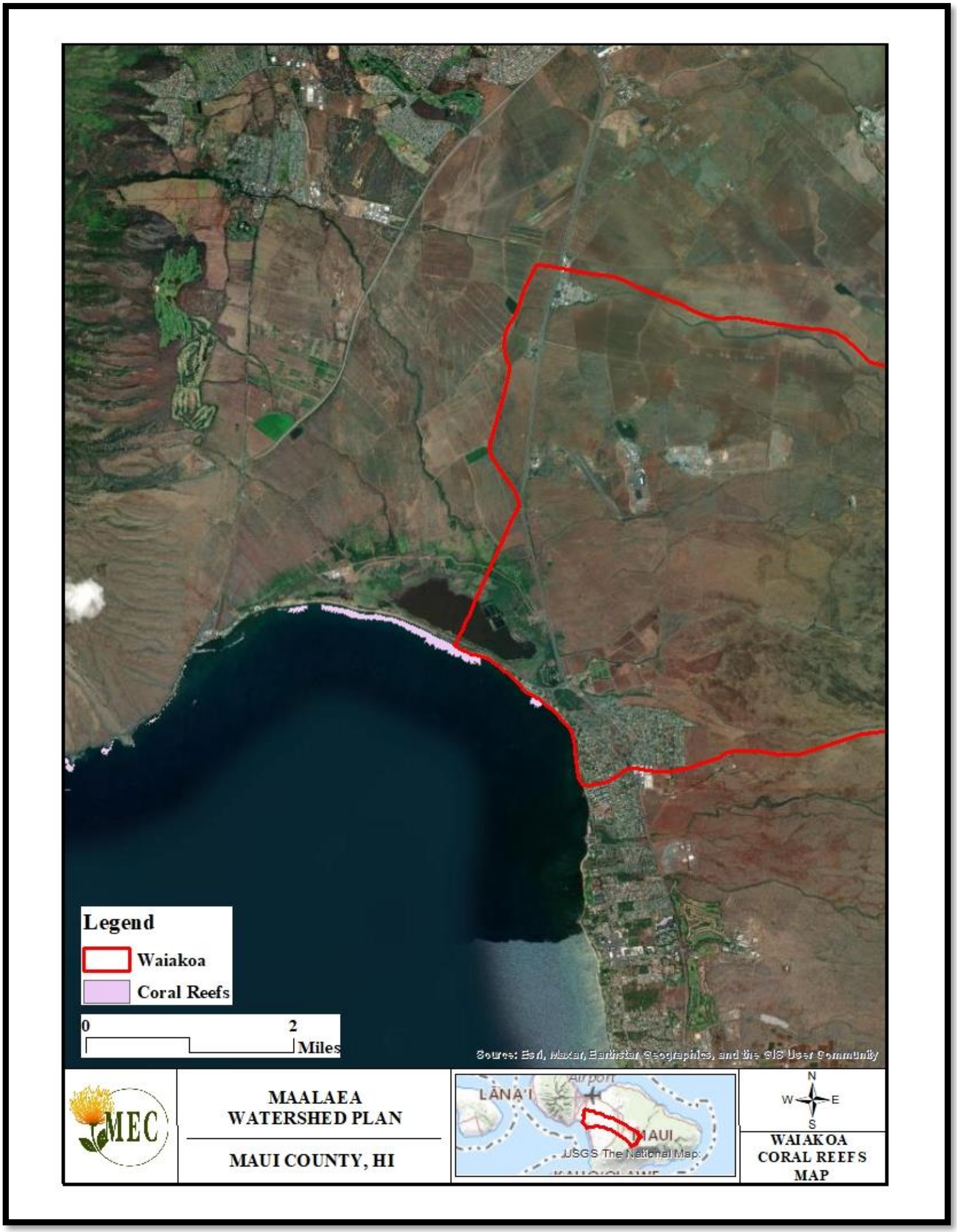


Figure 26. Waiakoa Coral Reefs Map



4.0 LAND USE AND POPULATION

4.1 Land Use Districts

Four land use districts exist within the Māʻalaea Watersheds: conservation, agriculture, rural, and urban (Figure 27. Waikapū State Land Use Districts Map and Figure 28. Waiakoa State Land Use Districts Map). Agriculture is the largest land use district for both Waikapū and Waiakoa Watersheds, and occupies the majority of the land area of Maui's central valley from sea level to 1,500 and 3,000 feet respectively. Conservation lands include Keālia Pond along the coast, and the upper elevations of the West Maui Mountians and Haleakalā for Waikapū and Waiakoa Watersheds respectively. Rural and Urban lands are clustered together along the northern boundaries, and comprise a combined 6.07 percent of the Waikapū Watershed. These lands are associated with the Waikapū township. Within the Waiakoa Watershed Rural and Urban land use districts make up 6.26 percent of land area. A small section of rural and urban lands exist along the western shorlines of the watershed boundaries in Kīhei while the majority are at elevations around 3,500 feet in the town of Kula. State land use boundaries were compiled by the State Land Use Commission and were most recently updated in 2023.

Table 8. Māʻalaea Watershed Land Use Districts

Land Use District	Waikapū		Waiakoa	
	Acres	Percent	Acres	Percent
Agriculture	5,856.08	56.35	29,202.67	82.66
Conservation	3,907.04	37.59	3,916.55	11.09
Rural	136.80	1.32	1,394.26	3.95
Urban	493.24	4.75	817.19	2.31

4.2 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 types, and ten exist within the Waikapū Watershed boundary. These include Residential, Cropland and Pasture, Herbaceous Rangeland, Shrub and Brush Rangeland, Mixed Rangeland, Evergreen Forest Land, Lakes, Reservoirs, Non-forested Wetland, Strip Mines, Quarries, and Gravel Pits. Cropland and Pasture is the largest land cover type, making up nearly half of the watershed (Figure 29. Waikapū State Land Use Classifications Map).

Waiakoa Watershed is diverse in its land cover types, containing 14 different categories. Cropland and Pasture and Shrub and Brush Rangeland are the two major land covers, comprising over 85 percent of the land area. The twelve other land coverstypes are: Residential, Commercial and Services, Cropland and Pasture, Orchards, Groves, Vineyards, Nurseries and Ornamental, Other Agricultural Land, Herbaceous Rangeland, Shrub and Brush Rangeland, Mixed Rangeland, Evergreen Forest Land, Lakes, Reservoirs, Nonforested Wetland, Bare Exposed Rock, and Transitional Areas (Figure 30. Waiakoa State Land Use Classifications Map).

Table 9. Māʻalaea Watershed Land Use Classifications

Land Cover	Land Use Description	Acreage	Percentage
Waikapū			
11	Residential	55.29	0.53
21	Cropland and Pasture	4789.09	46.09
31	Herbaceous Rangeland	670.01	6.45
32	Shrub and Brush Rangeland	1587.82	15.28
33	Mixed Rangeland	73.8	0.71
42	Evergreen Forest Land	2853.54	27.46
52	Lakes	101.76	0.98
53	Reservoirs	16.07	0.15
62	Non forested Wetland	186.34	1.79
75	Strip Mines, Quarries, and Gravel Pits	57.80	0.56
Waiakoa			
11	Residential	763.15	2.16
12	Commercial and Services	134.92	0.38
21	Cropland and Pasture	15931.59	45.10
22	Orchards, Groves, Vineyards, Nurseries, Ornamental	67.05	0.19
24	Other Agricultural Land	51.90	0.15
31	Herbaceous Rangeland	1251.27	3.54
32	Shrub and Brush Rangeland	14216.75	40.25
33	Mixed Rangeland	253.77	0.72
42	Evergreen Forest Land	1643.66	4.65
52	Lakes	79.19	0.22
53	Reservoirs	55.16	0.16
62	Non forested Wetland	103.06	0.29
74	Bare Exposed Rock	7.18	0.02
76	Transitional Areas	765.30	2.17

Figure 27. Waikapū State Land Use Districts Map

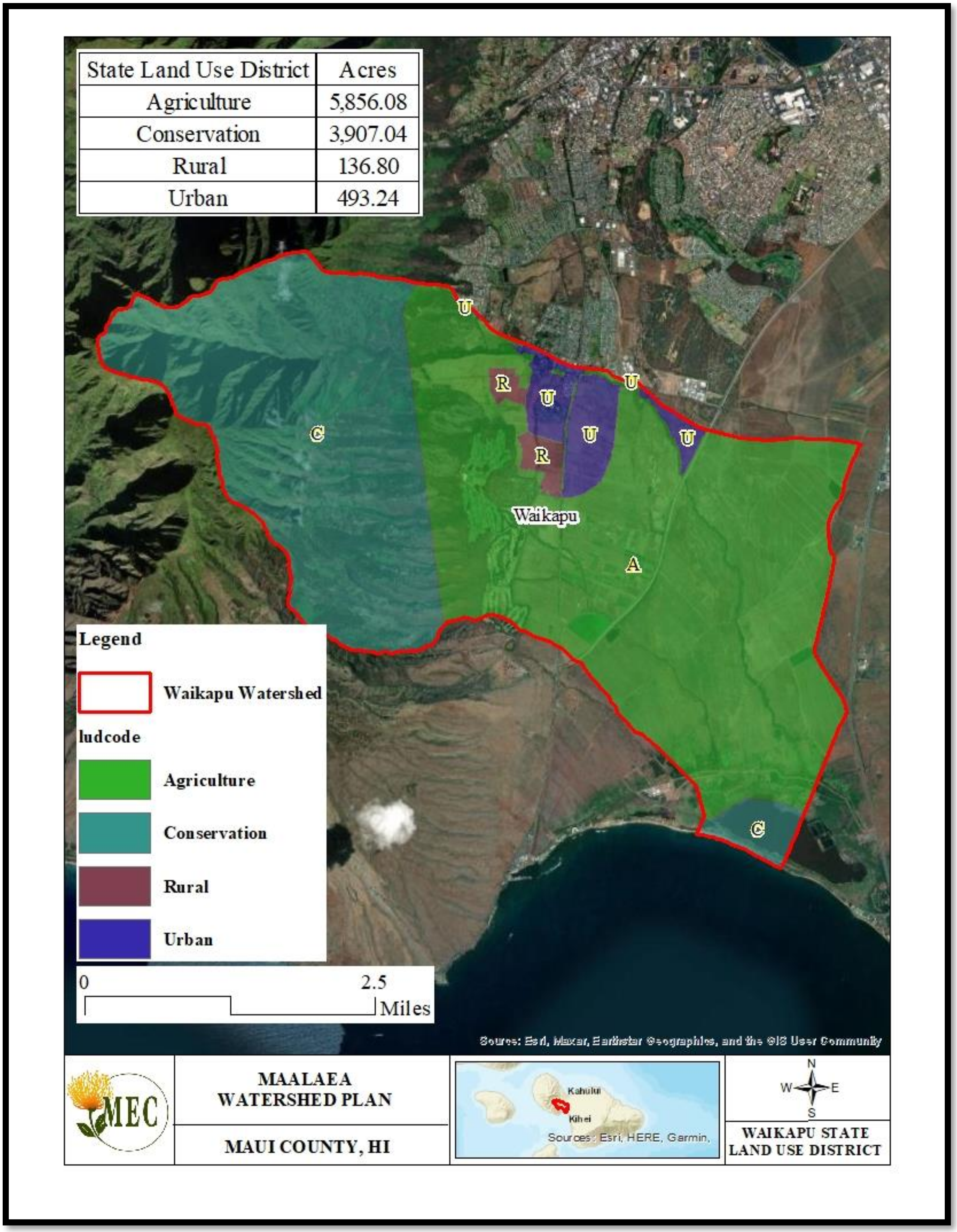


Figure 28. Waiakoa State Land Use Districts Map

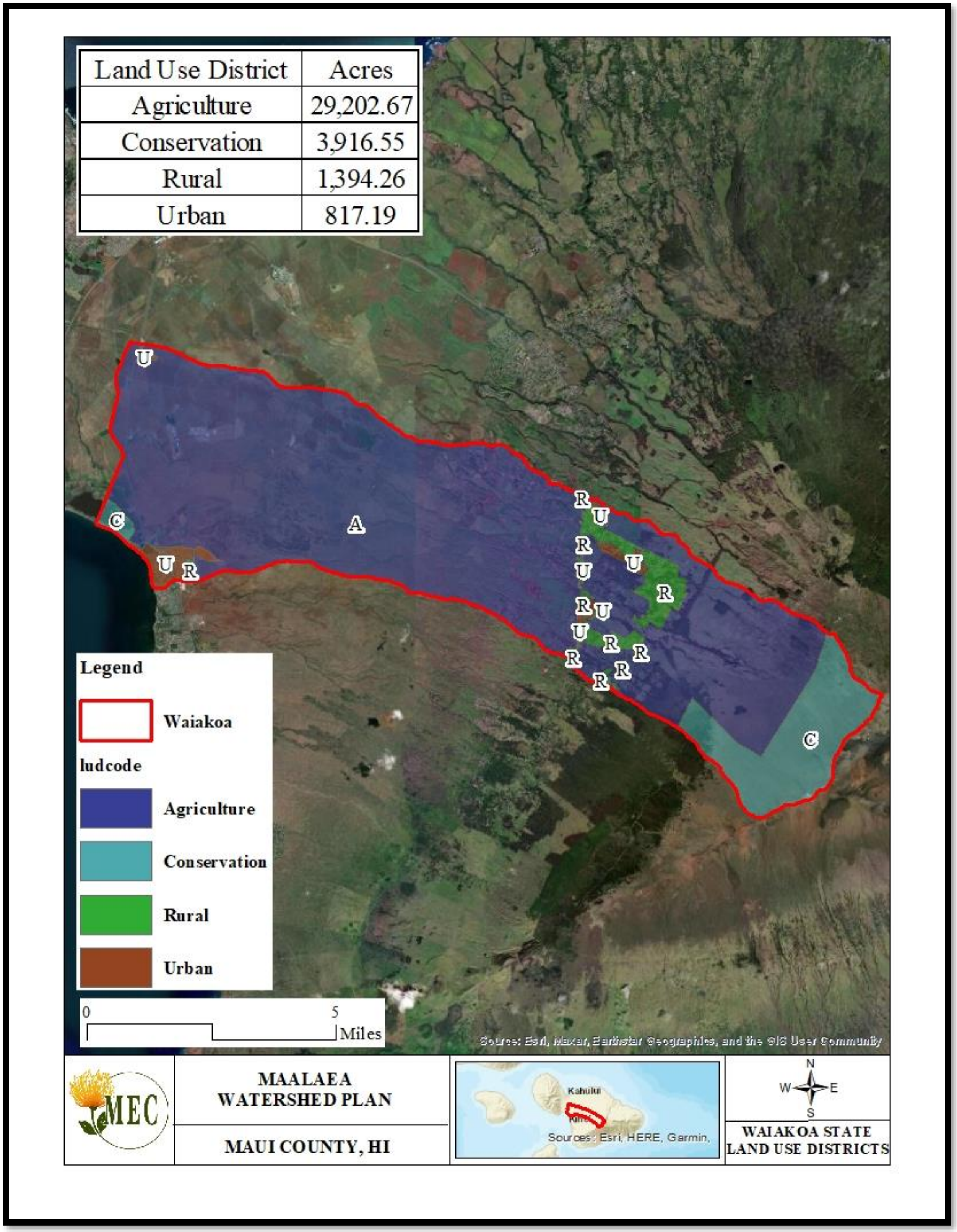
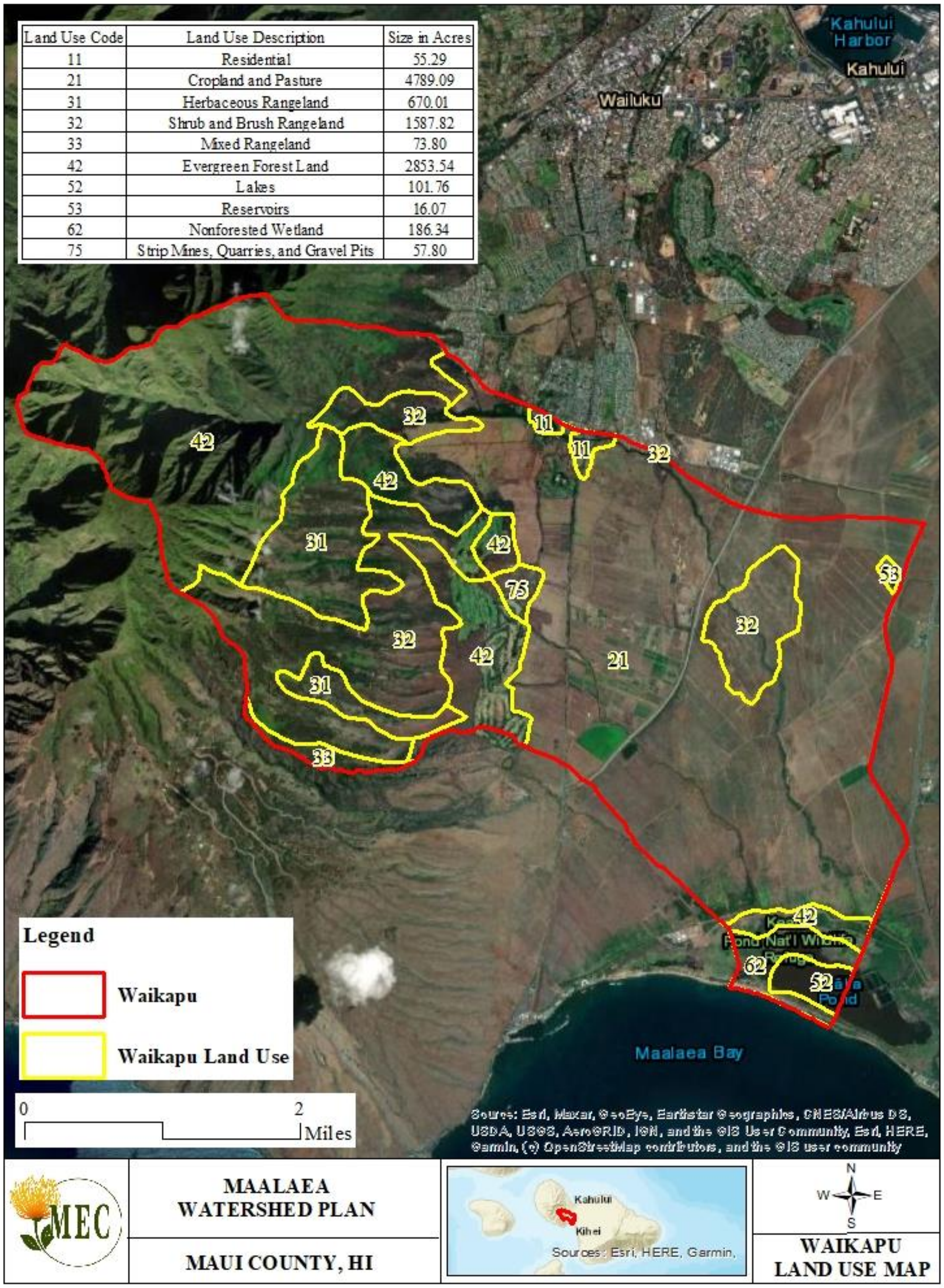
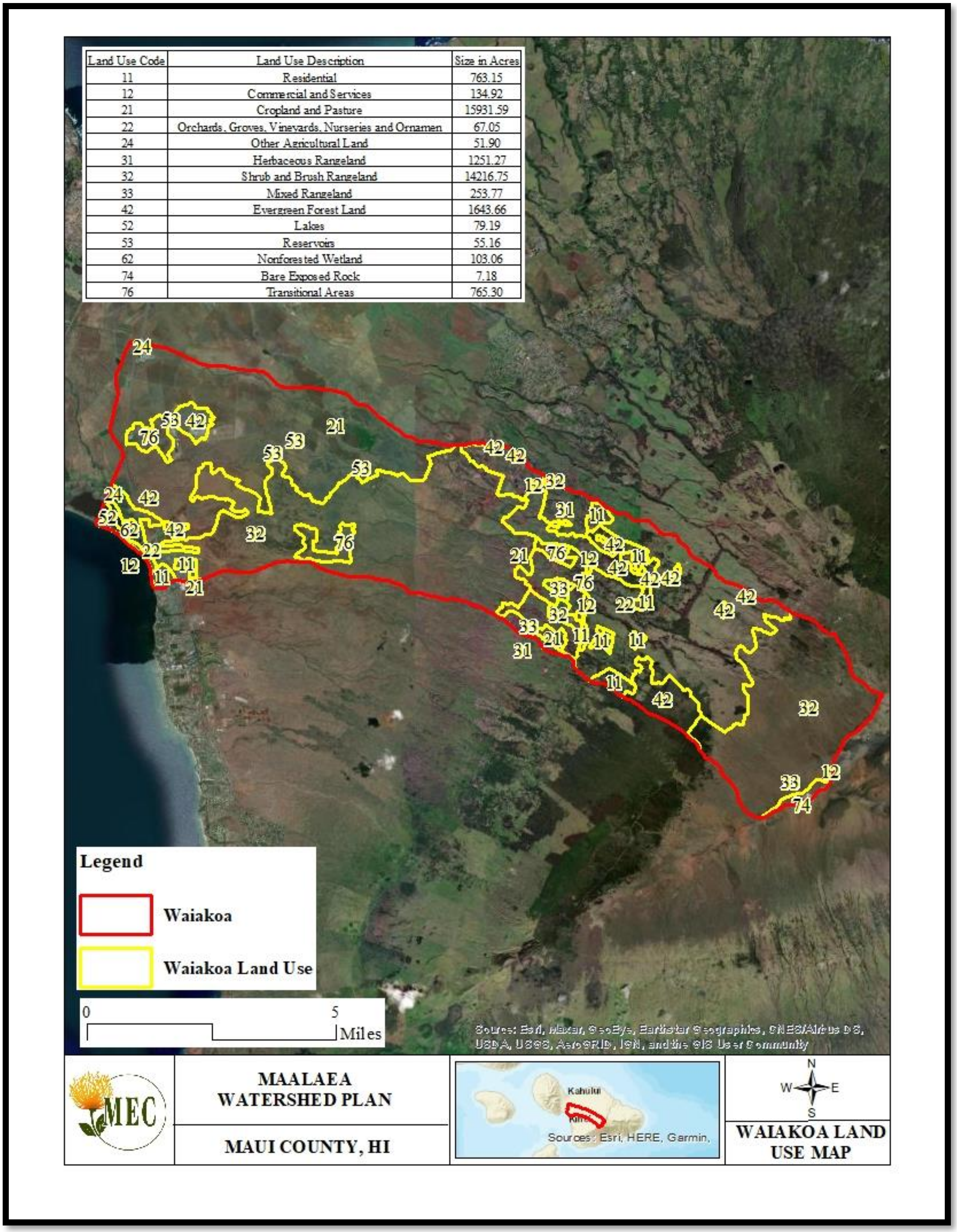


Figure 29. Waikapū State Land Use Classifications Map



Land Use Code	Land Use Description	Size in Acres
11	Residential	55.29
21	Cropland and Pasture	4789.09
31	Herbaceous Rangeland	670.01
32	Shrub and Brush Rangeland	1587.82
33	Mixed Rangeland	73.80
42	Evergreen Forest Land	2853.54
52	Lakes	101.76
53	Reservoirs	16.07
62	Nonforested Wetland	186.34
75	Strip Mines, Quarries, and Gravel Pits	57.80

Figure 30. Waiakoa State Land Use Classifications Map



Land Use Code	Land Use Description	Size in Acres
11	Residential	763.15
12	Commercial and Services	134.92
21	Cropland and Pasture	15931.59
22	Orchards, Groves, Vineyards, Nurseries and Ornamen	67.05
24	Other Agricultural Land	51.90
31	Herbaceous Rangeland	1251.27
32	Shrub and Brush Rangeland	14216.75
33	Mixed Rangeland	253.77
42	Evergreen Forest Land	1643.66
52	Lakes	79.19
53	Reservoirs	55.16
62	Nonforested Wetland	103.06
74	Bare Exposed Rock	7.18
76	Transitional Areas	765.30

4.3 Government and Large Land Ownership

This dataset was created using the TMK Parcel shapefiles from the counties of Honolulu, Kauai, Maui, and Hawaiʻi. The "MajorOwner" field was queried for all private landowners owning a cumulative land area of at least 1,000 acres *per island*, as well as those parcels owned by government agencies (public lands). All landowners with "MajorOwner" = "other" were excluded. Within Waikapū, the largest landowners include Maui County, Mahi Pono, and Wailuku Water Company. Within the Waiakoa planning area, large landowners consist of the State of Hawaii, United States of America, A&B LLC, DHHL, Haleakalā Ranch, Kula Ranch, Māʻalaea C and D Landfill Condominium, and Von Tempsky Ranch (Figure 31. Waikapū Large Landowners Map and Figure 32. Waiakoa Large Landowners Map).

4.4 Impervious vs. Pervious Surface

In 2007, an inventory of impervious surfaces for the island of Maui was produced by the NOAA Coastal Services Center. Impervious surfaces prevent infiltration of precipitation into the soil, disrupting the water cycle, and affecting both the quantity and quality of water resources. Impervious surfaces include manmade features such as building rooftops, parking lots, and roads consisting of asphalt, concrete, and/or compacted dirt. This data set utilized 52 full or partial Quickbird multispectral scenes, which were processed to detect impervious features on the island of Maui (Figure 33. Waikapū Impervious Surfaces Map and Figure 34. Waiakoa Impervious Surfaces Map).

Impervious surface areas, such as those shown in Figures 33 and 34, convey more runoff than pervious surfaces such as lawns, fields, shrub lands, or woods. Areas that become developed and are converted from pervious to impervious surfaces increase surface runoff. Correspondingly, increased impervious surfaces and the channelization of streams due to development convey runoff without infiltration and frequently at high speeds. The transport of water in this manner allows pollutants to be carried and deposited quickly, in large pulses, into receiving water bodies with no opportunity for filtration. The amount of infiltration into groundwater resources is reduced as impervious surfaces are increased.

While much of Waikapū is agricultural and conservation land, some impervious surfaces do exist associated with residential communities. A major development named Waikapū Country Town is to include 1,500 new homes and an additional 146 ohana units, in addition to a school and shops. This development will add to the impervious surfaces already associated with this watershed.

In Waiakoa, most of the impervious surfaces are associated with upcountry residential communities and with industrial uses along Mokulele Highway. Additional residential homes associated with North Kīhei also add to the impervious surfaces in this watershed.

Figure 31. Waikapū Large Landowners

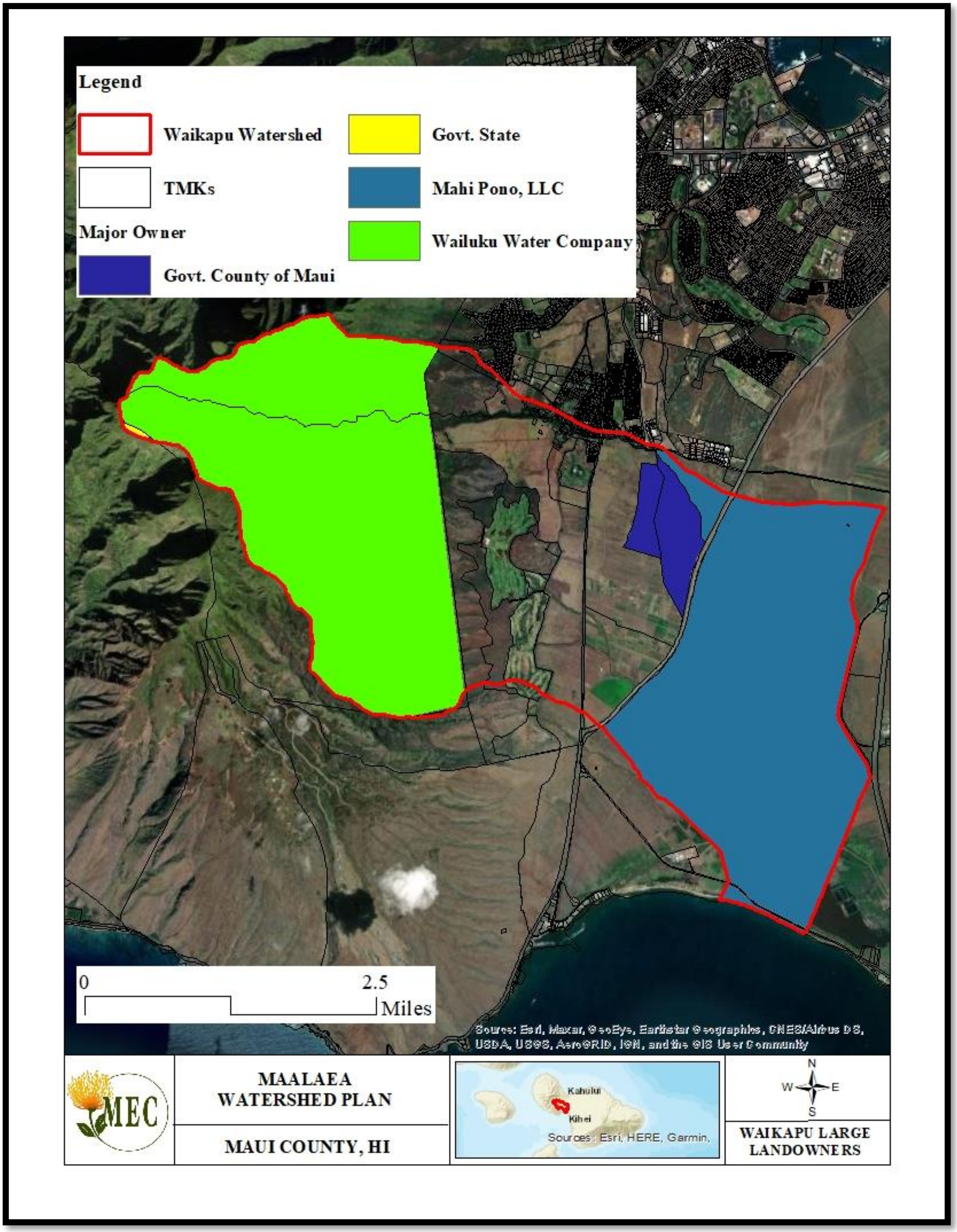


Figure 32. Waiakoa Large Landowners

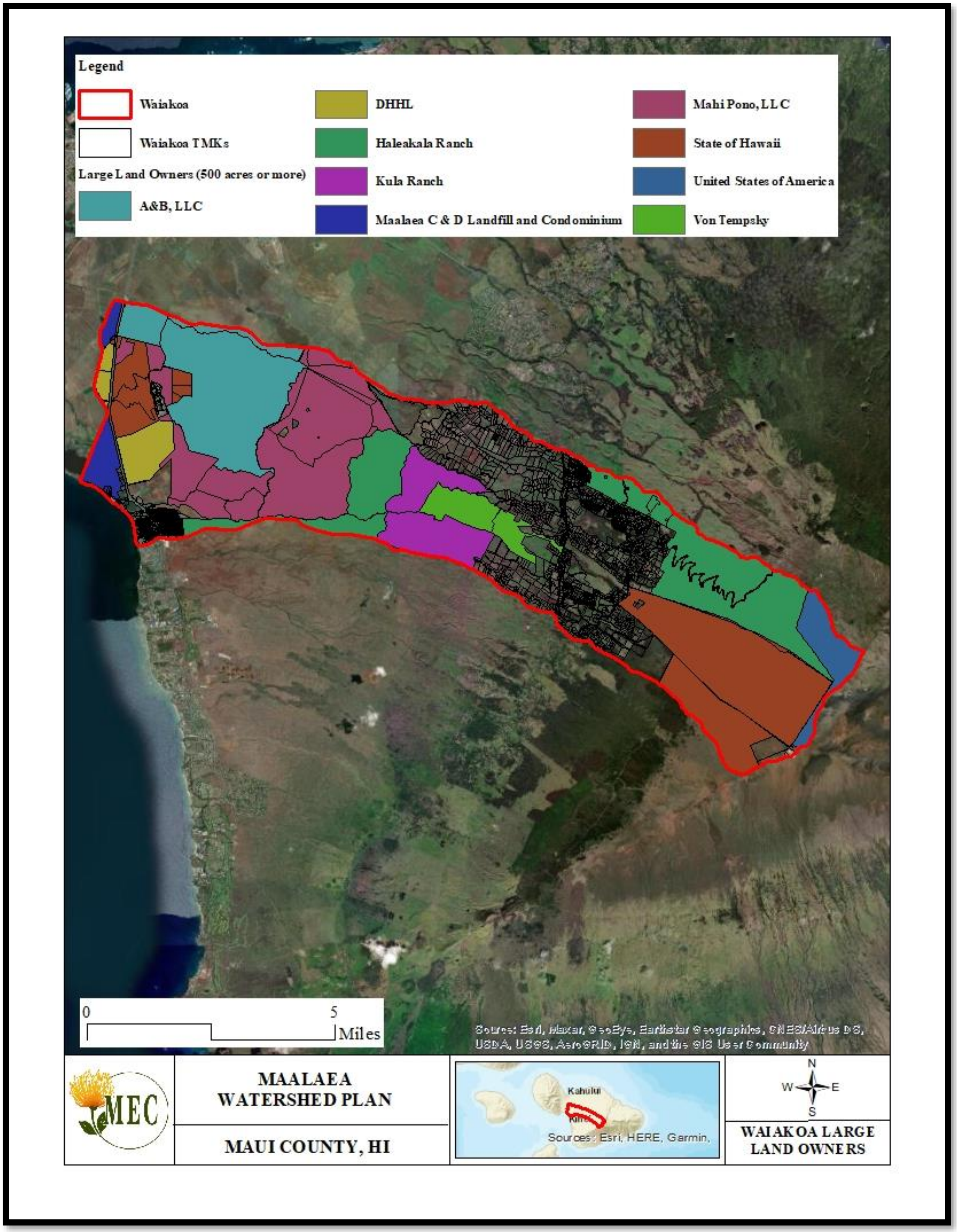


Figure 33. Waikapū Impervious Surfaces

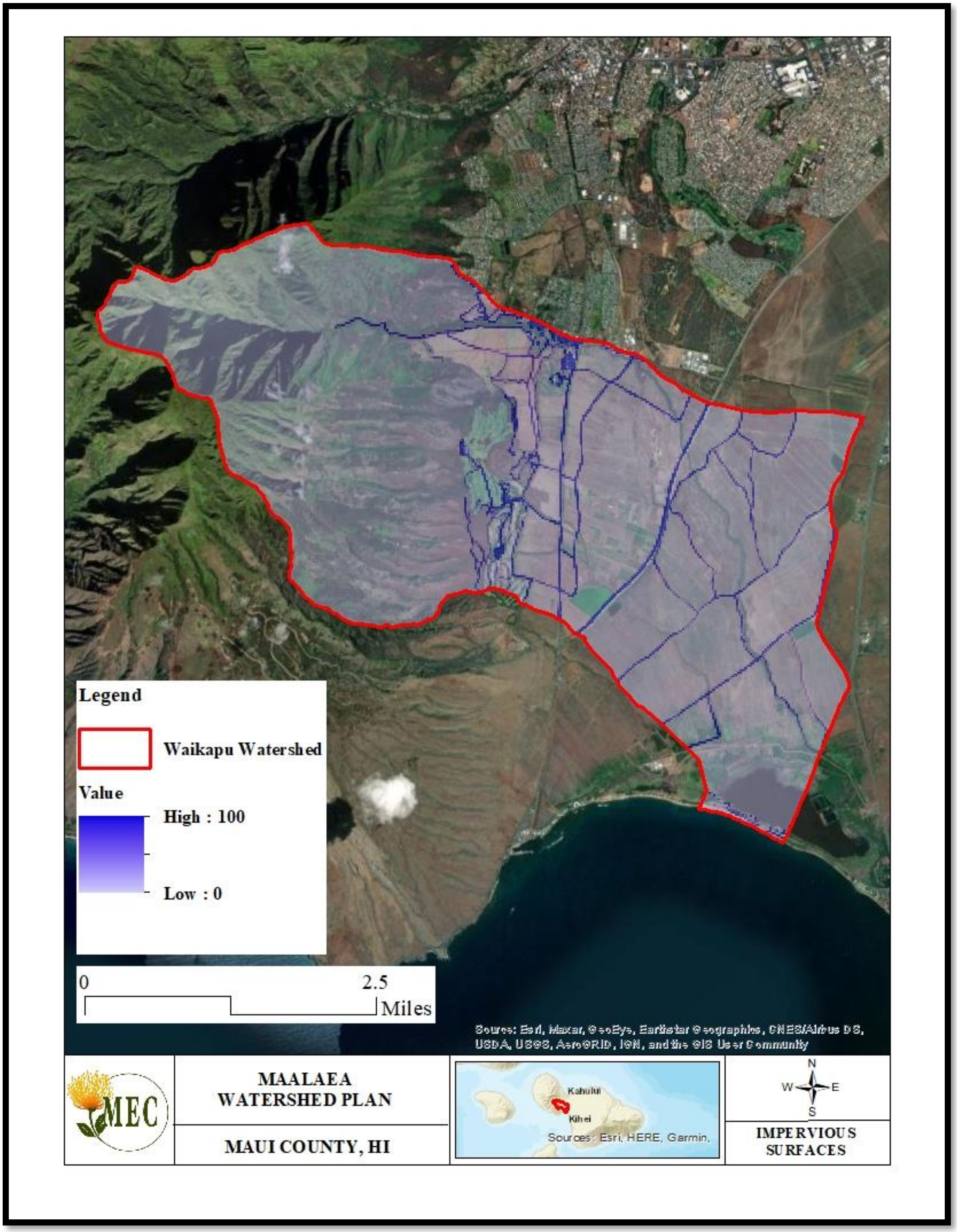
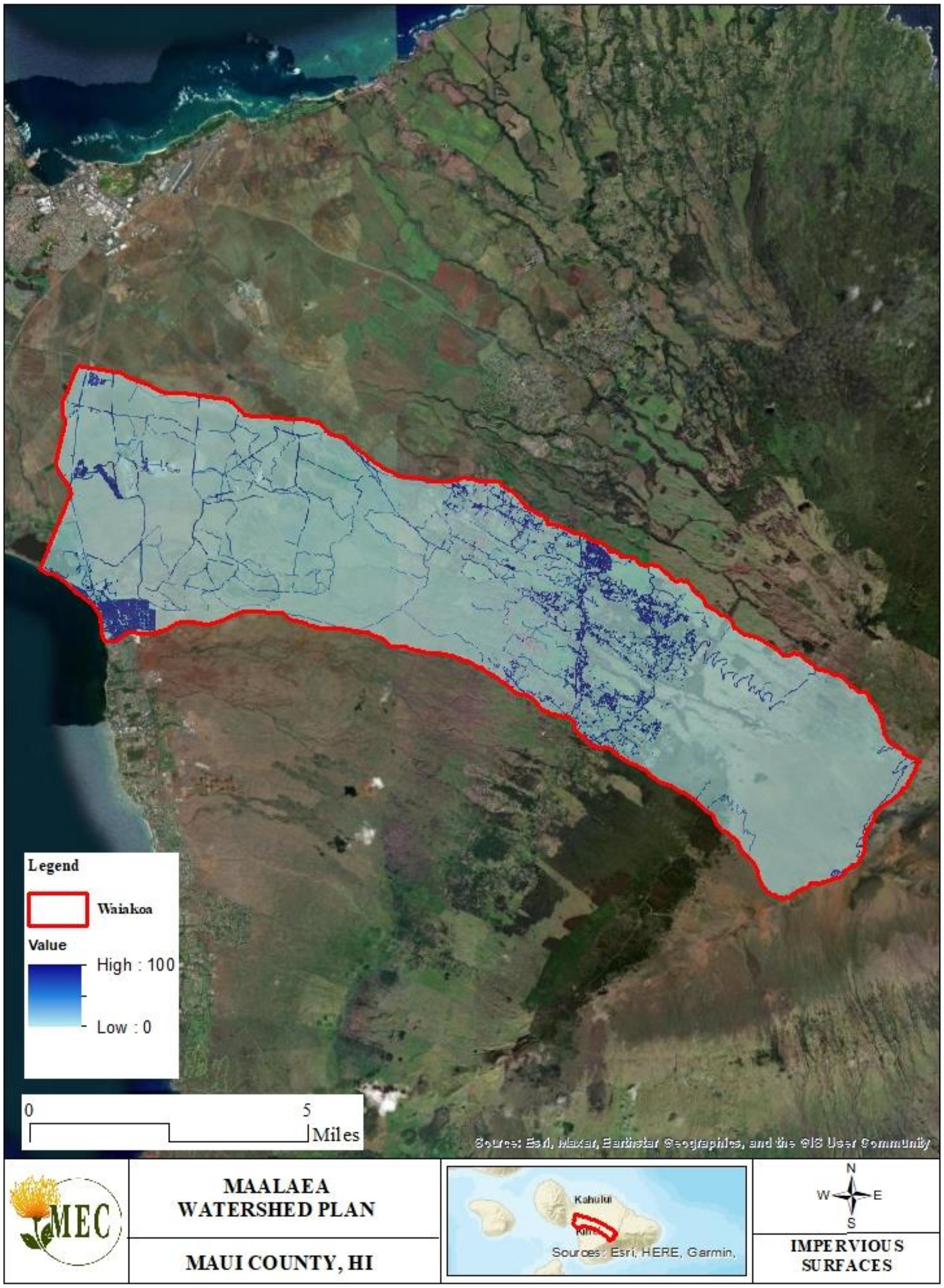


Figure 34. Waiakoa Impervious Surfaces



4.4.1 Planned Development

Planned development within the Māʻalaea Watersheds are notable because such projects increase the amount of impervious surfaces. This may affect the hydrology of the planning area and will likely increase the amount and velocity of surface runoff. It is recommended that all planned developments employ Low Impact Design (LID) technologies.

Waikapū Watershed has several large development projects planned within its boundaries, including the aforementioned Waikapū Country Town, The Kuihelani Solar Project, and the Central Maui Wastewater Reclamation Facility. The County of Maui Planning Department (COM Planning) reported that there are approximately 1,500 acres of approved development projects and 281 acres of proposed projects within Waikapū Watershed (Figure 35. Waikapū Proposed Development Map).

Within Waiakoa, in the makai portions of the watershed, several projects have either been proposed or are currently under construction. These include DHHL Pūlehunui North and South, the DLNR Industrial and Business Park, the Puunene Heavy Industrial Park, the Maui Baseyard Expansion, and Ohukai Village. In the mauka portions of the watershed, Omaʻopio Estates, Pūlehu Solar, Omaʻopio Ridge, Makani O Kula, and Kula ʻI ʻO have been proposed or are currently under construction (Figure 36. Waiakoa Proposed Development Map).

4.4.2 Historic Population Trends

Residential populations within the Māʻalaea Watershed are minimal. The Waikapū Watershed boundaries are adjacent to the town of Waikapū, however, the populous residential area is not included within the watershed boundaries. According to the 2020 census, the population of Waikapū is 3,437 (U.S. Census Bureau, 2022). Waiakoa Watershed intersects a small section of the northern-most urban area of Kīhei, and small population clusters exist with the urban and rurual districts of Kula. In 2020 the populations of Kīhei and Kula were 21,423 and 6,942 respectively (U.S. Census Bureau, 2022).

The overall population of Maui Island has increased dramatically in recent decades. In 2000, Maui Island had a population of 117,644, the third-most populous of the Hawaiian Islands, after Oahu and Hawaiʻi. Maui's population has risen to 144,444 in 2010, and to 164,351 in 2022 (U.S. Census Bureau, 2022). According to projections set forth by the County of Maui Planning Department, Long Range Division, the island's population is expected to reach 194,630 by 2030, a 35% increase from 2010 (Maui Island Plan, 2012).

Figure 35. Waikapū Proposed Development Map

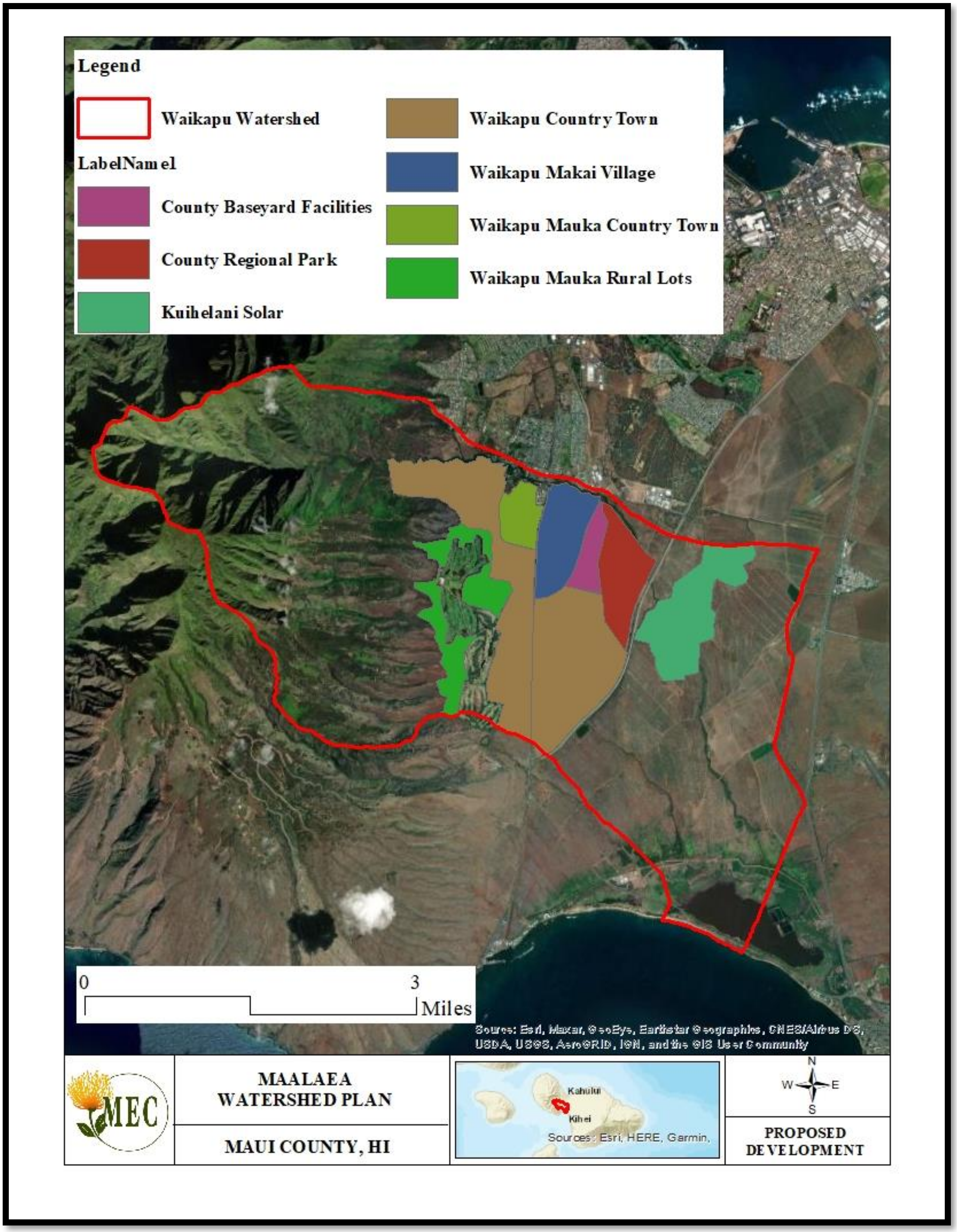
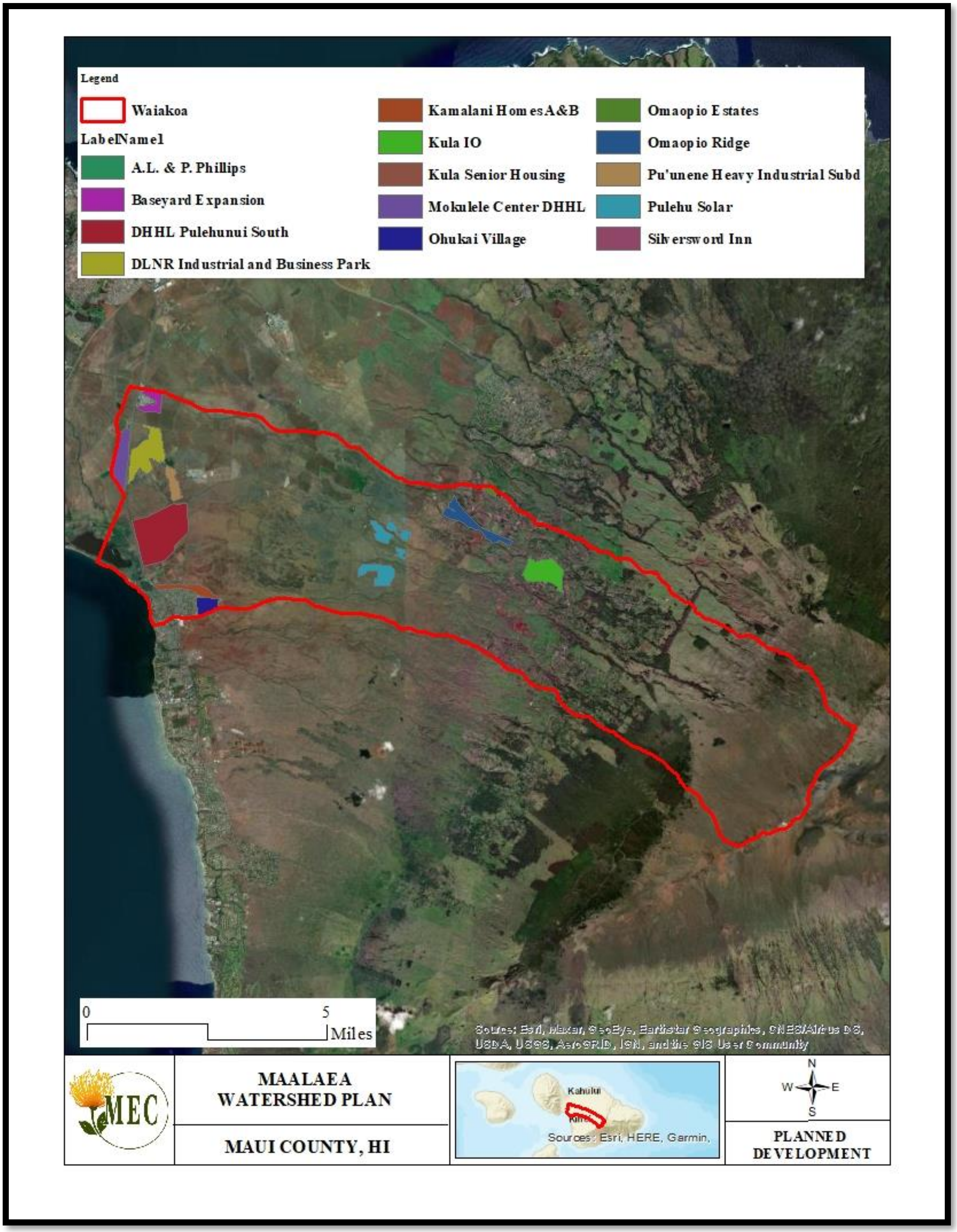


Figure 36. Waiakoa Proposed Development Map



5.0 WATERBODY CONDITIONS

In an effort to identify water quality trends over time, MEC reviewed the Final 2020 and 2022 State of Hawaiʻi Department of Health (DOH) Clean Water Branch (CWB) Integrated Water Quality Report (IR) for water quality data specific to the Māʻalaea Watersheds.

5.1 Applicable Water Quality Standards

Water Quality Standards (WQS) for the State of Hawaiʻi, including designated uses, water quality criteria, and the anti-degradation policy, are found in the Hawaiʻi Administrative Rule (HAR) Chapter 11-54. In the Hawaiʻi regulations, waters are first classified by waterbody type as inland waters, marine waters, or marine bottom ecosystem, and are then further categorized into classes based on ecological characteristics and other criteria. To access (HAR) Chapter 11-54: Water Quality Standards go to:
http://health.Hawaiʻi.gov/cwb/files/2013/04/Clean_Water_Branch_HAR_11-54_20141115.pdf

5.1.1 Waterbody Types and Classes

The three main waterbody types are inland waters, marine waters, and marine bottom ecosystems. Inland waterbody types found within the planning area include intermittent freshwater flowing streams, low wetlands, brackish or saline standing waters, coastal wetlands, and estuaries. Marine waterbody types found within the planning area include open coastal waters, and oceanic waters.

These waterbody types encompass diverse aquatic ecosystems. The uses of these waters will vary along with the type of aquatic organisms each supports. These waterbody types are grouped into classes, and beneficial uses are designated for each waterbody class. Waterbody classes are defined in HAR §11-54-3 and described below.

5.1.2 Designation of Water Class and Beneficial Uses in Hawaiʻi

Specific waterbodies are assigned to classes based on both waterbody characteristics (e.g. fresh or saline, standing or flowing) and other considerations described in the state's anti-degradation policy, such as outstanding natural resource, or important economic or social development. Class determinations are made in accordance with provisions of the water quality law, HAR §11-54. Some waterbodies are specifically named and assigned a class, while for most waterbodies the determination is made based on the class description.

Table 10. Waterbody Classes and Designated Uses

Designated Uses	**Inland Waters**			**Marine Waters**		**Marine Bottom Ecosystem**	
	Class 1a	Class 1b	Class 2	Class AA	Class A	Class I	Class II
Natural Waters							
Native Aquatic Life							
Aquatic Life							
Recreation							
Aesthetics							

Designated Uses	**Inland Waters**			**Marine Waters**		**Marine Bottom Ecosystem**	
	Class 1a	Class 1b	Class 2	Class AA	Class A	Class I	Class II
Wildlife							
Drinking Water							
Food Processing							
Agricultural Water Source							
Industrial Water Source							
Shipping							

*Legend:

Use is designated for class	
Use is not designated for class	

5.1.2.1 __Inland Water Classes__

Inland waters within the Māʻalaea Watershed Management Planning area include a perennial stream as well as numerous ephemeral streams and gulches as well as Keālia Pond.

<u>Class 1:</u> Waters must remain in their natural state as nearly as possible with an absolute minimum of pollution from any human-caused source. To the extent possible, the wilderness character of these areas shall be protected.

<u>Class 1a)</u>: The uses to be protected in class 1a waters are scientific and educational purposes, protection of native breeding stock, baseline references from which human-caused changes can be measured, compatible recreation, aesthetic enjoyment, and other non-degrading uses which are compatible with the protection of the ecosystems associated with waters of this class

<u>Class 1b)</u>: The uses to be protected in class 1b waters are domestic water supplies, food processing, protection of native breeding stock, the support and propagation of aquatic life, baseline references from which human-caused changes can be measured, scientific and educational purposes, compatible recreation, and aesthetic enjoyment. Public access to these waters may be restricted to protect drinking water supplies.

<u>Class 2</u>: The objective of class 2 waters is to protect their uses for recreational purposes, the support and propagation of aquatic life, agricultural and industrial water supplies, shipping, and navigation.

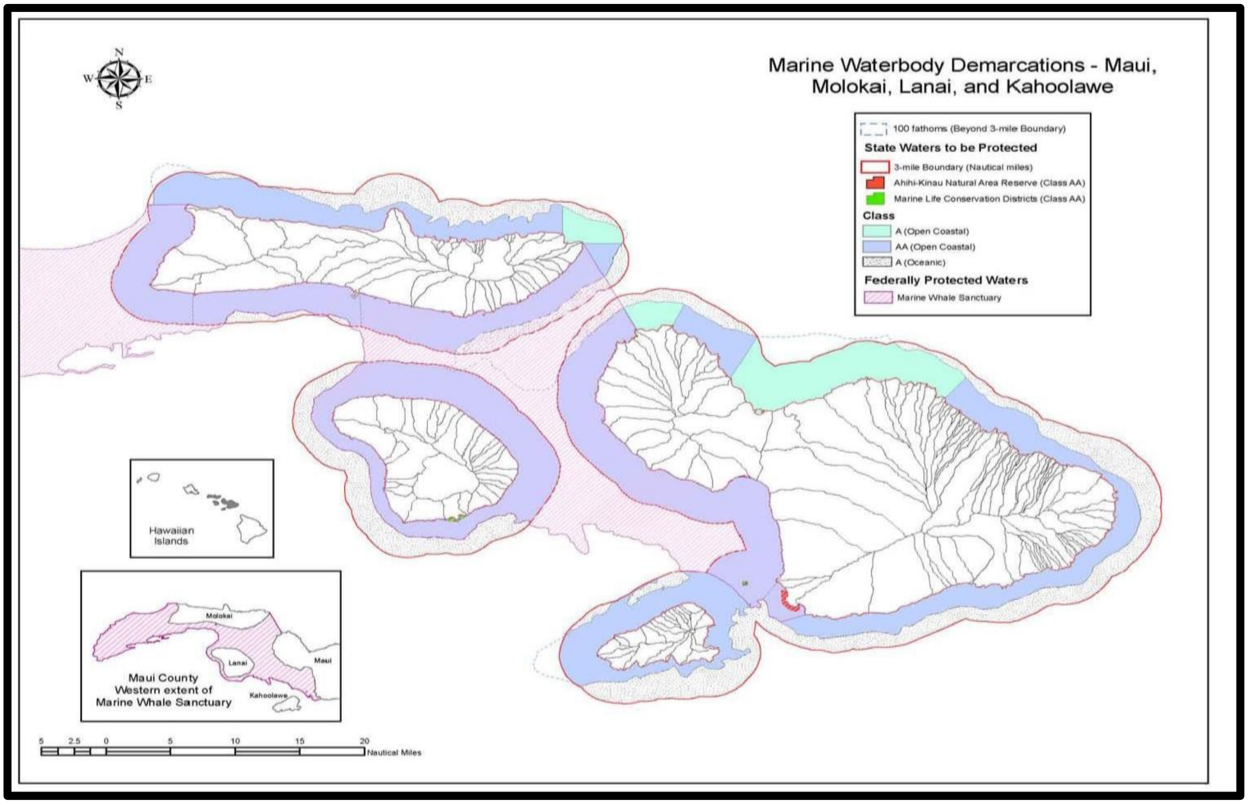
5.1.2.2 __Marine Water Classes__

The open coastal waters of Māʻalaea Bay are designated as Class AA waters. The receiving waters for drainages from the remainder of the watershed planning area include open coastal and oceanic marine waters within the Hawaiian Islands Humpback Whale National Marine Sanctuary. These waters may be considered Class AA by virtue of being in a Federal Marine Sanctuary (Figure 19. Maui County Marine Water Classes).

Class AA: It is the objective of class AA waters that these waters remain in their natural pristine state as nearly as possible with an absolute minimum of pollution or alteration of water quality from any human-caused source or actions. To the extent practicable, the wilderness character of these areas shall be protected.

Class A: It is the objective of class A waters that their use for recreational purposes and aesthetic enjoyment be protected. Any other use shall be permitted as long as it is compatible with the protection and propagation of fish, shellfish, and wildlife, and with recreation in and on these waters. These waters shall not act as receiving waters for any discharge which has not received the best degree of treatment or control compatible with the criteria established for this class. No new sewage discharges shall be permitted within embayments.

Figure 37. Maui County Marine Water Classes



5.1.2.3 Marine Bottom Ecosystem Classes

For sandy beaches, the Northwest Hawaiian Islands are Class I; all other beaches in the state are Class II.

Class I: It is the objective of class I marine bottom ecosystems that they remain as nearly as possible in their natural pristine state with an absolute minimum of pollution from any human-induced source. Uses of marine bottom ecosystems in this class are passive human uses without intervention or alteration, allowing the perpetuation and preservation of the marine bottom in a most natural state, such as non-consumptive scientific research, non-consumptive education, aesthetic enjoyment, passive activities, and preservation.

Class II: It is the objective of class II marine bottom ecosystems that their use for protection including propagation of fish, shellfish, and wildlife, and for recreational purposes not be limited in any way. The uses to be protected in this class of marine bottom ecosystems are all uses compatible with the protection and propagation of fish, shellfish, and wildlife, and with recreation. Any action which may permanently or completely modify, alter, consume, or degrade marine bottoms, such as structural flood control channelization, landfill and reclamation, navigational structures, structural shore protection, and wastewater effluent outfall structures may be allowed on securing approval in writing from the director, considering the environmental impact and the public interest pursuant to sections 342D-4, 342D-5, 342D-6, and 642D-50, HRS, in accordance with the applicable provisions of chapter 91, HRS.

5.1.3 Water Quality Criteria

Basic criteria are applied to all classes of waters, and specific criteria are assigned to some, but not all classes. Within a class, the specific criteria may not apply to all waterbody types. The regulations do not provide specific criteria for uses for all waterbody types. Therefore, the regulations provide a nexus between waterbody class and use, but not between use and criteria. An exception is that recreational waters are defined and recreational uses are tied to bacterial criteria in the water quality standards.

5.1.3.1 Basic Criteria

The basic criteria apply to all waters (HAR §11-54-4). These criteria include narrative statements for controlling substances, including materials that settle or float, or that can have toxic or other undesirable effects. The narrative criteria include that all waters should be free of “deleterious substances sufficient to be toxic or harmful to human, animal, plant, or aquatic life, or in amounts to interfere with any beneficial use of the water.” A translator for these narrative criteria is contained within the regulation in the requirement that waters be free from pollutants in concentrations exceeding acute and chronic toxicity and human health standards (expressed as average criteria concentrations at specified durations). There are also provisions translating the narrative criteria in terms of toxicity testing (bioassay) results.

5.1.3.2 Specific Criteria

For some waterbody types, there are specific narrative or numeric criteria. There are specific criteria for inland waters (HAR §11-54-5), marine waters (HAR §11-54-6), marine bottom types (HAR §11-54-7), and recreational areas (HAR §11-54-8).

5.1.4 Numeric Criteria for Water Column Chemistry

Numeric criteria for water column chemistry for marine waters are defined for wet and dry conditions as values not to be exceeded by the geometric mean, more than ten percent of the time and more than two percent of the time, respectively. Tables 11 through 16 provide the applicable numeric criteria for water column chemistry in inland waters (streams and estuaries) and marine waters (open coastal and oceanic) within the MWMP area (Source HAR§11-54, 2014).

Table 11. Inland Waters - Specific Water Quality Criteria for Streams

Parameter	Hawaiʻi State Water Quality Standards HAR §11-54-5.2(b)					
	Geometric Mean (Not to Exceed)		Not to Exceed > 10% of time		Not to Exceed > 2% of time	
	wet	dry	wet	dry	wet	dry
Nitrate+Nitrite (as N) (µg/L)	70.0	30.0	180.0	90.0	300.0	170.0
Nitrogen, Total (µg/L)	250.0	180.0	520.0	380.0	800.0	600.0
Phosphorus, Total (µg/L)	50.0	30.0	100.0	60.0	150.0	80.0
Total Suspended Solids (mg/L)	20.0	10.0	50.0	30.0	80.0	55.0
Turbidity (NTU)	5.0	2.0	15.0	5.5	25.0	10.0

Notes: Wet Season = November 1 through April 30; Dry Season = May 1 through October 31;

Table 12. Specific Water Quality Criteria for Estuaries (except Pearl Harbor)

Parameter	Hawaiʻi State Water Quality Standards HAR §11-54-5.2(d)(1)		
	Geometric Mean (Not to Exceed)	Not to Exceed > 10% of time	Not to Exceed > 2% of time
Nitrogen, Total (µg/L)	200.00	350.00	500.00
Ammonia (as N) (µg/L)	6.00	10.00	20.00
Nitrate+Nitrite (as N) (µg/L)	8.00	25.00	35.00
Phosphorous, Total (µg/L)	25.00	50.00	75.00
Chlorophyll a (µg/L)	2.00	5.00	10.00
Turbidity (NTU)	1.5	3.00	5.00

Table 13. Specific Water Quality Criteria for Embayments

Parameter	Hawaiʻi State Water Quality Standards HAR §11-54-6(b)					
	Geometric Mean (Not to Exceed)		Not to Exceed > 10% of time		Not to Exceed > 2% of time	
	wet	dry	wet	dry	wet	dry
Nitrogen, Total (as N) (µg/L)	200.00	150.00	350.00	250.00	500.00	350.00
Ammonia (as N) (µg/L)	6.00	3.50	13.00	8.50	20.00	15.00
Nitrate+Nitrite (as N) (µg/L)	8.00	5.00	20.00	14.00	35.00	25.00
Phosphorus, Total (µg/L)	25.00	20.00	50.00	40.00	75.00	60.00
Chlorophyll a (µg/L)	1.50	0.50	4.50	1.50	8.50	3.00
Turbidity (NTU)	1.50	0.40	3.00	1.00	5.00	1.5

Table 14. Specific Marine Water Quality Criteria for Open Coastal Waters

Parameter	Hawaiʻi State Water Quality Standards HAR §11-54-6(b)					
	Geometric Mean (Not to Exceed)		Not to Exceed > 10% of time		Not to Exceed > 2% of time	
	wet	dry	wet	dry	wet	dry
Nitrogen, Total (as N) (µg/L)	150.00	110.00	250.00	180.00	350.00	250.00
Ammonia (as N) (µg/L)	3.50	2.00	8.50	5.00	15.00	9.00
Nitrate+Nitrite (as N) (µg/L)	5.00	3.50	14.00	10.00	25.00	20.00
Phosphorus, Total (µg/L)	20.00	16.00	40.00	30.00	60.00	45.00
Chlorophyll a (µg/L)	0.30	0.15	0.90	0.50	1.75	1.00
Light Extinction Coef (k units)	0.20	0.10	0.50	0.30	0.85	0.55
Turbidity (NTU)	0.50	0.20	1.25	0.50	2.00	1.00

Notes: Wet Season When open coastal waters receive **more** than three million gallons per day of fresh water discharge per shoreline mile; Dry Season = When open coastal waters receive **less** than three million gallons per day of fresh water discharge per shoreline mile

Table 15. Marine Water Quality Criteria for Oceanic Waters

Parameter	Hawaiʻi State Water Quality Standards HAR §11-54-6(c)		
	Geometric Mean (Not to Exceed)	Not to Exceed > 10% of time	Not to Exceed > 2% of time
Nitrogen, Total (µg/L)	50.00	80.00	100.00
Ammonia (as N) (µg/L)	1.00	1.75	2.50
Nitrate+Nitrite (as N) (µg/L)	1.50	2.50	3.50
Phosphorus, Total (µg/L)	10.00	18.00	25.00
Chlorophyll a (µg/L)	0.06	0.12	0.20
Turbidity (NTU)	0.03	0.10	0.20

Table 16. Recreational Criteria for all Sate Waters

Parameter	Hawaiʻi State Water Quality Standards HAR §11-54-8		
	Geometric Mean (Not to Exceed)	Statistical Threshold Value Not to Exceed > 10% of time	Not to Exceed > 2% of time
Enterococcus (cfus/100ml)	35	130	NA

Notes: Enterococcus content shall not exceed a geometric mean of 35 colony forming units (cfu's) per 100 milliliters over any 30-day interval. A statistical threshold value (STV) of 130 colony forming units shall be used for enterococcus. The STV value shall not be exceeded by more than ten percent of samples taken within the same 30-day interval in which the geometric mean is calculated.

5.1.5 Criteria for Marine Bottom Ecosystems

The criteria for Marine Bottom Ecosystems are found at HAR §11-54-7. A major reef tract for Maui begins in Māʻalaea Bay and extends south through North Kīhei. The marine bottoms of the Hawaiian Islands Humpback Whale National Marine Sanctuary may be considered Class I depending on the interpretation of the language, "in preserves, reserves, sanctuaries, and refuges established by the department of land and natural resources under chapter 195 or chapter 190, HRS, or similar reserves for the protection of marine life established under chapter 190, HRS, as amended; or in refuges or sanctuaries established by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service."

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

The Hawaiʻi 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 IR 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 2020 IR incorporates data collected from November 1, 2017 to October 31, 2019 to provide an updated snapshot of water body conditions throughout the state and carries over the assessment results from previous IRs. In addition, the Final 2022 IR report incorporates data collected from November 1st, 2019 to October 31st, 2021. These documents can be found on the DOH CWB website:
https://health.Hawaiʻi.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 IR 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 IR 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.

5.2.1 2022 State of Hawaiʻi 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 (Hawaiʻi Department of Health, 2022), three water quality monitoring stations are listed by the DOH CWB that fall within the Māʻalaea Watershed boundary. They include Mai Poina Oe Iau Beach Co. Park, Kīhei Coast-Mokulele, and Keālia Pond.

HIW00025 – Mai Poina ʻOe Iʻau Beach Co. Park

Mai Poina ʻOe Iʻau Beach Co. Park is listed in both the 2020 and 2022 Final IR reports for Total Nitrogen, Nitrate+Nitrite, Ammonium, and Turbidity impairments. The site has been given low priority status for the development of a Total Maximum Daily Load (TMDL) for these parameters. No attainment status is offered in either report for chlorophyll-*a*.

<u>HIW00042 – Kīhei Coast-Mokulele</u>

Kīhei Coast-Mokulele is listed in both the 2020 and 2022 Final IR reports for Total Nitrogen, Nitrate+Nitrite, Ammonium, Turbidity, and chlorophyll-*a* impairments. The site has been given low priority status for the development of a Total Maximum Daily Load (TMDL) for these parameters.

<u>HIW00224 – Keālia Pond</u>

Keālia Pond was added as a sample site in the Final 2022 IR report. It was listed for Nitrate+Nitrite, Ammonium, and Turbidity impairments. No attainment statuses were given for Enterococcus or Chlorophyll-*a*. The site has been given low priority status for the development of a Total Maximum Daily Load (TMDL) for these parameters.

Table 17. Māʻalaea Watershed Water Quality Stations and Impairments for the 2020 Final and 2022 Final Integrated Water Quality Reports

Final 2020 Integrated Water Quality Report								
Station	Water Body ID	Water Quality Parameters						
		Enterococcus	TN	Nitrate + Nitrite	Ammonium	TP	Turbidity	Chlorophyll-*a*
Waiakoa Watershed								
Mai Poina ʻOe Iʻau Beach Co. Park	HIW00025	A	<u>**N**</u>	<u>**N**</u>	<u>**N**</u>	<u>**A**</u>	N	-
Kīhei Coast-Mokulele	HIW00042	-	N	N	<u>**N**</u>	<u>**A**</u>	N	N
Final 2022 Integrated Water Quality Report								
Station	Water Body ID	Water Quality Parameters						
		Enterococcus	TN	Nitrate + Nitrite	Ammonium	TP	Turbidity	Chlorophyll-*a*
Waiakoa Watershed								
Mai Poina ʻOe Iʻau Beach Co. Park	HIW00025	A	N	N	N	A	N	-

Kīhei Coast-Mokulele	HIW00042	**<u>A</u>**	N	N	N	A	N	N
Waikapū Watershed								
Keālia	HIW00224	-	**<u>A</u>**	**<u>N</u>**	**<u>N</u>**	**<u>A</u>**	**<u>N</u>**	-

N indicates that the water quality standard was not attained
A indicates that the water quality standard was attained
- indicates insufficient data
*Site is not currently sampled and data have been carried over from previous reports
Changes in attainment status from previous years are bolded and underlined

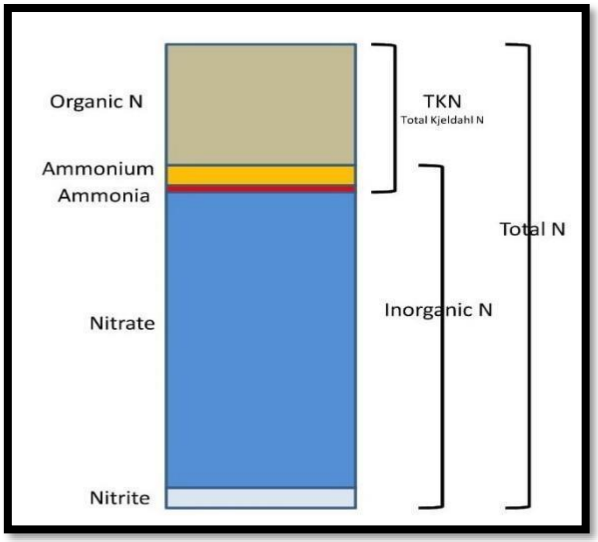
Turbidity measurements in exceedance of water quality standards can be caused by sediment laden water discharging from freshwater streams and/or from the resuspension of sediment caused by tidal or wave action within coastal waters. Increased sedimentation and nutrient loading on the extensive offshore reef complex threaten 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.

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 organisms 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)

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).

Figure 38. Total Nitrogen and Nitrogen Components in Surface Water



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).

Cesspools, feral ungulate feces, human feces, decomposing vegetation, agricultural fertilizer, golf courses, and other sources of nutrients may be causing or contributing to the high nutrient concentrations observed in Māʻalaea Bay. Section 14.0 of this document entitled Monitoring Program for Evaluating Implementation Project Success 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 Keālia Pond and Māʻalaea Bay. In addition, by testing for a suite of nutrient species, the origin of these pollutants can be better understood as discussed in detail above.

6.0 Element A – SOURCES AND CAUSES OF POLLUTANTS

Primary sources of water pollution in the Māʻalaea Watersheds are nutrients and sediment. Nutrients may enter coastal waters through various mechanisms including shallow wastewater injection wells, malfunctioning septic systems, cesspools, 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.

6.1 Point Sources

6.1.1 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 Hawaiʻi 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 in the 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 18 below lists the active NPDES permits that exist within the Māʻalaea Watershed boundaries. No active NPDES permits exist within the Waikapū Watershed Boundary. This data was pulled from the Hawaiʻi Department of Health Environmental Health Portal Water Pollution Control Viewer (https://wpc-viewer.doh.hawaii.gov/).

Table 18. Active NPDES Permits within the Māʻalaea Watersheds

Polynesian Adventure Tours Bus Yard - Waiakoa	HIR10G977	182 Nopu Street, Puunene, HI 96784.	Notice of General Permit Coverage	Form C: Storm water associated with construction activity	10/14/2022	2/8/2024
Kula I'o Residence, Lot 26 - Waiakoa	HIR10H038	126 Kula I'o Road, Kula, HI 96790	Notice of General Permit Coverage	Form C: Storm water associated with construction activity	12/8/2022	2/8/2024

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 HDOH and permit exceedances have been developed by the regulatory agency to ensure Hawaiʻi 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.

6.1.2 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.

Seven active injection well UIC permits exist within the Māʻalaea Watersheds, all of which lie within the Waiakoa Watershed boundaries (Figure 40. Waiakoa NPDES – UIC – Cess Pool Map). Of these, four are used for sewage, one is used for industrial wastewater, and two are used for stormwater runoff. The table below lists these wells and provides information on their permit number, operator and location within the Māʻalaea Watersheds (Table 19. UIC Permits Within Māʻalaea Watersheds).

Table 19. UIC Permits within the Māʻalaea Watersheds

Permit Number	Operator/Facility	TMK	Discharge Type	Well Classification	Location
UM-2678	Ilima Houselots	2-3-9-028-039	Storm Runoff	Class V, Subclass C	Kenolio Rd and Kuilima PL, Kīhei
UM-2192	Central Maui Baseyard	Not Listed	Sewage	Class V, Subclass AB	Not Listed
UM-2933	Pūlehunui Industrial Park	2-3-8-008-019	Industrial	Class V, Subclass AB	Puunene, Wailuku, Maui
UM-1442	Kaiola Heights Subdivision	2-3-9-035-048	Storm Runoff	Class V, Subclass C	Between Kenolio Rd. & Kaiola Place, Kīhei, Maui 96753
UM-2670, 2876	Kula Elementary School	2-2-2-014-002	Sewage	Class V, Subclass E	500 Kula Highway, Kula, HI 96790
UM-2164	Kula Experiment Station	2-2-2-011-033	Sewage	Class V, Subclass A	424 Mauna Place, Kula, HI
UM-2700, UM-2803	Haleakalā National Park	2-2-3-005-001, 2-2-3-005-024	Sewage	Class V, Subclass A	Haleakalā National Park Summit

Figure 39. Waikapū Cesspool Map

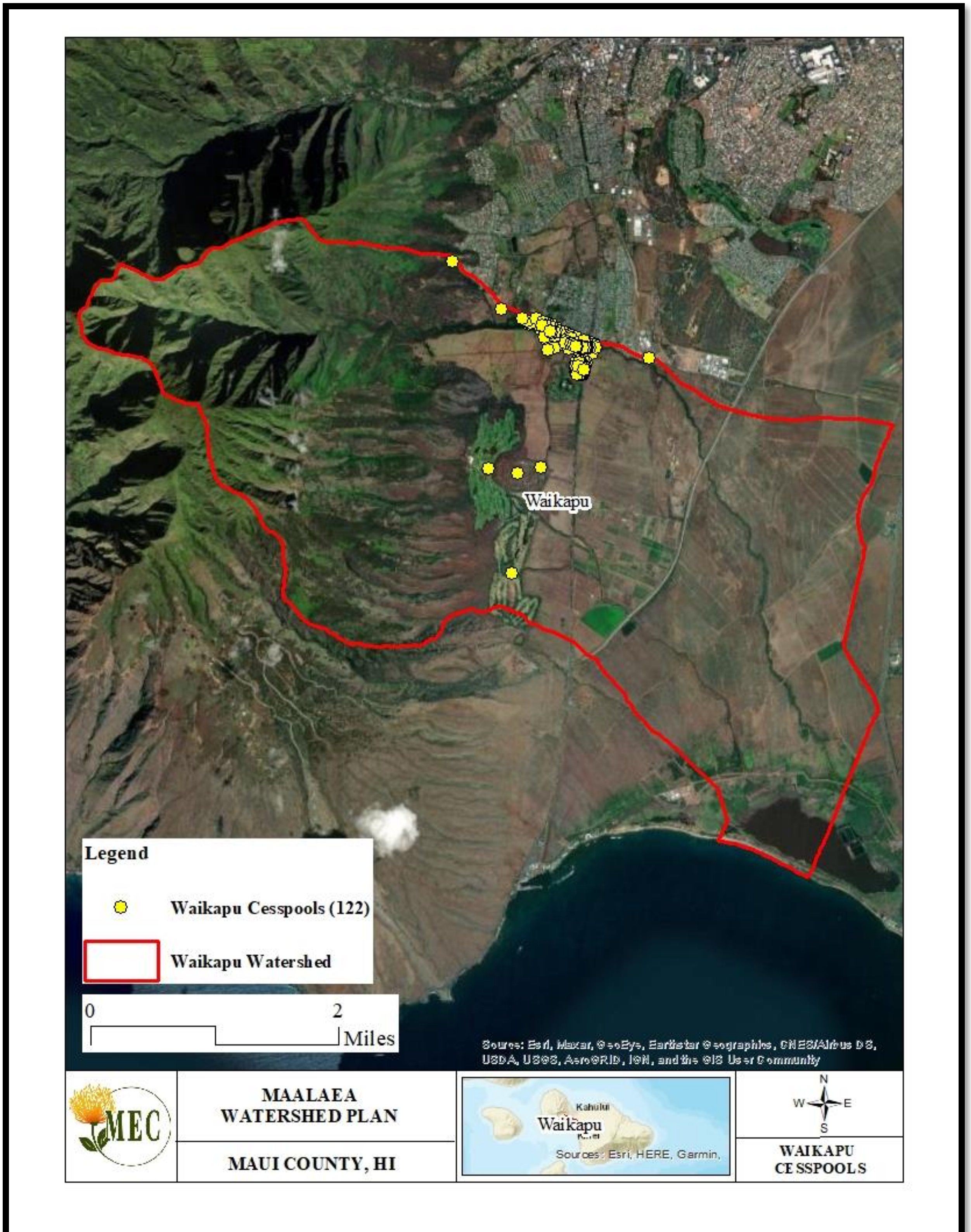
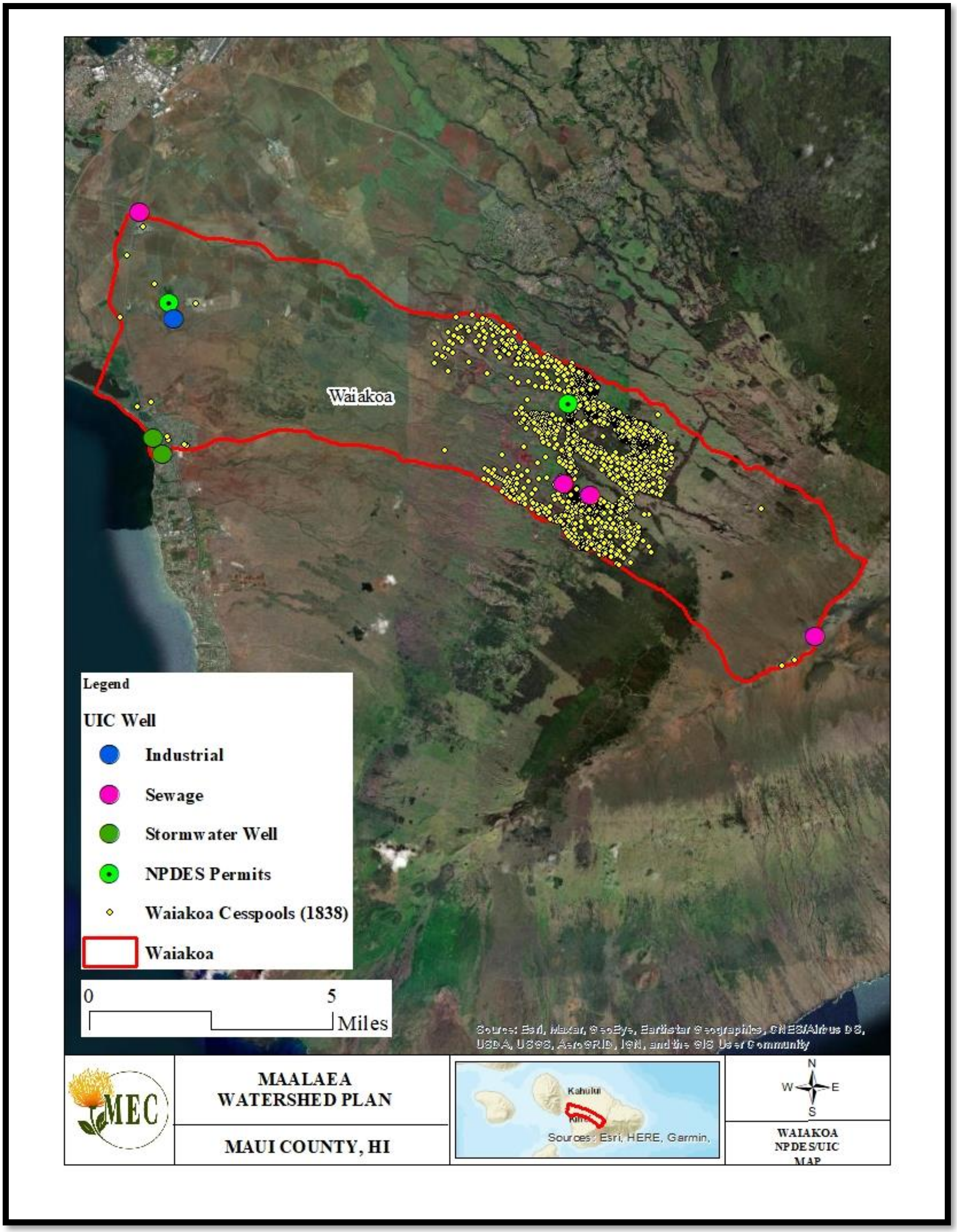


Figure 40. Waiakoa NPDES – UIC - Cesspool Map



6.1.3 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 groundwater by releasing disease-causing pathogens and nitrates.

Approximately 1,960 cesspools exist in the Māʻalaea watershed, with 122 occurring in Waikapū (Figure 39. Waikapū Cesspool Map) and 1,838 occurring in Waiakoa (Figure 40. Waiakoa NPDES – UIC – Cesspool Map). Residential areas, including the homes located upcountry in Kula and mauka of Honoapi'ilani Highway in Wailuku 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. Figures 39 and 40 display the locations of cesspools within the Waikapū and Waiakoa Watershed boundaries.

Leaching from these cesspools may be contributing to the high levels of enterococcus and nutrients observed within Māʻalaea Bay. The coastal waters of Hawaiʻi are naturally low in nutrients, and the marine ecosystems are sensitive to influxes of nutrients. 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. According to a report prepared by the HDOH Environmental Management Division, "The cumulative loading of nitrogen and phosphorous from all cesspools in a watershed is delivered to nearshore waters and can result in ecosystem shifts from a coral-dominated ecosystem to one dominated by macroalgae." During large storm events, pathogens from cesspools may entering coastal waters in appreciable amounts.

6.2 Estimating Nonpoint Source Pollutant Loads

6.2.1 INVEST Modeling

InVEST is an informative geospatial tool developed by the Natural Capital Project for watershed managers and planners (Natural Capital Project, 2022). It is a GIS-based application with several different models. To estimate and identify potential water-quality impacts from nonpoint source pollution and erosion in the Waikapū and Waiakoa watersheds, MEC staff utilized the Sediment Delivery Ratio and Nutrient Delivery Ratio models. MEC ran the InVEST model for sediment, nitrogen, and phosphorus delivery throughout the Waikapū and Waiakoa Watersheds. The models provide 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.

The objective of the InVEST Sediment Delivery Ratio (SDR) model is to quantify and map overland sediment generation and delivery to the stream. For the SDR model, inputs include the following:

1. 30m Digital Elevation Models (DEMs) from the United States Geological Survey (USGS)
2. An erosivity raster file, which is a map of rainfall erosivity (R-factor), reflecting the intensity and duration of rainfall in the area of interest
3. A soil erodibility raster file, which is a map depicting the susceptibility of soil particles to detach and transport by rainfall and runoff
4. Coastal Change Analysis Program (CCAP) land cover - each land cover type has an associated impervious surface co-efficient.

5. A biophysical table organized in Xcel. This table maps each LULC code to biophysical properties of that LULC class, including USLE c and p values
6. A watershed vector map
7. Threshold Flow Accumulation value
8. Borselli K Parameter value
9. Maximum SDR value as a function of soil texture
10. Borselli IC0 Parameter value
11. Maximum L value, which is the maximum allowed slope length

The objective of the InVEST nutrient delivery ratio model (NDR) is to map nutrient sources from watersheds and their transport to the stream. For the NDR model, inputs include the following;

1. 30m Digital Elevation Models (DEMs) from the United States Geological Survey (USGS)
2. Coastal Change Analysis Program (CCAP) land cover - each land cover type has an associated impervious surface co-efficient.
3. A Nutrient Runoff Proxy, which is a map of runoff potential, the capacity to transport nutrients downslope
4. A watershed vector map
5. A biophysical table organized in Xcel. This table maps each LULC code to biophysical properties of that LULC class, including usle c and p values
6. Subsurface Critical Length for Nitrogen
7. Subsurface Maximum Retention Efficiency
8. Threshold Flow Accumulation value
9. Borselli K Parameter value

It should be noted that geospatial models like InVEST have known limitations with accuracy and precision when modeling for erosion in wet, steep slopes like those in the upper reaches of the Waikapū and Waiakoa Watersheds. This is due, in part, to a lack of available data collection from inaccessible mountainous areas. Inputs to InVEST, 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, portions of the watersheds are not actively being farmed. MEC recognizes that there are other models available, and that there are trade-offs between cost-efficiency and higher accuracy (more robust modeling methods and procedures can be costly and time-intensive).

Within InVEST, the NDR model has a small number of parameters, and outputs generally show a high sensitivity to inputs. This implies that errors in the empirical load parameter values will have a large effect on predictions. Similarly, the retention efficiency values are based on empirical studies, and factors affecting these values (like slope or intra-annual variability) are averaged. These values implicitly incorporate information about the dominant nutrient dynamics, influenced by climate and soils. The model also assumes that once nutrient reaches the stream it impacts water quality at the watershed outlet, no in-stream processes are captured.

Among the main limitations of the InVEST SDR model is its reliance on the USLE (Renard et al., 1997). This equation is widely used but is limited in scope, only representing overland (rill/inter-rill) erosion processes. Other sources of sediment include gully erosion, streambank erosion, and mass wasting from landslides or rockfalls, and glacial erosion. A good description of the gully and streambank erosion processes is provided by Wilkinson et al. 2014, with possible modeling approaches. Mass movements (landslide) are not represented in the model but can be a significant source in some areas or under certain land use change, such as road construction.

Given the simplicity of the SDR and NDR models and low number of parameters, outputs are very sensitive to most input parameters. Errors in the empirical parameters of the USLE equations will therefore have a large effect on predictions. Sensitivity analyses are recommended to investigate how the confidence intervals in input parameters affect the study conclusions (Natural Capital Project, 2022).

Tables 20 and 21 list the quantitative data resulting from the INVEST modeling effort. In addition, the results of the INVEST modeling exercises for localized sediment, nitrogen and phosphorus are included as figures below (Figures 41-46). These figures are offered as qualitative data serving as visual representations of the various sediment and nutrient sources that are exported from their origin to the actual streams as predicted by the InVEST model.

The Waikapū and Waiakoa Sediment Export Maps (Figure 41 and 42) depict several areas within the watershed where sediment transport (tons per pixel) is particularly high. The INVEST model predicts heavy amounts of localized sediment for land uses at higher elevations where mountain slopes are fairly steep. This is especially true within the Waikapū Watershed, where the model shows the highest amount of sediment export occurring at the upper reaches of Mauna Kahālāwai. InVEST depicts the lowest sediment export to be associated with Mahi Pono and other agricultural lands east of Honoapiʻilani Highway.

According to the model, localized sediment export is significantly lower within the Waiakoa Watershed. As with Waikapū, sediment export is highest near the summit of Haleakalā and is directly correlated with steeper slopes. In the lower reaches of the watershed, where the slope changes from being extremely steep into the gulches and gullies within the coastal floodplain, localized sediment availability is also relatively high. At the upper reaches of the watershed, portions of State lands as well as Haleakalā Ranch depict higher sediment transport. Within the central and lower portions of Waiakoa higher sediment transport is depicted within A&B and Mahi Pono properties.

As stated previously, the InVEST pollutant models are limited by the datasets that go into the model. The sediment values depicted in steeper areas may be overestimated because the soils are quite rocky and are largely covered by dense grasses. InVEST values for annual sediment export to streams equaled 4,314 tons in the Waikapū Watershed and 7,068 tons in the Waiakoa Watershed.

Table 20. InVEST Sediment Delivery Ratio Results

InVEST Sediment Delivery Ratio Results (Annually)			
Watershed	Total amount of potential soil loss as calculated by the USLE equation (Tons)	Sediment discharge into stream (Tons)	Total amount of sediment deposited on the landscape in each watershed, which does not enter the stream
Waiakoa	55,527	7,068	17,174
Waikapū	35,120	4,314	9,765

The InVEST Nitrogen and Phosphorus Maps generated by the NDR model for nutrient concentrations report high amounts of nutrient export in those land uses associated with ranching and agriculture and in areas with steep slopes. As stated above, the InVEST model does not consider specific details like herd size, rotational grazing practices, fallow or in-production agricultural land, fertilizing techniques and schedules, etc.

InVEST values for total phosphorus loads in Waikapū and Waiakoa were 676 kg/year and 2,864 kg/year respectively. Total nitrogen loads were 1,395 kg/year in Waikapū and 4,946 kg/year in Waiakoa.

Table 21. InVEST Nutrient Delivery Ratio Results

InVEST Nutrient Delivery Ratio Results				
Watershed	Total phosphorus load (kg/year)	Total phosphorus export from the watershed by surface flow (kg/year)	Total nitrogen load (kg/year)	Total nitrogen export from the watershed by surface flow (kg/year)
Waikapū	676	76	1,395	207
Waiakoa	2,864	345	4,946	593

Figure 41. Waikapū Sediment Export Map

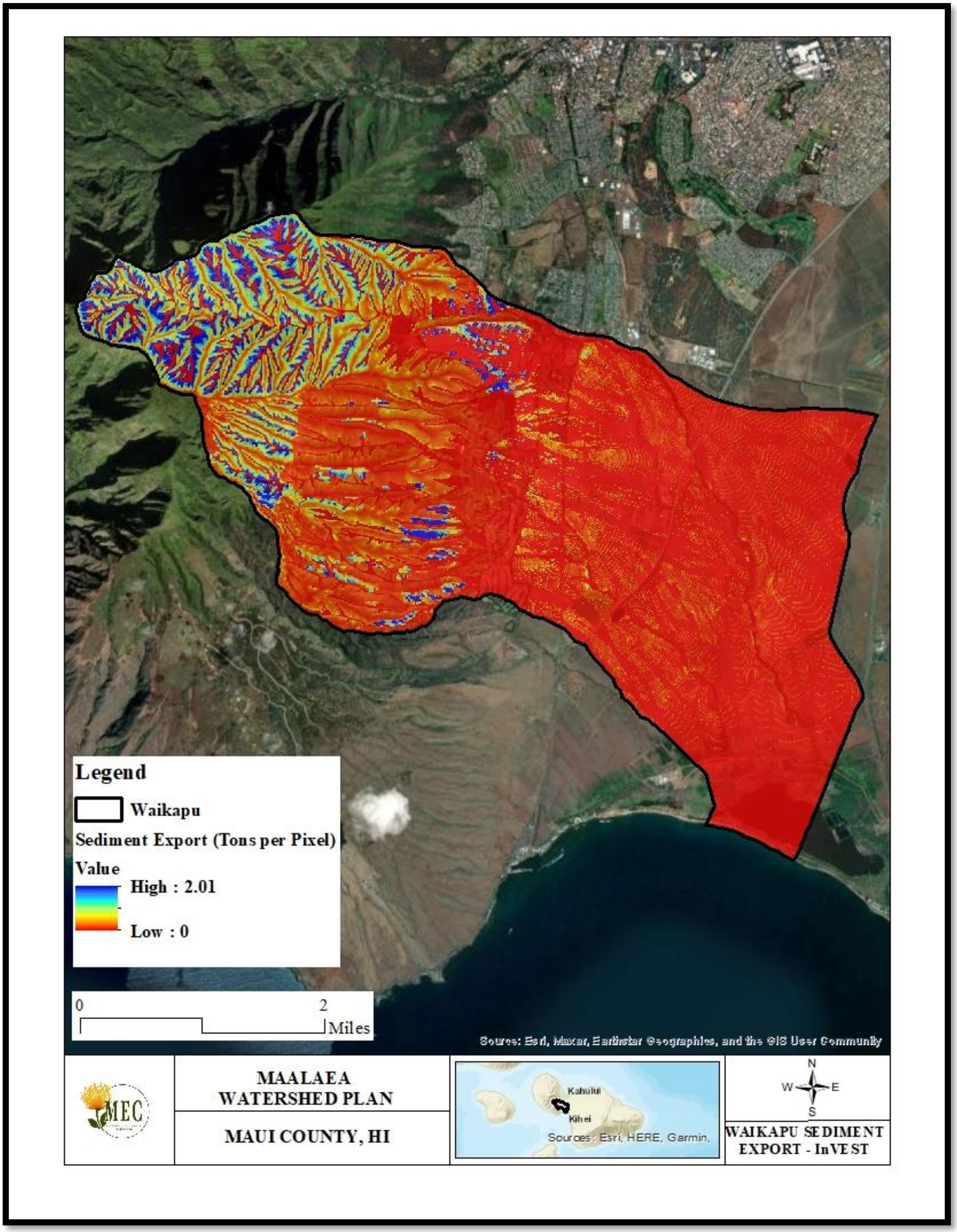


Figure 42. Waiakoa Sediment Export Map

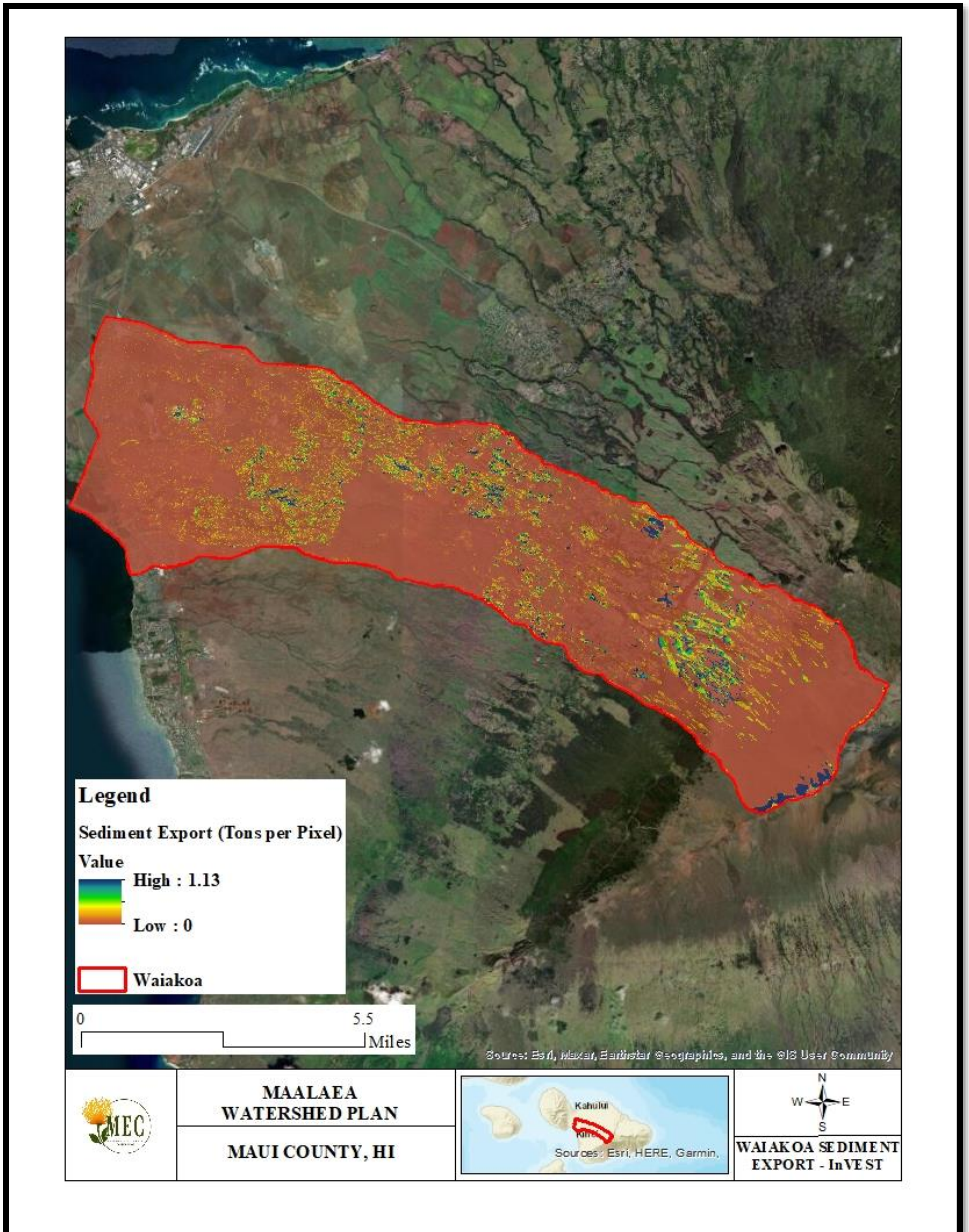


Figure 43. Waikapū Nitrogen Export Map

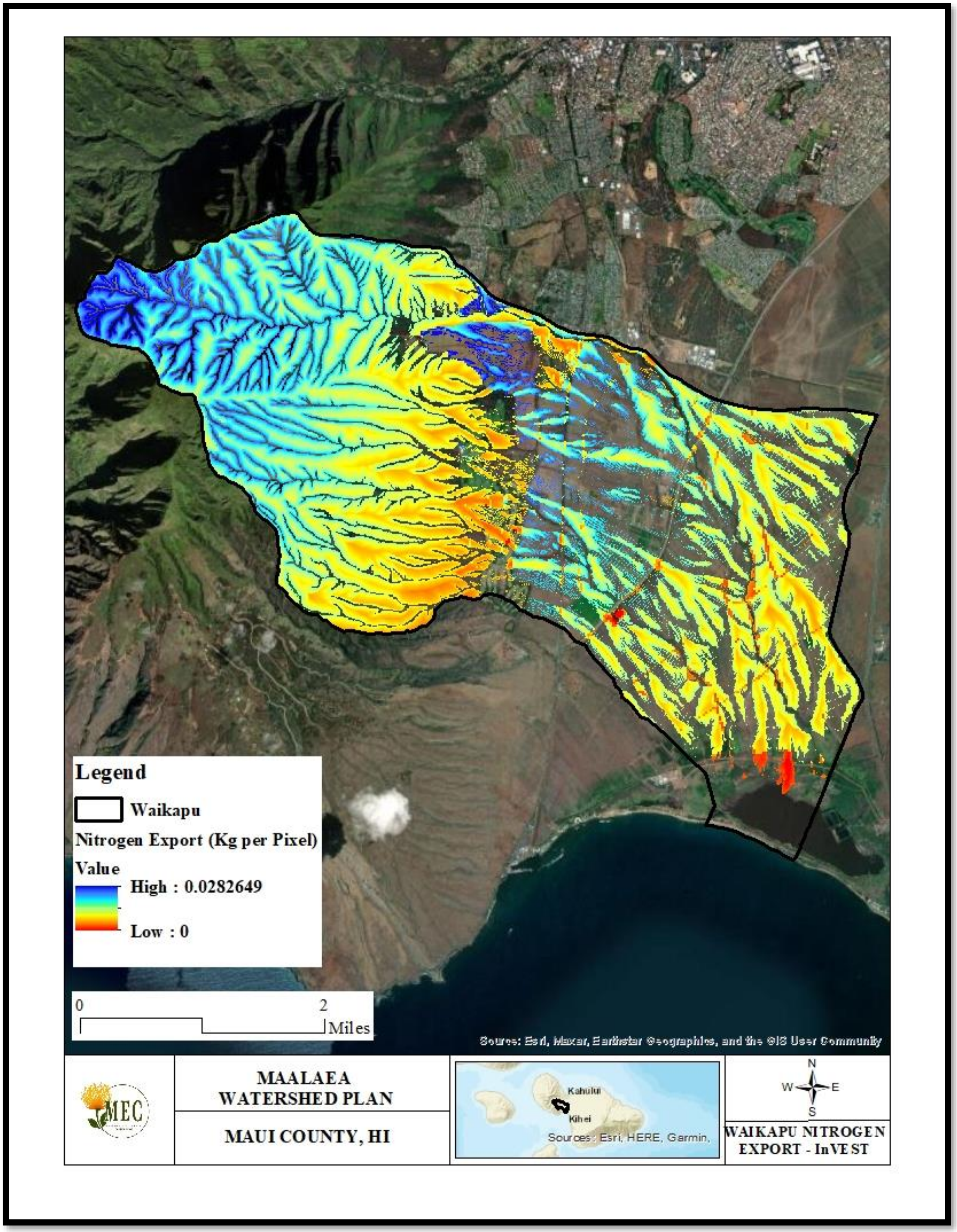


Figure 44. Waikapū Phosphorus Export Map

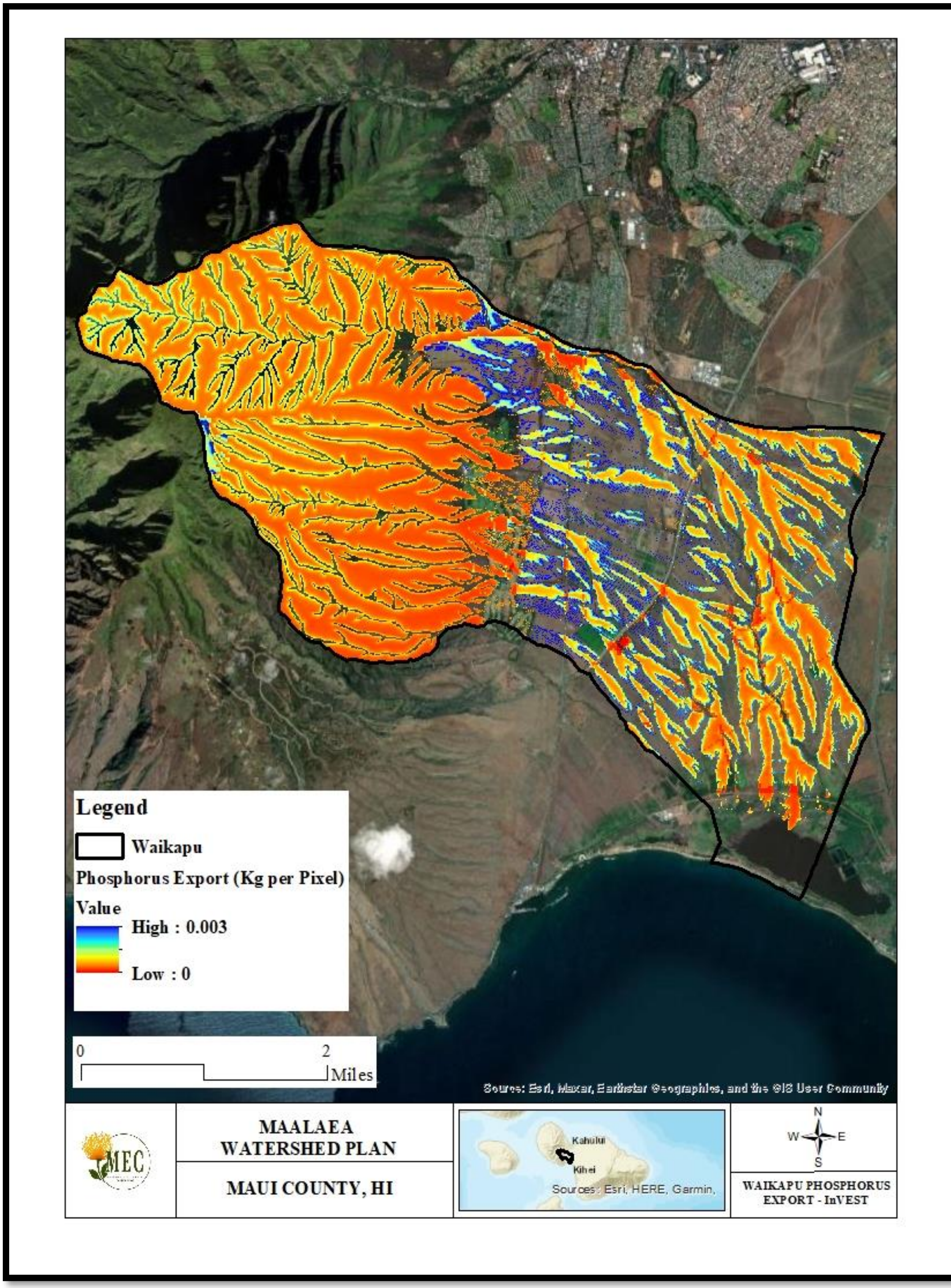


Figure 45. Waiakoa Nitrogen Export Map

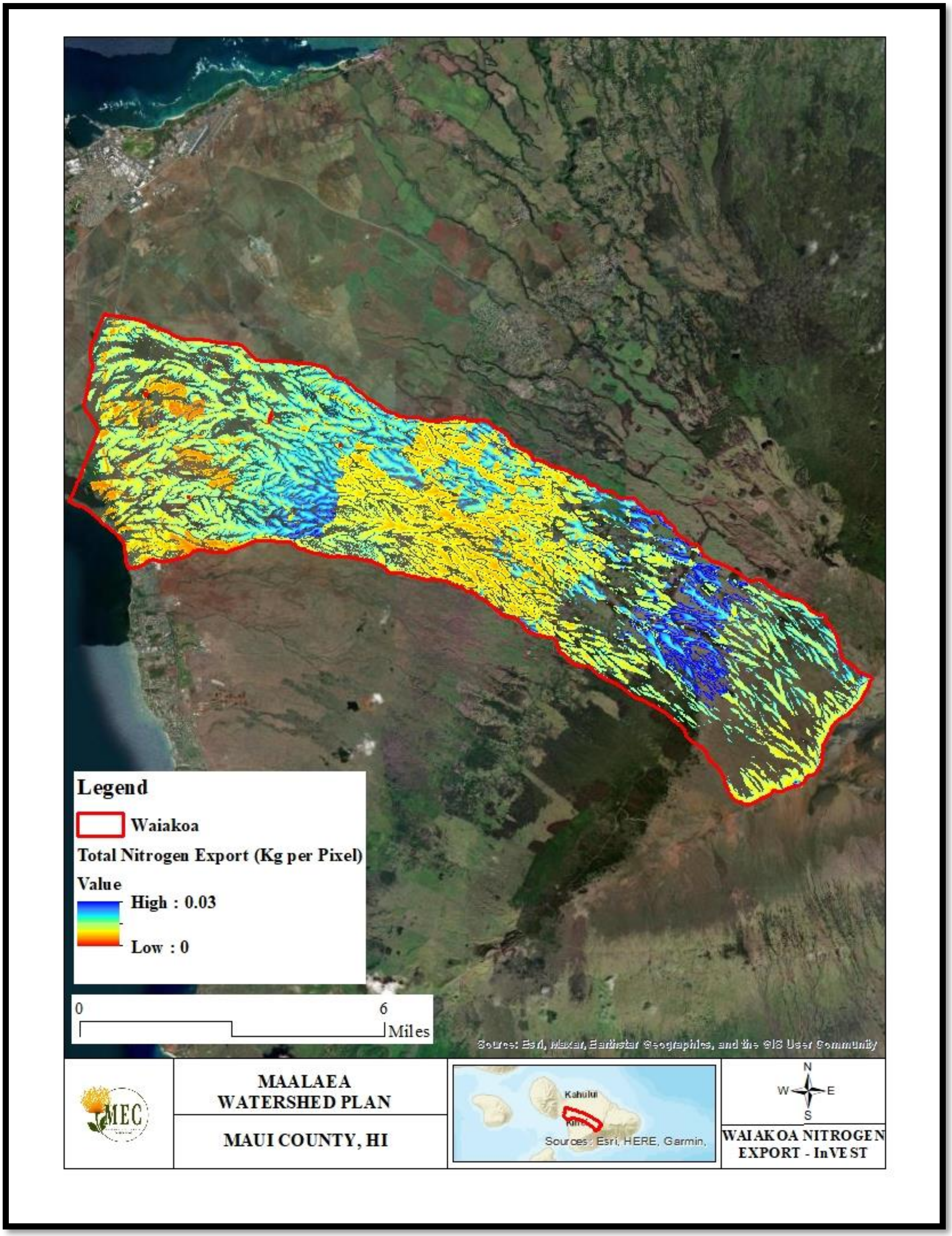
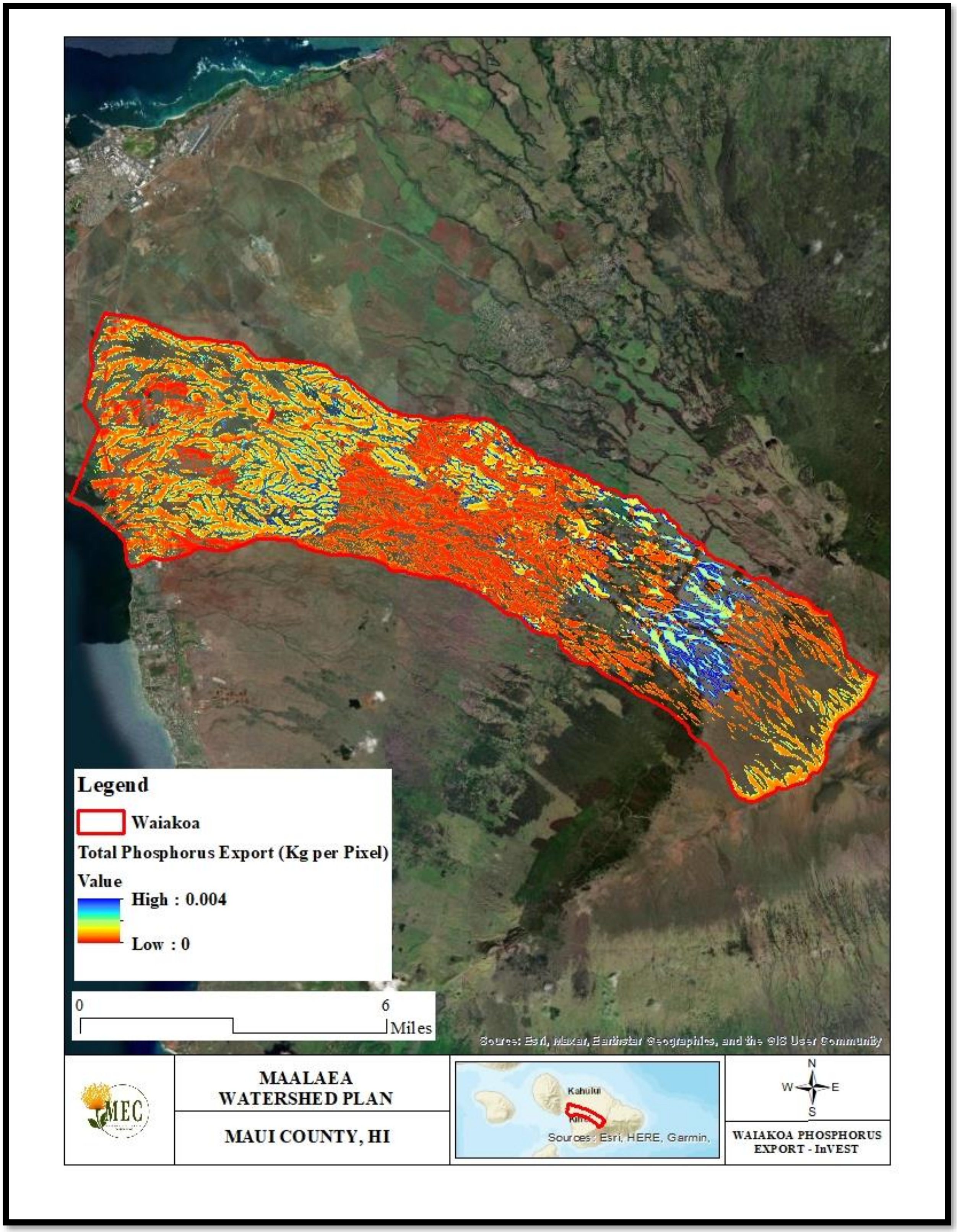


Figure 46. Waiakoa Phosphorus Export Map



6.2.2 STEPL

The EPA has developed the Spreadsheet Tool for Estimating Pollutant Load (STEPL) which employs simple algorithms to calculate nutrient and sediment loads from different land uses and the load reductions that would result from the implementation of various BMPs. STEPL provides a user-friendly Visual Basic (VB) interface to create a customized spreadsheet-based model in Microsoft (MS) Excel. It computes watershed surface runoff; nutrient loads, including nitrogen, phosphorus, and 5-day biological oxygen demand (BOD5); and sediment delivery based on various land uses and management practices. STEPL does not take into account slope and should be considered a very generalized model.

For the Waikapū and Waiakoa Watersheds, annual nutrient loading is calculated based on the runoff volume and the pollutant concentrations in the runoff water as influenced by factors such as the land use distribution and management practices. The annual sediment load (sheet and rill erosion only) is calculated based on the Universal Soil Loss Equation (USLE) and the sediment delivery ratio. The sediment and pollutant load reductions that result from the implementation of BMPs are computed using the known BMP efficiencies (http://it.tetratech-ffx.com/steplweb/). For Waikapū, the Pōhākea rain gauge was used. For Waiakoa, the average rainfall for Maui was used. These numbers generate the amount of rain days and average amount of rain per event.

Region 5 Model is an Excel workbook that provides a gross estimate of sediment and nutrient load reductions from the implementation of agricultural and urban BMPs. The algorithms for non-urban BMPs are based on the "Pollutants controlled: Calculation and documentation for Section 319 watersheds training manual" (Michigan Department of Environmental Quality, June 1999). The algorithms for urban BMPs are based on the data and calculations developed by Illinois EPA, Region 5 Model. The model does not estimate pollutant load reductions for dissolved constituents.

Cesspool contributions were also accounted for. There are 122 known cesspools in the Waikapū Watershed and 1,838 cesspools in the Waiakoa Watershed. The national average of 2.43 persons per household was used as the number of persons serviced by each cesspool. Table 22 presents the STEPL total load estimates by land use type for Nitrogen, Phosphorus, and Sediment within the Waikapū and Waiakoa Watershed Boundaries. Septic systems and Advanced Treatment Units (ATU's) that are not properly maintained can contribute nutrient pollution in the same fashion as cesspools.

Table 22. STEPL Pollutant Loads by Land Use within Waikapū and Waiakoa

Total Load by Land Use			
Sources	**N Load (lb/yr)**	**P Load (lb/yr)**	**Sediment Load (t/yr)**
Waikapū			
Urban	312.81	48.14	7.18
Cropland	74,446.63	27,039.91	21,032.62
Pastureland	11,871.52	3,018.02	2,144.81
Forest	847.22	351.16	196.87
Cesspools	3,792.76	1,485.50	0.00
Total	91,270.95	31,942.72	23,381.48

Total Load by Land Use			
Sources	**N Load (lb/yr)**	**P Load (lb/yr)**	**Sediment Load (t/yr)**
Waiakoa			
Urban	14,697.78	2,261.89	337.49
Cropland	241,411.82	75,338.96	51,217.04
Pastureland	143,392.88	21,178.32	10,507.92
Forest	674.31	306.70	82.75
Cesspools	57,140.14	22,379.89	0.00
Total	457,316.94	121,465.77	62,145.20

6.3 Waikapū Field Assessments of Nonpoint Source Pollution

Sediment, nutrient, and other pollutant sources associated with the Māʻalaea Watershed were assessed using field observations. In addition, the Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) Sediment and Nutrient Delivery Ratio models were used to identify pollutant hot spots for the watershed to better understand these sources at a landscape level.

MEC staff canvassed both the Waikapū and Waiakoa Watersheds 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, denuded areas caused by the expanding axis deer population, and 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. These watersheds were divided into four distinct areas including Mauka/Conservation Lands, the Agricultural Lands mentioned above, Commercial and Urban Lands generally occurring in coastal communities, and Keālia 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 areas denuded by axis deer and unimproved dirt roads) 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 for both Waikapū and Waiakoa are discussed below.

6.3.1 <u>Waikapū Mauka/Conservation Lands</u>

6.3.1.1 <u>Axis Deer</u>

Axis deer populations have been exploding in numbers throughout the central valley of Maui. A study conducted in 2021 estimated 46,000 deer exist within the Central Valley (Ulupalakua to Paia) and those numbers are believed to be growing exponentially. As deer populations continue to grow, they overgraze and denude landscapes of vegetative cover. The unarmored soils that become exposed are highly susceptible to erosion during storm events. In addition, vital native and endangered vegetation within the conservation lands is lost to these feral ungulates.

6.3.1.2 Ditch System and the Wailuku Water Company

The Wailuku Water Company's Waikapū ditch system diverts water from Waikapū Stream at approximately 1,200 feet in elevation. Water is diverted through open ditches and two tunnels to a reservoir named Reservoir #1. This reservoir has a capacity of 8.1 million gallons. Water is then discharged from Reservoir #1 and distributed to agricultural lands and golf courses via the South Waikapū Auwai. The Palolo Ditch also connects with Waikapū Stream from the north, connecting to several reservoirs just north of the Waikapū Watershed boundary. While this ditch system is likely not a source of pollution, as the only perennial stream in the Waikapū Watershed, water should be sampled above the diversion and throughout the distribution network to capture any nonpoint sources of pollution.

6.3.1.3 Land Slides

Native scrub habitat is being lost as 'mini' landslides occur within the conservation lands in the upper reaches of the Wailuku Watershed and in the surrounding watersheds associated with the eastern range of Mauna Kahālāwai. 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 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.

6.3.2 Waikapū Agricultural Lands

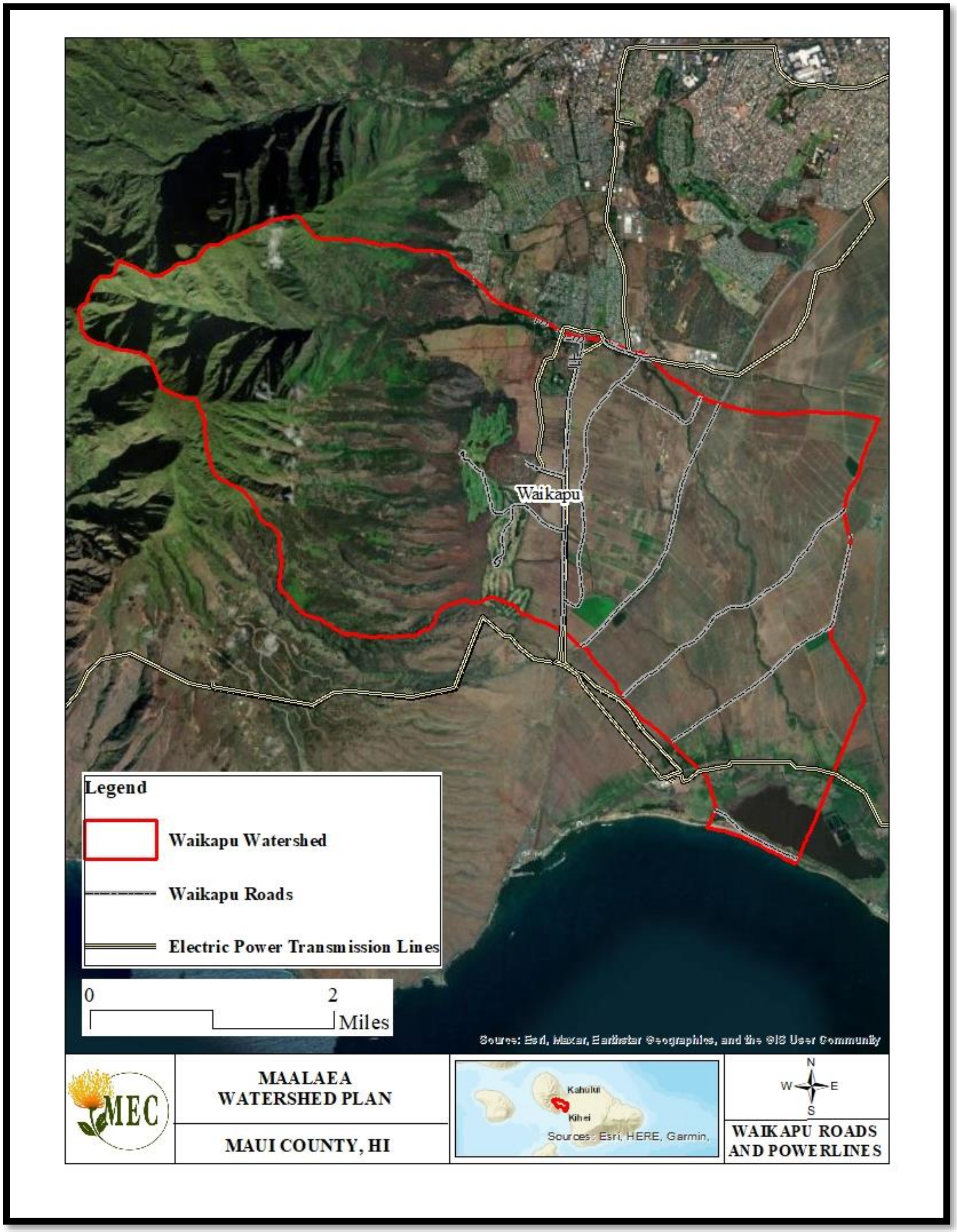
Agricultural lands may provide a nonpoint source for sediment, pathogens, and nutrient pollution. Within the Waikapū Watershed, fallow agricultural plots associated with Mahi Pono and smaller agricultural operations are situated on gently sloping fields throughout much of the watershed, beginning immediately mauka of Keālia Pond and continuing west across Honoapiʻilani Highway to the base of Mauna Kahālāwai. These agricultural lands make up approximately 5,856-acres of the overall watershed. Waikapū streams 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 Keālia Pond and Māʻalaea 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.

6.3.2.1 Powerline Corridors

There are two powerline corridors associated with the Waikapū Watershed. The main powerline corridor runs parallel with Honoapiʻilani Highway. The second transmission line branches off this first line just north of the watershed boundary and runs south, just mauka of the Maui Tropical Plantation, running along an open agricultural ditch before turning back to the east along Golf Course Road and reconnecting with the main transmission corridor (Figure 47. Waikapū Roads and Powerlines Map).

Maintenance of this smaller transmission corridor should be conducted in such a way to ensure clearing of vegetative debris does not enter the open agricultural ditch. In addition, access roads associated with this corridor should be well maintained to ensure dirt is not eroding into the ditch system during stormwater events.

Figure 47. Waikapū Roads and Powerlines Map



6.3.2.2 __Landscaped Golf Courses, Resorts and Residential Communities__

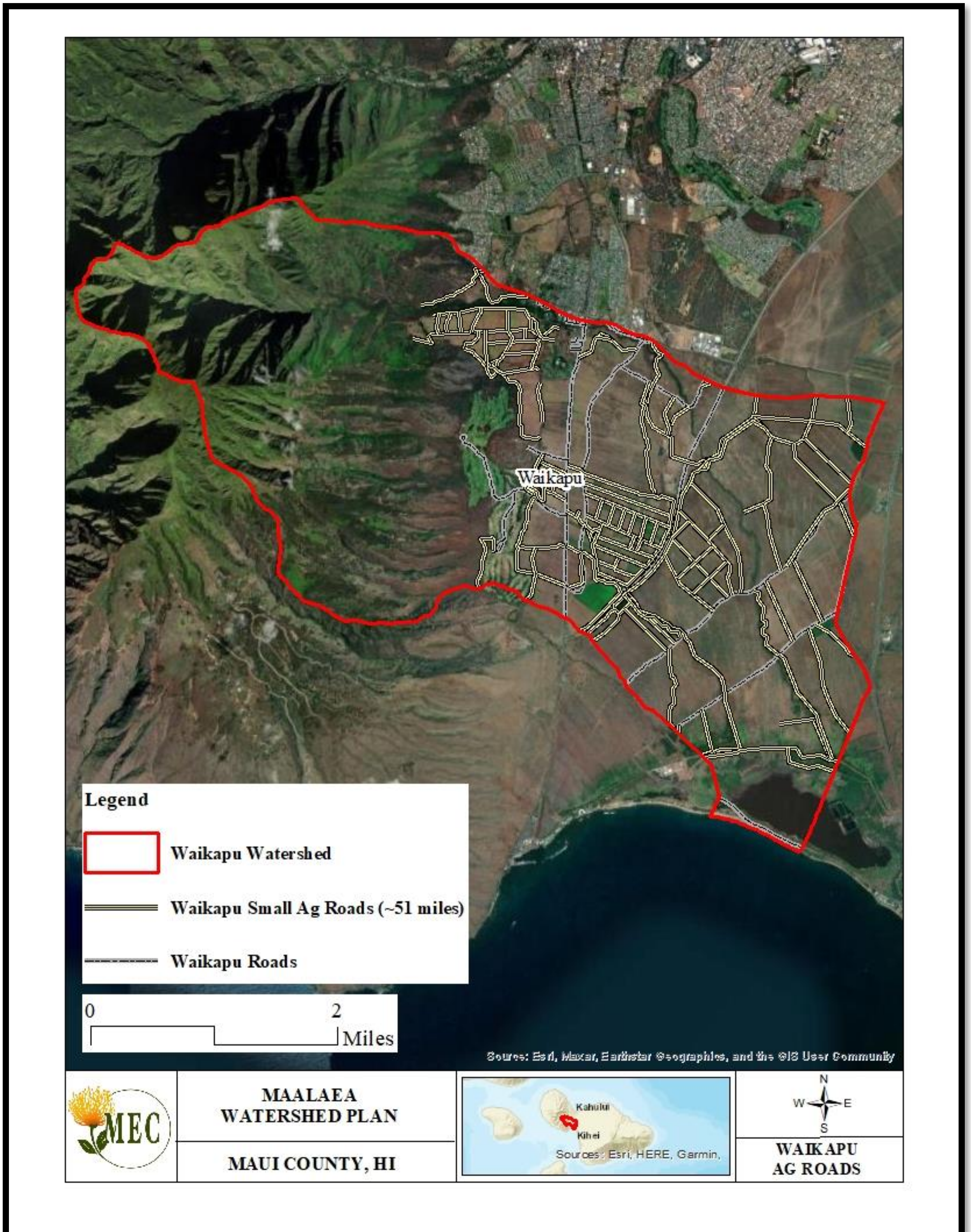
Several landscapes throughout the Waikapū and Waiakoa Watersheds are unnatural, requiring irrigation and fertilizer to exist. The Kahili and Kamehameha golf courses within Waikapū Watershed are likely the best examples of these unnatural landscapes. The resorts and condominiums on the makai side of North Kīhei Road in the Waikapū Watershed are also good examples of unnatural areas. These properties require large amounts of water and fertilizer to remain green. When fertilizers are placed in the soil, they can be transferred to the ocean by both surface water and groundwater. 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. The golf courses were not contacted as part of this watershed management plan and any course turf management BMPs that may currently be in use were not evaluated by this Plan.

6.3.2.3 __Unimproved Roads__

Historic agricultural land uses in this area (primarily sugar production) have left behind a network of unimproved roadways. Many of these roads run parallel to or directly cross the two main stream channels in the Waikapū Watershed. These roads should be maintained to ensure they do not "kickout" into ditches or streams and that they are not providing a source of sediment by eroding into these systems. Often, unused and unmaintained roadways act as stormwater conveyances during rain events and channel stormwater and sediment into adjacent gulches (Figure 49. Waikapū Ag Roads Map).

Figure 48. Example of Unmaintained Dirt Road

Figure 49. Waikapū Ag Roads Map



6.3.2.4 Ditch and Reservoir Systems

In addition to the Wailuku Water Company's Waikapū ditch system, smaller ditches and reservoirs associated with Mahi Pono and other agricultural entities are dispersed throughout the Waikapū Watershed (Figure 50. Waikapū Streams, Ditches and Wetlands Map). Water distributed by this ditch and reservoir system is brought over from Waiheʻe, Waiehu, ʻĪao, and Waikapū within Mauna Kahālāwai. In addition to this water, ditch systems associated with windward Haleakalā stream diversions also convey water into the central valley.

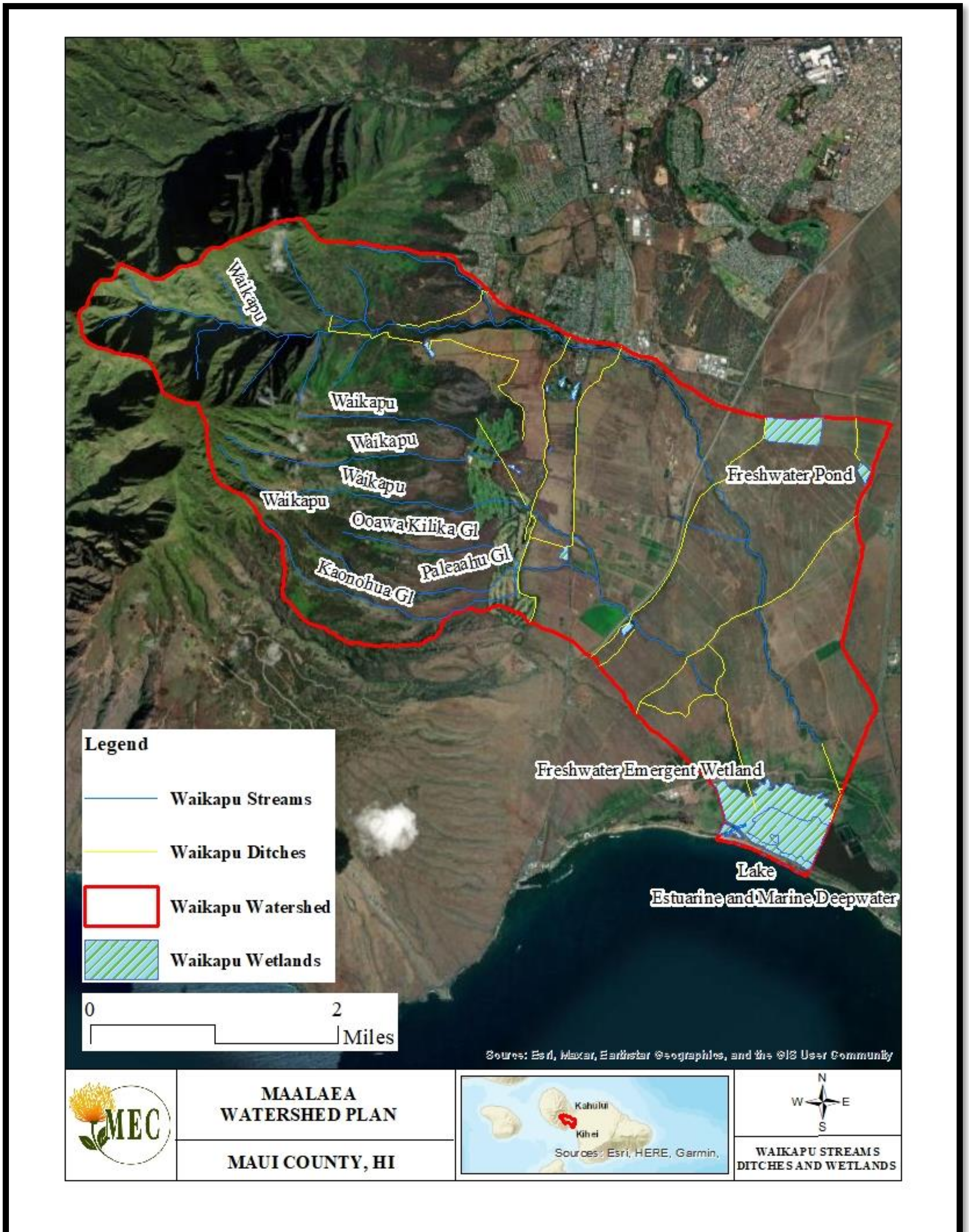
6.3.2.5 Kuihelani Solar

The Kuihelani Solar Project, which is currently under construction will utilize 450-acres of land leased from Mahi Pono. This solar farm will produce 60 MW of alternating current and provide 240 MWh of battery storage. Large solar farms consisting of ground-mounted solar panels have the potential to produce large volumes of stormwater runoff, as each individual panel is an impervious surface. To avoid erosion issues, subsoil compaction should be avoided during construction and installation to allow for natural stormwater infiltration. In addition, rows of panels should be installed with sufficient distance between rows to allow for groundcover vegetation to grow.

6.3.2.6 Central Maui Wastewater Reclamation Facility

The Central Maui Wastewater Reclamation Facility will be located on a 14.9-acre parcel within a larger 209.4-acre parcel (TMK (2)3-8-005:023). The recycled water from this facility will comply with HDOH requirements for R-1 recycled water and can be used to irrigate agricultural fields, parks, schools, and other areas. R-1 water from this facility should also be used to mitigate axis deer damage in locations where groundcover vegetation has been denuded.

Figure 50. Waikapū Streams, Ditches and Wetlands Map



6.3.3 Waikapū Urban Areas

While the Waikapū Watershed does not currently have an urban area, the Waikapū Country Town is slated for development. This residential mixed-use community will be located on 499-acres of land surrounding the existing Maui Tropical Plantation. This development will include 1,433 residential units, plus about 146 ʻOhana' units, retail and commercial buildings, and a school. This development will generate additional impervious surfaces and the appropriate stormwater infrastructure should be implemented to ensure stormwater is detained on site. Additionally, reef-friendly landscaping and agricultural practices should be employed. These practices include a buffer between landscaped and farmed areas and gulches and streams, a reduction in the amount of fertilizers used, and the use of R-1 water whenever it is accessible. The Final Environmental Impact Statement for this development does include Low Impact Development (LID) techniques to reduce runoff volumes, promote stormwater infiltration, and remove pollutants.

6.3.4 Keālia Pond

Keālia Pond National Wildlife Refuge (KPNWR) is a natural 704-acre pond located along the coast between north Kīhei and Māʻalaea. All the streams and ditches from both Waikapū and Waiakoa watersheds historically discharged into Keālia Pond. It is home to two endangered waterbirds, the ae'o (Hawaiian stilt) and the ʻalae keʻokeʻo (Hawaiian coot), and provides habitat for one of the largest migratory bird populations in the State of Hawaiʻi. Along the beach, the refuge provides nesting habitat for the threatened honu (Hawaiian green sea turtle), the endangered honuʻea (hawksbill sea turtle), and the ʻuaʻu kani (wedge-tailed shearwater).

Currently, little to no surface water flows from Waikapū and Waiakoa Watersheds into Keālia Pond. During large storm events, KPNWR staff have reported receiving stormwater from Waikapū Stream as well as from Keahuaiwi and Waiakoa Gulches as they flood their banks and fan out across the coastal floodplain associated with North Kīhei Road.

While Waikapū Stream is perennial, surface water from this stream does not reach Keālia Pond. This lack of surface water connection has caused portions of Keālia Pond to become hypersaline, especially in smaller ponds that were historically used for aquaponics. During the dry summer months, as the pond evaporates, these hypersaline conditions cause fish (mainly invasive tilapia) to die in large amounts. Fish die offs can cause eutrification of the entire pond, creating ideal conditions for avian botulism. Currently, ground water is pumped into the pond when water levels are low and to dilute hyper saline conditions.

6.4 Waiakoa Field Assessment of Nonpoint Source Pollution

6.4.1 Waiakoa Conservation Lands

Conservation lands exist from the summit of Haleakalā to approximately 8,000 feet. This area includes portions of Haleakalā National Park, State of Hawaii, and Haleakalā Ranch lands. Soils in this section of the watershed are extremely rocky with a high runoff potential. In addition, slopes are steep. Because of the elevation, vegetation is also sparse, creating ideal conditions for sediment transport during stormwater events. These areas should continue to be protected with feral ungulate fencing, invasive plant and animal species removal, and the planting of native plant species.

6.4.2 Agricultural Lands

Within the Waiakoa Watershed, agricultural lands make up almost 83 percent of the total land area with approximately 29,22-acres. At the lower part of the watershed, agricultural lands begin immediately mauka of Keālia pond, continuing eastsoutheast towards the summit of Haleakalā. These agricultural lands are interrupted briefly in Kula where rural and small pockets of urban landuse exist. Beyond the upcountry communities, agricultural lands continue, primarily owned by the State of Hawaiʻi and Haleakalā Ranch, ending just before the summit of Haleakalā where a band of conservation land exists.

At the lower portions of these agricultural lands, most of the area is currently fallow, with smaller farming operations being conducted by Bayer and Mahi Pono. In the mauka portions, pasture and rangeland dominate most of this land use designation. The lower portions of the Waiakoa Watershed are extremely dry and prone to wildfires.

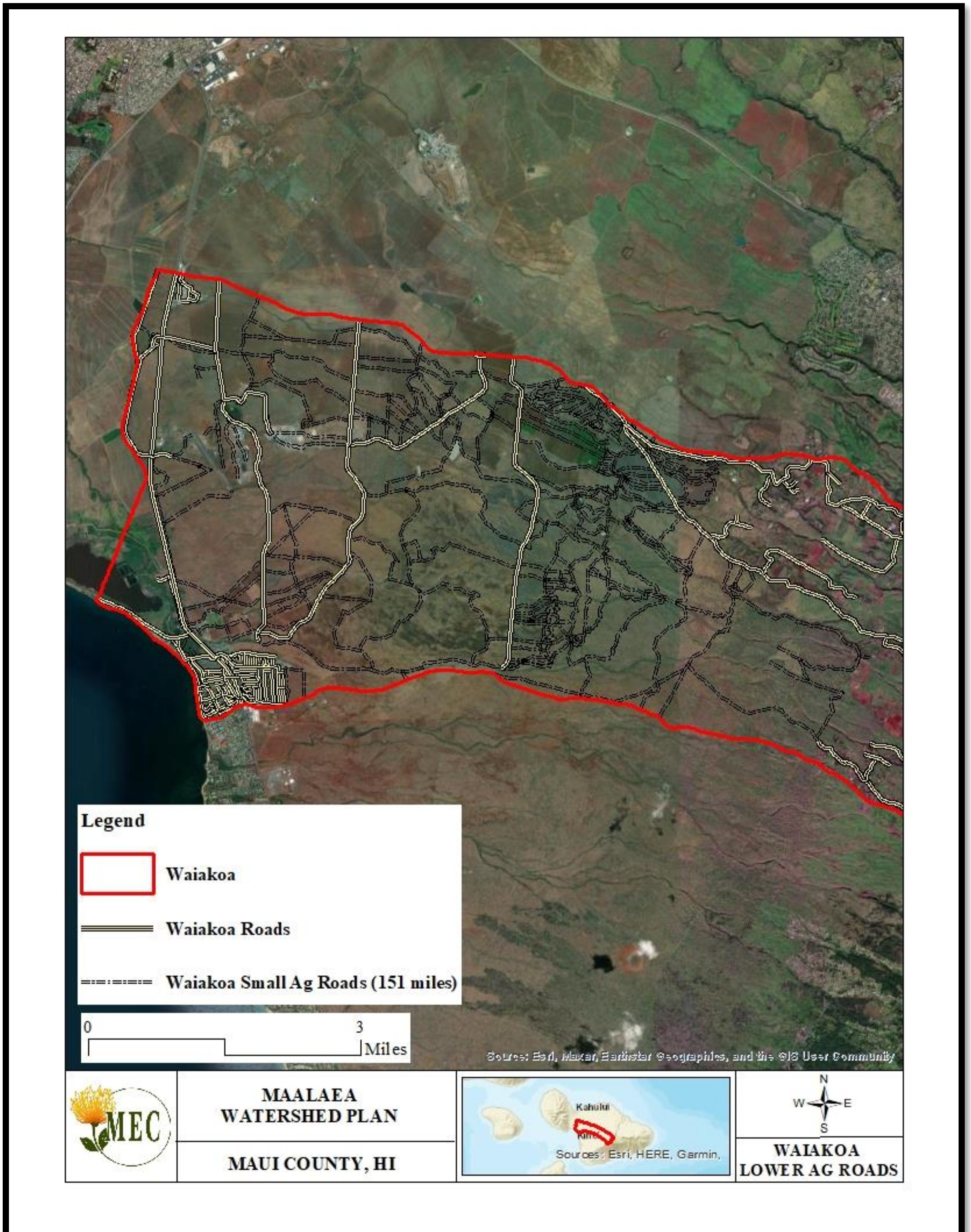
6.4.2.1 Axis Deer

Large axis deer populations exist within Waiakoa Watershed (an estimated 46,000 deer are present within the central valley of Maui), and much of the landscape has been denuded of vegetation. Axis deer are likely the main cause of sediment pollution in the Waiakoa Watershed. During storm events, soils within these agricultural areas are easily eroded, causing sediment deposition at the outfalls of Waiakoa and Keahuaiwi Gulches in North Kīhei, and within the ditch and reservoir systems that ultimately lead to Keālia Pond. Feral ungulate fencing is needed to create management units within these agricultural lands. Once in place, these management units will provide a way to control axis deer populations by limiting herd migrations and by allowing for controlled removal of this highly invasive species.

6.4.2.2 Agricultural Roads

As with Waikapū Watershed, agricultural operations have left behind a network of unimproved roadways. These include what are referred to as the Upper and Lower Kīhei Road, Ah Yen Road, Keahua Road, and Waiakoa Road. In addition to the larger unimproved roads, many smaller roads associated with farming and ranching exist. These roads should be maintained to ensure they do not “kickout” into ditches or streams and that they are not providing a source of sediment by eroding into these systems. Often, unused and unmaintained roadways act as stormwater conveyances during rain events and channel stormwater and sediment into adjacent gulches (Figure 51. Lower Waiakoa Ag Roads Map).

Figure 51. Lower Waiakoa Roads and Ag Roads Map



6.4.2.3 Nutrients and Fertilizer

Both Mahi Pono and Bayer have agricultural operations within the agricultural lands associated with the Waiakoa Watershed. Fertilizer used in these operations has the potential to be swept away with surface water sheet flow, erosion, or leached into groundwater. In addition to these potential sources of nutrient pollution, feces from the growing axis deer population have the potential to raise nitrogen and phosphorus levels in the watershed.

6.4.2.4 Industrial Operations

Hawaiian Cement and the Puunene Heavy Industrial Park are located within the Agricultural State Land Use District. In addition, a portion of the Maui Base Yard also exists within the Waiakoa Watershed (this area has been designated urban but has been included here). Sediment along with petrochemicals and other pollutants have the potential to be swept into Kolaloa Stream, which is located just south of the Hawaiian Cement and Puunene Heavy Industrial Park. Pūlehu Gulch flows just south of the Maui Base Yard. Best Management Practices should be employed to ensure that sediment remains in place and that petrochemicals and other toxins are stored properly so as not to enter the watershed during storm events.

6.4.3 Upcountry Urban and Rural Communities

This portion of the Waiakoa Watershed is associated with the Kula community, largely located between Kula Highway and Kekaulike Avenue. Flooding has damaged portions of Kekaulike Avenue as debris conveyed by stormwater collects on the upstream side of bridges, causing streams to back up. Stormwater then overtops these bridges and culverts, causing flooding and damaging infrastructure.

Figure 52. Clogged Drainage Infrastructure and Flooding Impacts on Roadways

*6.4.3.1 **Invasive Plant Species***

Invasive species such as black wattle (*Acacia mearnsii*), which was historically used in the hide tanning industry, have since taken over pastures and gulches throughout much of the upcountry community. Wattle grows in dense stands, chocking out shrub and groundcover species. This leaves the soil within these stands of trees barren, allowing for erosion during storm events.

*6.4.3.2 **Axis Deer***

Axis deer are also a major concern in the upcountry community. In addition to the damages inflicted upon small farmers and larger agricultural operations such as the Kula Ag Park, the ever-expanding axis deer population has denuded the landscape of both native and non-native plant species, leaving soils highly vulnerable to erosion.

*6.4.3.3 **Drought Resilience***

Upcountry residents have expressed interest in watershed projects that capture stormwater while providing drought resilience. Discussions are ongoing and include lined retention basins that divert stormwater from gulches and store it as a resource to be used by agricultural operations. Sediment captured in these basins could also be used as soil amendments.

6.4.4 Urban Communities Associated with North Kīhei

The urban community of North Kīhei has been largely affected by stormwater flooding and sediment deposition. Both the Waiakoa and Keahuaiwi Gulches discharge into North Kīhei, just south and east of Keālia Pond. Both of these streams are ephemeral, only flowing occasionally each wet season. While this flooding has been documented for some time, in recent years the stormwater has become saturated with sediment. This sediment is deposited onto roads, houses, and other vital infrastructure associated with the urban community, before ultimately discharging into the ocean, where it causes major brown water events. Sediment deposited into nearshore coastal waters settle on coral reefs, degrading marine habitat.

Figure 53. Sediment built up along the banks and within Waiakoa Gulch

6.4.4.1 Impervious Surfaces

The roads, parking lots and buildings associated with the North Kīhei community, including homes, roads, oceanfront resorts, and condominiums represent a significant area of impervious surface. Urban runoff from these areas increases the volume of stormwater reaching the ocean, and is a significant contributor of sediment as well as petrochemicals, heavy metals, trash, and other pollutants. There are likely additional sources of nutrient pollution associated with landscaped portions of the urban corridor.

6.4.4.2 Urban Debris

Urban debris from illegal dumping and homeless encampments is widespread throughout the Kīhei Community. As stormwater moves through the watershed, it collects this debris, which is then deposited on the upstream side of culverts and bridges. Once this debris becomes lodged in place, stormwater infrastructure becomes clogged, and flooding occurs as stormwater is forced out of gulches and into upland areas. Debris not captured by stormwater infrastructure is discharged out into the Pacific Ocean, where it becomes a hazard to both water quality and marine life.

6.4.4.3 Wetland Losses

Wetland losses in the coastal communities of Kīhei, Wailea, and Makena are well documented. Historically, streams such as Waiakoa and Keahuaiwi likely fanned out into muliwai, or small estuaries during large storm events. Even today, these streams connect with Keālia Pond to the north when flooded. This is evident at the intersection of North and South Kīhei Road, where flooding and sediment deposition has been frequent in recent years.

6.4.5 Keālia Pond

As noted above, Keālia Pond and its surrounding wetlands are extremely important for preventing pollution from entering the ocean. The ecological function of Keālia Pond as a wetland provides numerous ecosystem services acting as both a nutrient sink and buffer against stormwater runoff pollution entering the ocean. The pond provides critical habitat for endangered aquatic bird species as well as many other flora and fauna. Pollution entering from the two Waikapū Streams and the five Waiakoa streams is likely contained within Keālia 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 Keālia Pond to handle large amounts of sediment and stormwater pollutants, it is fortunate that Waikapū and Waiakoa streams discharge into the pond instead of directly into the ocean. That said, it is likely that sediment deposits in Keālia are gradually filling in the pond, and further study of the sediment dynamics of the system is warranted. Sediment laden stormwater captured in Keālia is discharged at the pond's outfall into Māʻalaea Bay and the ocean during large stormwater events.

7.0 GOALS AND MANAGEMENT RECOMMENDATIONS

The Waikapū Watershed consists of two major drainage ways, both of which are referred to as Waikapū Stream on maps provided by the Hawaiʻi Department of Land and Natural Resources Division of Aquatic Resources. The northern-most Waikapū Stream is considered perennial and originates at approximately 3,300 feet in the West Maui Mountains with several smaller tributaries flowing into it at upper elevations. Rainfall in the upper reaches of Mauna Kahālāwai is greater that 120-inches per year while in the agricultural lands nearest Keālia Pond, less than 15-inches of annual rainfall are typically recorded. The southern Waikapū Stream is considered non-perennial, and the tributaries associated with it include Ooawa Kilika, Paleaahu, and Kaonohua Gulches.

Because the streams flow through agricultural fields for much of the watershed, sediment and nutrient loading should be made a priority concern. In this section, management recommendations for the Waikapū Watershed include unimproved road stabilization, riparian buffer protection and rehabilitation, as well as reef friendly landscaping for Kahili and Kamehameha golf courses. Lastly, vital native forests in conservation lands at the upper reaches of the Waikapū Watershed should be fenced off from feral ungulates, and non-native plant and animal species removal should continue.

The Waiakoa watershed can be divided into the upcountry portion of the watershed which receives from 25 to over 35-inches of rainfall annually and the makai portion of the watershed which is characterized by long periods with little to no rainfall. Waiakoa gulches and gullies rarely discharge into the ocean. Unfortunately, when stormwater events do occur, the potential for large stormwater volumes and flash flooding is possible within the watershed. All stormwater mitigation measures and restoration activities must be engineered to handle high flow events that are likely to increase as weather patterns fluctuate in the face of climate change.

Extremely limited water quality data exists for the Māʻalaea Watersheds. As stated earlier, the DOH CWB currently only monitors at one location within the entire 10,393-acre area of the Waikapū Watershed, within the coastal waters immediately off of Keālia Pond. Within the 35,330-acre Waiakoa Watershed, only two sampling stations exist. These include Mai Poina ʻOe Iʻau Beach Co. Park and the Kīhei Coast-Mokulele.

The entire coastline associated with Keālia Pond and Māʻalaea Bay is important for providing public access to fishing, swimming, boating, and other recreational activities. A Māʻalaea Watershed Water Quality Monitoring Plan was created and is included as Section 14.0 to this watershed plan. At a minimum, if none of the other management projects and strategies listed below are implemented, the Māʻalaea Watershed Water Quality Monitoring Plan (or portions of this plan) should be implemented to narrow existing data gaps in water quality issues, and to better determine where sediment and nutrient pollution is occurring throughout the Waikapū and Waiakoa Watersheds.

The following sections provide projects and strategies designed to address specific land use issues known to occur or that have been observed in the field during this study. Many of the proposed management measures in this report are highlighted in Chapter 5 of the *Hawaiʻi Watershed Guidance* report and are referenced when applicable. Stakeholders in the watershed are encouraged to collaborate on and actively participate in the implementation of these projects. Load reduction estimates for high priority projects are provided to better inform stakeholders on the potential efficacy of each project.

7.1 Waikapū

7.1.1 Axis Deer Fencing

At a minimum, axis deer fencing should be placed along the conservation land boundary to protect native forests from this invasive species. Working with the Hawaiʻi Department of Land and Natural Resources, Division of Forestry and Wildlife and the Mauna Kahālāwai Watershed Partnership, this project would require a minimum of 15,832 linear feet of fencing. At approximately $26 a linear foot, fencing off this portion of the Waikapū Watershed would cost roughly $411,632.00.

Additional fencing is needed to create axis deer management units (Figure 54. Waiakoa Watershed Feral Ungulate Fencing Map). By creating these management areas, the community can control the migration of axis deer throughout the watershed. While it is believed that axis deer do not typically roam very far, during drought, wildfire, or other pressures such as removal, fencing enables proper management of this invasive species. Due to the amount of agricultural land in production, this watershed plan has suggested additional fencing between Honoapʻilani Highway and Kuihelani Highway to protect this area. Additional fencing has been proposed between Kuihelani Highway and Mokulele Highway, which would tie into the exist feral ungulate fencing already in place around Keālia Pond.

Table 23. Waikapū Feral Ungulate Fencing with Costs

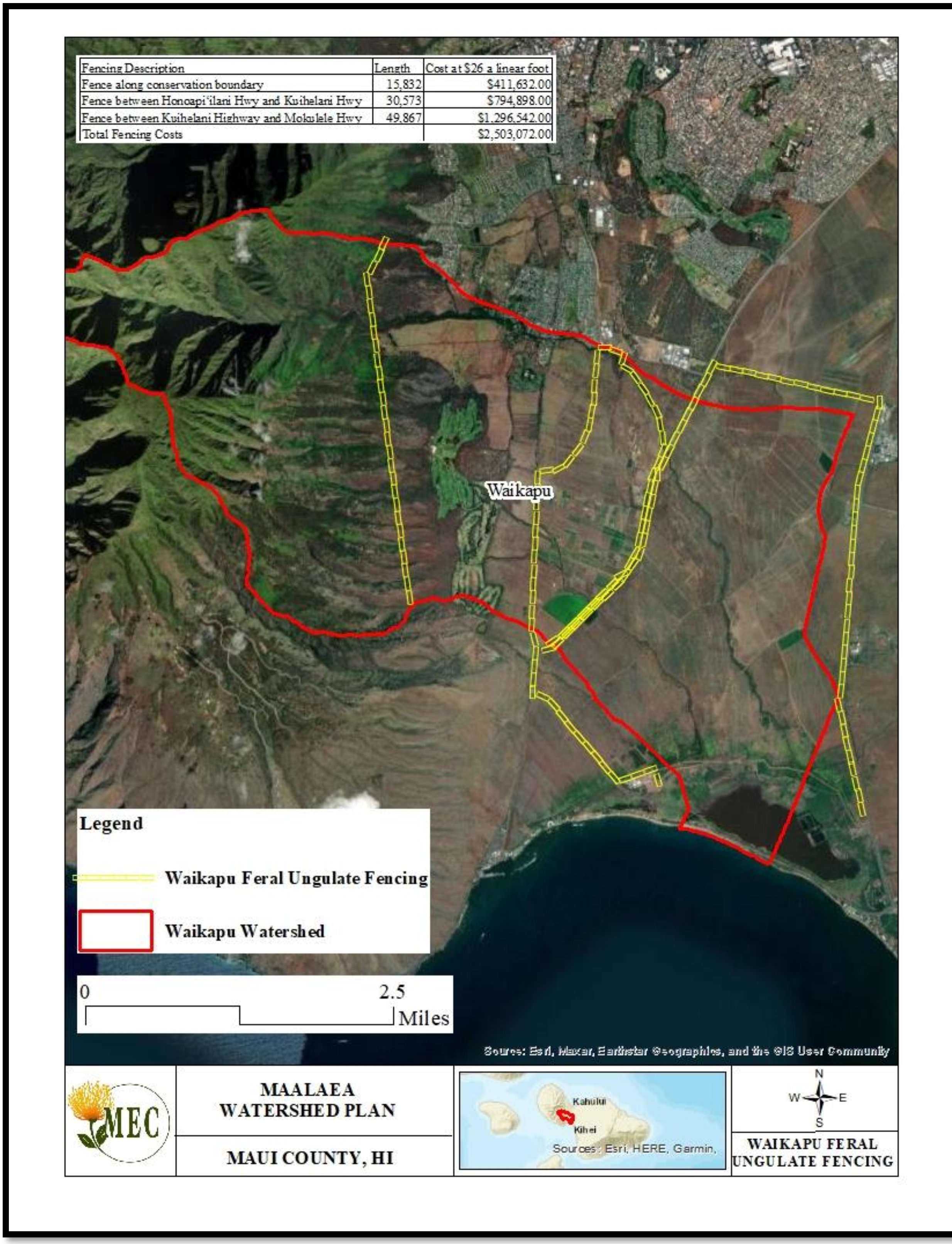
Fencing Description	Length	Cost at $26 a linear foot
Fence along conservation boundary	15,832	$411,632.00
Fence between Honoapiʻilani Hwy and Kuihelani Hwy	30,573	$794,898.00
Fence between Kuihelani Highway and Mokulele Hwy	49,867	$1,296,542.00
Total Fencing Costs		$2,503,072.00

7.1.2 Axis Deer Removal

In concert with fencing, axis deer removal from conservation areas, agricultural areas, and areas in close proximity to highways is recommended. Several options for removal exist and include aerial hunts with helicopters, recreational hunting by the community, and commercialized hunting by organizations with the capability to process meat for sale and consumption.

As stated above, removing all axis deer from conservation lands in the Waikapū Watershed is highly recommended to protect native habitats. Those areas where axis deer herds are in close proximity to Honoapiʻilani, Kuihelani, and Mokulele Highways should also be considered high priority areas for removal to safeguard the community from collisions with these animals.

Figure 54. Waikapū Watershed Feral Ungulate Fencing Map

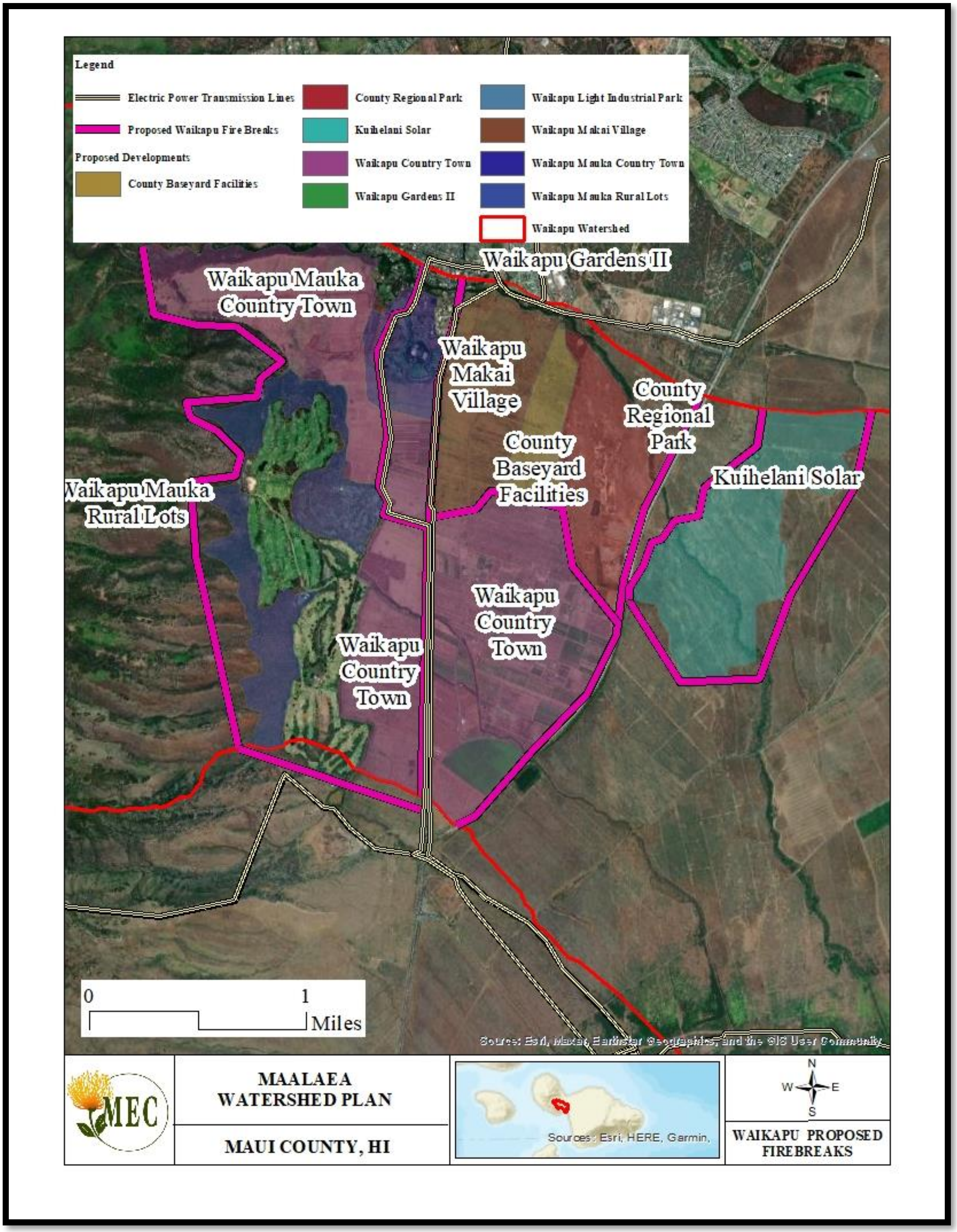


7.1.3 Wildfires and Fire Breaks

Waikapū Watershed and the neighboring Pōhākea Watershed are both known for high winds and high wildfire potential. In lieu of the devastating August 2023 wildfires that burned Lahaina Town, Olinda, Kula, and Pūlehu, fire breaks should be installed at priority locations throughout the Waikapū Watershed. These fire breaks should run parallel to all electric transmission and distribution powerlines. Firebreaks should also be placed around the Kuihelani Solar project, on both sides of Honoapiilani Highway, and placed strategically within and around the Waikapū Country Town development (Figure 55. Waikapū Proposed Firebreak Map).

As stated in Chapter 5 Section 2 of the Hawaiʻi Watershed Guidance report, strategies that minimize erosion potential are important to consider when fire suppression techniques clear vegetated areas. Plowing should be combined with sowing a suitable cover crop. The ideal crop would provide an effective fire break by not creating excessive biomass, be dense growing to prevent invasive species from rooting, and ideally be a nitrogen fixing legume that could nourish degraded soils. Native species such as aweoweo and naio should also be considered for their relatively low pyrophytic ratings. 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 Hawaiʻi can be found at the link below.
https://cms.ctahr.Hawaiʻi.edu/soap/Resources/Sustainable-and-Organic-Topics/cc-gm

Figure 55. Waikapū Proposed Firebreak Map



7.1.4 Unimproved Road Stabilization

Mahi Pono and other agricultural entities should conduct an assessment of the current necessity and future needs of dirt agriculture roads within the Waikapū and Waiakoa Watersheds. 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. 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.

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. Waikapū has approximately 51 miles of unimproved dirt roads (Figure 49. Waikapū Ag Roads Map). Chapter 5 Sections 2 and 3 of the Hawaiʻi Watershed Guidance report states that proper road management and runoff mitigation efforts are important to consider in managing pollution within a watershed. A comprehensive inventory of the Waikapū roads should be conducted to determine stakeholder access needs and to identify those roads that are candidates for decommissioning or repair. Stakeholders should refer to HAR 11-56, Appendix A and "National Management Measures to Control Nonpoint Source Pollution from Agriculture" EPA, EPA-841-B-03-004, July 2003. Closing roads using structural methods (barriers) such rocks, logs, or vetiver plantings can capture sediment and attenuate runoff. In coordination with landowners and potential road users, disused, and unnecessary or redundant roadways should be identified for decommissioning. Any roads likely to stay in use should be improved using water bars, sediment traps and other BMPs to minimize downslope transport of eroded sediments. Several appropriate BMPs can be found in the document entitled: Unpaved Road Standards for Caribbean and Pacific Islands. Common drainage control techniques highlighted in the document include grade breaks, dips and low water crossings, water bars, cross-drains and culverts, ditches, turnouts, sediment traps, geosynthetics, soil and/or aggregate stabilization, and slope stabilization. Examples are displayed below. The example diagrams are courtesy of Brian Kent from the *Gravel Road Maintenance Manual: A Guide for Landowners on Camp and Other Gravel Roads*.

https://www.ncei.noaa.gov/data/oceans/coris/library/NOAA/CRCP/NMFS/OHC/Projects/30033/HorsleyWittenGroup2017_Island_Unpaved_Road_Standards.pdf)

Figure 56. Water Bar Example Diagram

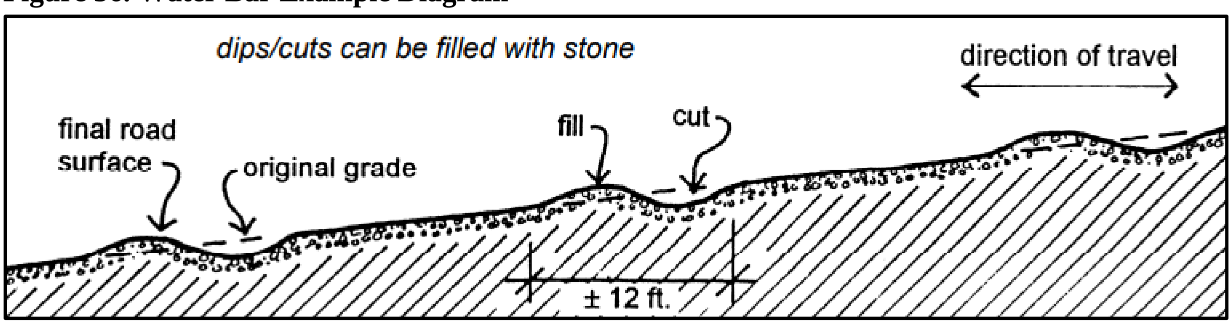
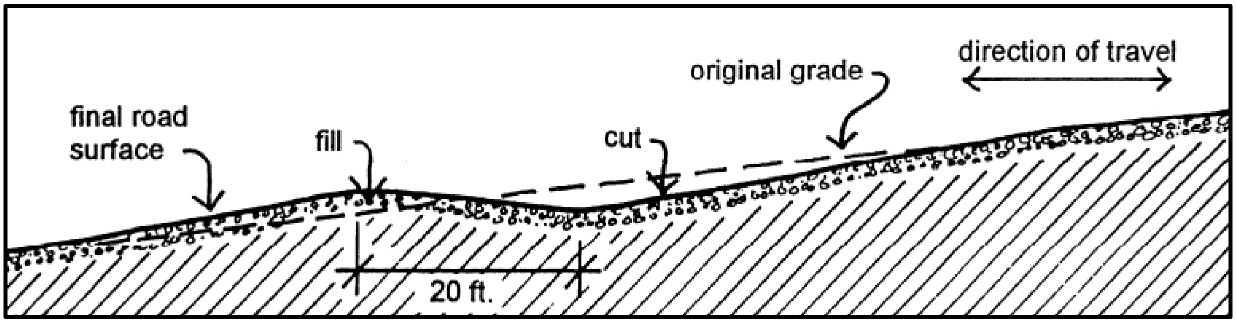


Figure 57. Water Dip Example Diagram



Roads identified for stabilization and/or closure should be prioritized based on 1) utility 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.

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 ranchers, fire crews, rangers, illicit dirt bikers, hunters, hikers, etc. to help select appropriate sites, and to ensure the purpose of the road closure is understood and not damaged or tampered with. Signage can be useful to convey this information.

Table 24 below provides a sample budget to repair approximately 3 miles of road based on a similar project that took place in 2019 in the neighboring Pōhākea Watershed. Note that this sample budget is for the repair of approximately 12,000 linear feet of dirt road. Repair included regrading to address channelizations and rills, the cleaning out and repair of kickouts, and the establishment of water bars where needed. In addition, herbicide treatment was included on either side of the road for fire suppression.

Table 24. Sample Budget for Road Repairs Based on Similar Projects in the Pōhākea Watershed

Task Description	Unit	Unit Price	Total Price
Mobilization	NA	$5,000	$5,000
Water Truck	10 Days	$1,530	$15,300
Spencer Road Grading	7920	$23	$182,160
MECO Road Grading	7920	$28	$221,760
Herbicide Treatments	15,840	$1	$16,000
Total Price			$440,220

7.1.5 Wetlands and Stream Riparian Buffers and Protection

Riparian buffers along gulches and gullies prevent sediment laden sheet flow from entering flow ways and ultimately discharging into coastal waters. They also offer important habitat for native flora and fauna to inhabit from mauka to makai throughout the watershed. Existing wetlands should be delineated, protected and restored wherever possible. Wetlands have the ability to filter stormwater for sediment, nutrients and pathogens. They provide habitat for native flora and fauna and serve as flood prevention and aquifer recharge locations. Lastly, wetlands represent greenspace within urban communities, offering a place for recreation that can improve the community's relationship with the natural environment.

The U.S. Army Corps of Engineers (USACE) has regulatory authority over wetlands and other water bodies of the U.S. (WBUS) based on two federal laws. These include Section 404 of the Clean Water Act (CWA) of 1972, and Section 10 of the Rivers and Harbors Act of 1899.

Section 404 of the CWA states that dredged and fill material may not be discharged into jurisdictional WBUS (including wetlands) without a permit. According to 40 CFR 230.3, WBUS subject to agency jurisdiction under Section 404 include navigable waters and their tributaries, interstate waters and their tributaries, wetlands adjacent to these waters, and impoundments of these waters.

A Section 404 permit is required for all fill or discharge activities below the high tide line in tidal waters or below the ordinary high-water mark (OHWM) for non-tidal, non-wetland waters. Corps regulations define the term "ordinary high-water mark" for purposes of the CWA lateral jurisdiction at 33 CFR 328.3(e), which states:

"The term ordinary high-water mark means that line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas."

The Rivers and Harbors Act of 1899 prevents unauthorized obstruction or alteration of navigable WBUS. Navigable waters are defined as waters that are "subject to the ebb and flow of the tide and/or presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce" (33 Code of Federal Regulations [CFR] 325.5(c)(2)). A Section 10 permit is required for non-fill discharging activities proposed in, over, or under WBUS.

In May of 2023, the United States Supreme Court released an opinion in Sackett v. EPA, in which the Court unanimously held that the Environmental Protection Agency (EPA) overstepped its jurisdiction in classifying wetlands on the Sackett property as "waters of the United States" (WOTUS). The court stated: "…the CWA extends to only those wetlands that are "as a practical matter indistinguishable from waters of the United States." This requires the party asserting jurisdiction over adjacent wetlands to establish "first, that the adjacent [body of water constitutes]… 'water[s] of the United States,' (i.e., a relatively permanent body of water connected to traditional interstate navigable waters); and second, that the wetland has a continuous surface connection with that water, making it difficult to determine where the 'water' ends and the 'wetland' begins."

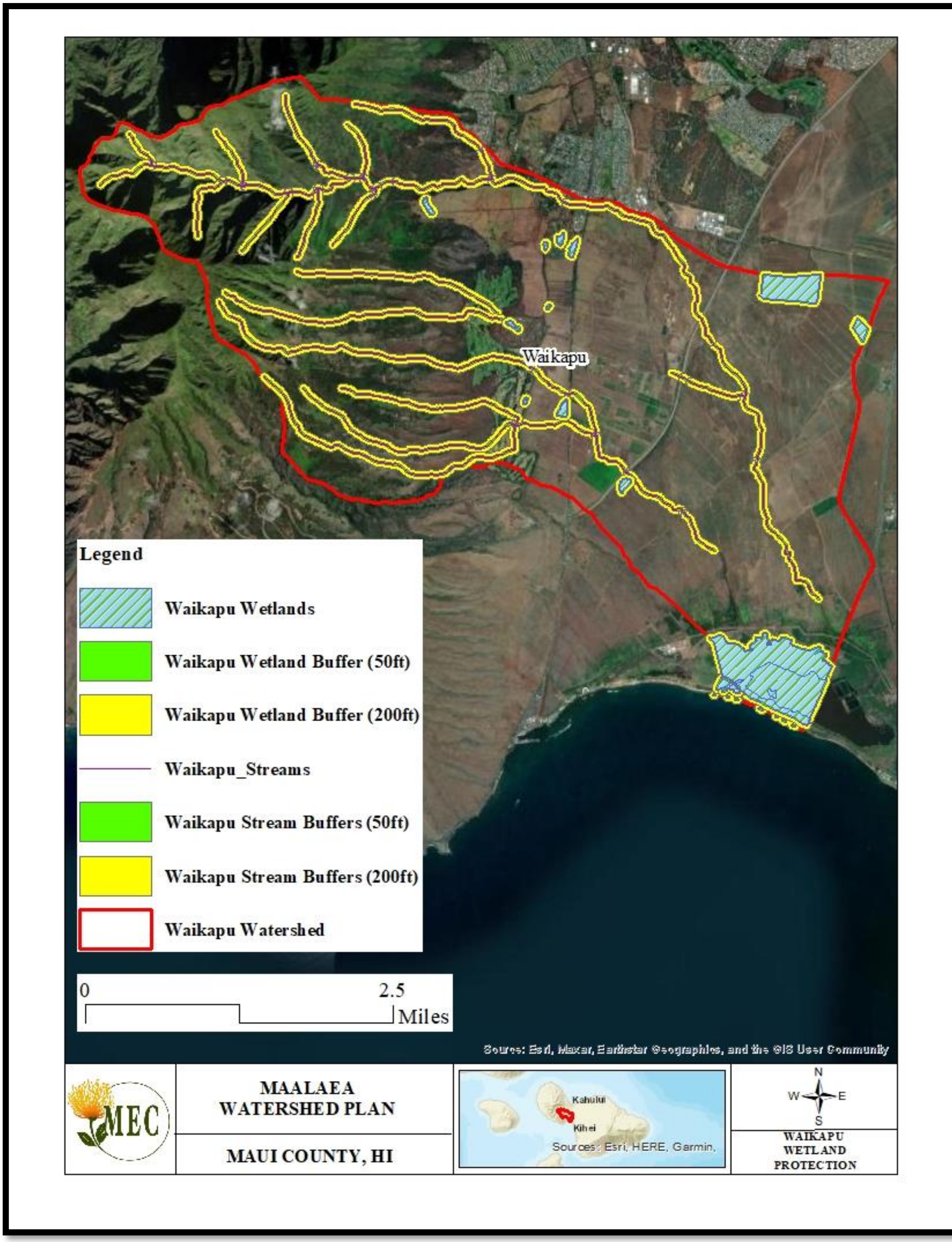
In October of 2022 the Maui County Council passed a bill to protect and restore wetlands (Ordinance 5421). As a requirement of this law, a wetland overlay map is being created. Any wetlands that contain at least two of the three wetland indicators listed by the USACE in their wetland delineation manual and any flow through systems depicting a high-water mark as defined in the 2005 USACE Regulatory Guidance Letter on Ordinary High Water Mark Determination are now considered protected by the bill. County protections may include 50-to-200-foot buffers placed around the wetland edges and stream banks as determined by the Maui County Planning Department. Figure 59 below depicts both 50-foot and 200-foot buffers around all streams and wetlands within the Waikapū Watershed.

Table 25. Cost Estimates for Approximately 10.8 Acres of Riparian Rehabilitation

Task	Cost per Unit	Number of Units	Total Cost
Weekly fencing and irrigation infrastructure inspections	$550.00	52	$28,600.00
Fencing Materials	$30.00	3,896	$116,880.00
Irrigation Infrastructure	$4,000.00	1	$4,000.00
Irrigation installation and planting	$2,200.00	5	$11,000.00
Plants	$4.00	1,000	$4,000.00
Quarterly vegetative monitoring, photo documents, drone flights	$1,100.00	4	$4,400.00
Quarterly and annual reports	$1,100.00	4	$4,400.00
Total Cost		$173,280.00	

Figure 58. Landscape denuded by axis deer on the left of the fence compared to rehabilitated riparian corridor on the right side of the fence.

Figure 59. Waikapū Streams and Wetlands with 50-ft and 200-ft Buffers



7.1.6 Golf Course Nutrient Program

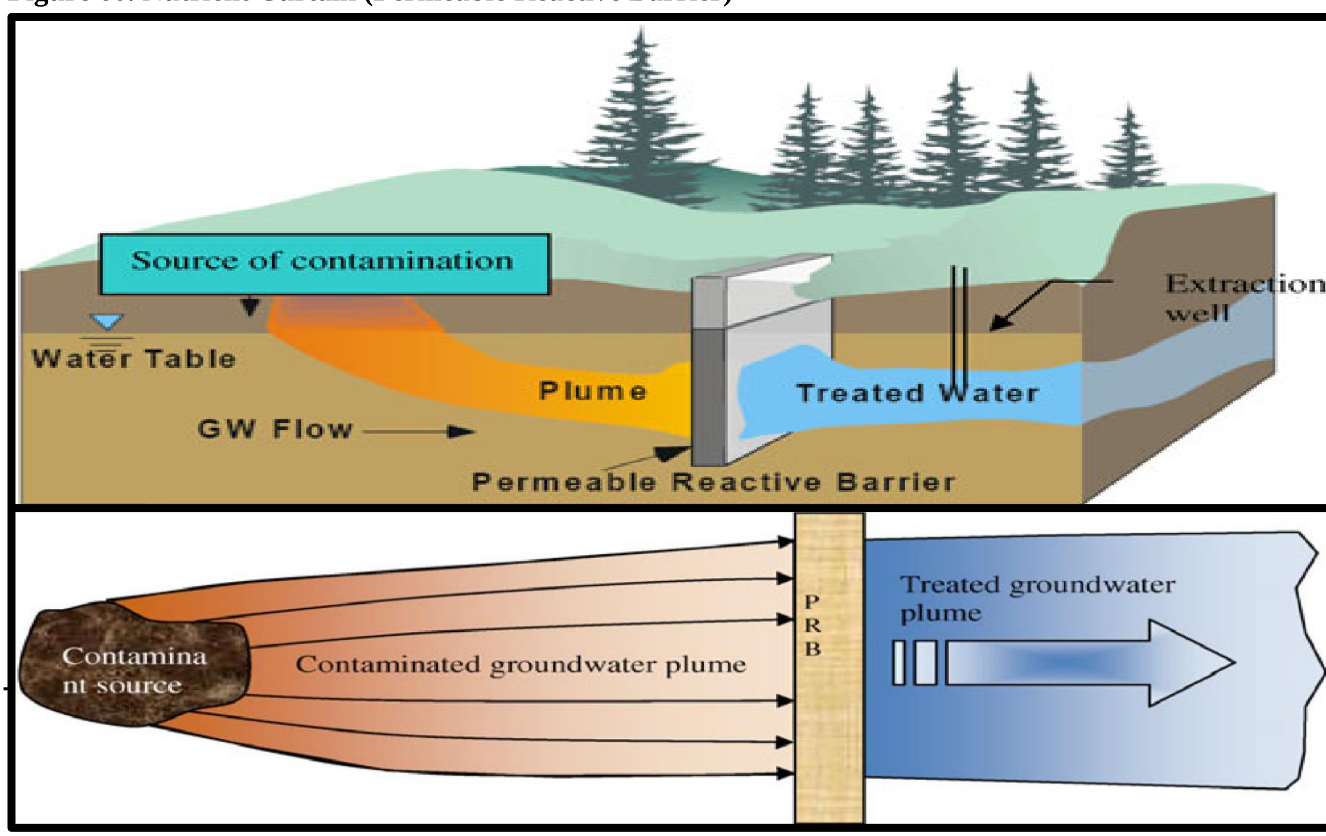
There are numerous turf management BMPs that can effectively reduce nutrient stormwater runoff and groundwater pollution on golf courses. Agricultural ditches run directly downstream and downhill from both Kahili and Kamehameha Golf Courses. This water should be regularly tested for water quality to ensure nutrients and sediment from the gold courses are not being distributed via this irrigation infrastructure. Additionally, agricultural and recreational entities should be in constant discussions with land managers for Keālia Pond National Wildlife Refuge to ensure adequate amounts of surface water is received, and that the water is clean and safe for wildlife that inhabit the refuge.

Golf course management measures have been developed specifically for Hawaiʻi and are included in Chapter 5 Section 3 of the Hawaiʻi Watershed Guidance report. Nutrient management and resourceful irrigation strategies are important to consider. Recent examples successfully piloted throughout Maui include:

7.1.6.1 Nutrient Curtain

A 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 60. Nutrient Curtain (Permeable Reactive Barrier)



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 26. 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**

7.1.6.2 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 61. Floating Treatment Wetland

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. Kamehameha and 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

7.1.7 Reef Friendly Landscaping

Chemical-free alternatives to synthetic pesticides, herbicides, and fertilizers should be considered to meet landscaping needs. Organic products enhance soil health by restoring the soil microbiome to create ideal conditions that support healthy vegetative growth while fighting against pests and disease. Healthy, biodiverse soils become low-maintenance and cost-saving once established. Maui Nui Marine Resource Council has conducted several pilot projects that demonstrate the success of biological soil amendments. MNMRC has also developed a Reef Friendly Landscaping Certification program, where interested parties can obtain a free consultation with an organic land care consultant and receive recommendations on products, equipment, and resources to aid in the transition to reef friendly landscaping. Reef-friendly landscaping practices can be adopted by commercial and residential properties alike.
https://www.mauireefs.org/residential-reef-friendly-landscaping/

Figure 62. MNMRC's Reef Friendly Landscaping Test Plot at Makena Golf and Beach Club

Photo Courtesy of Maui Nui Marine Resource Council.

7.1.8 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. Landslides are discussed in Chapter 5 Section 2 of the Hawaiʻi Watershed Guidance report, and areas with high erosion potential need to be identified and addressed. Preserving high quality functional, native habitat should be a priority. Drawing upon lessons learned from projects conducted in Hawaiʻi 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.

7.1.8.1 Fiber Rolls

In areas with high erosion potential, fiber rolls could be placed in intervals along the slope face and/or within stream banks. Fiber rolls are made of straw, coir (coconut fibers), or other biodegradable materials to redirect runoff, decrease stormwater flow velocity, and trap sediment. To maximize effectiveness, fiber rolls should be placed on a level contour in a shallow trench, staked at regular intervals, and tightly abutted to one another. Fiber rolls can also be seeded with native vegetation or coupled with plantings behind it for continued slope stabilization once the roll decomposes.

7.2 Waiakoa

7.2.1 Detention Basins and Basins in Series

Excavated basins in series, connected by berms or channels for sedimentation and infiltration purposes, have been identified as having a high priority as a management measure to improve water quality in the watersheds. "Excavated basins are often constructed in sequences adjacent to streams, so that excess stormwater flows, from the stream or stormwater channel, can be diverted under gravity to the first basin, then overflows from each basin to the next under gravity, and back to the stream or stormwater channel at the end" (A Handbook for Stormwater Reclamation and Reuse Best Management Practices in Hawaii, December 2008, Commission on Water Reclamation Management).

The Final Report for the Kīhei Drainage Master Plan (KDMP) was released in November of 2016. While several detention basins are proposed in the County plan associated with the Waiakoa drainage area, none are proposed to occur in immediate proximity to Waiakoa Gulch. Figures 63 and 64 below provide examples for a series of basins and a large detention basin associated with Waiakoa Gulch. While the locations of the basins are subject to change, appropriate sites can be found in the watershed gulch systems based on the following criteria:

- Where sufficient undeveloped land exists on the sides of the gulches for the infiltration drain field
- After the convergence of tributaries to maximize efficiency
- Preferably in shallow segments where earth-moving to extract the water can be minimized
- In locations where stormwater intakes can be feasibly installed
- On soils which have adequate permeability

Table 27. Approximate Costs for a Large Detention Basin (Kīhei Drainage Master Plan, 2016)

Task	Quantity	Unit	Unit Price	Total
Environmental Assessment	1	1	$350,000	$350,000
Excavation of Detention Basin	25820	CY	$30	$774,600
Hydromulch for Detention Basin	95800	SF	$2	$191,600
GRP Slope Protection at Spillway	60	CY	$540	$32,400

Task	Quantity	Unit	Unit Price	Total
Inlet/Outlet Concrete Headwall	2	ea	$16,050	$32,100
Perimeter Chain Link Fence (6ft)	1240	LF	$60	$74,400
1-18' RCP	50	LF	$260	$13,000
Subtotal				$1,468,100
Contingency (20%)				$293,620.0
Total				$1,761,720

CY=Cubic Yard
SF=Square Feet
Ea=each
LF=Linear Foot

Figure 63. Example of Waiakoa Gulch Basins in Series

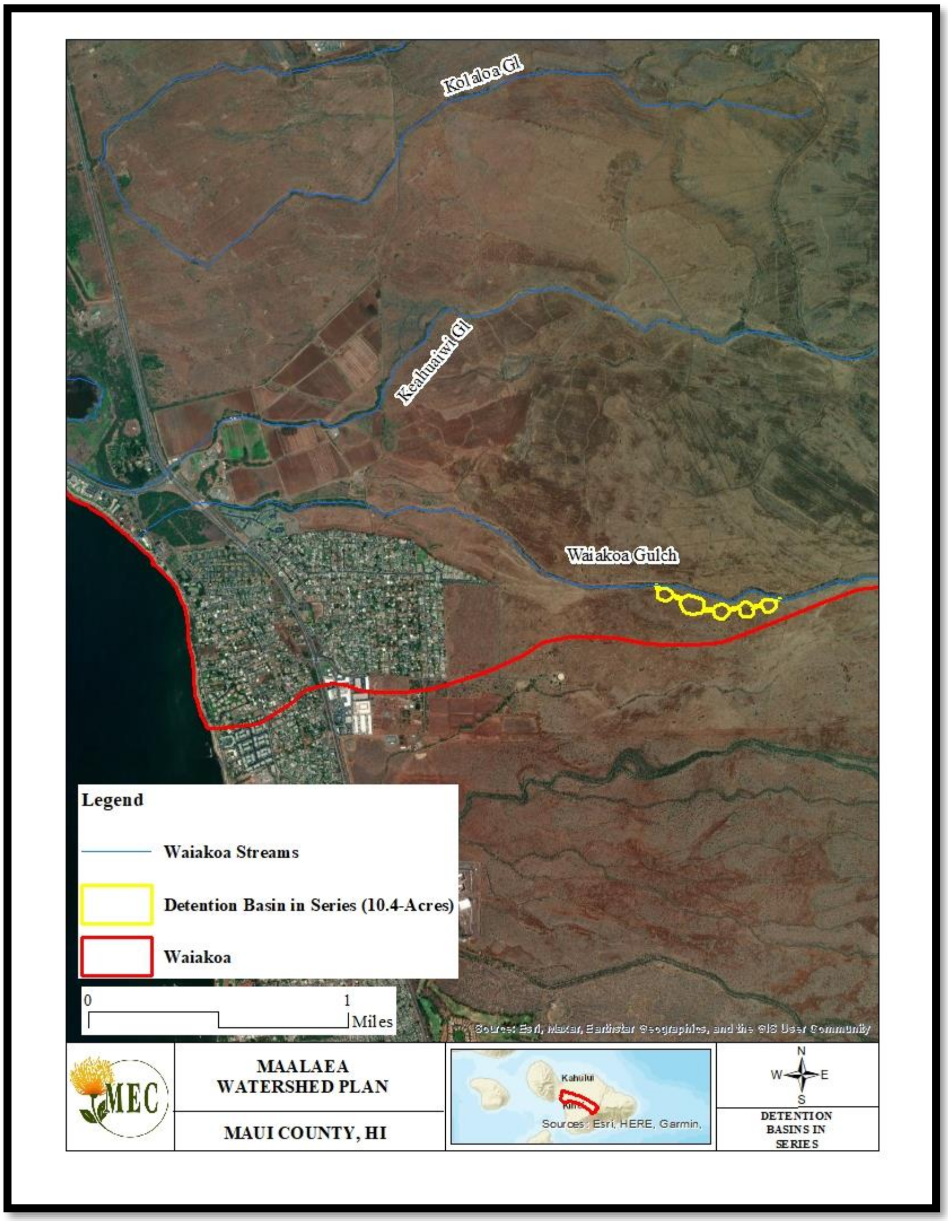
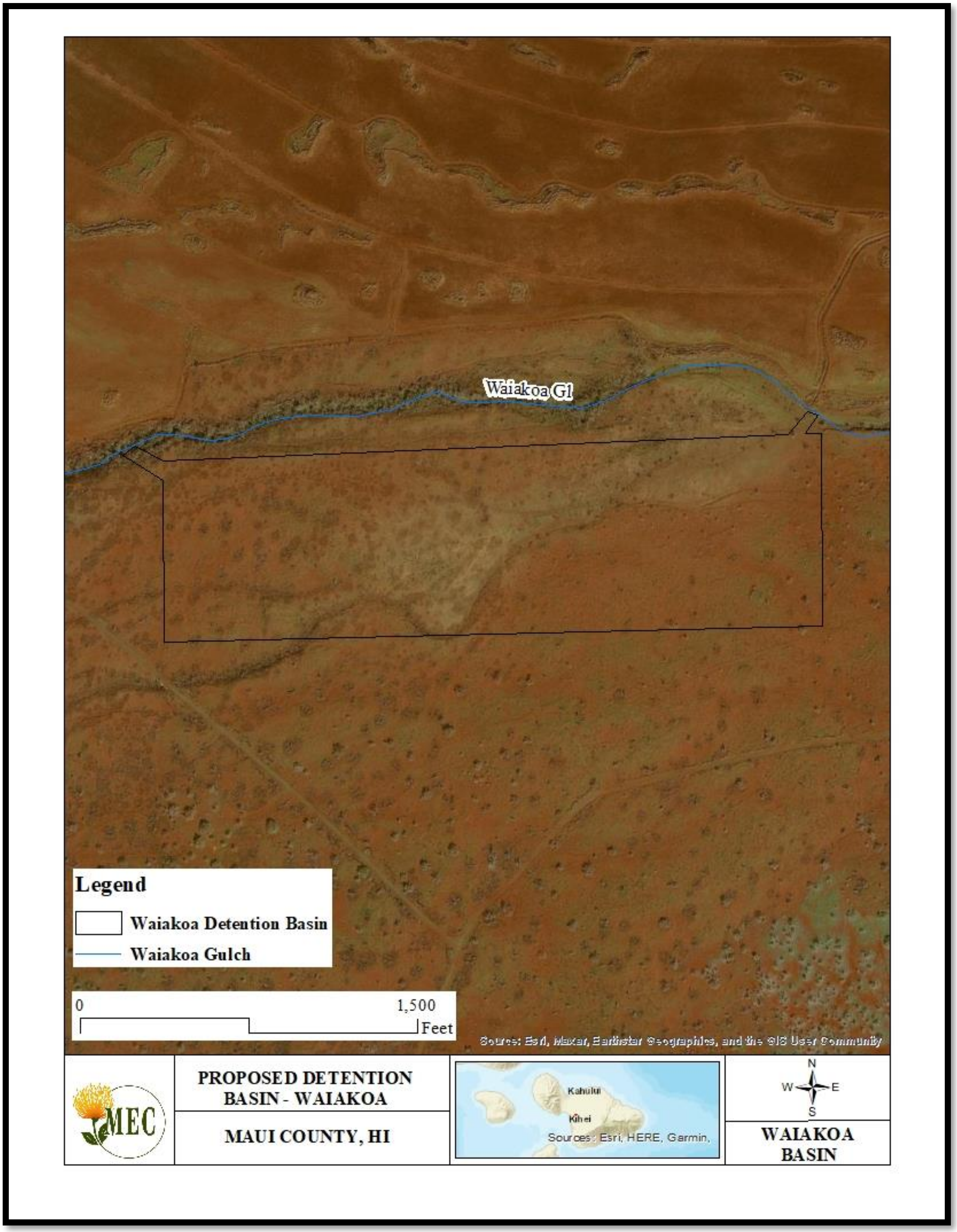


Figure 64. Example of Large Detention Basin in Waiakoa Gulch



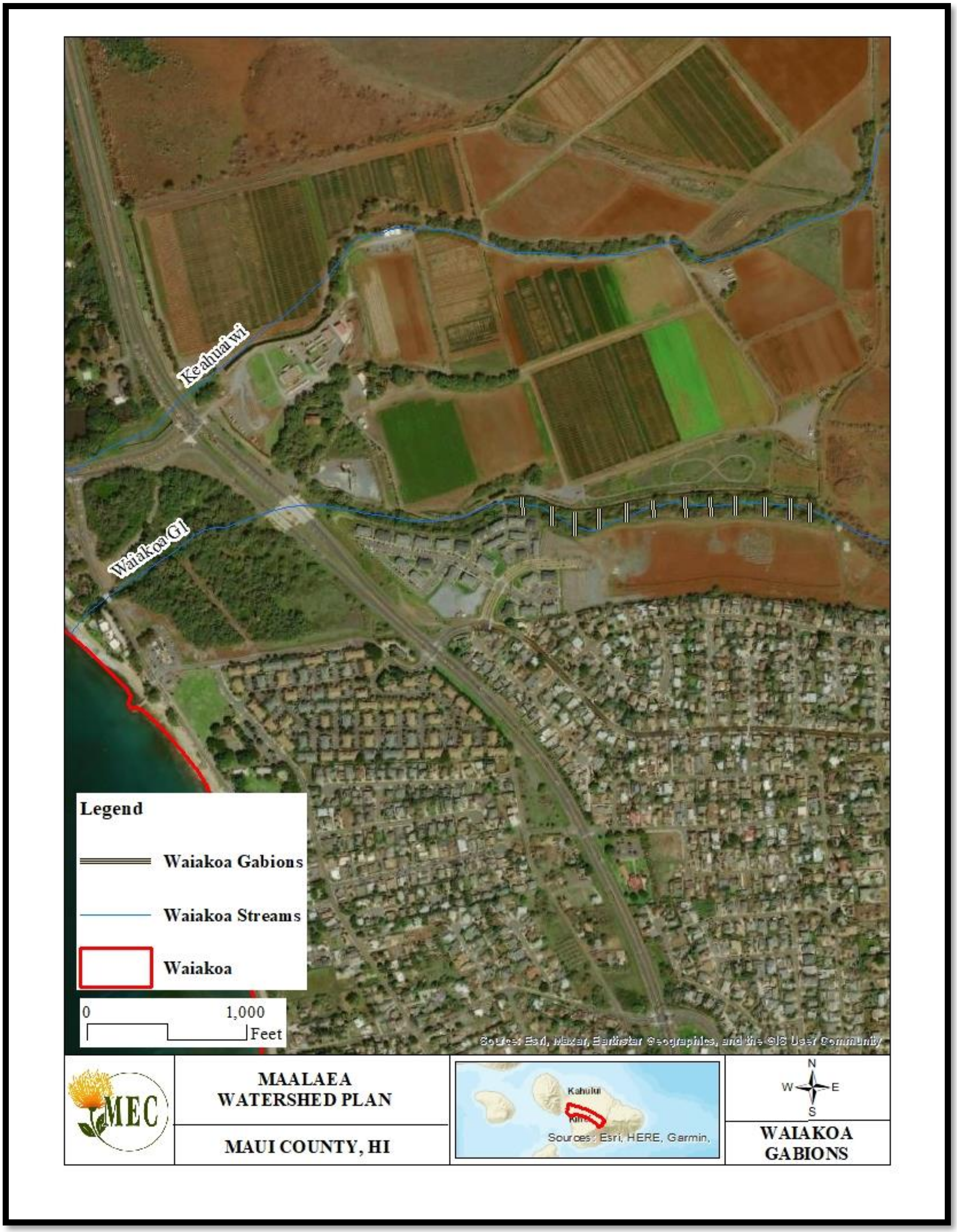
7.2.2 Gabions

Gabions are wire containers filled with rock, gravel, broken concrete, riprap, or other material to create large blocks. These blocks can be placed within stream beds to create small weirs or dams. As stormwater flows down a gulch, it pools behind the gabions, slowing in velocity and losing erosional force. Pools created by these gabions allow sediment in the water to fall out of suspension. When placed in stepped series, these structures can provide flood protection by dissipating energy in flowing systems. Over time the voids fill with sediment and promote vegetative growth, which will further enhance stormwater slowing and sediment trapping capabilities.

Figure 65. Image of Gabion Weirs in Series

The following map provides an example for potential locations for gabion placement in Waiakoa Gulch (Figure 66. Waiakoa Gabions). Actual placement should be determined by topography, access for installation and maintenance, land ownership, and other factors. The life expectancy of gabion is based on the type of wire used to create the cage and not on the material used as filling. Typically, these cages are constructed of galvanized steel wire with a life expectancy of 50 years.

Figure 66. Waiakoa Gabions



7.2.3 Regional Stormwater Management Park

Large detention basins can be engineered to function as recreational facilities or green spaces. The Weinburg Property is located just mauka of South Kīhei Road, immediately above the outfall of Waiakoa Gulch into the Pacific Ocean. This area could be repurposed as a community park with sports fields, community gardens, dog parks, etc.

These stormwater management parks are essentially large, shallow detention basins that collect stormwater and provide flood control, aquifer recharge, stormwater treatment, and wetland protection. All of these benefits are in addition to the recreational opportunities provided by these spaces (Figure 67. Example of a Regional Stormwater Management Park).

Across North Kīhei Road, Keahuaiwi Gulch discharges into a narrow strip of land immediately north of North Kīhei Road, before flowing into Keālia Pond. Adjacent landowners include the State of Hawaiʻi and Mahi Pono. While Keahuaiwi Gulch does not discharge frequently, when it does, it typically floods into the intersection of North and South Kīhei Roads. Like the Weinburg property on the south side of this intersection, the State of Hawaiʻi and Mahi Pono properties should be repurposed to capture flood waters from Keahuaiwi Gulch and properly direct stormwater towards Keālia Pond. Figure 68 below displays potential locations for a regional stormwater management park within Waiakoa Watershed.

Figure 67. Example of a Regional Stormwater Management Park

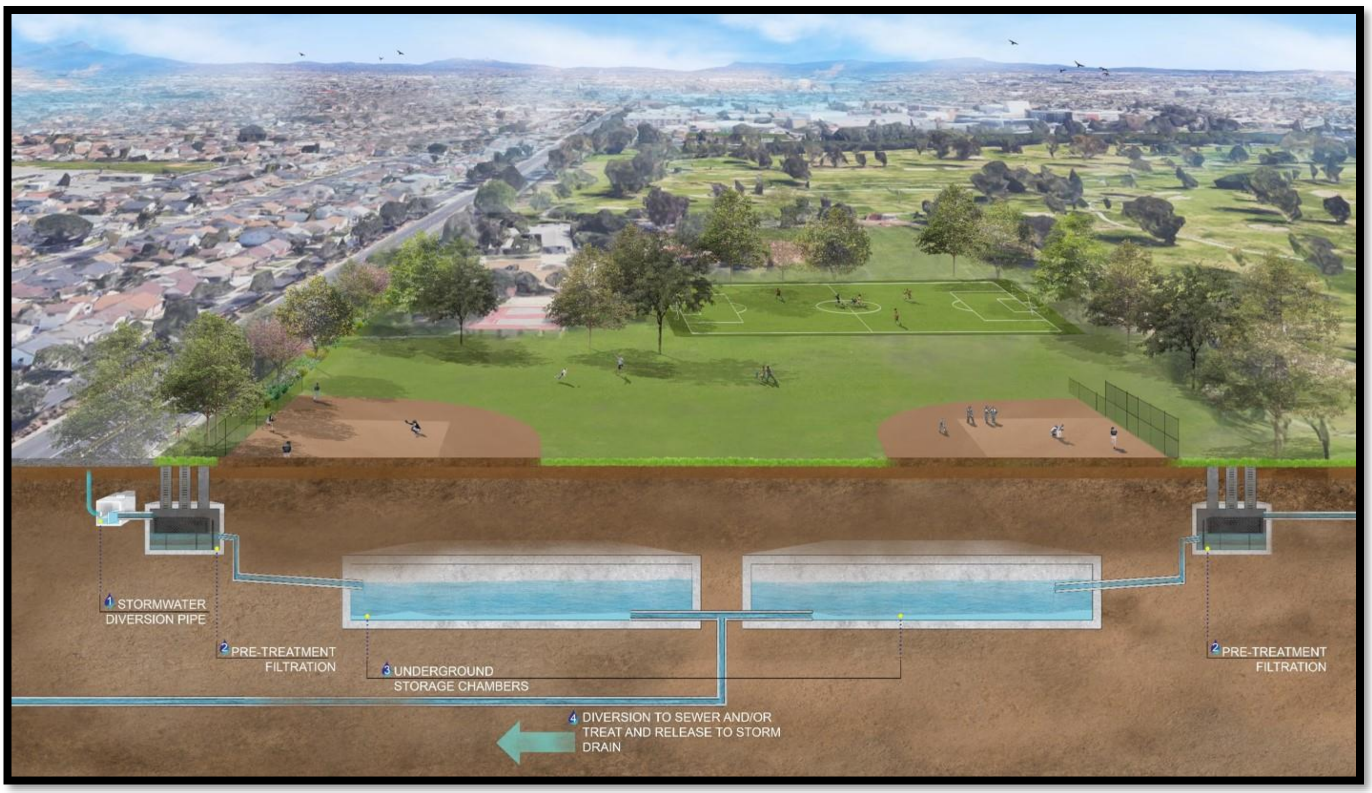
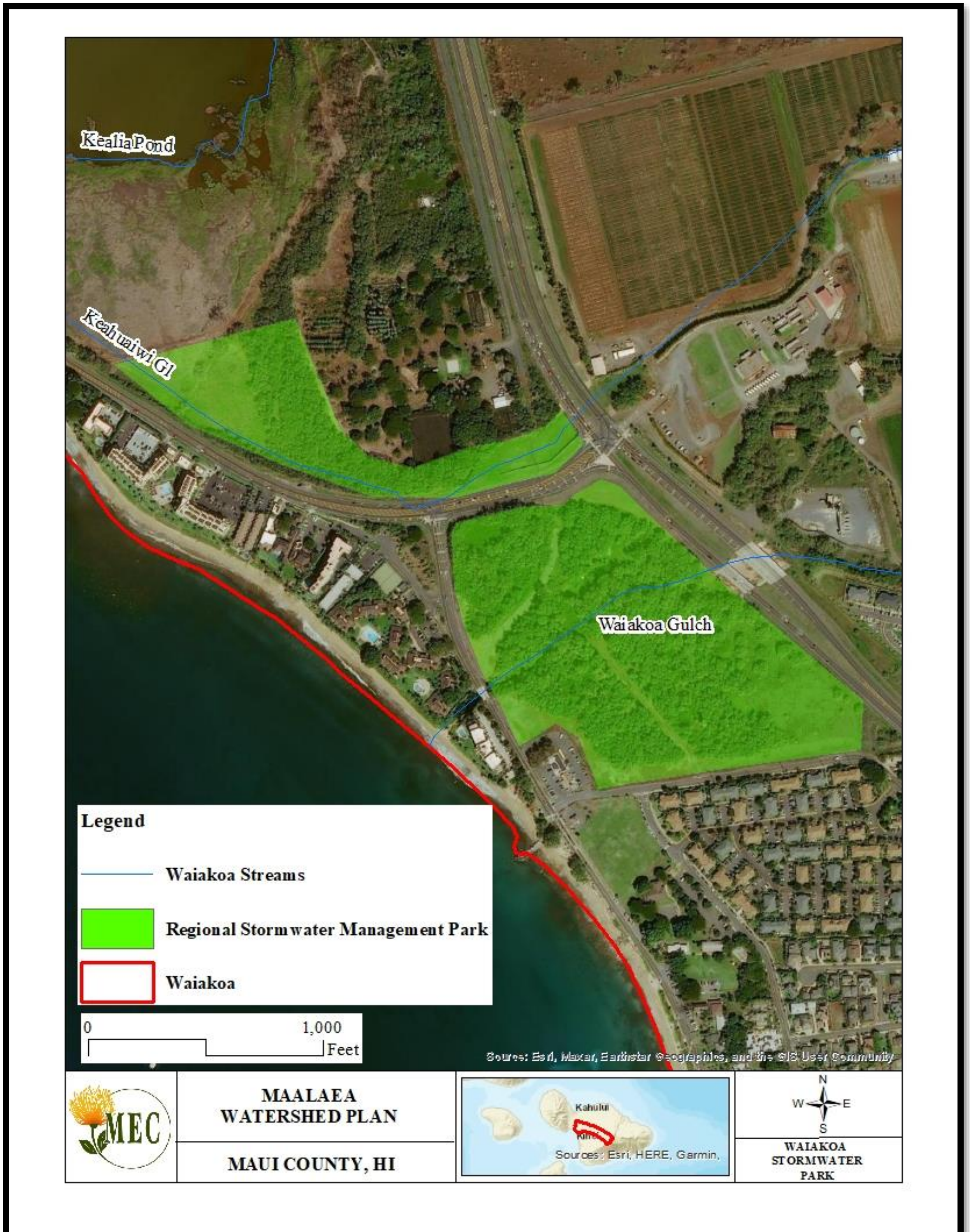


Figure 68. Waiakoa Stormwater Management Park

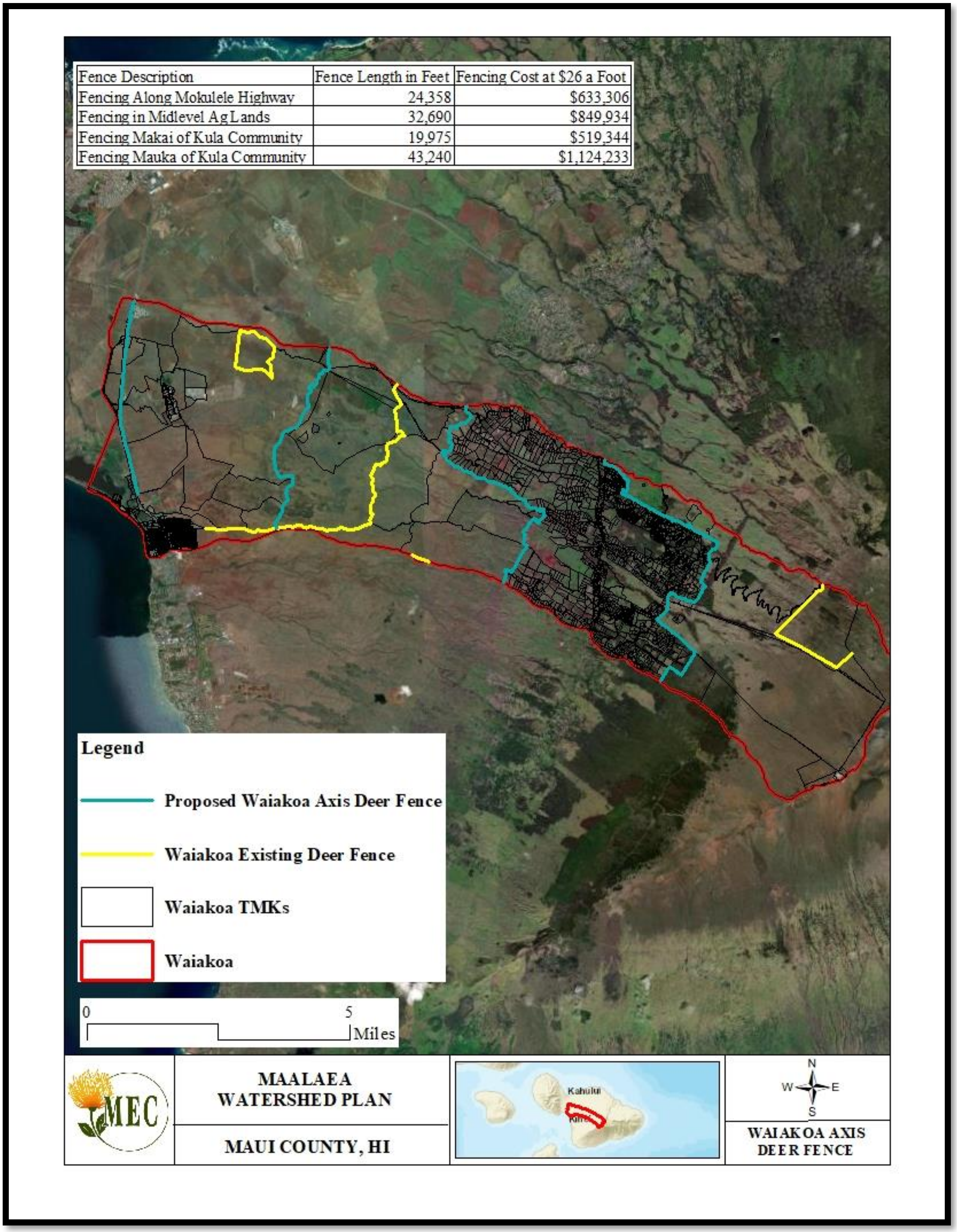


*The locations depicted are for illustrative purposes and may not represent property owner intentions.

7.2.4 Axis Deer Regional Fencing

As with the Waikapū Watershed, additional fencing is needed to create axis deer management units in the Waiakoa Watershed (Figure 69. Waiakoa Regional Axis Deer Fencing Map). Large herds of deer are regularly observed in the lower, dry regions of Leeward Haleakalā. Substantial vegetation has been lost in the Waiakoa Watershed, leading to sediment laden stormwater discharging into Māʻalaea Bay and vital nearshore marine habitats. Regional axis deer management areas provide the opportunity to control the migration of axis deer throughout the watershed. During drought, wildfire, or other pressures such as removal, fencing enables proper management of this invasive species.

Figure 69. Waiakoa Regional Axis Deer Fencing Map



Fence Description	Fence Length in Feet	Fencing Cost at $26 a Foot
Fencing Along Mokulele Highway	24,358	$633,306
Fencing in Midlevel Ag Lands	32,690	$849,934
Fencing Makai of Kula Community	19,975	$519,344
Fencing Mauka of Kula Community	43,240	$1,124,233

7.2.5 Waiakoa Unimproved Agricultural Roads

As mentioned in Section 7.1.4, 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. Small Waiakoa agricultural roads should be canvassed to see if they require decommissioning or repair. Closing roads using structural methods (barriers) such rocks, logs, or vetiver plantings can capture sediment and attenuate runoff. By reestablishing a dense groundcover like buffelgrass, the potential for soil loss decreases dramatically. In coordination with landowners and potential road users, disused, and unnecessary or redundant roadways should be identified for decommissioning. Any roads likely to stay in use should be improved using water bars, sediment traps and other BMPs to minimize downslope transport of eroded sediments. The lower portions of the Waiakoa Watershed have approximately 151 miles of unimproved agricultural roads (Figure 51. Lower Waiakoa Roads and Ag Roads Map).

7.2.6 Wetland and Stream Riparian Buffers and Protection

According to data presented by Terrell Erickson (Erickson, NRCS 2002), Hawaiʻi has lost tens of thousands of acres of wetlands. USFWS estimated 31% of the coastal wetlands were lost during the 1970's to 1990's. Wetlands in Kīhei were determined to have decreased from 199 acres in 1965 to 83 acres in 2001 (including 7.3 acres of mitigation). These wetland losses occur due to development and from aquifer drawdown.

As stated earlier, in October of 2022 the Maui County Council passed a bill to protect and restore wetlands (Ordinance 5421). As a requirement of this law, a wetland overlay map is being created. Any wetlands that contain at least two of the three wetland indicators listed by the USACE in their wetland delineation manual and any flow through systems depicting a high-water mark as defined in the 2005 USACE Regulatory Guidance Letter on Ordinary High Water Mark Determination are now considered protected by the bill. County protections may include 50-to-200-foot buffers placed around the wetland edge as determined by the Maui County Planning Department (Figure 70. Waiakoa Streams and Wetlands with 50-foot and 200-foot Buffers). Figure 71 depicts a riparian buffer to protect the riparian corridor along Waiakoa Gulch.

Costs for this project include axis deer fencing, irrigation infrastructure and installation, native plants, and weekly monitoring and maintenance.

Table 28. Waiakoa Riparian Protection Costs

Task	Cost per Unit	Number of Units	Total Cost
Weekly fencing and irrigation infrastructure inspections	$550.00	52	$28,600.00
Fencing Materials	$30.00	3,896	$116,880.00
Irrigation Infrastructure	$4,000.00	1	$4,000.00
Irrigation installation and planting	$2,200.00	5	$11,000.00
Plants	$4.00	1,000	$4,000.00

Quarterly vegetative monitoring, photo documents, drone flights	$1,100.00	4	$4,400.00
Quarterly and annual reports	$1,100.00	4	$4,400.00
Total Cost			$173,280.00

Figure 70. Waiakoa Streams and Wetlands with 50-ft and 200-ft Buffers

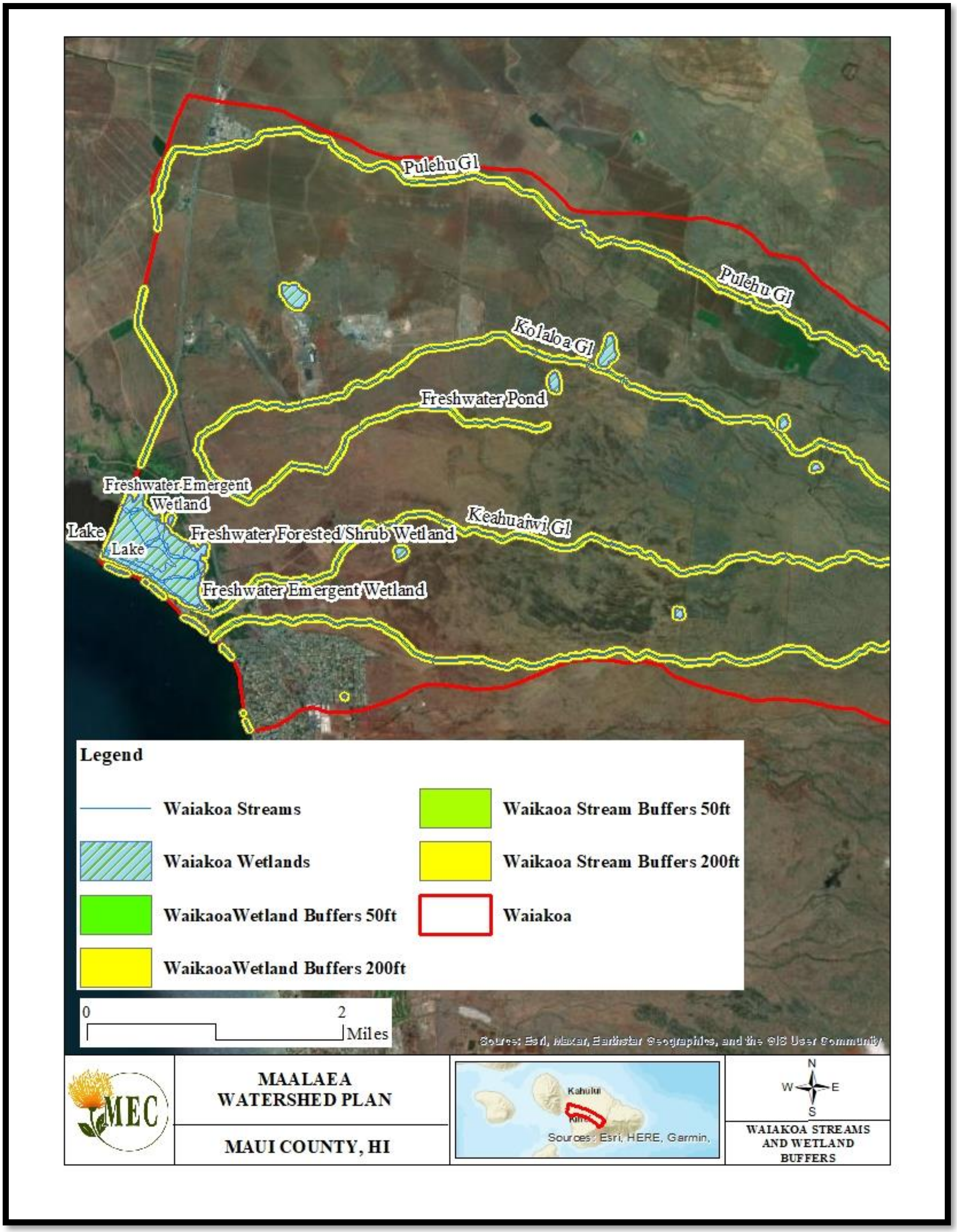
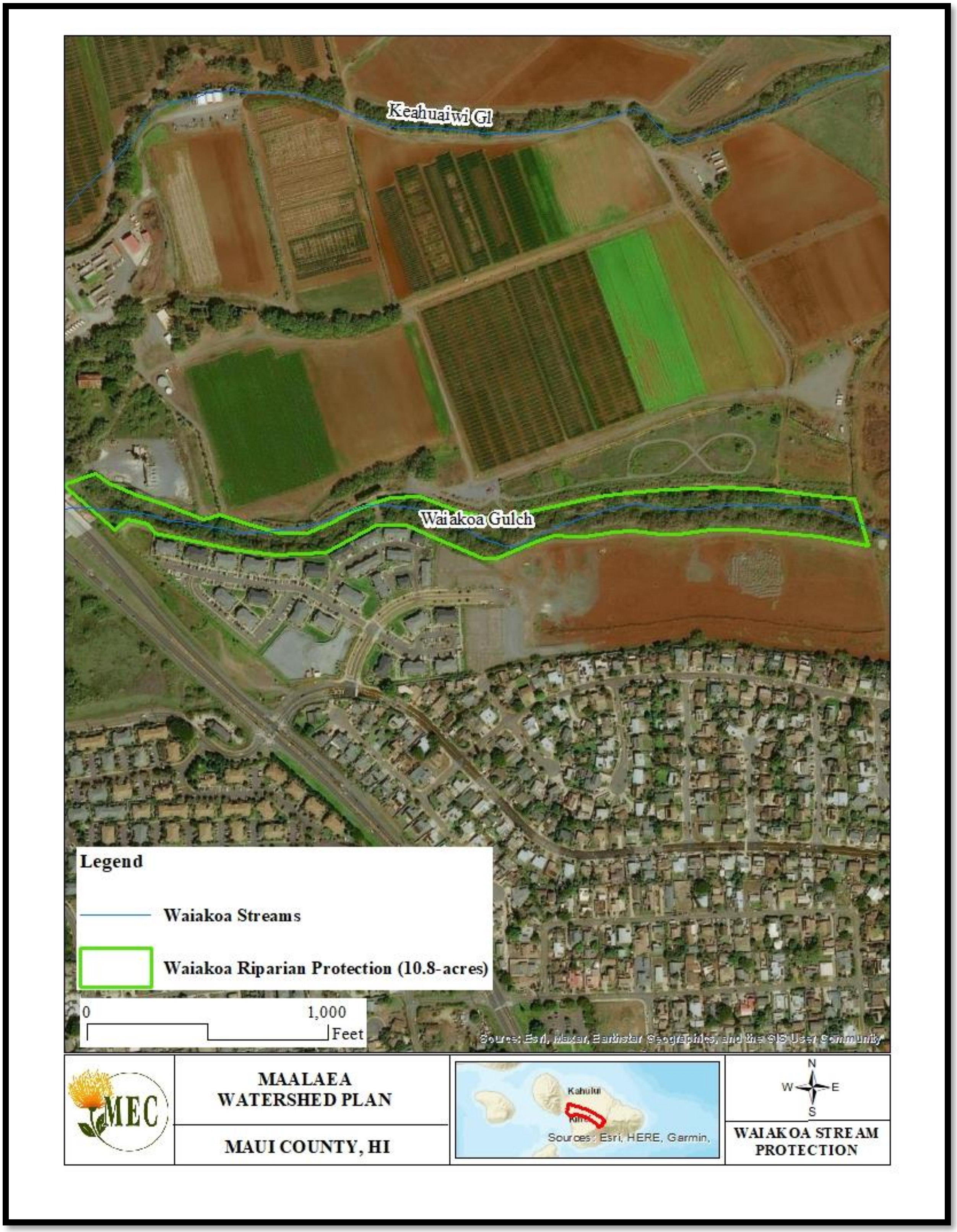


Figure 71. Waiakoa Riparian Protection



7.2.7 Stormwater Infrastructure Damage

Much of the flooding that occurs in the Waiakoa Watershed is due to debris piling up on the mauka side of stormwater infrastructure such as culverts and bridges. The debris clogs drainageways, which then causes stormwater to flood surrounding upland areas as it finds alternative routes downstream within the watershed.

A study should be conducted to identify those portions of the watershed that have inadequate or outdated stormwater infrastructure. Engineers working with the Department of Public Works and affected stakeholders from the community should come together to retrofit this infrastructure with protective devices that allow for stormwater flow to continue even when debris has stacked up in a stream.

Figure 72. Culvert Protection from Debris

7.2.8 Adopt-A-Culvert Program

Suggested by community members at an outreach event, an Adopt-A-Culvert program would provide opportunities for individuals, clubs, nonprofits, and other organizations to take part in improving the environment. Similar to the Adopt-A-Highway program, organizations would "adopt" a culvert of their choice and be responsible for a set number of clean-up events annually. Along with a formal application process and requirements of adoption, adequate safety protocol and procedures would need to be in designed. Keeping culverts clear of rubbish and debris remains an effective strategy for flood mitigation and improving water quality.

7.2.9 High Flow Warning System

During community outreach with the Kula Community Association, Dick Mayer proposed the installation of a high flow warning system for the gulches that discharge into the Kīhei, Wailea, and Makena coastal communities. This warning system would consist of flow and stage gauging systems disbursed in gulches makai of Kula and mauka of Kīhei that would send alerts to the community, informing them when stormwater discharge was eminent. This system would provide for flood resiliency by allowing the

Department of Public Works to react in real-time to flooding events. It would also provide the community with a warning system, informing them to stay clear of gulches and to exit the ocean prior to brown water events.

7.2.10 Drought Resilience and Stormwater Reuse

Within the agricultural community of Kula, residents have expressed interest in the construction of retention basins that capture sediment and stormwater for reuse in farming activities. These basins would likely have to be lined to ensure captured stormwater doesn't percolate back into the ground quickly after a storm event. To work properly, at least two basins would have to be constructed. The first basin would not be lined, and its primary purpose would be to capture raw stormwater and allow sediment to fall out of suspension. This basin likely could not be lined because it would require heavy machinery to excavate sediment and other debris captured during stormwater events. Once this water has been allowed to settle, it would be transferred to a second lined basin. This basin would retain water and would be connected to nearby agricultural operations with irrigation infrastructure. This project would benefit the community by dissipating flood energy while also capturing water that could be used in place of potable drinking water to irrigate crops. Sediment captured by this system could also be reused in compost or as aggregate.

7.2.11 Stream Reconnection/restoration

Many of the streams within the Waiakoa Watershed have been historically impacted by agriculture and urban development. As stated previously, the outfalls for both Waiakoa and Keahuaiwi Gulches have been significantly altered by the construction of the intersection of North and South Kīhei Road. Pūlehu and Kolaloa Gulches are essentially ditched into Keālia pond once they intersect with Mokulele Highway.

All of these streams would be good candidates for stream channel restoration, and reestablishment of pre-alteration flow regimes. Hydromodifications are discussed in Chapter 5 Section 5 of the Hawaiʻi Watershed Guidance report, and all efforts that improve the overall physical and chemical characteristics of surface waters are supported. Coupled with appropriate infiltration and detention BMPs, restoration of these streams would have a positive impact on the hydrology of Keālia Pond.

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 the streams in the Waiakoa Watershed, the streams are ephemeral, essentially eliminating this expense. This also could allow a longer-term phased approach to restoration activities conducted in the dry stream channels.

7.2.12 Kamehamenui

In 2017, a 3,434-acre parcel in Kamehamenui was offered on the open market and threatened with sale and private development. The Trust for Public Land, DLNR, and others collaborated on an offer to purchase this land on behalf of the people of Hawai'i rather than see the land privately developed. The Board of Land and Natural Resources (BLNR) approved the purchase on May 8, 2020, with terms and conditions that the land be used for forest restoration, endangered species recovery, and public access. On June 25, 2021, the BLNR set aside the lands as a state Forest Reserve, preserving lands that would have been sold for private development for the people of Hawai'i. These lands will be managed for reforestation, endangered species recovery, and public access.

7.2.13 Wetland Protection and Buy Back

The U.S. Army Corps of Engineers (USACE) has regulatory authority over wetlands and other water bodies of the U.S. (WBUS) based on two federal laws. These include Section 404 of the Clean Water Act (CWA) of 1972, and Section 10 of the Rivers and Harbors Act of 1899.

Section 404 of the CWA states that dredged and fill material may not be discharged into jurisdictional WBUS (including wetlands) without a permit. According to 40 CFR 230.3, WBUS subject to agency jurisdiction under Section 404 include navigable waters and their tributaries, interstate waters and their tributaries, wetlands adjacent to these waters, and impoundments of these waters.

A Section 404 permit is required for all fill or discharge activities below the high tide line in tidal waters or below the ordinary high-water mark (OHWM) for non-tidal, non-wetland waters. Corps regulations define the term "ordinary high-water mark" for purposes of the CWA lateral jurisdiction at 33 CFR 328.3(e), which states:

"The term ordinary high-water mark means that line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas."

The Rivers and Harbors Act of 1899 prevents unauthorized obstruction or alteration of navigable WBUS. Navigable waters are defined as waters that are "subject to the ebb and flow of the tide and/or presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce" (33 Code of Federal Regulations [CFR] 325.5(c)(2)). A Section 10 permit is required for non-fill discharging activities proposed in, over, or under WBUS.

In May of 2023, the United States Supreme Court released an opinion in Sackett v. EPA, in which the Court unanimously held that the Environmental Protection Agency (EPA) overstepped its jurisdiction in classifying wetlands on the Sackett property as "waters of the United States" (WOTUS). The court stated: "…the CWA extends to only those wetlands that are "as a practical matter indistinguishable from waters of the United States." This requires the party asserting jurisdiction over adjacent wetlands to establish "first, that the adjacent [body of water constitutes]… 'water[s] of the United States,' (i.e., a relatively permanent body of water connected to traditional interstate navigable waters); and second, that the wetland has a continuous surface connection with that water, making it difficult to determine where the 'water' ends and the 'wetland' begins."

In October of 2022 the Maui County Council passed a bill to protect and restore wetlands (Ordinance 5421). As a requirement of this law, a wetland overlay map is being created. Any wetlands that contain at least two of the three wetland indicators listed by the USACE in their wetland delineation manual and any flow through systems depicting a high-water mark as defined in the 2005 USACE Regulatory Guidance Letter on Ordinary High Water Mark Determination are now considered protected by the bill. County protections may include 50-to-200-foot buffers placed around the wetland edges and stream banks as determined by the Maui County Planning Department.

In Fiscal Year 2024, the Maui County Council allocated 5 million dollars for the purchase of wetland resources. This money is intended to protect vital wetlands throughout Maui County. As stated earlier, the USFWS estimated 31% of the coastal wetlands were lost during the 1970's to 1990's. Wetlands in Kīhei were determined to have decreased from 199 acres in 1965 to 83 acres in 2001 (including 7.3 acres of mitigation). Wetlands provide critical habitat for threatened and endangered waterbird species such as the Hawaiian Stilt and the Hawaiian Coot. They capture floodwater and provide treatment, cleaning stormwater before it enters nearshore coastal habitat. They also provide locations for aquifer recharge, recreation, and culture activities.

7.2.14 Powerline Corridors

The extent to which access is needed and vegetation must be controlled or removed from powerline corridors should be assessed (Figure 73. Waiakoa Roads and Powerlines Map). 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 placed underground should also be conducted.

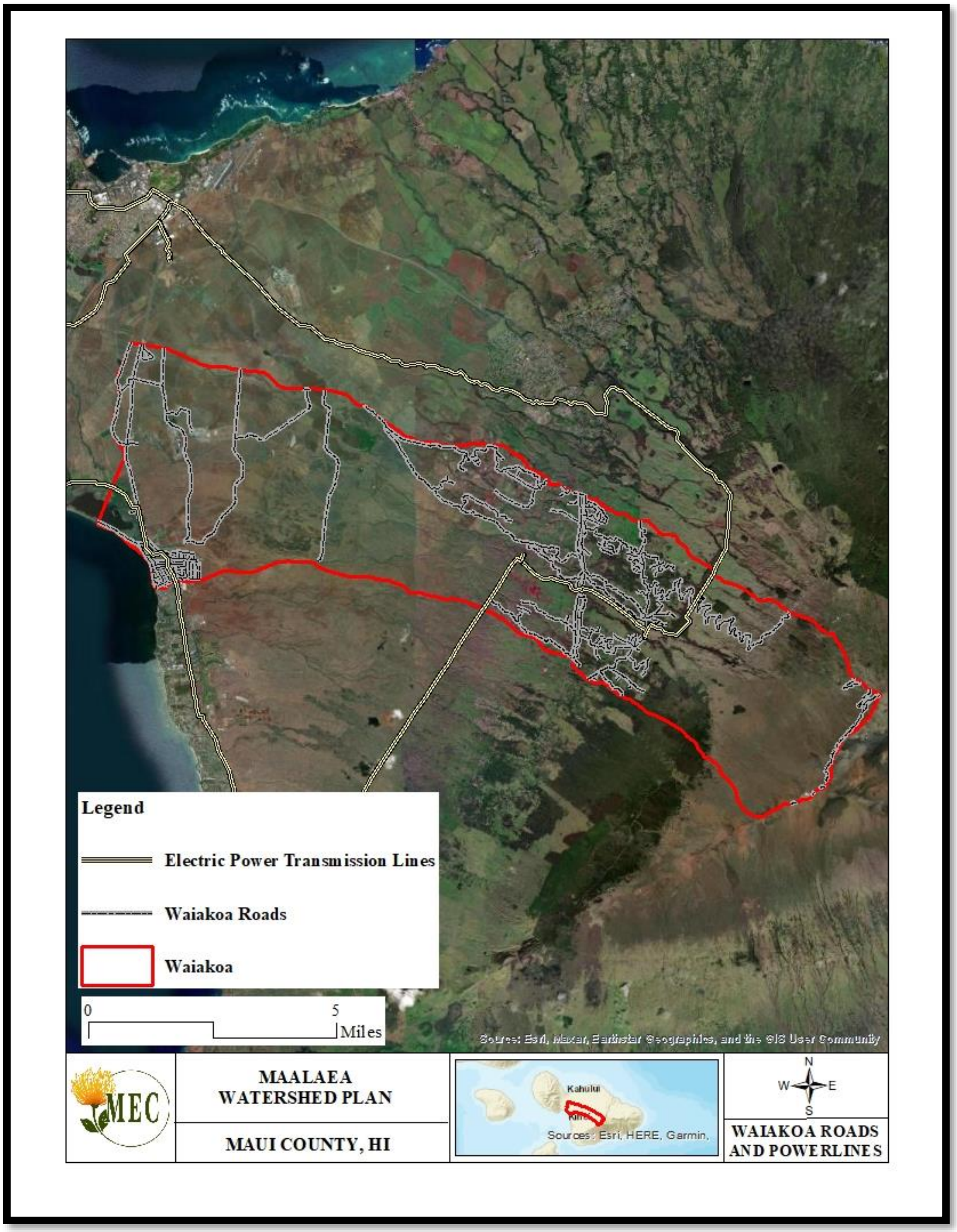
Extreme caution must be exercised when conducting maintenance and repair in transmission and distribution powerline corridors because they are often sited within and adjacent to stream riparian corridors. Grading and grubbing activities must be conducted in a way to ensure that sediment deposits are not left in the regular flow path or floodways of streams to be transported downstream during stormwater events. 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.

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 resilient infrastructure as they do not 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. Hawaiʻi Revised Statute § 269-27.6 (https://law.justia.com/codes/Hawaiʻi/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.

Figure 73. Waiakoa Roads and Powerlines Map



7.2.15 Wildfires

Extremely windy conditions and aging infrastructure make powerline corridors vulnerable ignition sources for wildfires. Fire prevention, revegetation, and stabilization of fire lines and road surfaces are listed as best management practices in Chapter 5 Section 2 of the Hawaiʻi Watershed Guidance report. Wildfires are extremely common in both the Waikapū and Waiakoa Watersheds, especially during the hot, dry summer months. This was made clear during the horrific August 2023 wildfires, which burned through Lahaina Town as well as over 5,000-acres in Pūlehu associated with the Waiakoa Watershed. Additional fires occurred in Kula and Olinda. 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 directly related to non-point source pollution.

Figure 74. Charred Vegetation, Sediment and Ash. Pūlehu Gulch, September, 2023

With regard to the Waiakoa Watershed, flooding and sediment pollution associated with the Pūlehu fire are of particular concern. Waiakoa and Kulanihakoi Gulches flow through the 5,000-acre burn area. These two gulches are both known to flow after Kona storm events, discharging sediment onto infrastructure associated with North Kīhei and into nearshore coastal waters and their associated coral reefs. To mitigate this fire and restore these slopes, Mahi Pono, Haleakala Ranch, and Kaonoulu Ranch have proposed the following tasks to reestablish vegetation and prevent soil loss (Figure 75. Pūlehu Wildfire Mitigation Strategy Map).

- Installation of 10,000 feet of game fence across Haleakala Ranch and Kaonoulu Ranch to tie into existing game fences installed by the ranches to create a 2,800-acre Axis Deer Exclusion Zone that includes the Waiakoa Stream and lower Kulanihakoi Gulch systems

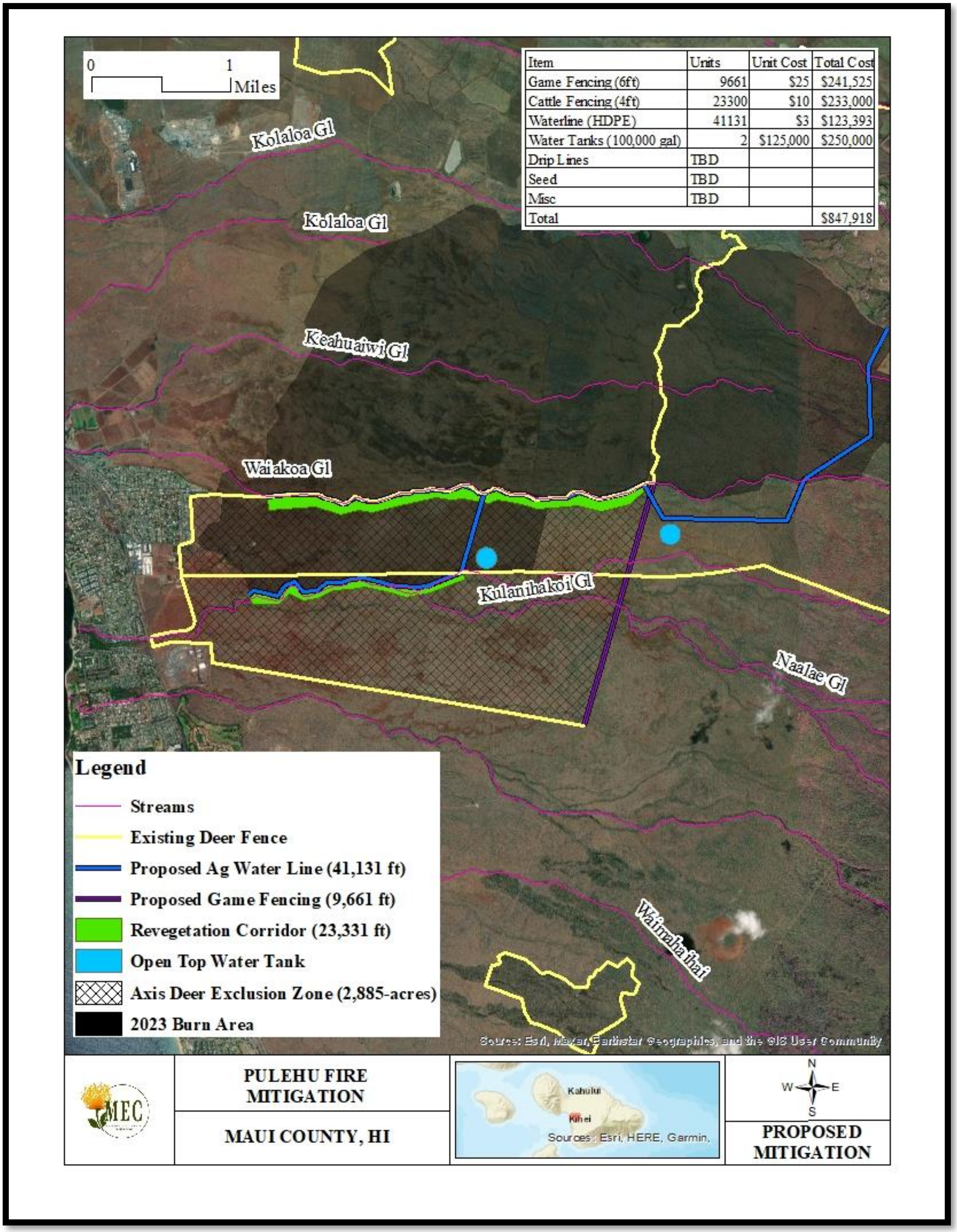
- Installation of a water system originating from the Kula Agricultural Park system meters to establish and maintain revegetated corridors of Waiakoa and Kulanihakoi within the exclusion zone
- Installation of open water tanks necessary to support irrigation, helicopters requiring water collection locations, and other regional wildfire suppression needs
- Installation of livestock fence to complement existing game fencing and to manage livestock access to the revegetated corridors for hazard fuel load control
- Installation of drip irrigation and associated practices of establishing appropriate vegetation
- Ongoing management of the area via aggressive deer control and rotational grazing

Costs associated with this effort include both feral ungulate and livestock fencing to protect riparian corridors, irrigation infrastructure, and water tanks. Other costs associated with the project are still being compiled.

Table 29. Pūlehu Fire Mitigation Estimated Costs

Item	Units	Unit Cost	Total Cost
Game Fencing (6ft)	9661	$25	$241,525
Cattle Fencing (4ft)	23300	$10	$233,000
Waterline (HDPE)	41131	$3	$123,393
Water Tanks (100,000 gal)	2	$125,000	$250,000
Drip Lines	TBD		
Seed	TBD		
Misc	TBD		
Total			$847,918

Figure 75. Pūlehu Wildfire Mitigation Strategy



Item	Units	Unit Cost	Total Cost
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Waterline (HDPE)	41131	$3	$123,393
Water Tanks (100,000 gal)	2	$125,000	$250,000
Drip Lines	TBD		
Seed	TBD		
Misc	TBD		
Total			$847,918

7.2.16 Stormwater Wells

Geology associated with the Waiakoa Watershed 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. Several stormwater wells already exist within the Waiakoa Watershed (Section 6.1.2).

7.2.17 Stormwater Infiltration (Dry) Wells

These wells are similar 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 76. Stormwater Infiltration Well

7.2.18 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.

7.2.19 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. Within the Waikapū Watershed there are 122 known cesspools. Within the Waiakoa Watershed, 1,838 cesspools are present. These systems are a known source of nutrient contamination to groundwater and the ocean. All of these wastewater systems should at the minimum be converted to individual waste systems (IWS) such as septic tanks. 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.

Generally, options for upgrade or closure include:

1. Closure and connection to an existing nearby sewer system with available capacity.
2. Closure and connection to a new private or public sewer system.
3. Closure and connection to a community-scale package wastewater treatment system.
4. Upgrade to an onsite septic tank and/or aerobic treatment unit system.

Signed into law in July of 2017, Act 125 requires all cesspools to be upgraded, converted to a septic system, or connected to a sewer system by Jan. 1, 2050. It directs the Hawaiʻi DOH to evaluate residential cesspools in the state, develop a Report to the Legislature that includes a prioritization method for cesspool upgrades, and work with the Department of Taxation on possible funding options to reduce the financial burden on homeowners.

Review and approval of IWS must be obtained through the the HDOH Wastewater Branch. Requirements include design, construction, and site plans as well as maintenance and operation manuals. Routine inspections and pumping, efficient water use, proper disposal of waste, and drainfield maintenance are necessary to ensure proper function and longevity of septic tanks.

7.2.20 Condominium Impervious Surfaces

The condominiums along North Kīhei Road 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 condos and resorts associated with North Kīhei in the Waiakoa Watershed is recommended to determine those sites best suited for LID retrofits. These projects could be developed and installed in collaboration with condo residents and community groups.

8.0 ELEMENTS B AND C – ESTIMATED LOAD REDUCTIONS FROM NONPOINT SOURCE POLLUTION IMPLEMENTATION PROJECTS

The implementation projects proposed in this Plan are outlined below. They include axis deer fencing, riparian protection, road stabilization, excavated detention basins, gabions in series, regional stormwater management parks, LID infrastructure within urban areas, and reef friendly landscaping programs. Below we discuss practices that have been deemed the most appropriate for implementation in the near future. Other projects may also be incorporated into the Plan in the future as needs and resources dictate. Appendix A includes "pull sheets" that summarize each of these projects with generalized information on estimated costs, expected load reductions, timelines, and permitting requirements.

In addition to modeling for current pollutant loads within the Waiakoa and Waikapū Watersheds, STEPL is able to estimate load reduction values for individual and combined BMPs implemented within each land use type. The list of BMPs provided in the STEPL model is quite extensive, with over 70 different practices to reduce pollutant loading.

The Revised Universal Soil Loss Equation - Version 2 (RUSLE2) program was developed primarily to guide conservation planning, inventory erosion rates and estimate sediment delivery. Values computed by RUSLE2 are supported by accepted scientific knowledge and technical judgment, are consistent with sound principles of conservation planning, and result in good conservation plans (USDA).

We have included load reduction estimates for each of the proposed implementation projects listed below as modeled using either the STEPL or RUSLE2 programs, as appropriate. When these models were not appropriate, or when actual data exists, we attempted to base load reduction estimates on existing datasets. Some projects lack load reduction estimates, either because of data gaps or because individual project design and implementation will dictate pollutant load reductions. This is the case for Low Impact Design projects, Culvert Protection, as well as Reef Friendly Landscaping projects.

8.1 Axis Deer Fencing

Axis deer populations are growing at an exponential rate in Maui County. These deer are voracious grazers, denuding the landscape of groundcover vegetation. By fencing off larger sections of the Waikapū and Waiakoa Watersheds, natural resource managers can create management units. By creating these management areas, the community can control the migration of axis deer throughout the watershed.

Using the STEPL BMP Heavy Use Area Protection BMP, and for the sake of this modeling effort, we assumed only Pasturelands will be fenced off. This assumption was made because the Heavy Use Area Protection BMP is specific to the Pastureland land use within the STEPL program and is not an option in either the Cropland or Forest land uses. We believe cropland, forest, and pasturelands should all be fenced off to best control axis deer populations and allow for various management units.

Using a base management unit size of a 100-acre pasture with four linear fencing distances of 2,087 feet of fencing or 8,348 total feet of fencing, this management unit would make up approximately 0.636 percent of the total 15,721.79 acres of pastureland in the Waiakoa Watershed and 4.28 percent of the total 2,331.63 acres in the Waikapū Watershed. At $30 a linear foot, a 100-acre axis deer exclusion area would cost approximately $250,440.00.

Table 30. below depicts the pollutant load reductions for Waiakoa and Waikapū Watersheds per 100-acre Heavy Use Protection BMP. These exclusion management units should be placed in high priority areas where groundcover vegetation has been nearly or completely denuded.

Table 30. Axis Deer Fencing Load Reduction Estimates

Watershed	N Reduction	P Reduction	BOD Reduction	Sediment Reduction
	pounds/year	pounds/year	pounds/year	tons/year
Waiakoa	198.97	37.52	142.43	22.25
Waikapū	137.05	40.76	195.64	30.57

8.2 Protect and Manage Riparian Corridors (Mauka to Makai Connections)

Riparian buffers along gulches and gullies prevent sediment laden sheet flow from entering flow ways and ultimately discharging into coastal waters. They also offer important habitat for native flora and fauna to inhabit from mauka to makai throughout the watershed.

All of the gulches in the Waikapū and Waiakoa Watersheds are now protected by Maui County Ordinance 5421. As a requirement of this law, a wetland overlay map is being created. Any wetlands that contain at least two of the three wetland indicators listed by the USACE in their wetland delineation manual and any flow through systems depicting a high-water mark as defined in the 2005 USACE Regulatory Guidance Letter on Ordinary High Water Mark Determination are now considered protected by the bill. County protections may include 50-to-200-foot buffers placed around the wetland edges and stream banks as determined by the Maui County Planning Department.

Fencing is the primary means of protection, preventing access by hoofed animals. The effectiveness of the removal of sediments and nutrients from stormwater runoff increases with buffer width (see Riparian Buffer Width, Vegetative Cover, and Nitrogen Removal Effectiveness, EPA/600/R-05/118, October 2005). Access crossings through the gulches may be incorporated into the fence design, and stream curtains can be installed to prevent animals from entering the buffers while crossing. These curtains allow stormwater to pass under without destroying the fence.

The Keokea Riparian Rehabilitation project is a pilot project funded by the HDOH and Maui County to show the proof of concept of large-scale riparian protection. The project consisted of first protecting the Keokea riparian zone with the installation of feral ungulate fencing. Next, R-1 dripline irrigation infrastructure was installed. This infrastructure included over 9,000 feet of dripline and approximately 3,000 emitters. Next, native dryland forest plant species were planted at each emitter. Each plant is watered with one gallon per day. Additional riparian rehabilitation projects are being proposed for streams within the Hapapa Watershed (covered by the Southwest Maui Watershed Plan).

Figure 77. Before and After Pictures from the Keokea Riparian Rehabilitation

Included below are the STEPL pollution load reduction estimates for the proposed Waiakoa Riparian Rehabilitation Project described in Section 7.2.5.

Table 31. STEPL Estimated Load Reduction from Riparian Protection and Rehabilitation

N Reduction	**P Reduction**	**BOD Reduction**	**Sediment Reduction**
Pounds/Year	Pounds/Year	Pounds/Year	Tons/Year
1086.4	339	1475.1	230.5

8.3 Excavated Basins

Section 7.2.1 discussed detention basins and their ability to capture sediment laden stormwater. While detention basins have been proposed to be associated with Waikapū Country Town, no dimensions are provided in the master plan available online. Several detention basins were depicted in maps created for Waiakoa. These include basins in series, a large detention basin, and a large regional stormwater management park. While these maps are for illustrative purposes, their sizes were used to generate load reduction estimates using STEPL software – specifically applying values to the Dry Detention BMP within the Urban BMP calculator. This software can be used to generate load reductions for detention basins proposed for the Waikapū Watershed as well.

Table 32. Waiakoa Detention Basin Load Reduction Estimates

Basin	Acreage Based on Map Renderings	Pollutant Load Reduction		
		N Reduction	P Reduction	Sediment Reduction
		lb/year	lb/year	t/year
Waiakoa Basins in Series	10.42	13.54	2.13	0.59
Large Waiakoa Basin	56.40	73.27	11.55	3.19
Regional Stormwater Management Park	45.43	35.69	3.09	1.60

8.4 Unpaved Roads

As discussed in Section 7.1.4, 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 Waiakoa and Waikapū roads should be conducted to determine stakeholder access needs and to identify those roads that are candidates for decommissioning or repair. In coordination with landowners and potential road users, disused, and unnecessary or redundant roadways should be identified for decommissioning. Any roads likely to stay in use should be improved using water bars, sediment traps and other BMPs to minimize downslope transport of eroded sediments.

Table 33. Comparison of Potential Soil Loss from Ag Roads with Bare Ground vs Dense Grass

Watershed	Unpaved Roads	Bare Ground Soil Loss	Potential Soil Loss in Tons from Unimproved Roads	Dense Groundcover Soil Loss	Potential Soil Loss in Tons if all Unimproved Roads were Grassed Over
	Acres	Tons per Acre per Year		Tons per Acre per Year	
Waikapu	123	4.7	578.1	0.006	0.738
Waiakoa	367	4.7	1724.9	0.006	2.202

To approximate the sediment reduction accomplished by the decommissioning of roads in the Waikapū and Waiakoa Watersheds, MEC used the RUSLE2 program. Several data points were entered into the program, including rainfall of 15-16 inches, major soil types, and a slope length of 1400 feet. Slope steepness was assumed to be approximately 6% based on contours and map measurements. Without any BMPs, soil loss was estimated to be 4.7 tons per acre of road. To calculate areage of dirt roads, the lengths in miles were converted to feet and multiplied by a assumed constant width of 20 feet. Once an area of dirt road was calculated in square feet, it was converted to acres of bare ground dirt road. Because much of the lower agricultural roads are associated with pastureland, the Dense Grass – Not Harvested BMP was entered into the program. RUSLE2 estimated soil loss to be lowered to 0.006 tons per acre, significantly reducing soil loss from agricultural roads.

9.0 ELEMENT D – TECHNICAL AND FINANCIAL ASSISTANCE NEEDED TO MEET GOALS AND CONDUCT IMPLEMENTATION PROJECTS

9.1 Technical Assistance and Permits

In addition to the key stakeholders listed in Section 2.1.3, implementation projects proposed in this Plan will often require technical assistance from engineers, architects, land surveyors, environmental consultants, and other professionals. The following chart lists the major permits, some of which may be required for the implementation of the various recommended management measures. Whenever a project will fall within the Special Management Area (SMA), impacts a stream, wetland, or other surface water feature, is within 150 feet of the shoreline, is in a flood zone, involves clearing of vegetation or earth moving activities, or will have a significant environmental impact, various permits will likely be required.

Table 34. Potential Permits needed for Implementation Projects

Permit Name	Issuer	Trigger	Application Requirements	Project Improvements
Grading and Grubbing Permit	Maui County Department of Public Works	Required for removal of vegetation and earthmoving activities associated with construction	Application will require construction plans to be submitted	Any activity that bares or grades the ground surface, such as structural installation, access roads, and equipment and material staging areas
Special Management Area (SMA) Permit	Maui County	Required for any work being conducted in the Special Management Area	Application will require plots/drawings of work being conducted	Any use, activity, or operation qualifying as "development", and has a total cost fair market value of $500,000 or more; or has significant adverse environmental or ecological effect within the Special Management Area.

Permit Name	Issuer	Trigger	Application Requirements	Project Improvements
Perform Work on County Highway Permit	Maui County Department of Public Works	Required when a County roadway is disturbed by installation of pipelines	Application will require construction plans for the affected area	Any activities affecting County-owned roadways or structures, such as pipeline installation, use of bridges, and traffic control
Stream Channel Alteration Permit	State of Hawaiʻi Commission on Water Resources Management	Any activity which will affect the stream course within the channel of a perennial or intermittent stream. The regulated channel extends to the top of the streambank.	Application will include design drawings, effects on and mitigation for aquatic organisms and communities, water pollution prevention plan	Intakes, stream crossings of pipelines, construction and maintenance roads
Stream Water Diversion Permit	Commission on Water Resources Management	Any new or modified diversion of water from streams for beneficial use	Application will include amount of water to be taken, assessment of other instream and non-instream water uses, design of intake	New stream intakes and change in diversion amount at existing intakes
Department of Army Permit	U.S. Army Corps of Engineers	Any activity resulting in filling of water bodies in the U.S., including flowing streams and wetlands. Fill includes sediment and structures.	Application will require site plan, design, construction methodology, CWA Section 401 Water Quality Certification by Hawaiʻi Department of Health	New stream intakes, road and pipeline crossings of streams and wetlands

Permit Name	Issuer	Trigger	Application Requirements	Project Improvements
Clean Water Act Section 401 Water Quality Certification	Clean Water Branch, Hawaiʻi Department of Health	Required for any Federal permit that will involve discharge into bodies of water including streams and wetlands	Application will require items submitted for Department of Army Permit, environmental and chemical evaluation of receiving water, and Hawaiʻi Water Quality Standards compliance plan	Applies to locations requiring Department of Army Permit
Conservation District Use Application (CDUA)	State of Hawaiʻi, Department of Land and Natural Resources	Any development actions in Conservation Districts as designated by the State Land Use Commission	Application will require a Hawaiʻi Chapter 343 EA/EIS	Pipeline or reservoir installation in the Conservation District
National Pollution Discharge Elimination System (NPDES) Permit	Clean Water Branch, Hawaiʻi Department of Health	Required for construction site runoff management when construction area exceeds one acre and if the operation of the improvement results in discharge into water bodies	Application will require sediment and runoff management designs and a water quality monitoring plan	Applies to all construction sites with potential of erosion and runoff

Permit Name	Issuer	Trigger	Application Requirements	Project Improvements
Use and Occupancy Permit/Construction within a State Highway Permit	Division of Highways, State of Hawaiʻi, Department of Transportation	Required for surveying, materials testing, and construction affecting State-owned roadways	Permit will depend on phase of work with full plans required for construction activities	Any activities that affect State-owned roadways or structures, such as pipeline installation, use of bridges, and traffic control

9.2 Implementation Project Cost Estimates

In addition to modeling pollutant load reductions from the various implementation projects outlined in this watershed plan, project costs were estimated to facilitate stakeholders in obtaining financial assistance and in the decision-making process. Cost estimates were generated using the best information available at the time this report was written. Stakeholders are encouraged to use these cost estimates when designing projects and applying for grants. It should be noted that certain costs are specific to the type of work being conducted, location in the watershed, community support, etc. While these costs were formulated using the best information available, it is recommended that stakeholders coduct their own research to develop accurate costs at the time of project implementation.

9.2.1 Axis Deer Fencing:

9.2.1.1 Cost for Waikapū:

At a minimum, axis deer fencing should be placed along the conservation land boundary to protect native forests from this invasive species. Working with the Hawaiʻi Department of Land and Natural Resources, Division of Forestry and Wildlife and the Mauna Kahālāwai Watershed Partnership, this project would require a minimum of 15,832 linear feet of fencing. At approximately $26 a linear foot, fencing off this portion of the Waikapū Watershed would cost roughly $411,632.00.

Table 35. Estimated Costs for Axis Deer Fencing in Waikapū

Fencing Description	Length in feet	Cost at $26 a linear foot
Fence along conservation boundary	15,832	$411,632.00
Fence between Honoapiʻilani Hwy and Kuihelani Hwy	30,573	$794,898.00
Fence between Kuihelani Highway and Mokulele Hwy	49,867	$1,296,542.00
Total Fencing Costs		$2,503,072.00

9.2.1.2 Cost for Waiakoa:

Deer fencing should be placed at strategic locations throughout the watershed and connect to existing fencing in order to establish management areas. It is recommended for fencing along Mokulele Highway, in Midlevel Ag lands, makai of the Kula Community, and mauka of the Kula Community. In total, this equals approximately 23 miles of fencing and would cost roughly $3,126,838.00.

Table 36. Estimated Costs for Axis Deer Fencing in Waiakoa

Fence Description	Fence Length in Feet	Fencing Cost at $26 a Foot
Fencing Along Mokulele Highway	24,358	$633,306
Fencing in Midlevel Ag Lands	32,690	$849,934
Fencing Makai of Kula Community	19,975	$519,344
Fencing Mauka of Kula Community	43,240	$1,124,233
Total Fencing Costs		$3,126,838.00

9.2.2 Culvert Protection from Debris:

Small culvert grates range in price from $150.00 to $350.00, and can vary depending on size, materials, and structure. Other costs may include an environmental assessment, engineering, and installation.

9.2.3 Detention Basins:

According to the 2016 Kīhei Drainage Master Plan, detentions basins proposed for Kīhei range in cost from approximately $700,000 to $3,500,000. The difference in price is largely based on the size of the basin, its location, and the permitting constraints associated with construction. See the table below for cost estimates for a single detention basin.

Table 37. Approximate Costs for a Large Detention Basin (Kīhei Drainage Master Plan, 2016)

Task	Quantity	Unit	Unit Price	Total
Environmental Assessment	1	1	$350,000	$350,000
Excavation of Detention Basin	25820	CY	$30	$774,600
Hydromulch for Detention Basin	95800	SF	$2	$191,600
GRP Slope Protection at Spillway	60	CY	$540	$32,400
Inlet/Outlet Concrete Headwall	2	EACH	$16,050	$32,100
Perimeter Chain Link Fence (6ft)	1240	LF	$60	$74,400
1-18' RCP	50	LF	$260	$13,000
Subtotal				$1,468,100
Contingency (20%)				$293,620.0
Total				$1,761,720

9.2.4 Gabions:

Gabion wire mesh walls are fairly inexpensive at $60-$100 a cubic yard. Other costs include an environmental assessment, rock fill, engineering, and placement.

9.2.5 Golf Course Nutrient Curtain:

Costs are highly variable per nutrient curtain installation. Estimated costs are approximately $15,000. 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 38. 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**

9.2.6 Land Slide Mitigation:

Costs will vary based on location, accessibility, planting density, plant availability, and project goals. To revegetate the landscape at a moderate density (200 plants per acre) would cost approximately $8,800 per acre.

Table 39. Cost Estimates for 1 Acre of Revegetation

Item	**Cost**
Plants	$800 ($4.00 x 200 plants)
Installation and Maintenance	$8,000
TOTAL	**$8,800**

9.2.7 Reef Friendly Landscaping:

Costs are highly variable depending on project objectives and property types. Large, commercial test plots can cost upwards of $12,000 per acre for labor and production application. Individuals can purchase a compost tea kit for (organic soil amendments) for as little as $120.00.

9.2.8 Regional Stormwater Management Park:

Costs for a Regional Stormwater Management Park are difficult to estimate. Because these areas are typically public spaces, the cost to purchase the land by the County should be included in the total price. To create the basin, costs would be similar to a detention basin as outlined in 9.2.3. Additional costs would be to landscape the area or place infrastructure such as parking, fences, and other facilities.

9.2.9 Unimproved Road Stabilization:

Costs can vary depending on the level of disrepair of each road. Slope steepness, soil composition, location, and other factors may influence road stabilization costs.

Table 40. Cost Estimates for Road Stabilization Based on a Project in the Pōhākea Watershed

Task Description	Unit	Unit Price	Total Price
Mobilization	NA	$5,000	$5,000
Water Truck	10 Days	$1,530	$15,300
Spencer Road Grading	7920	$23	$182,160
MECO Road Grading	7920	$28	$221,760
Herbicide Treatments	15,840	$1	$16,000
Total Price			$440,220

9.2.10 Wetland and Stream Buffers and Protection:

Costs can vary depending on buffer size and project objectives. An estimated cost to restore 10.8 acres of a riparian corridor along Waiakoa Gulch is $173,280.

Table 41. Cost Estimates for 10.8 Acres of Riparian Rehabilitation Along Waiakoa Gulch

Task	Cost per Unit	Number of Units	Total Cost
Weekly fencing and irrigation infrastructure inspections	$550.00	52	$28,600.00
Fencing Materials	$30.00	3,896	$116,880.00
Irrigation Infrastructure	$4,000.00	1	$4,000.00
Irrigation installation and planting	$2,200.00	5	$11,000.00
Plants	$4.00	1,000	$4,000.00
Quarterly vegetative monitoring, photo documents, drone flights	$1,100.00	4	$4,400.00
Quarterly and annual reports	$1,100.00	4	$4,400.00
Total Cost		$173,280.00	

10.0 ELEMENT E – INFORMATION AND EDUCATION OUTREACH PROGRAM

10.1 Education and Outreach Program Goals

The main goal of the Information and Education Outreach Program is to build public understanding of the Māʻalaea Watershed Management Plan, Hawaiʻi water quality standards, and the projects proposed by the Plan to remove and reduce pollutants entering our coastal waters through stormwater runoff. Efforts will be focused on discussing nonpoint sources of pollution and how these pollutants enter streams and coastal waters and harm coral reefs. In addition, land-based issues relating to flooding and erosion from stormwater, nutrient runoff, oil and hazardous materials, and wastewater reclamation will all be addressed.

10.2 Education and Outreach Objectives

The Central Maui Soil and Water Conservation District, the Hawaii Department of Health Clean Water Branch, and Maui County should consider establishing and maintaining a Watershed Coordinator position to direct, organize, and coordinate efforts related to the Māʻalaea Watershed Management Plan. This individual would be the primary contact between the conservation district, the community, government entities, and other organizations involved in improving water quality within the watershed. The Watershed Coordinator would be responsible for spearheading the education and outreach objectives listed below.

10.2.1 Build Public Awareness and Support

Lack of understanding of nonpoint sources of pollution is a major factor affecting water quality. The implementation projects outlined in the MWMP will require some level of stakeholder awareness and involvement. The community will be educated about current DOH, CWB, and Hui O Ka Wai Ola water quality monitoring locations and data trends arising from these water quality monitoring efforts. Links to both organizations’ data portals are available on the www.mauiwatershed.org website.

Stakeholders who implement projects proposed in this Plan should incorporate community education and engagement. Information on project location, objectives, and the improvements to water quality should be made available to the public. Providing opportunities for volunteers to participate in project implementation is also an effective mechanism to gain community involvement and support. The community can also provide technical assistance. Sharing knowledge of project implementation strategies to improve water quality will empower members of the community to refrain from engaging in and to report activities that cause pollution. Public awareness can be expected to improve water quality and coral reef health.

10.2.2 Focused Outreach to Engage Businesses and Decision Makers

In conjunction with the project implementation schedule offered in Section 11 of this watershed plan, the SWCD, as well as MNMRC will continue to conduct focused outreach to natural resource managers, large landowners, and businesses. Examples of focused outreach include:

- Updates to Mauiwatershed.org
- Maui Nui Marine Resource Council’s Reef in Brief Newsletter
- Maui Nui Marine Resource Council’s Know Your Ocean Speaker Series

10.2.3 Advertise Implementation Projects

Implementation projects can be featured on the www.mauiwatershed.org website, on social media, as well as various news outlets. Individual stakeholders are encouraged to promote their contributions to watershed management measures on platforms that best serve them. The main purpose of advertisement is to inform the community about projects occurring within the watershed to improve water quality, and to highlight successes, failures, and data gaps. Marketing events can serve as public relations opportunities for businesses and large landowners alike. Informing the public will provide opportunities for community members to participate in improving and maintaining healthy water quality standards. Utilizing volunteers can also make projects more feasible by lowering costs.

Maui County and/or the Central Maui Soil and Water Conservation District can create mailings, pamphlets, brochures, and other project-specific materials as well as design informative materials and presentations to engage potential project partners.

10.2.4 Participation with Government Agencies and Community Groups

Implementation projects listed in this Plan are all meant to improve water quality by reducing pollutant loads entering coastal waters. Depending on the proposed project, meetings will have to be conducted between the SWCD, the watershed coordinator, and government agencies, community groups, and businesses. Government agencies at the Federal, State, and local levels will have to be engaged on several fronts. These agencies can act in their regulatory capacity to force action be taken for certain pollutants or to provide a permit. They can provide technical support, expertise, training, and background knowledge and can serve as a source of funding for implementation projects.

10.3 Education and Outreach Structure and Support

Table 42 provides the basic components making up the structure of the Education and Outreach Program. This table includes tasks associated with the objectives listed above, cost per unit, and a five-year budget for enacting the programs.

Table 42. Māʻalaea Watershed Management Plan Education and Outreach with Costs

Māʻalaea Watershed Management Plan Education and Outreach Program							
Objectives	Cost per Unit	Year 1	Year 2	Year 3	Year 4	Year 5	Total 5 Year Cost
Build Public Awareness and Support							
Maintain Central Maui Soil and Water Conservation District website dedicated to watershed information - www.mauiwatershed.org	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$10,000
Maintain Central Maui Soil and Water Conservation District administrative staff support of outreach and education efforts	$8,000	$8,000	$8,000	$8,000	$8,000	$8,000	$40,000
Focused Outreach to Engage Businesses and Decision Makers							
Establish mailings, pamphlets, brochures and other materials specific to projects being implemented and design persuasive materials and presentations to provide to potential project partners such as resorts and golf courses.	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$10,000
Participation with Government Agencies, Community Groups, Small Group Meetings, and Trainings							
Meetings between Maui County, the SWCD, the watershed coordinator, and government agencies, community groups, and businesses	Included in Watershed Coordinator position costs	$2,000	$2,000	$2,000	$2,000	$2,000	$10,000
Total for Outreach and Education							$70,000

11.0 ELEMENT F - IMPLEMENTATION SCHEDULE

Water quality data from the State of Hawaiʻi Integrated Water Quality Report Assessments, 303d list of impaired waters, and Hui O Ka Wai Ola water quality data was compared with nonpoint sources of pollution on the landscape to develop the schedule for the Māʻalaea Watershed Management Plan, This comparison assisted in identifying which projects should be given priority status. Project costs and complexity were also considered when assigning priority status.

Considerations regarding the severity of pollution as represented in the water quality data, expected load reductions of individual projects, and whether the nonpoint source of pollution is related to stormwater or groundwater were used to estimate when water quality standards would be achieved. Timelines for individual project completion generally range from six months to five years. Several projects may need to be implemented in succession before water quality standards are met for particular pollutants. Estimated timelines for water quality standard attainment generally range from 15 to 20 years. Timelines specific to individual water quality attainment statuses are discussed in detail in Section 13, Element H. Funding and feasibility of execution are also limiting factors on the timeliness of this plan. Projects that require large amounts of funding and development of infrastructure will likely extend the timeline.

Table 43. Implementation Project Priority Status and Approximate Timeline

Implementation Project	Location (Gulch)	Description	Approximate Timeline to Completion	Organization(s) Responsible for Implementation	Priority
Axis Deer Fencing	At strategic locations throughout Waikapū and Waiakoa Watersheds	Install feral ungulate fencing to manage axis deer populations	Ongoing with 10 miles of fencing installed every five years	Hawaiʻi Department of Land and Natural Resources, Division of Forestry and Wildlife, Mauna Kahālāwai Watershed Partnership, Haleakalā Ranch, State of Hawaiʻi, Kula Ranch, Von Tempsky, Alexander and Baldwin, Mahi Pono, Department of Hawaiian Homelands, Mālama Haleakalā Foundation	High

Implementation Project	Location (Gulch)	Description	Approximate Timeline to Completion	Organization(s) Responsible for Implementation	Priority
Culvert Protection from Debris	Mauka side of stormwater infrastructure in Waiakoa watershed	Retrofit culverts with protective devices to prevent clogging of drainageways	5-10 years	Maui County Department of Transportation, Department of Public Works	High
Detention Basins	Waiakoa Gulches	Install detention basins to capture stormwater and reduce sedimentation and increase infiltration	Ongoing-20years	County of Maui, Department of Public Works, Mālama Haleakalā Foundation	High
Gabions	Waiakoa Gulches	Install gabions to reduce velocity of flowing stormwater	20 years, with Gabions installed in Waiakoa Watershed Gulches every 5 years	Central Maui Soil and Water Conservation district, private landowners, Mālama Haleakalā Foundation, Maui Nui Marine Resource Council	High
Golf Course Nutrient Curtain	Kahili and Kamehameha Golf Courses within Waikapū Watershed	Install nutrient curtains to filter excess nutrients and pollutants from groundwater	Ongoing	Kahili and Kamehameha Golf Courses, Maui Nui Marine Resource Council	Medium
Land Slide Mitigation	Mauka regions of Waikapū Watershed	Stabilize hillslopes to prevent landslides from occurring	Ongoing	Mauna Kahālāwai Watershed Partnership, Maui Nui Marine Resource Council, private landowners	Low

Implementation Project	Location (Gulch)	Description	Approximate Timeline to Completion	Organization(s) Responsible for Implementation	Priority
Reef Friendly Landscaping	Commercial and private properties throughout Waikapū and Waiakoa Watersheds	Utilize organic products to enhance soil health and meet landscaping needs.	Ongoing	Kahili Golf Course, Kamehameha Golf Course, Sugar Beach Resort, Keālia Resort, Māʻalaea Surf Resort, Kīhei Beach Condos, Maui Nui Marine Resource Council, private landowners	Medium
Regional Stormwater Managment Park	Outfalls of Waiakoa and Keahuaiwi Gulches	Build stormwater management park to be utilized dually for community park and flood control	20 years, with one stormwater park constructed every 10 years	State of Hawaiʻi, Maui County Department of Public Works, Mahi Pono, Weinberg Property Owners	High
Unimproved Road Stabilization	Throughout Watersheds	Decommission, repair, and stabilize roads to prevent erosion	Ongoing	Mahi Pono, Goodfellow Bros, Wailuku Water Company, County of Maui, Alexander and Baldwin, Haleakala Ranch, Kula Ranch	High
Wetland and Stream Buffers and Protection	Throughout Watersheds	Protect and restore buffers along gulches and wetalnds	Ongoing	Maui County, Mālama Haleakalā Foundation, Maui Nui Marine Resource Council, Haleakalā Ranch, Mahi Pono	High
Education and Outreach	Throughout Watersheds	Watershed coordinator to oversee Plan implementation and conduct outreach	Ongoing	Maui County, Central Maui Soil and Water Conservation District, Keālia Pond National Wildlife Refuge, Maui Nui Marine Resource Council	Medium

12.0 ELEMENT G – INTERIM MILESTONES

The following section provides interim milestones for the various implementation projects proposed in the watershed management plan. Individual project timelines were estimated based on five-year increments and a total timeline of twenty years. While watershed planning and project implementation is continuous, the scope of this Plan spans two decades. Milestones listed in this section are meant to be both measurable and attainable, with clearly described benchmarks for measuring progress. Table 44 summarizes the information presented in this section.

12.1 Axis Deer Fencing

The installation of axis deer fencing has been given a high priority status. As deer populations grow exponentially, denuded landscapes continue to erode and negatively impact water quality. Fencing is needed to control migrations throughout the watersheds and to enable proper management and control of this invasive species. The magnitude of the problem is widespread, and fencing to be placed at strategic locations throughout the watershed is recommended. Approximately 40 miles of feral ungulate fencing is proposed in this Plan.

12.2 Culvert Protection from Debris

Protecting culverts from debris has been given a high priority status. A study should be conducted to identify those portions of the watershed that have inadequate of outdated stormwater infrastructure. Once identified, culverts can be retrofitted with protective devices that allow for stormwater flow to continue. Culvert grates are relatively inexpensive and easy to install, therefore, this implementation project would be a feasible action to mitigate flooding.

12.3 Detention Basins

The basins described in this Plan have been given high priorty status. While detention basins are regarded as highly effective in the capturing of stormwater and in the removal of sediment, they are expensive to construct and often require extensive permitting, especially if connected to an existing stream.

Estimated costs for detention basin installation ranges from $700,000 to is $3,500,00 according to the 2016 Kīhei Drainage Master Plan. A realistic goal for achievement would be to construct one basin every five years. Basins should be constructed in succession beginning with the greatest capacity to capture stormwater and sediment and ending with the least capacity.

12.4 Gabions

Gabion installation has been given a high priority status of implementation. Highly effective at reducing the velocity of stormwater, gabions can have a direct and immediate impact of minimizing the impacts of flooding. A comprehensive assessment to include engineering, placement, fill materials, and to determine permitting requirements is needed before installation can begin.

12.5 Golf Course Nutrient Curtain

Golf course nutrient curtains have been given a medium priority status. To filter nutrients from entering groundwater, it is proposed that a nutrient curtain be installed every five years alternating between Kahili and Kamehameha Golf Courses.

12.6 Landslide Mitigation

Hillslope stabilization methods to address landslides have been given a low priority status. Beginning with an assessment of landscapes that are vulnerable to the potential occurrence of landslides, projects to address and mitigate for loss of soil can be employed at strategic locations. Stabilizing one hillside annually would reduce sediment loads within Waikapū Watershed.

12.7 Reef Friendly Landscaping

Transitioning to chemical-free landscaping alternatives has been given a medium priority status. Programs and resources to do so are available through Maui Nui Marine Resource Council. Beginning with golf courses and stakeholders that manage large landscapes will have the greatest impact to water quality. Education and outreach to smaller entities and individuals should continue to highlight the importance to chemical-free alternatives to synthetic pesticides, herbicides, and fertilizers.

12.8 Regional Stormwater Management Park

Converting the Weinburg Property at the base of Waiakoa Gulch and the State of Hawaiʻi and Mahi Pono properties at the base of Keahuaiwi Gulch into a stormwater management park has been given a high priority status. Once engineering, permitting, and environmental assessment requirements are met, project design can be determined. A new regional stormwater management park can be installed every 10 years.

12.9 Unimproved Road Stabilization

Decommissioning, repair, and stabilization of unpaved roads are a high priority in this Plan. A comprehensive assessment needs to be conducted for work to begin. The Plan proposes completing an inventory of roads every five years to fully understand condition and to prioritize repair needs. Based on this assessment, repairs or decommissioning would occur as needed throughout the timeline of this Plan.

12.10 Wetland and Stream Buffers and Protection

Protection of wetlands and stream riparian buffers have been given high priority status. In October of 2022 the Maui County Council passed a bill to protect and restore wetlands (Ordinance 5421). As a requirement of this law, a wetland overlay map is currently in the works.

12.11 Education and Outreach

Education and outreach events will occur quarterly every year throughout the duration of the Plan. Each event will focus on educating the community and engaging stakeholders on water quality standards and current trends, nonpoint sources of pollution, wetlands and riparian corridors, and the various implementation projects either ongoing or proposed for the watershed.

Table 44. Interim Milestones

Implementation Project	Location (Gulch)	Description	Priority	Twenty Year Timeline			
				Present - 2029	2034	2039	2044
Axis Deer Fencing	At strategic locations throughout Waikapū and Waiakoa Watersheds	Install feral ungulate fencing to manage axis deer populations	High	10 miles of fencing installed	20 miles of fencing installed	30 miles of fencing installed	40 miles of fencing installed
Culvert Protection from Debris	Mauka side of stormwater infrastructure in Waiakoa watershed	Retrofit culverts with protective devices to prevent clogging of drainageways	High	Conduct a study to identify inadequate or outdated stormwater infrastructure Retrofit stormwater infrastructure with protective devices	Retrofit stormwater infrastructure with protective devices	Continued monitoring and maintenance	Continued monitoring and maintenance
Detention Basins	Waiakoa Gulches	Install detention basins to capture stormwater and reduce sedimentation and increase infiltration	High	1st basin completed	2nd basin completed	3rd basin completed	4th basin completed

Implementation Project	Location (Gulch)	Description	Priority	Twenty Year Timeline			
				Present - 2029	2034	2039	2044
Gabions	Waiakoa Gulch	Install gabions to reduce velocity of flowing stormwater	High	Gabions installed in Waiakoa Gulch	Gabions installed in Keahuaiwi Gulch	Gabions installed in Pūlehu Gulch	Gabions installed in Kolaloa Gulch
Golf Course Nutrient Curtain	Kahili and Kamehameha Golf Courses within Waikapū Watershed	Install nutrient curtains to filter excess nutrients and pollutants from groundwater	Medium	Nutrient curtain installed at Kahili Golf Course	Nutrient curtain installed at Kamehameha Golf Course	Nutrient Curtain installed at Kahili Golf Course	Nutrient curtain installed at Kamehameha Golf Course
Land Slide Mitigation	Mauka regions of Waikapū Watershed	Stabilize hillslopes to prevent landslides from occurring	Low	Five hillslopes stabilized	Ten hillslopes stabilized	15 hillslopes stabilized	20 hillslopes stabilized
Reef Friendly Landscaping	Commercial and private properties throughout Waikapū and Waiakoa Watersheds	Utilize organic products to enhance soil health and meet landscaping needs.	Medium	Obtain RFL Certification for Kahili Golf Course	Obtain RFL Certification for Kamehameha Golf Course	Obtain RFL certification for Keālia Resort and Sugar Beach Resort	Obtain RFL certification for Māʻalaea Surf Resort and Kīhei Beach Condos
Regional Stormwater Management Park	Outfalls of Waiakoa and Keahuaiwi Gulches	Build stormwater management park to be utilized dually for community	High	Conduct engineering, permitting, environmental assessments, overall project design and	Continued maintenance	Conduct engineering, permitting, environmental assessments, overall project design and	Continued maintenance

Implementation Project	Location (Gulch)	Description	Priority	Twenty Year Timeline			
				Present - 2029	2034	2039	2044
		park and flood control		construct first stormwater management park		construct 2nd stormwater management park	
Unimproved Road Stabilization	Throughout Watersheds	Decommission, repair, and stabilize roads to prevent erosion	High	Conduct assessment and inventory of roads. Begin repair and stabilization of priority roads	Conduct additional assessments every five years and repair roads as necessary	Conduct additional assessments every five years and repair roads as necessary	Conduct additional assessments every five years and repair roads as necessary
Wetland and Stream Buffers and Protection	Throughout Watersheds	Protect and restore buffers along gulches and wetalnds	High	Protect riparian corridor of Waiakoa Gulch	Protect riparian corridor of Keahuaiwi Gulch	Protect riparian corridor of Waikapū Gulch (east)	Rehabilitate riparian corridor of Waikapū Gulch (west)
Education and Outreach	Throughout Watershed	Watershed coordinator to oversee Plan implementation and conduct outreach	Medium	Quarterly events per year = 20 events by 2029	40 events by 2034	60 events by 2039	80 events by 2044

12.12 Existing Management Practices

12.12.1 Water Quality Monitoring

Increased water quality monitoring is recommended as a high priority in the MWMP. HOKWO currently samples two locations in the nearshore waters associated with Maʻalaea Bay and Keālia Pond. These include one site directly offshore from the pond and a second site in front of Kīhei Canoe Club. A Water Quality Monitoring Plan has since been proposed and is described in Section 14.0. Marine surface waters, stormwater, stream and pond surface waters, and subsurface groundwater should all be monitored to better assess pollutant sources and the success of management measures as they are employed.

12.12.2 Feral Ungulate Control

The infiltration of feral ungulates pose a great threat throughout the MWMP watersheds. Problems associated with these animals, in particular axis deer, include depletion of native forests, land and habitat degradation, topsoil exposure and loss, and the spread of invasive species. DOFAW has aerially removed several thousand axis deer from upper elevations of the Waikapū watershed. Mahi Pono, Haleakal Ranch, Kaonoulu Ranch, and other large landowners have axis deer population management programs in place and continue to install feral ungulate fencing. Feral ungulate management remains a priority BMP in protecting native forests and improving water quality within the watershed.

13.0 ELEMENT H - INTERIM NUMERIC CRITERIA

13.1 Interim Numeric Criteria

The lack of surface water within the Māʻalaea Watershed makes it difficult to measure load reductions. The continued monitoring of coastal waters will be used to show the success of projects following implementation. Interim numeric criteria were developed to assist in quantifying progress made towards attaining water quality standards over the course of time (Table 45. Interim Numeric Criteria for Māʻalaea Watershed). To develop these criteria, Hui O Ka Wai Ola's entire period of record data from two sites within Waikapū and Waiakoa watersheds were analyzed. Keālia Pond sampling occurs within Waikapū Watershed and the Kīhei Canoe Club sample site lies within Waiakoa Watershed. The geometric mean was calculated for measurements of turbidity, total nitrogen, total phosphorus, nitrate + nitrite, and ammonia. Geometric means were compared with the listed open coastal waters criteria for Dry Season water quality standards due to the highly ephemeral nature of the streams in the watershed planning area. Dry season criteria apply when the open coastal waters receive less than three million gallons per day of freshwater discharge per shoreline mile. The difference between the geometric mean and the dry season water quality standard for the period of record for each pollutant listed was calculated.

13.2 Expected Dates of Achievement

To define realistic dates of achievement, this difference between observed values and the dry standard were divided into thirds to create interim numeric criteria to be attained over the next 18 years. In other words, every six years the Plan aims to decrease pollutants by one-third of the amount that they are currently observed above the water quality standard.

As an example, the period of record geometric mean for total nitrogen at Kīhei Canoe Club is 230.01 µg/L. The Dry criteria for total nitrogen in open coastal waters is 110.00 µg/L. This means that currently, Kīhei Canoe Club is 120.01 µg/L above the standard. To generate interim numeric criteria, we divided 120.01 µg/L by three to generate a six-year target reduction value of 40.003 µg/L. Therefore, beginning in 2022 and running through 2028, the geometric mean for this period needs to decrease by 40.003 µg/L to a value of 80.01 µg/L .

13.3 Review Process

Data will be reviewed annually by the acting watershed coordinator, the Hui O Ka Wai Ola staff, and by DOH CWB staff. While interim numeric criteria were developed along an 18 to 20-year timeline, many sampling locations may attain water quality standards in a much shorter timeframe.

13.4 Criteria for Plan Revision

Whenever data shows that interim numeric criteria will not be met for a given pollutant, an analysis of potential pollutant sources will be conducted. Additional implementation projects will be developed to address pollutant loading not being reduced by current activities. Likewise, any on-going projects will be reviewed to determine their effect on removing pollutants.

13.5 Revisions Strategy

When interim numeric criteria are not being met, the watershed coordinator will work with the SWCD and other stakeholders in the community to change the management practices currently being implemented. This will include updating and or reevaluating critical source areas of pollution. Additional models or sampling will be utilized to better understand the sources of pollution affecting water quality. Timelines will be reassessed based on this information.

13.6 Agency Responsible for Evaluating Progress

As implementation projects are executed on the landscape, their effectiveness at reducing pollutant loads will be analyzed by the watershed coordinator and the SWCD. In addition, the DOH CWB will play an active role in determining the overall success of the watershed plan by their preparation of biannual IR Reports, water quality data provided to them by the Hui O Ka Wai Ola, and from input from the community.

Table 45. Interim Numeric Criteria for Māʻalaea Watershed

Site	Hui O Ka Wai Ola Period of Record	Number of Data Points	Interim Numeric Criteria - Difference between Geometric Mean Value and Dry Water Quality Standard	Pollutant				
				Turbidity (NTU)	Total Nitrogen (µg/L)	Total Phosphorus (µg/L)	Nitrate + Nitrite (µg/L)	Ammonia (µg/L)
				Geometric Mean Not to Exceed:				
				0.20	110.00	16.00	3.50	2.00
Keālia Pond	02/22/2018 to 08/04/2022	75	2022	1.09	Meeting Standard	Meeting Standard	0.34	0.05
			2028 IR Report	0.73	NA	NA	0.23	0.03
			2034 IR Report	0.36	NA	NA	0.11	0.02
			2042 IR Report	0.00	NA	NA	0.00	0.00
Kīhei Canoe Club	02/22/2018 to 08/04/2022	75	2022	3.53	120.01	Meeting Standard	141.74	0.17
			2028 IR Report	2.35	80.01	NA	94.47	0.11
			2034 IR Report	1.18	40.00	NA	47.23	0.06
			2042 IR Report	0.00	0.00	NA	0.00	0.00

14.0 ELEMENT I – MONITORING PROGRAM FOR EVALUATING IMPLEMENTATION PROJECT SUCCESS

The current water quality monitoring program within the MWMP is limited to the coastal waters just outside Keālia Pond. Currently, the DOH CWB lists three water quality monitoring sites, including Keālia Pond, Mai Poina ʻOe Iʻau Beach Co. Park, and Kīhei Coast-Mokulele. Of these three sites, Keālia Pond is the only site to attain water quality standards for nitrogen and phosphorus. Unfortunately, this site is listed as having insufficient data for each of the water quality parameters tested. The Hui O Ka Wai Ola tests along the beach in front of Keālia Pond and at the beach in front of the Kīhei Canoe Club.

A major flaw in the current sampling methodology is that sampling is only pulled from the surface of coastal waters, meaning that the samples are a diluted representation of pollutants without any indication to the pollutant origin. To better identify and quantify land-based sources of pollution, a more robust and inclusive water sampling methodology should be employed. Identifying pollutant sources and quantifying pollutant loads will provide insight into solutions to improving water quality and will highlight the efficacy of projects implemented within the watershed. Due to the ephemeral nature of streams and wetlands in the MWMP, water quality sampling must take place during stormwater events when these gulches are actually discharging. In addition, ground water sampling can provide information on sources of pollution. A Water Quality Monitoring Plan has been developed and is described below.

14.1 Waikapū Water Quality Monitoring Plan Methodology

To fully capture pollution loads and stormwater runoff within the Waikapū Watershed, surface waters associated with Waikapū Stream, which is perrenial, Keālia Pond, and the coastal waters of Māʻalaea Bay should be monitored at various locations listed in the map below (Figure 78. Waikapū Water Quality Monitoring Map). Several locations within the larger portion of the pond should be sampled as well as a sample from the smaller portion of the pond, makai of North Kīhei Road. In addition to these sites, surface water sampling should be collected from the smaller Waikapū Stream, which only discharges after rain events, using an automatic stormwater sampler.

A total of five groundwater monitoring stations have been proposed within the Waikapū Watershed to collect water quality samples of groundwater immediately mauka of Keālia Pond. Groundwater samples will be collected via installed piezometers. These devices serve two puposes. They allow for water quality sample collection and provide an opportunity for groundwater level monitoring.

A depiction of a typical piezometer installation is included as Figure 79 below. Placement of piezometers was designed to collect representative samples from locations in the Waikapū Watershed potentially affecting nearshore coastal water quality associated with Keālia Pond and Māʻalaea Bay. These include anthropogenic alterations associated with Haycraft Beach, North Kīhei Road, The Maui Electric Company Power Plant, Mahi Pono Agricultural lands, and the central portion of Keālia Pond, which has histroically been used for aquaculture.

Figure 78. Waikapū Water Quality Monitoring Map

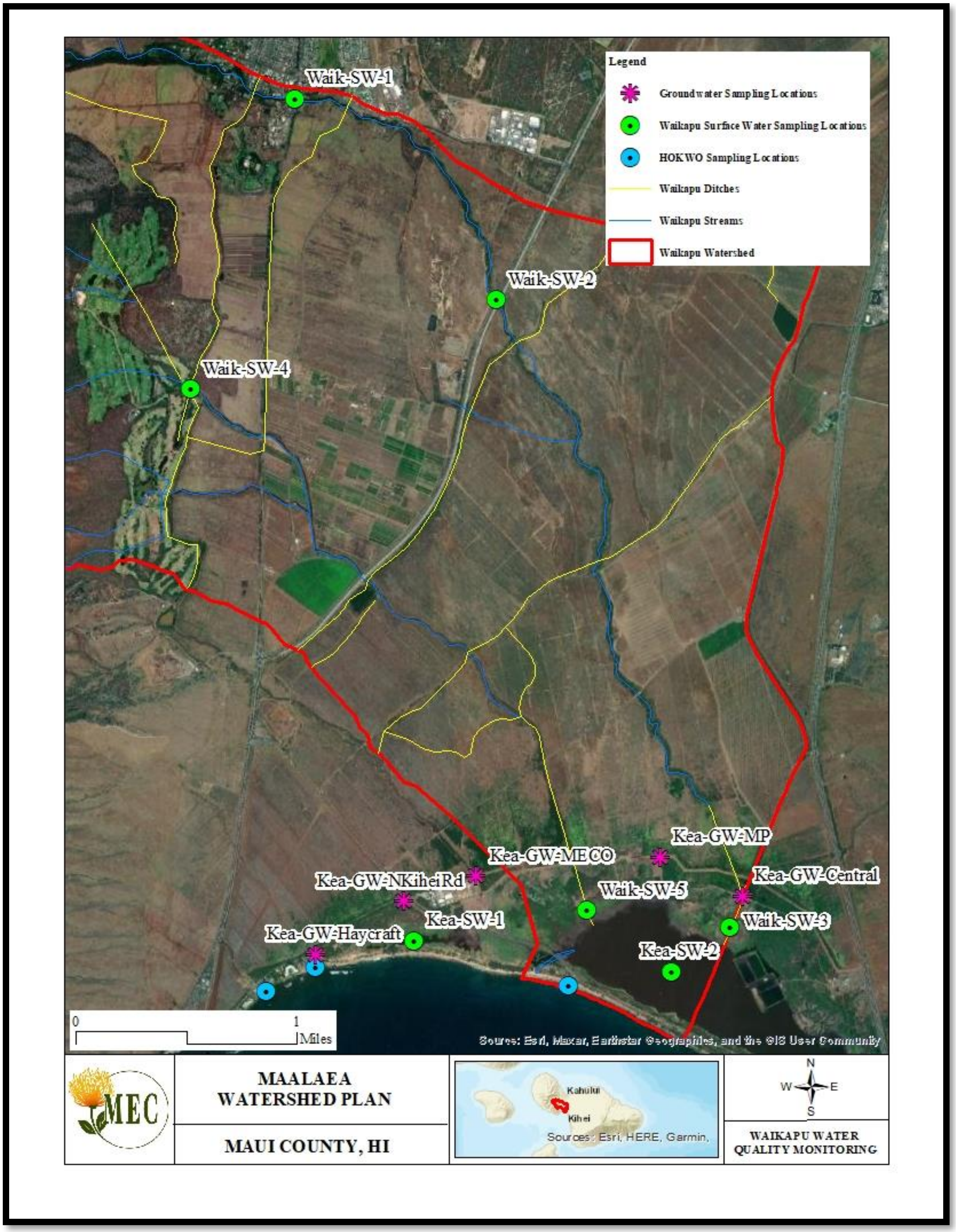
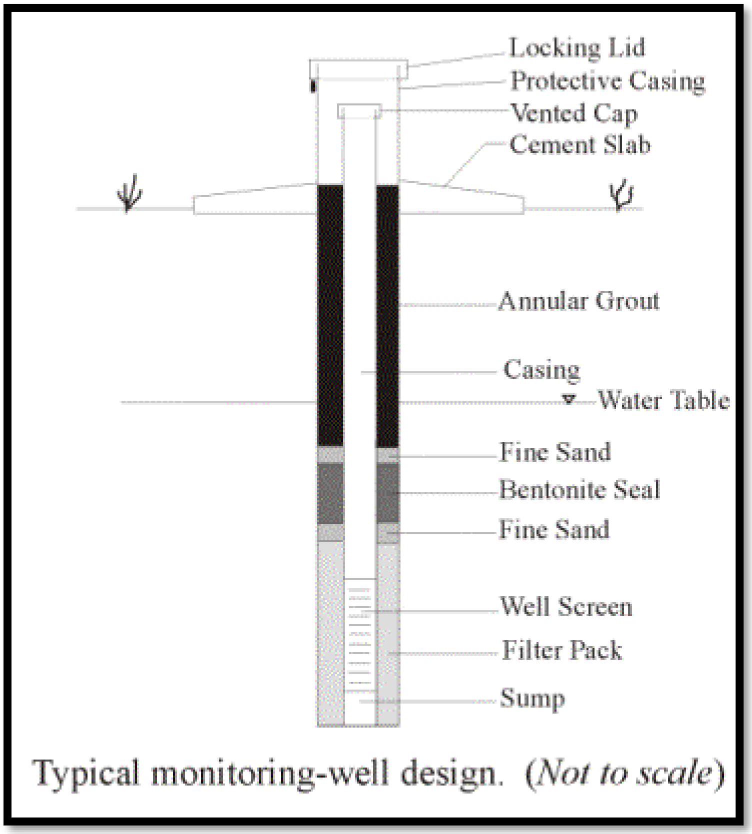


Figure 79. Depiction of a typical Piezometer Installation

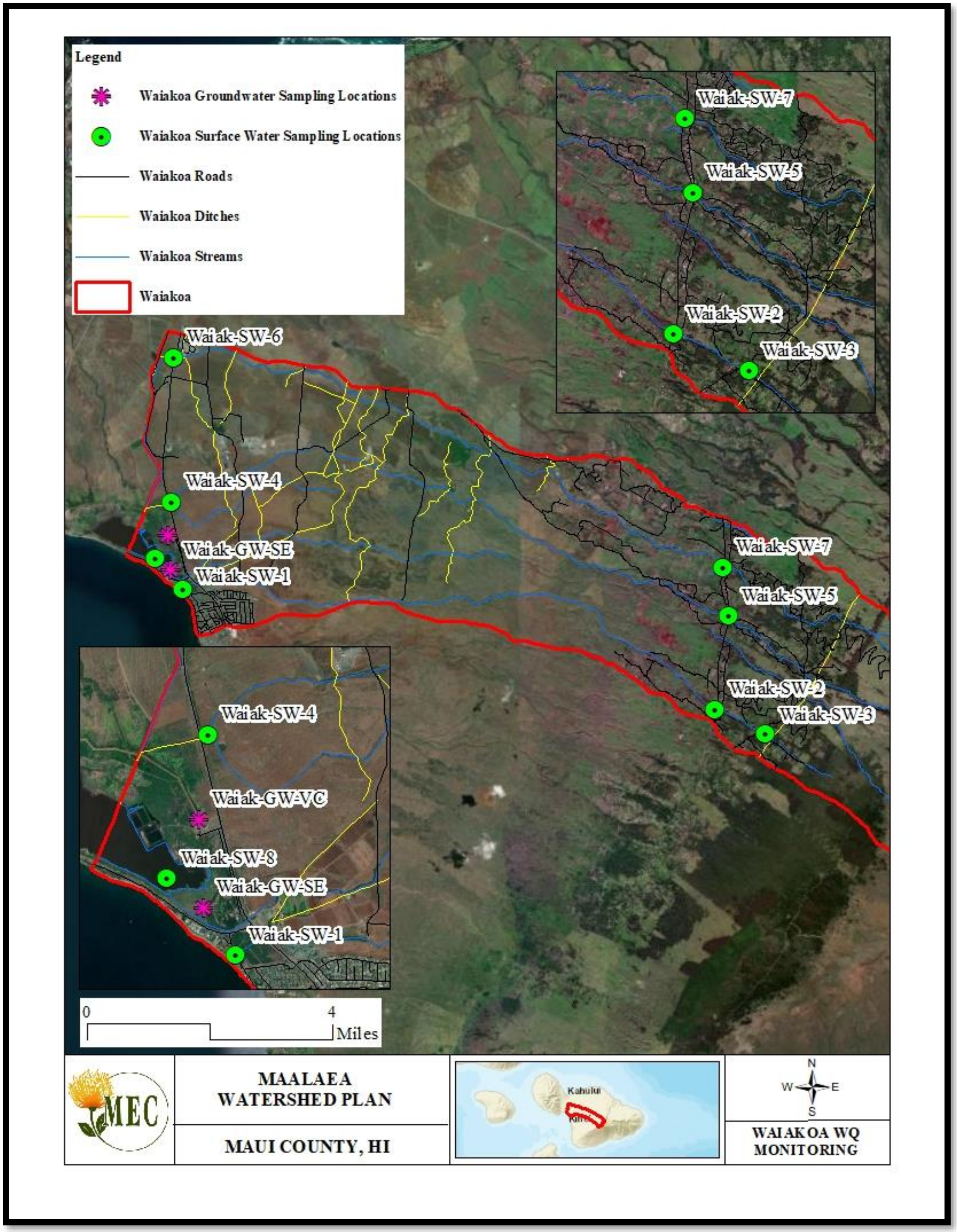


14.2 Waiakoa Water Quality Monitoring Plan Methodology

To better understand the sources of pollution within the Waiakoa Watershed, stormwater sampling should occur at eight locations throughout the watershed (Figure 80. Waiakoa Water Quality Monitoring Map). Because all of the gulches associated with the Waiakoa Watershed are ephemeral, automatic stormwater samplers should be employed. Three sampling locations are proposed for the upcountry portions of the watershed, where Waiakoa, Kolaloa, and Pūlehu Gulches cross under Kula Highway. A forth upcountry surface water sampling location is proposed for Waiakoa Gulch at the intersection of Kekaulike Avenue. Within the makai portions of the watershed, an additional four surface water sampling stations are being proposed. These include the downstream side of the intersection of Pūlehu Gulch with Mokulele Highway, the downstream side of Kolaloa Gulch where it interescts with Mokulele Highway and enters into a ditch system, the downstream side of Waiakoa Gulch where it intersects South Kīhei Road prior to discharging into the Pacific Ocean, and the southeastern portion of Keālia Pond where Keahuaiwi Gulch is believed to discharge during large storm events.

In addition to these surface water sampling locations, additional ground water sampling via piezometers is proposed for the vistor center and southeast corner of Keālia Pond.

Figure 80. Waiakoa Water Quality Monitoring Map



14.3 Water Quality Monitoring Parameters

Each site was selected specifically to represent samples from locations within the watershed that are likely to influence nearshore coastal water quality. Surface samples and groundwater samples should be collected from perrenial locations monthly, and again from ephemeral streams and gulches when stormwater flow is occurring. Local rain gauges should be referenced after storm events to categorize each storm event and to correlate rainfall amounts to observed flows and groundwater levels in the watershed.

In Situ Sampling Parameters:

Temperature
Salinity / Conductivity
Dissolved Oxygen
pH
Turbidity

Laboratory Sampling Parameters:

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

Table 46. Proposed Water Quality Monitoring Sites and Sampling Frequency

Waikapū Watershed			
Station	Description	Sampling Type	Frequency
Waik-SW-1	Waikapu at Honoapiilani Highway	Surface Water	Monthly
Waik-SW-2	Waikapu at Kuihelani Highway	Surface Water	Monthly
Waik-SW-3	Waikapu at Keālia Pond Outfall	Surface Water	Monthly
Waik-SW-4	Ditch System Makai of Gold Courses	Surface Water	Storm
Waik-SW-5	Second Outfall into Keālia Pond	Surface Water	Storm
Kea-SW-1	Secondary Pond at Keālia	Surface Water	Monthly
Kea-SW-2	Center of Keālia Pond	Surface Water	Monthly
Kea-GW-Central	Central Pond	Groundwater	Monthly
Kea-GW-MP	Mahi Pono at Keālia Pond	Groundwater	Monthly
Kea-GW-MECO	MECO Powerplant at Keālia Pond	Groundwater	Monthly
Kea-GW-NKīheiRd	North Kīhei Road at Keālia Pond	Groundwater	Monthly
Kea-GW-Haycraft	Haycraft Park at Keālia Pond	Groundwater	Monthly
Waiakoa Watershed			
Station	Description	Sampling Type	Frequency
Waiak-GW-SE	Southeast Corner of Keālia Pond	Groundwater	Monthly
Waiak-GW-VC	Keālia Pond Visitor Center	Groundwater	Monthly
Waiak-SW-1	Waiakoa Outfall to Pacific Ocean	Surface Water	Storm
Waiak-SW-2	Waiakoa Gulch and Kula Highway	Surface Water	Storm
Waiak-SW-3	Waiakoa Gulch and Kekaulike Highway	Surface Water	Storm
Waiak-SW-4	Kolaloa Gulch and Mokulele Highway	Surface Water	Storm
Waiak-SW-5	Kolaloa Gulch and Kula Highway	Surface Water	Storm
Waiak-SW-6	Pūlehu Gulch and Mokulele Highway	Surface Water	Storm
Waiak-SW-7	Pūlehu Gulch and Kula Highway	Surface Water	Storm
Waiak-SW-8	Southeast Corner of Keālia Pond	Surface Water	Monthly

In an effort to generate quality-assured coastal water-quality data to be used by the DOH CWB and other interested entities, a Quality Assurance Project Plan (QAPP) will be prepared for this water quality monitoring methodology. This will ensure that information used to address water quality issues within the watershed is accurate. 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.

14.4 Consistency in Monitoring

Discrepancies currently exist regarding site names and locations recorded in the State of Hawaiʻi Integrated Water Quality Reports. Site locations and names should match across the board to avoid confusion when interpreting data. A strict sampling schedule should also be adhered to, and stormwater sampling events should not be skipped. Consistent naming, mapping, and sampling throughout the watershed is needed to ensure accuracy in identifying and addressing sources of pollution and monitoring project effectiveness.

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APPENDIX A.
NONPOINT SOURCE POLLUTION IMPLEMENTATION PROJECTS

Axis Deer Fencing

	High	Med.	Low
Priority	X		

	High	Med.	Low
Feasibility		X	

Sediment Trapping	
Nutrient Reduction	X
Flood Mitigation	
Stormwater Infrastructure	
Erosion Prevention	X
Feral Ungulate Control	X

Description: Fencing is needed to manage the increasing population of axis deer. Creating management areas allows the community to control the migration of axis deer throughout the watershed. While it is believed that axis deer do not typically roam very far, during drought, wildfire, or other pressures such as removal, fencing enables proper management of this invasive species.

Cost For Waikapū: At a minimum, axis deer fencing should be placed along the conservation land boundary to protect native forests from this invasive species. Working with the Hawaiʻi Department of Land and Natural Resources, Division of Forestry and Wildlife and the Mauna Kahālāwai Watershed Partnership, this project would require a minimum of 15,832 linear feet of fencing. At approximately $26 a linear foot, fencing off this portion of the Waikapū Watershed would cost roughly $411,632.00.

Fencing Description	Length in feet	Cost at $26 a linear foot
Fence along conservation boundary	15,832	$411,632.00
Fence between Honoapiʻilani Hwy and Kuihelani Hwy	30,573	$794,898.00
Fence between Kuihelani Highway and Mokulele Hwy	49,867	$1,296,542.00
Total Fencing Costs		$2,503,072.00

Cost For Waiakoa: Deer fencing should be placed at strategic locations throughout the watershed and connect to existing fencing in order to establish management areas. It is recommended for fencing along Mokulele Highway, in Midlevel Ag lands, makai of the Kula Community, and mauka of the Kula Community. In total, this equals approximately 23 miles of fencing and would cost roughly $3,126,838.00.

Fence Description	Fence Length in Feet	Fencing Cost at $26 a Foot
Fencing Along Mokulele Highway	24,358	$633,306
Fencing in Midlevel Ag Lands	32,690	$849,934
Fencing Makai of Kula Community	19,975	$519,344
Fencing Mauka of Kula Community	43,240	$1,124,233
Total Fencing Costs		$3,126,838.00

Estimated Load Reductions: The table below depicts the pollutant load reductions for Waiakoa and Waikapu Watersheds per 100-acre Heavy Use Protection BMP. These exclusion management units should be placed in high priority areas where groundcover vegetation has been nearly or completely denuded.

Watershed	N Reduction	P Reduction	BOD Reduction	Sediment Reduction
	pounds/year	pounds/year	pounds/year	tons/year
Waiakoa	198.97	37.52	142.43	22.25
Waikapu	137.05	40.76	195.64	30.57

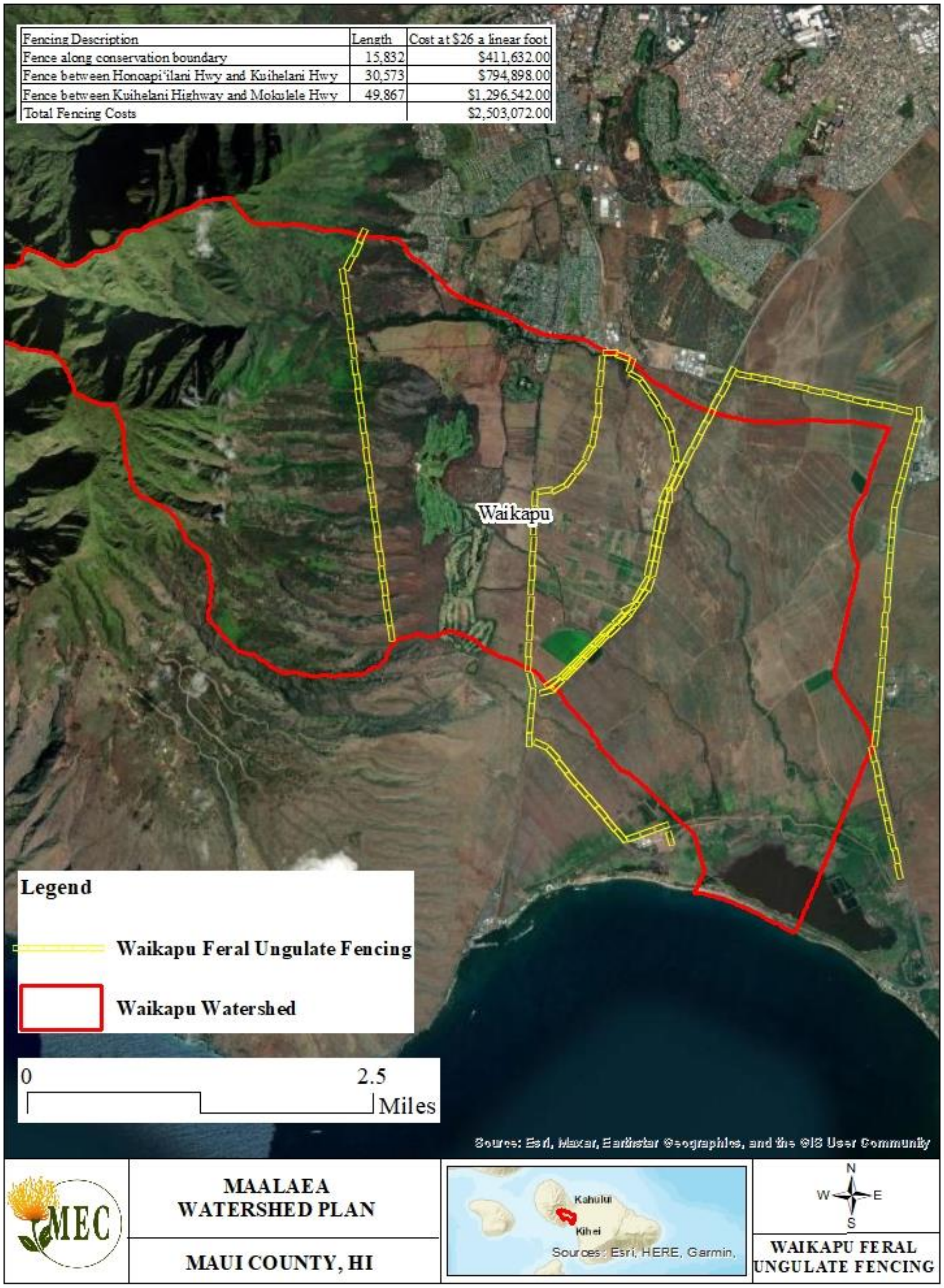
Timeline and Milestones:

Location (Gulch)	Description	Priority	Twenty Year Timeline			
			Present - 2029	2034	2039	2044
At strategic locations throughout Waikapū and Waiakoa Watersheds	Install feral ungulate fencing to manage axis deer populations	High	10 miles of fencing installed	20 miles of fencing installed	30 miles of fencing installed	40 miles of fencing installed

Based on length of fencing recommended in this plan for both Waikapū and Waiakoa Watersheds, approximately 40 miles of feral ungulate fencing is needed.

Potential Permitting Requirements:
If placed on private land, axis deer fencing should not require permitting.

Regional Axis Deer Fencing Proposed for Waikapū Watershed



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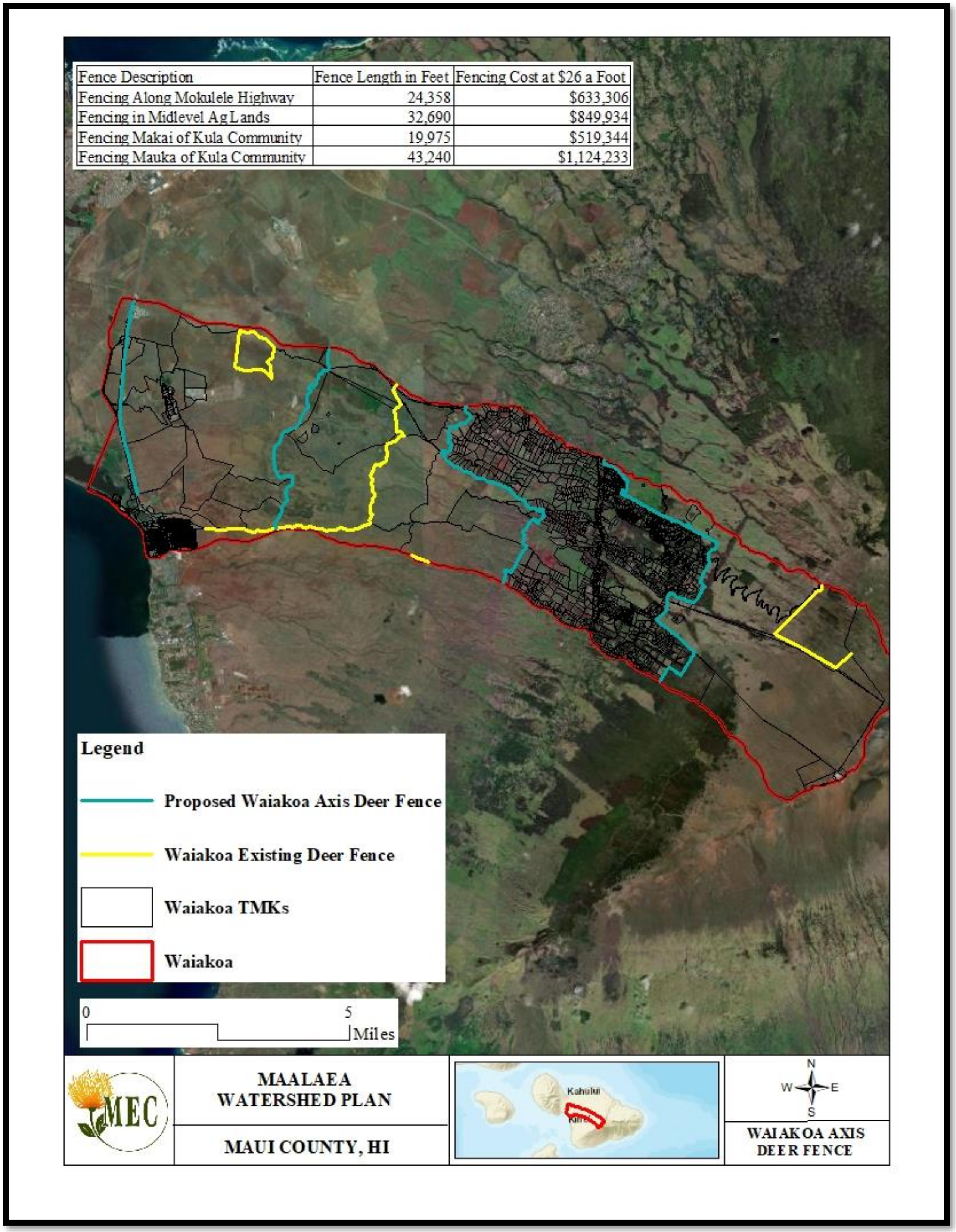

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Fencing Makai of Kula Community	19,975	$519,344
Fencing Mauka of Kula Community	43,240	$1,124,233

Culvert Protection from Debris

	High	Med.	Low
Priority	X		

	High	Med.	Low
Feasibility	X		

Sediment Trapping	
Nutrient Reduction	
Flood Mitigation	X
Stormwater Infrastructure	X
Erosion Prevention	
Feral Ungulate Control	

Description: Much of the flooding that occurs in the Waiakoa Watershed is due to debris piling up on the mauka side of stormwater infrastructure such as culverts and bridges. The debris clogs drainageways, which then causes stormwater to flood surrounding upland areas as it finds alternative routes downstream within the watershed. A study should be conducted to identify those portions of the watershed that have inadequate or outdated stormwater infrastructure. Engineers working with the Department of Public Works and affected stakeholders from the community should come together to retrofit this infrastructure with protective devices that allow for stormwater flow to continue even when debris has stacked up in a stream.

Cost: Culvert grates range in price from $150.00 to $350.00, and can vary depending on size, materials, and structure. Other costs include an environmental assessment, engineering, and installation.

Estimated Load Reductions: Load reductions are highly variable depending on rainfall, land uses, and location.

Timeline and Milestones:

Location (Gulch)	Description	Priority	Twenty Year Timeline			
			Present - 2029	2034	2039	2044
Mauka side of stormwater infrastructure in Waiakoa watershed	Retrofit culverts with protective devices to prevent clogging of drainageways	High	Conduct a study to identify inadequate or outdated stormwater infrastructure, Retrofit stormwater infrastructure with protective devices	Retrofit stormwater infrastructure with protective devices	Continued monitoring and maintenance	Continued monitoring and maintenance

Potential Permitting Requirements:

Permit Name	Issuer	Trigger	Application Requirements	Project Improvements
Clean Water Act Section 401 Water Quality Certification	Clean Water Branch, Hawaiʻi Department of Health	Required for any Federal permit that will involve discharge into bodies of water including streams and wetlands	Application will require items submitted for Department of Army Permit, environmental and chemical evaluation of receiving water, and Hawaiʻi Water Quality Standards compliance plan	Applies to locations requiring Department of Army Permit
Department of Army Permit	U.S. Army Corps of Engineers	Any activity resulting in filling of water bodies in the U.S., including flowing streams and wetlands. Fill includes sediment and structures.	Application will require site plan, design, construction methodology, CWA Section 401 Water Quality Certification by Hawaiʻi Department of Health	New stream intakes, road and pipeline crossings of streams and wetlands
Perform Work on County Highway Permit	Maui County Department of Public Works	Required when a County roadway is disturbed by installation of pipelines	Application will require construction plans for the affected area	Any activities affecting County-owned roadways or structures, such as pipeline installation, use of bridges, and traffic control

Detention Basins

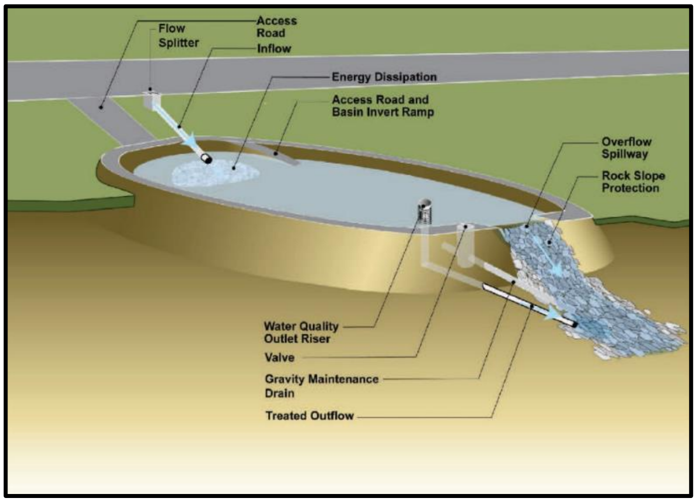


Photo courtesy of Caltrans.gov

	High	Med.	Low
Priority	X		

	High	Med.	Low
Feasibility		X	

Sediment Trapping	X
Nutrient Reduction	X
Flood Mitigation	X
Stormwater Infrastructure	X
Erosion Prevention	
Feral Ungulate Control	

Description: Excavated basins in series, connected by berms or channels for sedimentation and infiltration purposes, have been identified as having a high priority as a management measure to improve water quality in the watersheds. "Excavated basins are often constructed in sequences adjacent to streams, so that excess stormwater flows, from the stream or stormwater channel, can be diverted under gravity to the first basin, then overflows from each basin to the next under gravity, and back to the stream or stormwater channel at the end" (A Handbook for Stormwater Reclamation and Reuse Best Management Practices in Hawaii, December 2008, Commission on Water Reclamation Management).

The Final Report for the Kīhei Drainage Master Plan (KDMP) was released in November of 2016. While several detention basins are proposed in the County plan associated with the Waiakoa drainage area, none are proposed to occur in immediate proximity to Waiakoa Gulch. While the locations of the basins proposed in the KDMP are subject to change, and the depiction of the basins are meant as an example, appropriate sites can be found in the watershed gulch systems, in locations based on the following:

- Where sufficient undeveloped land exists on the sides of the gulches for the infiltration drain field
- After the convergence of tributaries to maximize efficiency
- Preferably in shallow segments where earth-moving to extract the water can be minimized
- In locations where stormwater intakes can be feasibly installed
- On soils which have adequate permeability

Cost: According to the 2016 Kihei Drainage Master Plan, detentions basins proposed for Kihei range in cost from approximately $700,000 to $3,500,000. The difference in price is largely based on the size of the basin, its location, and the permitting constrains associated with construction. See the table below for cost estimates for a single detention basin.

Approximate Costs for a Large Detention Basin (Kihei Drainage Master Plan, 2016)

Task	Quantity	Unit	Unit Price	Total
Environmental Assessment	1	1	$350,000	$350,000
Excavation of Detention Basin	25820	CY	$30	$774,600
Hydromulch for Detention Basin	95800	SF	$2	$191,600
GRP Slope Protection at Spillway	60	CY	$540	$32,400
Inlet/Outlet Concrete Headwall	2	EACH	$16,050	$32,100
Perimeter Chain Link Fence (6ft)	1240	LF	$60	$74,400
1-18' RCP	50	LF	$260	$13,000
Subtotal				$1,468,100
Contingency (20%)				$293,620.0
Total				$1,761,720

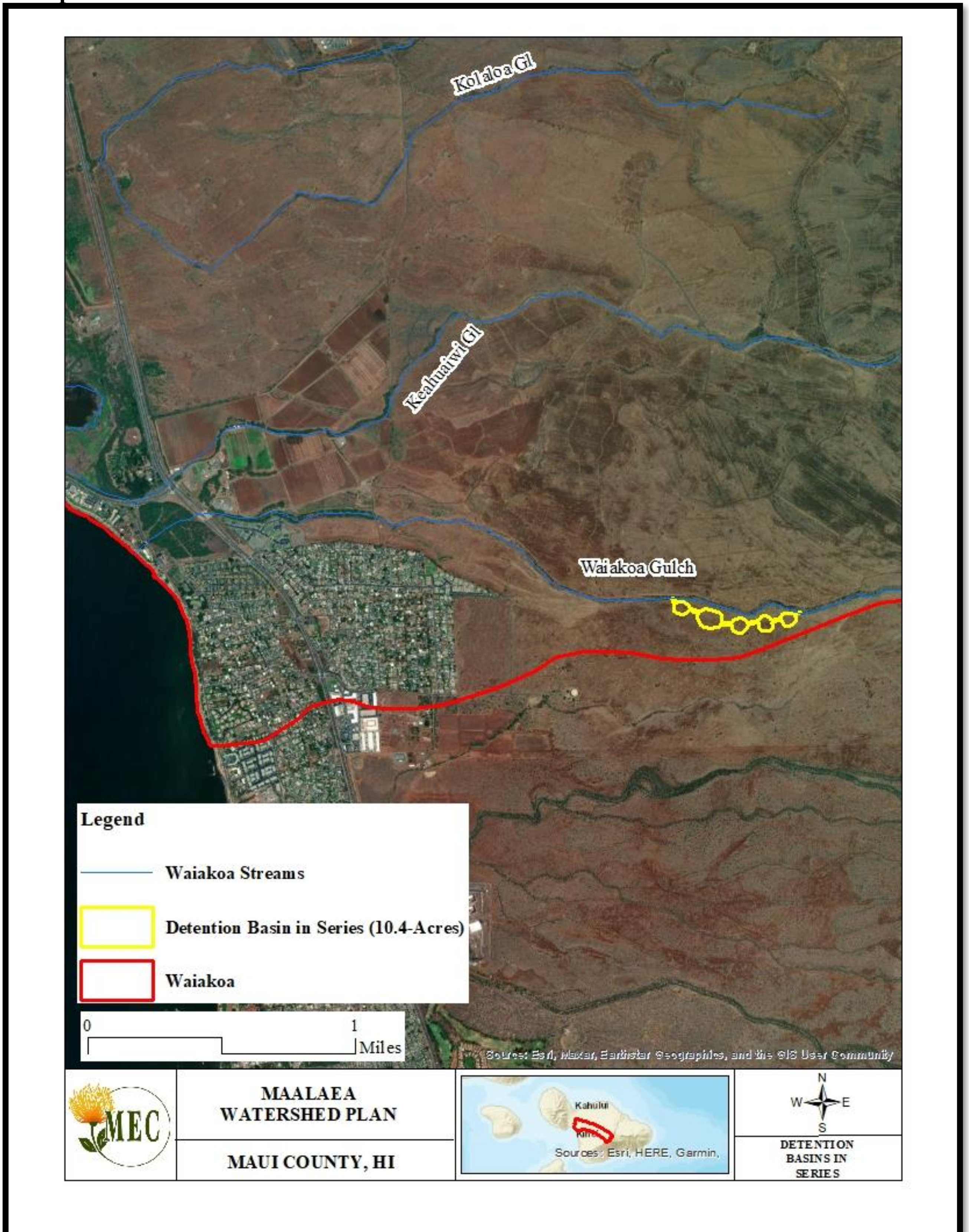
Estimated Load Reductions:

Basin	Acreage Based on Map Renderings	Pollutant Load Reduction		
		N Reduction	P Reduction	Sediment Reduction
		lb/year	lb/year	t/year
Waiakoa Basins in Series	10.42	13.54	2.13	0.59
Large Waiakoa Basin	56.40	73.27	11.55	3.19

Timeline and Milestones:

Location (Gulch)	Description	Priority	Twenty Year Timeline			
			Present - 2029	2034	2039	2044
Waiakoa Gulches	Install detention basins to capture stormwater and reduce sedimentation and increase infiltration	High	1st basin completed	2nd basin completed	3rd basin completed	4th basin completed

Example of Waiakoa Gulch Basins in Series



Potential Permitting Requirements:

Permit Name	Issuer	Trigger	Application Requirements	Project Improvements
Grading and Grubbing Permit	Maui County Department of Public Works	Required for removal of vegetation and earthmoving activities associated with construction	Application will require construction plans to be submitted	Any activity that bares or grades the ground surface, such as structural installation, access roads, and equipment and material staging areas
Special Management Area (SMA) Permit	Maui County	Required for any work being conducted in the Special Management Area	Application will require plots/drawings of work being conducted	Any use, activity, or operation qualifying as "development", and has a total cost fair market value of $500,000 or more; or has significant adverse environmental or ecological effect within the Special Management Area.
Stream Channel Alteration Permit	State of Hawaiʻi Commission on Water Resources Management	Any activity which will affect the stream course within the channel of a perennial or intermittent stream. The regulated channel extends to the top of the streambank.	Application will include design drawings, effects on and mitigation for aquatic organisms and communities, water pollution prevention plan	Intakes, stream crossings of pipelines, construction and maintenance roads
Stream Water Diversion Permit	Commission on Water Resources Management	Any new or modified diversion of water from streams for beneficial use	Application will include amount of water to be taken, assessment of other instream and non-instream water uses, design of intake	New stream intakes and change in diversion amount at existing intakes
Department of Army Permit	U.S. Army Corps of Engineers	Any activity resulting in filling of water bodies in the U.S., including flowing streams and wetlands. Fill includes sediment and structures.	Application will require site plan, design, construction methodology, CWA Section 401 Water Quality Certification by Hawaiʻi Department of Health	New stream intakes, road and pipeline crossings of streams and wetlands

Permit Name	Issuer	Trigger	Application Requirements	Project Improvements
Clean Water Act Section 401 Water Quality Certification	Clean Water Branch, Hawaiʻi Department of Health	Required for any Federal permit that will involve discharge into bodies of water including streams and wetlands	Application will require items submitted for Department of Army Permit, environmental and chemical evaluation of receiving water, and Hawaiʻi Water Quality Standards compliance plan	Applies to locations requiring Department of Army Permit

Gabions

	High	Med.	Low
Priority	X		

	High	Med.	Low
Feasibility	X		

Sediment Trapping	X
Nutrient Reduction	X
Flood Mitigation	X
Stormwater Infrastructure	X
Erosion Prevention	
Feral Ungulate Control	

Description: Gabions are wire containers filled with rock, gravel, broken concrete, riprap, or other material to create large blocks. These blocks can be placed within stream beds to create small weirs or dams. As stormwater flows down a gulch, it pools behind the gabions, slowing in velocity and losing erosional force. Pools created by these gabions allow sediment in the water to fall out of suspension. When placed in stepped series, these structures can provide flood protection by dissipating energy in flowing systems. Over time the voids fill with sediment and promote vegetative growth, which will further enhance stormwater slowing and sediment trapping capabilities.

Cost: Gabion wire mesh walls are fairly inexpensive at $60-$100 a cubic yard. Other costs include an environmental assessment, rock fill, engineering, and placement.

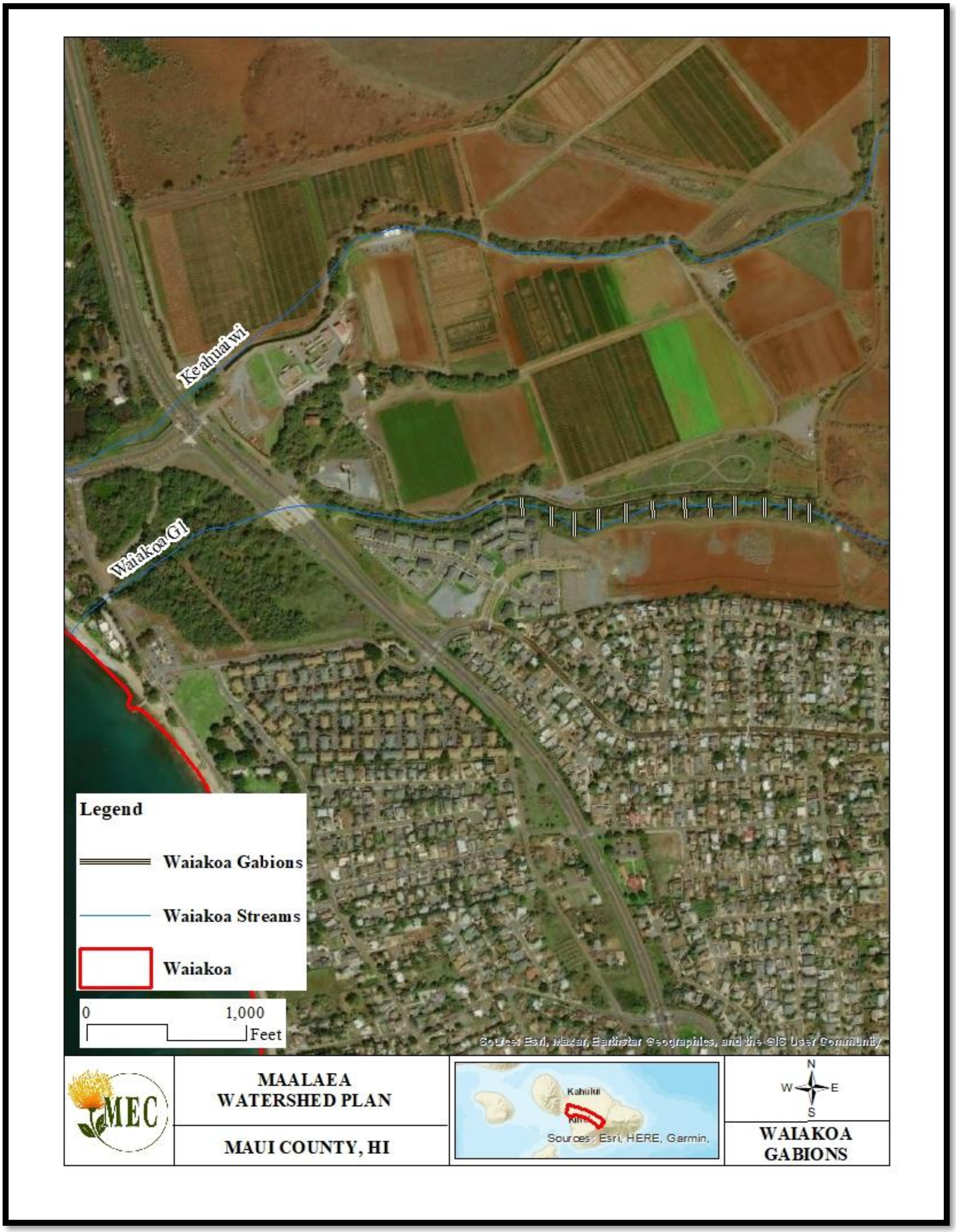
Estimated Load Reductions: Load reductions are highly variable depending on rainfall, land uses, and location, fill materials, and scale of project.

Timeline and Milestones:

Location (Gulch)	Description	Priority	Twenty Year Timeline			
			Present - 2029	2034	2039	2044
Waiakoa Gulches	Install gabions to reduce velocity of flowing stormwater	High	Gabions installed in Waiakoa Gulch	Gabions installed in Keahuaiwi Gulch	Gabions installed in Pūlehu Gulch	Gabions installed in Kolaloa Gulch

The following map provides potential locations for gabion placement in Waiakoa Gulch. Actual placement should be determined by topography, access for installation and maintenance, land ownership, and other factors. The life expectancy of gabion is based on the type of wire used to create the cage and not on the material used as filling. Typically, these cages are constructed of galvanized steel wire with a life expectancy of 50 years.

Proposed Waiakoa Gabions



Potential Permitting Requirements:

Permit Name	Issuer	Trigger	Application Requirements	Project Improvements
Grading and Grubbing Permit	Maui County Department of Public Works	Required for removal of vegetation and earthmoving activities associated with construction	Application will require construction plans to be submitted	Any activity that bares or grades the ground surface, such as structural installation, access roads, and equipment and material staging areas
Stream Channel Alteration Permit	State of Hawaiʻi Commission on Water Resources Management	Any activity which will affect the stream course within the channel of a perennial or intermittent stream. The regulated channel extends to the top of the streambank.	Application will include design drawings, effects on and mitigation for aquatic organisms and communities, water pollution prevention plan	Intakes, stream crossings of pipelines, construction and maintenance roads
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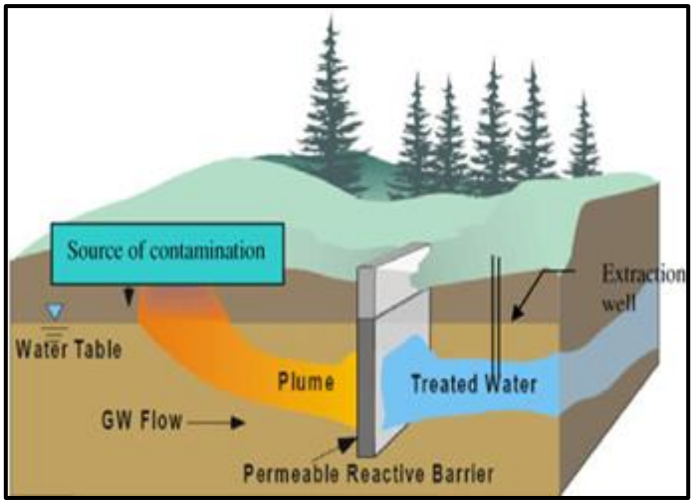
Department of Army Permit	U.S. Army Corps of Engineers	Any activity resulting in filling of water bodies in the U.S., including flowing streams and wetlands. Fill includes sediment and structures.	Application will require site plan, design, construction methodology, CWA Section 401 Water Quality Certification by Hawaiʻi Department of Health	New stream intakes, road and pipeline crossings of streams and wetlands
Clean Water Act Section 401 Water Quality Certification	Clean Water Branch, Hawaiʻi Department of Health	Required for any Federal permit that will involve discharge into bodies of water including streams and wetlands	Application will require items submitted for Department of Army Permit, environmental and chemical evaluation of receiving water, and Hawaiʻi Water Quality Standards compliance plan	Applies to locations requiring Department of Army Permit

Golf Course Nutrient Curtain



	High	Med.	Low
Priority		X	

	High	Med.	Low
Feasibility		X	

Sediment Trapping	
Nutrient Reduction	X
Flood Mitigation	
Stormwater Infrastructure	
Erosion Prevention	
Feral Ungulate Control	

Description: A 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.

Cost: Costs are highly variable nutrient curtain installation. An estimated cost is $15,000. 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).

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**

Estimated Load Reductions: Load reductions would be determined based on current landscaping practices and overall project design.

Timeline and Milestones:

Location (Gulch)	Description	Priority	Twenty Year Timeline			
			Present - 2029	2034	2039	2044
Kahili and Kamehameha Golf Courses within Waikapū Watershed	Install nutrient curtains to filter excess nutrients and pollutants from groundwater	Medium	Nutrient curtain installed at Kahili Golf Course	Nutrient curtain installed at Kamehameha Golf Course	Nutrient Curtain installed at Kahili Golf Course	Nutrient curtain installed at Kamehameha Golf Course

Potential Permitting Requirements:

Permit Name	Issuer	Trigger	Application Requirements	Project Improvements
Grading and Grubbing Permit	Maui County Department of Public Works	Required for removal of vegetation and earthmoving activities associated with construction	Application will require construction plans to be submitted	Any activity that bares or grades the ground surface, such as structural installation, access roads, and equipment and material staging areas
Department of Army Permit	U.S. Army Corps of Engineers	Any activity resulting in filling of water bodies in the U.S., including flowing streams and wetlands. Fill includes sediment and structures.	Application will require site plan, design, construction methodology, CWA Section 401 Water Quality Certification by Hawaiʻi Department of Health	New stream intakes, road and pipeline crossings of streams and wetlands
Clean Water Act Section 401 Water Quality Certification	Clean Water Branch, Hawaiʻi Department of Health	Required for any Federal permit that will involve discharge into bodies of water including streams and wetlands	Application will require items submitted for Department of Army Permit, environmental and chemical evaluation of receiving water, and Hawaiʻi Water Quality Standards compliance plan	Applies to locations requiring Department of Army Permit

Land Slide Mitigation

	High	Med.	Low
Priority	X		

	High	Med.	Low
Feasibility		X	

Sediment Trapping	X
Nutrient Reduction	X
Flood Mitigation	X
Stormwater Infrastructure	
Erosion Prevention	X
Feral Ungulate Control	

Description: 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. Landslides are discussed in Chapter 5 Section 2 of the Hawaiʻi Watershed Guidance report, and areas with high erosion potential need to be identified and addressed. Preserving high quality functional, native habitat should be a priority. Drawing upon lessons learned from projects conducted in Hawaiʻi 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.

Cost: Costs will vary based on location, accessibility, planting density, plant availability, and project goals. To revegetate the landscape at a moderate density (200 plants per acre) would cost approximately $5,800 per acre.

Cost Estimates for 1 Acre of Revegetation

Item	**Cost**
Plants	$800 ($4.00 x 200 plants)
Installation and Maintenance	$8,000
TOTAL	**$8,800**

Estimated Load Reductions: Load reductions are dependent on topography, project design, and stabilization methodology.

Timeline and Milestones:

Location (Gulch)	Description	Priority	Twenty Year Timeline			
			Present - 2029	2034	2039	2044
Mauka regions of Waikapū Watershed	Stabilize hillslopes to prevent landslides from occurring	High	Five hillslopes stabilized	Ten hillslopes stabilized	15 hillslopes stabilized	20 hillslopes stabilized

*Assesments should be made annually to determine and prioritize locations for hillslope stabilization projects

Permitting Requirements:

Permit Name	Issuer	Trigger	Application Requirements	Project Improvements
Grading and Grubbing Permit	Maui County Department of Public Works	Required for removal of vegetation and earthmoving activities associated with construction	Application will require construction plans to be submitted	Any activity that bares or grades the ground surface, such as structural installation, access roads, and equipment and material staging areas

*A grading and grubbing permit may not be required, depending on project needs and designs

Reef Friendly Landscaping

Photo courtesy of Maui Nui Marine Resource Council

	High	Med.	Low
Priority	X		

	High	Med.	Low
Feasibility	X		

Sediment Trapping	
Nutrient Reduction	X
Flood Mitigation	
Stormwater Infrastructure	
Erosion Prevention	
Feral Ungulate Control	

Description: Chemical-free alternatives to synthetic pesticides, herbicides, and fertilizers should be considered to meet landscaping needs. Organic products enhance soil health by restoring the soil microbiome to create ideal conditions that support healthy vegetative growth while fighting against pests and disease. Healthy, biodiverse soils become low-maintenance and cost-saving once established. Maui Nui Marine Resource Council has conducted several pilot projects that demonstrate the success of biological soil amendments. MNMRC has also developed a Reef Friendly Landscaping (RFL) Certification program, where interested parties can obtain a free consultation with an organic land care consultant and receive recommendations on products, equipment, and resources to aid in the transition to reef friendly landscaping. Reef-friendly landscaping practices can be adopted by commercial and residential properties alike. More information can be found on Maui Nui Marine Resource Council's Page. https://www.mauireefs.org/residential-reef-friendly-landscaping/

Cost: Costs are highly variable depending on project objectives and property types. Large, commercial test plots can cost upwards of $12,000 per acre for labor and product application. Individuals can purchase a compost tea kit (organic soil amendments) for as little as $120.00.

Estimated Load Reductions: Load reductions would be determined based on current landscaping practices and the scale of project implementation.

Timeline and Milestones:

Location (Gulch)	Description	Priority	Twenty Year Timeline			
			Present - 2029	2034	2039	2044
Commercial and private properties throughout Waikapū and Waiakoa Watersheds	Utilize organic products to enhance soil health and meet landscaping needs.	High	Obtain RFL Certification for Kahili Golf Course	Obtain RFL Certification for Kamehameha Golf Course	Obtain RFL certification for Keālia Resort and Sugar Beach Resort	Obtain RFL certification for Māʻalaea Surf Resort and Kīhei Beach Condos

Potential Permitting Requirements:
Transitioning to organic, reef-friendly landscaping practices should not require any permits.

Regional Stormwater Management Park

	High	Med.	Low
Priority	X		

	High	Med.	Low
Feasibility		X	

Sediment Trapping	X
Nutrient Reduction	X
Flood Mitigation	X
Stormwater Infrastructure	X
Erosion Prevention	
Feral Ungulate Control	

Description: Stormwater management parks are essentially large, shallow detention basins engineered to be multifunctional and utilized as recreational facilities or open spaces such as community parks, sports fields, community gardens, dog parks, etc. During times of heavy rainfall, they collect stormwater and provide flood control, stormwater treatment, wetland protection, and contribute to aquifer recharge. The Weinburg Property, located just mauka of South Kīhei Road and immediately above the outfall of Waiakoa Gulch into the Pacific Ocean, could be repurposed as a community park.

Across North Kīhei Road, Keahuaiwi Gulch discharges into a narrow strip of land immediately north of North Kīhei Road, before flowing into Keālia Pond. Adjacent landowners include the State of Hawaiʻi and Mahi Pono. While Keahuaiwi Gulch does not discharge frequently, when it does, it typically floods into the intersection of North and South Kīhei Roads. Like the Weinburg property on the south side of this intersection, the State of Hawaiʻi and Mahi Pono properties should be repurposed to capture flood waters from Keahuaiwi Gulch and properly direct stormwater towards Keālia Pond.

Costs: Costs for a Regional Stormwater Management Park are difficult to estimate. Because these areas are typically public spaces, the cost to purchase the land by the County should be included in the total price. To create the basin, costs would be similar to a detention basin as outlined in 9.2.3. Additional costs would be to landscape the area or place infrastructure such as parking, fences, and other facilities.

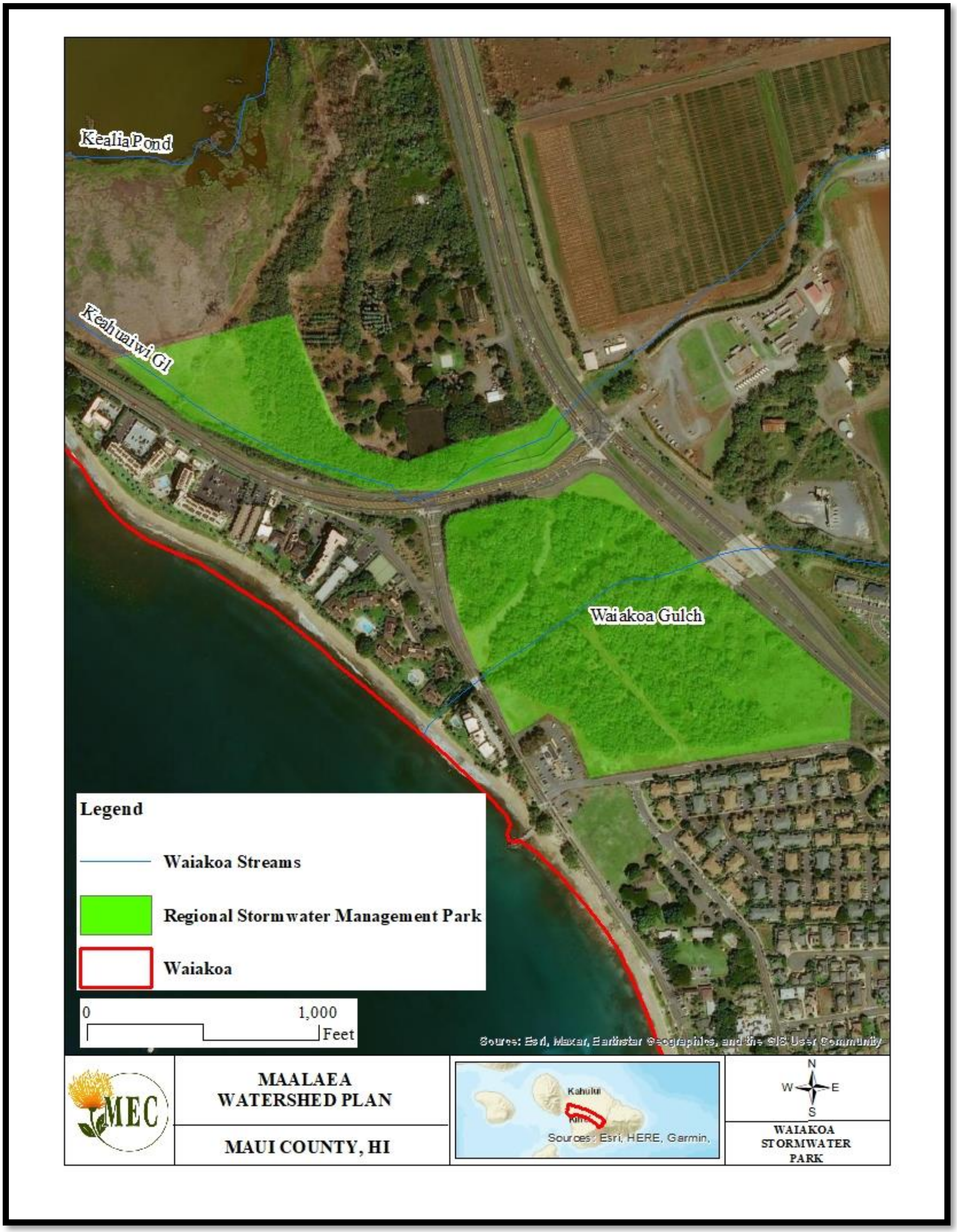
Estimated Load Reductions:

Basin	Acreage Based on Map Renderings	Pollutant Load Reduction		
		N Reduction	P Reduction	Sediment Reduction
		lb/year	lb/year	t/year
Regional Stormwater Management Park	45.43	35.69	3.09	1.60

Timeline and Milestones:

Proposed Location (Gulch)	Description	Priority	Twenty Year Timeline			
			Present - 2029	2034	2039	2044
Outfalls of Waiakoa and Keahuaiwi Gulches	Build stormwater management park to be utilized dually for community park and flood control	High	Conduct engineering, permitting, environmental assessments, overall project design and construct first stormwater management park	Continued maintenance	Conduct engineering, permitting, environmental assessments, overall project design and construct 2nd stormwater management park	Continued maintenance

Waiakoa Potential Stormwater Management Park Location



***Locations depicted are for illustrative purposes and may not represent property owner intentions for these areas.**

Potential Permitting Requirements:

Permit Name	Issuer	Trigger	Application Requirements	Project Improvements
Grading and Grubbing Permit	Maui County Department of Public Works	Required for removal of vegetation and earthmoving activities associated with construction	Application will require construction plans to be submitted	Any activity that bares or grades the ground surface, such as structural installation, access roads, and equipment and material staging areas
Special Management Area (SMA) Permit	Maui County	Required for any work being conducted in the Special Management Area	Application will require plots/drawings of work being conducted	Any use, activity, or operation qualifying as "development", and has a total cost fair market value of $500,000 or more; or has significant adverse environmental or ecological effect within the Special Management Area.
Perform Work on County Highway Permit	Maui County Department of Public Works	Required when a County roadway is disturbed by installation of pipelines	Application will require construction plans for the affected area	Any activities affecting County-owned roadways or structures, such as pipeline installation, use of bridges, and traffic control
Stream Channel Alteration Permit	State of Hawaiʻi Commission on Water Resources Management	Any activity which will affect the stream course within the channel of a perennial or intermittent stream. The regulated channel extends to the top of the streambank.	Application will include design drawings, effects on and mitigation for aquatic organisms and communities, water pollution prevention plan	Intakes, stream crossings of pipelines, construction and maintenance roads
Stream Water Diversion Permit	Commission on Water Resources Management	Any new or modified diversion of water from streams for beneficial use	Application will include amount of water to be taken, assessment of other instream and non-instream water uses, design of intake	New stream intakes and change in diversion amount at existing intakes

Permit Name	Issuer	Trigger	Application Requirements	Project Improvements
Department of Army Permit	U.S. Army Corps of Engineers	Any activity resulting in filling of water bodies in the U.S., including flowing streams and wetlands. Fill includes sediment and structures.	Application will require site plan, design, construction methodology, CWA Section 401 Water Quality Certification by Hawaiʻi Department of Health	New stream intakes, road and pipeline crossings of streams and wetlands
Clean Water Act Section 401 Water Quality Certification	Clean Water Branch, Hawaiʻi Department of Health	Required for any Federal permit that will involve discharge into bodies of water including streams and wetlands	Application will require items submitted for Department of Army Permit, environmental and chemical evaluation of receiving water, and Hawaiʻi Water Quality Standards compliance plan	Applies to locations requiring Department of Army Permit
National Pollution Discharge Elimination System (NPDES) Permit	Clean Water Branch, Hawaiʻi Department of Health	Required for construction site runoff management when construction area exceeds one acre and if the operation of the improvement results in discharge into water bodies	Application will require sediment and runoff management designs and a water quality monitoring plan	Applies to all construction sites with potential of erosion and runoff
Use and Occupancy Permit/Construction within a State Highway Permit	Division of Highways, State of Hawaiʻi, Department of Transportation	Required for surveying, materials testing, and construction affecting State-owned roadways	Permit will depend on phase of work with full plans required for construction activities	Any activities that affect State-owned roadways or structures, such as pipeline installation, use of bridges, and traffic control

Unimproved Road Stabilization

	High	Med.	Low
Priority		X	

	High	Med.	Low
Feasibility	X		

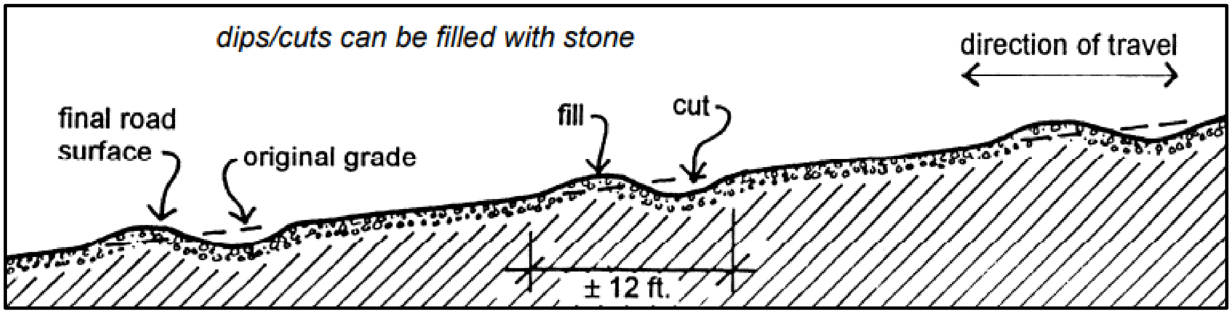
Sediment Trapping	X
Nutrient Reduction	
Flood Mitigation	X
Stormwater Infrastructure	
Erosion Prevention	X
Feral Ungulate Control	

Description: Miles of poorly maintained and disused former agricultural roads are major sources of sediment transfer and pathways for channeling stormwater runoff into stream gulches. As mentioned in Chapter 5 Sections 2 and 3 of the Hawaiʻi Watershed Guidance report, proper road management and runoff mitigation efforts are important to consider in managing pollution within a watershed. A comprehensive inventory of the Waiakoa and Waikapū roads should be conducted to determine stakeholder access needs and to identify those 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. In coordination with landowners and potential road users, disused, and unnecessary or redundant roadways should be identified for decommissioning. Any roads likely to stay in use should be improved using water bars, sediment traps and other BMPs to minimize downslope transport of eroded sediments. Several appropriate BMPs can be found in the document entitled: Unpaved Road Standards for Caribbean and Pacific Islands. Common drainage control techniques highlighted in the document include grade breaks, dips and low water crossings, water bars, cross-drains and culverts, ditches, turnouts, sediment traps, geosynthetics, soil and/or aggregate stabilization, and slope stabilization. Examples from the *Gravel Road Maintenance Manual: A Guide for Landowners on Camp and Other Gravel Roads* are displayed below.

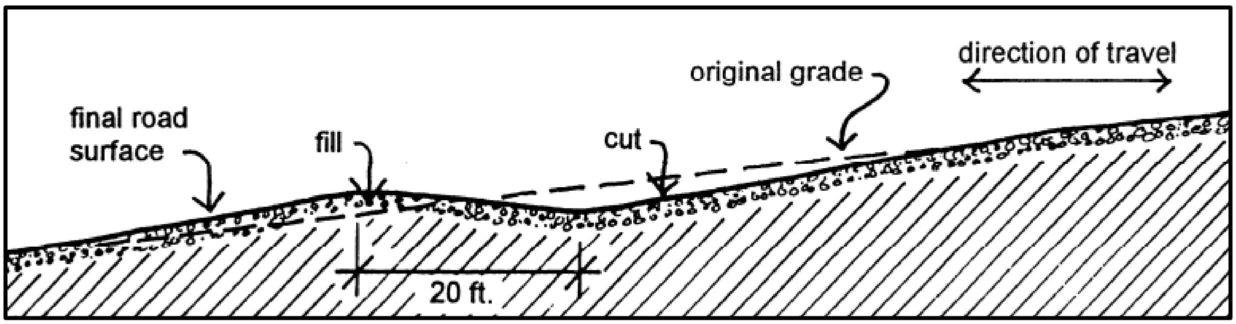
https://www.maine.gov/dep/land/watershed/camp/road/gravel_road_manual.pdf

Mahi Pono and other agricultural entities should conduct an assessment of the current necessity and future needs of dirt agriculture roads within the Waikapū and Waiakoa Watersheds. 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. 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.

Water Bar Example Diagram



Water Dip Example Diagram



Diagrams are courtesy of Brian Kent from the *Gravel Road Maintenance Manual: A Guide for Landowners on Camp and Other Gravel Roads*.

Roads identified for stabilization and/or closure should be prioritized based on 1) utility 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.

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 ranchers, fire crews, rangers, illicit dirt bikers, hunters, hikers, etc. to help select appropriate sites, and to ensure the purpose of the road closure is understood and not damaged or tampered with. Signage can be useful to convey this information.

Cost Estimates for Road Stabilization Based on a Project in the Pōhākea Watershed

Task Description	Unit	Unit Price	Total Price
Mobilization	NA	$5,000	$5,000
Water Truck	10 Days	$1,530	$15,300
Spencer Road Grading	7920	$23	$182,160
MECO Road Grading	7920	$28	$221,760
Herbicide Treatments	15,840	$1	$16,000
Total Price			$440,220

Estimated Load Reductions:

Watershed	Unpaved Roads	Bare Ground Soil Loss	Potential Soil Loss in Tons from Unimproved Roads	Dense Groundcover Soil Loss	Potential Soil Loss in Tons if all Unimproved Roads were Grassed Over
	Acres	Tons per Acre per Year		Tons per Acre per Year	
Waikapu	123	4.7	578.1	0.006	0.738
Waiakoa	367	4.7	1724.9	0.006	2.202

To approximate the sediment reduction accomplished by the decommissioning of roads in the Waikapū and Waiakoa Watersheds, MEC used the RUSLE2 program. Several data points were entered into the program, including rainfall of 15-16 inches, major soil types, and a slope length of 1400 feet. Slope steepness was assumed to be approximately 6% based on contours and map measurements. Without any BMPs, soil loss was estimated to be 4.7 tons per acre of road. To calculate areage of dirt roads, the lengths in miles were converted to feet and multiplied by a assumed constant width of 20 feet. Once an area of dirt road was calculated in square feet, it was converted to acres of bare ground dirt road. Because much of the lower agricultural roads are associated with pastureland, the Dense Grass – Not Harvested BMP was entered into the program. RUSLE2 estimated soil loss to be lowered to 0.006 tons per acre, significantly reducing soil loss from agricultural roads.

Timeline and Milestones:

Location (Gulch)	Description	Priority	Twenty Year Timeline			
			Present - 2029	2034	2039	2044
Throughout Watersheds	Decommission, repair, and stabilize roads to prevent erosion	Medium	Conduct assessment and inventory of roads. Begin repair and stabilization of priority roads	Conduct additional assessments every five years and repair roads as necessary	Conduct additional assessments every five years and repair roads as necessary	Conduct additional assessments every five years and repair roads as necessary

Potential Permitting Requirements:

Permit Name	Issuer	Trigger	Application Requirements	Project Improvements
Grading and Grubbing Permit	Maui County Department of Public Works	Required for removal of vegetation and earthmoving activities associated with construction	Application will require construction plans to be submitted	Any activity that bares or grades the ground surface, such as structural installation, access roads, and equipment and material staging areas
Special Management Area (SMA) Permit	Maui County	Required for any work being conducted in the Special Management Area	Application will require plots/drawings of work being conducted	Any use, activity, or operation qualifying as "development", and has a total cost fair market value of $500,000 or more; or has significant adverse environmental or ecological effect within the Special Management Area.

Wetland and Stream Riparian Buffers and Protection

	High	Med.	Low
Priority	X		

	High	Med.	Low
Feasibility		X	

Sediment Trapping	X
Nutrient Reduction	X
Flood Mitigation	X
Stormwater Infrastructure	
Erosion Prevention	X
Feral Ungulate Control	X

Description: Riparian buffers along gulches and gullies prevent sediment laden sheet flow from entering flow ways and ultimately discharging into coastal waters. They also offer important habitat for native flora and fauna to inhabit from mauka to makai throughout the watershed. Existing wetlands should be delineated, protected and restored wherever possible. Wetlands have the ability to filter stormwater from sediment, nutrients and pathogens, they serve as flood prevention and aquifer recharge locations, and provide habitat for native flora and fauna. Lastly, wetlands represent greenspace within urban communities, offering a place for recreation that can improve the community's relationship with the natural environment.

The U.S. Army Corps of Engineers (USACE) has regulatory authority over wetlands and other water bodies of the U.S. (WBUS) based on two federal laws. These include Section 404 of the Clean Water Act (CWA) of 1972, and Section 10 of the Rivers and Harbors Act of 1899.

Section 404 of the CWA states that dredged and fill material may not be discharged into jurisdictional WBUS (including wetlands) without a permit. According to 40 CFR 230.3, WBUS subject to agency jurisdiction under Section 404 include navigable waters and their tributaries, interstate waters and their tributaries, wetlands adjacent to these waters, and impoundments of these waters.

A Section 404 permit is required for all fill or discharge activities below the high tide line in tidal waters or below the ordinary high-water mark (OHWM) for non-tidal, non-wetland waters. Corps regulations define the term "ordinary high-water mark" for purposes of the CWA lateral jurisdiction at 33 CFR 328.3(e), which states:

"The term ordinary high-water mark means that line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas."

The Rivers and Harbors Act of 1899 prevents unauthorized obstruction or alteration of navigable WBUS. Navigable waters are defined as waters that are "subject to the ebb and flow of the tide and/or presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce” (33 Code of Federal Regulations [CFR] 325.5(c)(2)). A Section 10 permit is required for non-fill discharging activities proposed in, over, or under WBUS.

In May of 2023, the United States Supreme Court released an opinion in Sackett v. EPA, in which the Court unanimously held that the Environmental Protection Agency (EPA) overstepped its jurisdiction in classifying wetlands on the Sackett property as “waters of the United States” (WOTUS). The court stated: “…the CWA extends to only those wetlands that are “as a practical matter indistinguishable from waters of the United States.” This requires the party asserting jurisdiction over adjacent wetlands to establish “first, that the adjacent [body of water constitutes]… ‘water[s] of the United States,’ (i.e., a relatively permanent body of water connected to traditional interstate navigable waters); and second, that the wetland has a continuous surface connection with that water, making it difficult to determine where the ‘water’ ends and the ‘wetland’ begins.”

In October of 2022 the Maui County Council passed a bill to protect and restore wetlands (Ordinance 5421). As a requirement of this law, a wetland overlay map is being created. Any wetlands that contain at least two of the three wetland indicators listed by the USACE in their wetland delineation manual and any flow through systems depicting a high-water mark as defined in the 2005 USACE Regulatory Guidance Letter on Ordinary High Water Mark Determination are now considered protected by the bill. County protections may include 50-to-200-foot buffers placed around the wetland edges and stream banks as determined by the Maui County Planning Department.

The Keokea Riparian Rehabilitation project is a pilot project funded by the HDOH and Maui County to show the proof of concept of large-scale riparian protection. The project consisted of first protecting the Keokea riparian zone with the installation of feral ungulate fencing. Next, R-1 dripline irrigation infrastructure was installed. This infrastructure included over 9,000 feet of dripline and approximately 3,000 emitters. Next, native dryland forest plant species were planted at each emitter. Each plant is watered with one gallon per day. Additional riparian rehabilitation projects are being proposed for streams within the Hapapa Watershed (covered by the Southwest Maui Watershed Plan).

Cost: Costs can vary depending on buffer size and project objectives. An estimated cost to restore 10.8 acres of a riparian corridor along Waiakoa Gulch is $173,280.

Cost Estimates for 10.8 Acres of Riparian Rehabilitation Along Waiakoa Gulch

Task	Cost per Unit	Number of Units	Total Cost
Weekly fencing and irrigation infrastructure inspections	$550.00	52	$28,600.00
Fencing Materials	$30.00	3,896	$116,880.00
Irrigation Infrastructure	$4,000.00	1	$4,000.00
Irrigation installation and planting	$2,200.00	5	$11,000.00
Plants	$4.00	1,000	$4,000.00
Quarterly vegetative monitoring, photo documents, drone flights	$1,100.00	4	$4,400.00
Quarterly and annual reports	$1,100.00	4	$4,400.00
Total Cost		$173,280.00	

Estimated Load Reductions: The table below depicts the STEPL pollution load reduction estimates for the proposed Waiakoa Riparian Rehabilitation Project.

N Reduction	**P Reduction**	**BOD Reduction**	**Sediment Reduction**
Pounds/Year	Pounds/Year	Pounds/Year	Tons/Year
1086.4	339	1475.1	230.5

Timeline and Milestones:

Location (Gulch)	Description	Priority	Twenty Year Timeline			
			Present - 2029	2034	2039	2044
Throughout Watersheds	Protect and restore buffers along gulches and wetalnds	High	Protect riparian corridor of Waiakoa Gulch	Protect riparian corridor of Keahuaiwi Gulch	Protect riparian corridor of Waikapū Gulch (east)	Rehabilitate riparian corridor of Waikapū Gulch (west)

Riparian protection should be performed in conjuction with restoration efforts conducted at Keālia Pond.

Potential Permitting Requirements:

No permits should be needed for fencing and irrigation installation and restoring vegetative cover.

Riparian Rehabilitation Proposed along Waiakoa Gulch.