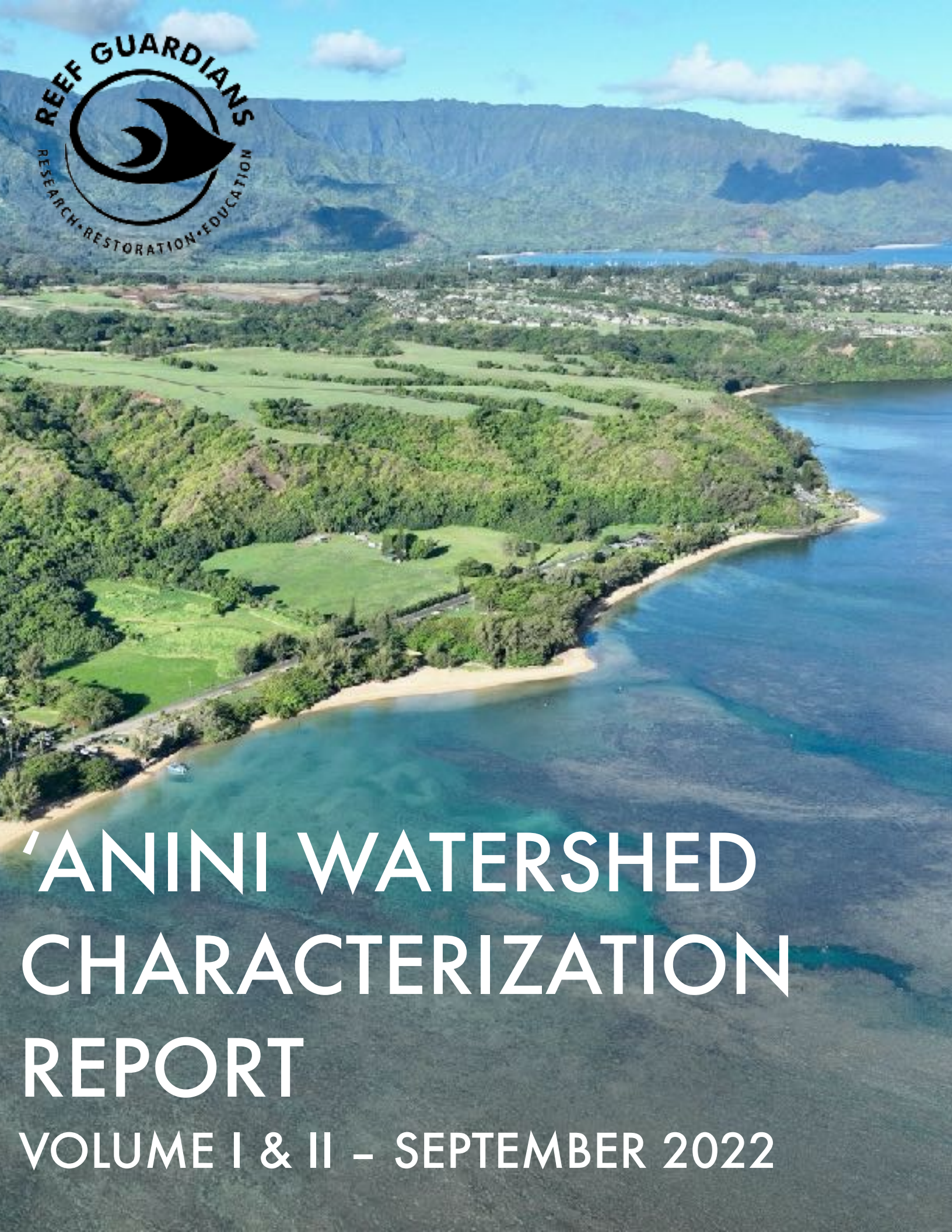

ʻANINI WATERSHED CHARACTERIZATION REPORT

VOLUME I & II – SEPTEMBER 2022

Volume I

September 2022

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Executive Summary

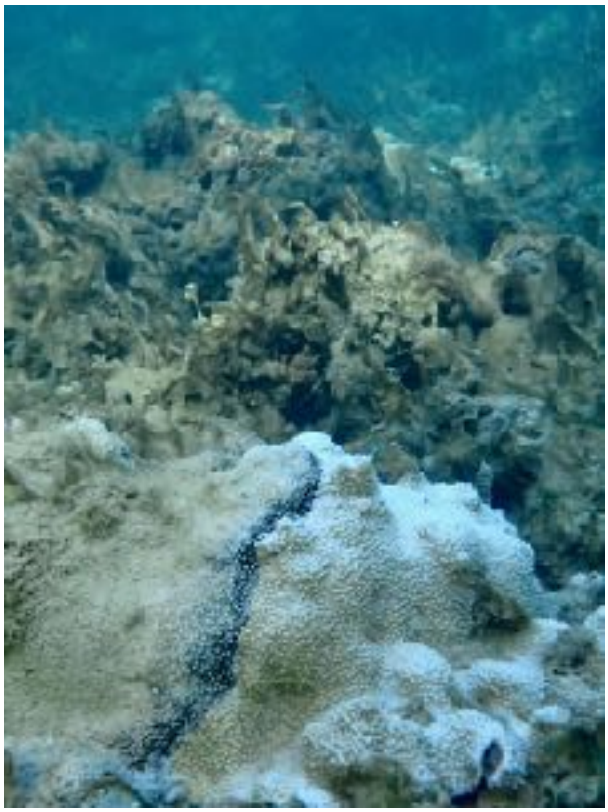
Reef Guardians Hawaii, hereafter RGH, is a non-profit 501(c)3 organization with the mission to preserve our reefs and near-shore environments through research, restoration and education. Thanks to the heart-based support from the citizens of Kauai, other Hawaiian Islands, and the mainland US, this report presents our findings with regard to the influence from nearby lands (Ahupua'a: Hanalei [Princeville], Kalihikai and Kalihiwai) surrounding and negatively impacting the streams which in turn flow into the lagoon and near-shore reefs. RGH's emphasis is on the recovery and restoration of this culturally and economically valuable natural habitat. This is our kuleana, the restoration of the flora, fauna and ecology.

Our report compiles existing research on the watershed that flows into Anini waters, some sources of water pollutants with locations of water quality impairment, and many other environmental factors. RGH suggests adherence to existing legal "Best Management Practices" to follow up with fines for noncompliance. RGH recommends increased funding for more comprehensive monitoring of sources of pollution. Achieving our goals will sustainably and economically assist this multi-use, culturally sensitive residential and visitor destination area of Kaua'i for future generations. Goals include improvement and protection of the water quality of all run-off emptying into 'Anini's fringing reef and waters.

Ua Mau ke Ea o ka 'Aina i ka Pono. This is most commonly translated as "the life of the land is perpetuated in righteousness."

Residents of Anini Lagoon

Antler coral in Anini lagoon is home for many marine animals including this Arc-Eye Hawkfish. This coral colony is winning the battle with the algae and cyanobacteria growth for now while others don't survive. Photographed Sept. 4, 2022.



Rice coral with blackband disease and cyanobacteria covering dead coral of 'Anini reef. Photographed August 22, 2022.

Monk seal pup at Anini lagoon (Endangered species) photographed March 24, 2022

Honu (Green Sea Turtle, Endangered species) swimming through cyanobacteria covered area of Anini lagoon. Photographed Sept. 2, 2022.

1. Introduction

The ʻAnini lagoon is the home and nursery for many of Kaua'i's reef fish species, invertebrates, and limu (algae). It is the home, food source and refuge for endangered sea turtles (both honu and honuea) and endangered monk seals. Indigenous ʻulili (Wandering Tattler) birds forage along the shore and muliwai (stream mouths). And above on land, endangered and indigenous birds forage in the wetlands which feed into the streams and underwater paths to the once pristine sea.

The ʻAnini area of Kauaʻi, Hawaiʻi is a diverse ecological system that holds great cultural and economic value. The inland streams, watersheds, marine waters, and fringing reef are historically understudied and not currently monitored on a routine basis. The ʻAnini watershed, as delineated by the Department of Aquatic Resources (DAR), encompasses the ʻAnini stream, yet the fringing reef extends westward and eastward of its boundaries. Outside of the watershed, there are other freshwater inputs and areas of runoff that affect the condition of the reef. ʻAnini's reef suffers from algal overgrowth and disease outbreaks facilitated by pollution carried in by freshwater inputs, including groundwater. This report focuses on the broader Anini region from mauka (toward the mountains) to makai (toward the sea) where land-based pollution impacts the ecosystem.

1.1 Geographic Scope

The ʻAnini watershed, with boundaries classified by the DAR, is within the Halele'a moku (district) of Kaua'i and is split between the ahupua'a (land divisions) of Hanalei and Kalihikai. This watershed covers about 0.5 miles of coastline, and encompasses the ʻAnini stream, which runs for about 10.5 miles from mauka to makai. The ʻAnini stream mouth lies on the western edge of ʻAnini beach within the Hanalei ahupua'a, and within the ʻili (subdivision of ahupua'a) known as ʻAnini or Wanini. This report also focuses on the eastern stretch of ʻAnini beach and inland areas within the ahupua'a of Kalihikai and Kalihiwai. This eastern section of ʻAnini beach stretches for about 1.5 miles, a portion of which is managed by the county of Kauaʻi as ʻAnini Beach Park. This section of beach contains the stream mouths of Honu, Kalihikai, and Kowali streams. The coast of ʻAnini beach is lined with fringing reefs that protect the shoreline from high surf activity, creating a lagoon, and the reefs are cut with multiple channels connecting the inner lagoon to the outer surf. The coastal and inland areas of Hanalei, Princeville, Kalihiwai, and Kilauea towns are also discussed in this report. Reference Figure 1 for a map of the general geographic scope for this report, and Appendix A: Topographic Map.

1.2 Pollutants and Impact on Water Quality

To determine the condition of a watershed and various water quality parameters, standardized monitoring and reporting are necessities. Water quality characteristics addressed in this report include turbidity, nutrients, chlorophyll-a, and *Enterococcus*. Turbidity is a

measurement of water clarity based on suspended materials in the water, including soil particles, algae, and microbes. Increased particles in the water can block sunlight, limiting photosynthesis for corals, algae, and other photosynthetic organisms. Decreased photosynthesis will lead to decreased oxygen production in the water. Suspended particles also absorb heat from the sun, which increases water temperature. Warmer water is unable to hold as much dissolved oxygen as compared to colder water, thus further depleting oxygen levels. Less dissolved oxygen in the water means that there is less oxygen for organisms that require oxygen for respiration, including fishes. Particles associated with high turbidity can also smother corals, plants, and fish eggs, as well as clog up the gills of fishes. Sources of increased turbidity include soil and stream bank erosion, wastewater discharge, urban runoff, and excessive algal growth (Environmental Protection Agency, 2012).

Additional pollutants include toxic substances, including metals and chemical compounds such as glyphosate. Metals that are leached from poor industrial wastewater management, including zinc, lead, aluminum, and iron can contaminate both surface and groundwater, and affect the biological functions, endocrine systems, and overall growth of organisms that interact with the contaminated environment (Okereafor, et al., 2020). Glyphosate, a compound associated with some herbicides, can leach into waterways from agricultural runoff or private home and business use near streams and oceans. Increased levels of glyphosate are associated with many toxicological effects on organisms, including decreased rates of photosynthesis, decreased mycorrhizal fungal growth, cytotoxicity, damage to DNA, and disruption in hormones (Gill et al., 2017).

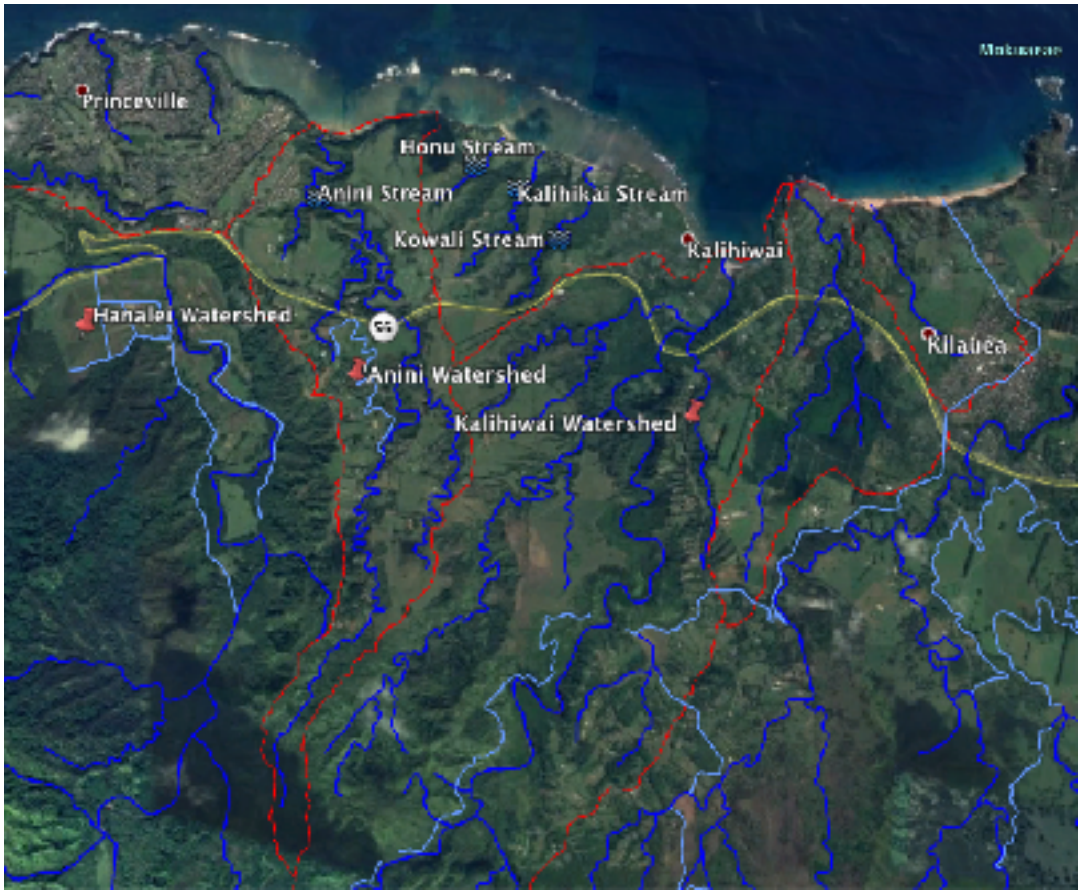


Figure 1: The 'Anini watershed and broader geographic scope utilized for this report. Watersheds, as delineated by the Department of Aquatic Resources (DAR), are outlined in red courtesy of the DAR Watersheds layer for Google Earth. Streams are outlined in dark blue, and canal ditches are outlined in light blue courtesy of the Environmental Protection Agency's WATERS layer for Google Earth.

Nutrients generally associated with water quality include nitrogen (nitrite, nitrate, ammonia), and phosphorus. Though these nutrients occur naturally in various environments, excess introduction of these nutrients is considered pollution. Sources of excess nitrogen and phosphorus include runoff associated with agriculture, stormwater, wastewater, fossil fuels, and fertilizers applied around the yards of households and businesses. Submarine groundwater discharge can also introduce these nutrients into the marine environment. Excess nutrients can facilitate harmful algal blooms that can increase turbidity and impair the ability of aquatic life to locate food. As algal blooms die, they consume oxygen, thus depleting oxygen levels of the surrounding environment. This phenomenon can eventually lead to hypoxic zones, also known as "dead zones", of minimal oxygen (Environmental Protection Agency, 2019). The process of oxygen deprivation due to excess nutrient loading is known as eutrophication. As algal blooms die, they release carbon dioxide as a byproduct, which causes the pH of the water to lower, or acidify. The acidification of streams, estuaries, and marine waters is detrimental to the reproductive, developmental, and feeding processes of many organisms (National Ocean Service, n.d.) . Additionally, marine algae can compete with coral polyps for substrate, reducing the opportunity for new coral growth (Henkel, 2010). Due to the year-round growing seasons for agriculture in Hawai'i, it is pertinent for the state to monitor, report, and mitigate nutrient-related pollution (Hawai'i Clean Water Branch, n.d.).

Chlorophyll-a is a predominant type of chlorophyll found in plants, and measurements of chlorophyll-a levels in waters can be used as a proxy of algal biomass. Waters that have excess nutrient loadings may have large amounts of algae, and therefore would generally measure high levels of chlorophyll-a (Environmental Protection Agency, 2016).

Enterococcus measurements refer to *enterococci* bacteria, a bacterium that lives in the intestinal tracts of warm-blooded animals. The presence of *Enterococcus* can be an indicator of contamination via fecal waste. *Enterococcus* can be an indicator of other disease-causing microbes, including bacteria, viruses and protozoa that can cause negative health effects in humans, including irritated skin, eyes, ears, respiratory tract, and gastrointestinal tract. High measurements of *enterococci* levels will cause managing authorities to temporarily close access to waterways in order to protect human health (Environmental Protection Agency, 2016).

1.2.1 Point and Nonpoint Source Pollution

Anthropogenic (human caused) pollution into waterways and the ocean is categorized into two main classes: point source and nonpoint source. Point source pollution refers to an identifiable source of pollution discharge and is often associated with a permit and monitoring efforts to mitigate negative ecological impacts. Point sources of pollution in waterways can include wastewater and industrial facilities that discharge pollutants as effluents and soil disturbance from grubbing and grading that discharges sediments. In contrast, nonpoint source pollution is the result of multiple diffuse sources. This can include land and agricultural runoff, precipitation, groundwater seepage, drainage, hydrologic modification, and atmospheric deposition. Potential contaminants from these sources include excess fertilizers, pesticides, herbicides, insecticides, oil, toxic chemicals, sediment, salt, acid, and bacteria. Various land use practices can contribute to nonpoint source pollution levels within a watershed (Environmental Protection Agency, 2020). Cesspools and other wastewater systems are discussed in section 3. Water Quality.

Figure 2: Point sources of pollution in waterways can include soil disturbance from grubbing and grading that discharges sediments. The current grubbing and grading of Princeville's Prince Golf Course as seen in this image photographed on August 31, 2022 is discussed in section 2 Watershed Characteristics.

Figure 3: A wetland bird 'auku'u (Black-crowned Night Heron) perched on a warning sign at a Princeville Makai Golf Course photographed Sept. 9, 2022. Some of the R-2 effluent from the Princeville Wastewater Treatment Center is stored in the Makai Golf Course's ponds (L. Vetter, Dept. of Health, Wastewater Branch, personal communication, November 18, 2020). R-2 water refers to recycled water that is disinfected and oxidized to a degree but is not potable. The stormwater utilized for dilution and R-2 water is recognized to contain nutrients and other toxic compounds that could spread to groundwater and runoff that can flow to the ocean.

2. Watershed Characteristics

2.1 Freshwater Streams

The ʻAnini watershed, as delineated by the DAR, covers 2.3 square miles and has a maximum elevation of 1037 ft. The upper watershed is steep, and the coastline recesses into a slight embayment. ʻAnini stream originates roughly 2.5 miles mauka of (up from) Kuhio Highway, and forks to cross the highway in two separate locations. There are three other locations where roadways cross ʻAnini stream (Figure 4). There is little recorded data on ʻAnini stream's discharge rates. Two miscellaneous discharge rates measured in April and June of 1962 by the United States Geological Survey (USGS), recorded at roughly 0.2 miles above the ʻAnini stream mouth, reported rates of 2.64 million gallons per day (MGD)/4.08 cubic feet per second (CFS) in April, and 1.99 MGD/3.08 CFS in June (United States Geological Survey, 1963). Details about this sampling location can be found in 3.5 Safe Drinking Water Branch Permits**.** The Environmental Protection Agency (EPA) and DAR recognize a canal ditch that originates from ʻAnini stream around the middle of the watershed, but there is a lack of published material that states when, why, and how the ditch was created. The DAR biotic surveys of the ʻAnini stream, completed in 1989-90, reported the presence of Hawai'i endemic ʻopae kala'ole (mountain shrimp, *Atyoida bisulacata*), ʻopae ʻoeha'a (Hawaiian prawn, *Macrobrachium grandimanus*), and hihiwai (freshwater snail, *Neritina granosa*), as well as the indigenous ʻo'opu nakea (freshwater goby, *Awaous guamensis*) (Hawaiian Division of Aquatic Resources & Bishop Museum, 2008).

Regarding sediments, the upper watershed contains silty clays including Po'oku and Hanalei varieties. The middle watershed contains largely Pooku and Makapili varieties, and the lower watershed contains largely Makapili silty clays. Pooku silty clays are deep, well drained soils associated with elevations from 250-1000 feet and a mean annual rainfall of up to 150 inches. Hanalei series soils are somewhat poorly drained, associated with elevations from sea level to 250 feet, and are associated with a mean annual rainfall of up to 120 inches. Makapili clays are deep, well drained soils associated with elevations of 100-350 feet and a mean annual rainfall of up to 80 inches. All soil varieties were formed in alluvium from weathered igneous rock and are associated with slopes ranging from 8-40% grade (Natural Resources Conservation Service, n.d.). For reference, a soil map can be found in Appendix B: Soil Map.

There are multiple cultural sites that have been assessed around ʻAnini stream, including irrigation ditches, agricultural terraces, human remains, and artifacts of pre-contact civilizations. Interviews with community contacts in ʻAnini, facilitated by Cultural Surveys Hawai'i, Inc., state that the ʻAnini streamflow and watershed have been altered over the years with modern development projects in the area. One person recounted a time when ʻAnini stream had five natural main distributary channels, but the majority of these have dried up over recent decades. Community contacts interviewed in ʻAnini state that increase of property taxes have forced many native Hawaiians to sell their Kuleana lands over the years. Cultural Surveys Hawai'i recommends proactive consultation with individuals having cultural and lineal ties to ʻAnini from project proponents in the area. Factors of high concern for ʻAnini include negative effects on

ʻAnini stream and shoreline from development projects, including construction runoff and infrastructure, and decreasing accessibility for subsistence practices such as pig hunting (Cultural Surveys Hawai'i, 2009).

The streams of Honu, Kalihikai, and Kowali are much shorter streams, each running roughly 0.5 to 1 mile in total length. Honu stream lies west of the ʻAnini Beach Park parking lot, and Kalihikai and Kowali streams lie to the east of the parking lot. The three streams originate southeast of ʻAnini stream mouth, makai of Kuhio Highway and flow through forested and developed lands before reaching the sea. There is no published data regarding stream flow, watershed, or water quality characteristics on these streams. An additional stream of interest is the Kaweonui stream, located in Princeville, slightly northwest of the ʻAnini stream mouth (Figure 4). This stream is not monitored in any way by the state of Hawai'i or federally, though pollutants may still enter the reef from this river mouth location from the golf course, resorts, condos, private residences and roads located along the stream's path. A sewage pumping station is located on the stream edge.

Figure 4: Inland water features in the ʻAnini area of Kaua'i, including the ʻAnini watershed boundaries, canal ditch, streams, location of an elevated culvert, and location of the ʻAnini Beach Park boat launch. Locations where roads cross ʻAnini stream are marked with blue car-shaped place markers. The ʻAnini watershed, as delineated by the Department of Aquatic Resources (DAR), is outlined in red courtesy of the DAR Watersheds layer for Google Earth. Streams are outlined in dark blue, and canal ditches are outlined in light blue courtesy of the Environmental Protection Agency's WATERS layer for Google Earth.

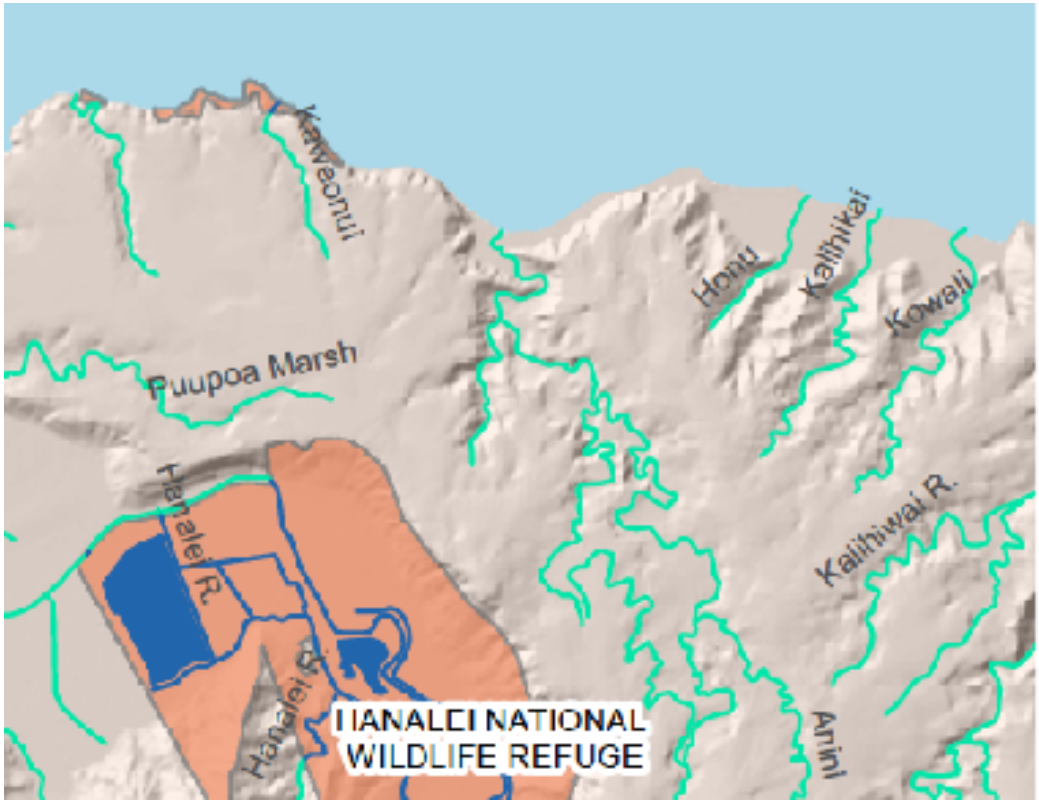


Figure 5: A section of map taken from the Hawai'i Department of Health's (DOH) Water Quality Standards Map (Water Quality Standards, n.d.), last updated June 2014. This shows where Kaweonui stream enters 'Anini lagoon to the north, and Honu, Kalihikai, and Kowali streams in the central part of the lagoon. Orange areas with dark blue streams represent Class 1 waters, and beige areas with green streams represent Class 2 waters. 'Anini, Honu, Kalihikai, and Kowali streams are listed as Class 2, while the mouth of Kaweonui stream is listed as Class 1. More information on these classifications of streams by the DOH can be found in section 3.1.2 Inland Waters.

2.1.1 Hawaiian Stream Assessment

The state of Hawai'i and the National Parks Service produced a Hawaiian Stream Assessment report in 1990, which classifies 'Anini stream as an exploitive-consumptive watershed that is utilized for water recreational activities and listed its water quality as moderate-low. The report lists 'Anini stream as continuously flowing year-round, and as having no diversions, but is interrupted with an elevated culvert (Figure 4). Less than 1% of the total stream length is listed as being altered. This report lists the presence of hau bush (*Hibiscus tiliaceus*) in the 'Anini watershed, and characterizes the plant as detrimental, referring to its invasive characteristics. It also lists the presence of pigs as a detrimental animal in the 'Anini watershed. The land within the 'Anini watershed is largely grassland and evergreen forests, with 0% of native forests being reported. Up to 10 acres of kalo lo'i were reported in 1990 as utilizing the 'Anini stream. The general resource assessment rank of 'Anini, including aquatic, riparian, cultural, and recreational resources, is listed as moderate (State of Hawai'i & National Park Service, 1990). There is a lack of recent information regarding current agricultural use adjacent to 'Anini's waterways. It would be helpful to assess Tax Map Key data and contact business and homeowners regarding agricultural use in this area.

2.1.2 Wetlands

The definition of wetlands can vary depending on the objective for defining it, but wetlands are essentially any area where water periodically saturates or inundates the soil. In wetlands, this water that is at or near the soil surface is a main driver of the plant and animal communities (US EPA, 2015). The EPA states that water quality standards pertaining to wetlands may differ compared to standards for surface waters in order to protect the broad spectrum of ecological functions associated with wetlands, including focusing on the diversity of vegetation or macroinvertebrate communities. The EPA focuses on narrative templates for wetland water quality standards, rather than the numerical templates utilized for surface waters, in order to adapt to the specific ecological functions of each location (US EPA, 2016).

According to the U.S. Fish and Wildlife National Wetlands Inventory, the coastal area of ʻAnini is an estuarine and marine wetland with intertidal habitats, unconsolidated shore, and a regularly flooded water regime. There are two small areas (7.93 and 2.22 acres) between Honu and Kalihikai streams which are listed as freshwater emergent wetland habitat, which is further described as palustrine wetlands (wetlands fed by springs and rainwater) with a temporary flooded water regime. The upper watershed lacks specific wetland definitions, with ʻAnini stream listed as riverine habitat, and a few small freshwater ponds. For a wetlands inventory map, see Appendix C: Wetlands Map (U.S. Fish & Wildlife Service, National Wetlands Inventory, n.d.). However, there is local anecdotal evidence of wetland habitat in the upper watershed and coastal areas. Local observations include much of the ground surrounding roads and within private properties collecting water after rains, and water seeping out of the pali (cliffs) in the upper watershed. Endangered birds including the endemic ʻalaeʼula (Hawaiian Moorhen), nene (Hawaiian Goose) and aukuʻu (Black-crowned night heron), as well as indiginous birds such as the ʻulili (Wandering Tattler), have been seen foraging in these various wetland areas.

Additionally, kalo loʻi agriculture has been practiced in this area since pre-contact times. Cultural surveys showed clear evidence of agricultural terraces, irrigation ditches, and walls built for water control in the ʻAnini area (Cultural Surveys Hawai'i, 2009). Though kalo loʻi is not currently practiced to a large extent in ʻAnini, historical evidence of these agricultural practices is evidence of wetland habitat. Appendix D: Aerial Photos show the extent of coastal agriculture of the ʻAnini area in 1960, as well as more modern development from 2000, courtesy of the University of Hawaiʻi Manoa digital archives.

Flood maps from the Federal Emergency Management Agency (FEMA) show similarities to the U.S. Fish and Wildlife National Wetlands Inventory map. The coastal area of ʻAnini is listed as 1% risk of flooding annually, while the middle and upper watershed are listed as some risk of flooding, but the risk of flooding is either negligible, or the potential flood damage is protected by other factors such as drainage (FEMA, n.d.). To see the FEMA flood map of ʻAnini, reference Appendix E: Flood Map. It is important to note that delineation of wetlands is dependent on the agency or individual that is surveying the area, and the extent of wetland habitat in the middle and upper watershed of ʻAnini is poorly understood.

Additionally, flood zones may be impacted with future sea level rise. More information surrounding sea level rise can be found in section 3.6.3 Individual Wastewater Systems and Wastewater Treatment Plants and in 4.4.2 Best Management Practices.

2.2 Marine Waters

ʻAnini experiences a mixed diurnal tide regime. Due to the protected lagoon, ʻAnini generally does not generally experience a large tidal range. At low tide, roughly up to 30 feet of sandy beach can be exposed, and high tide will cover most of this exposed beach. King tides that occur a few times a year in summer and winter will expose the majority of the reef at low tide, and water levels will extend to the grass-covered areas of ʻAnini at high tide. Summer conditions of the offshore marine environment consist of northeasterly trade winds generating typical wave heights of 1-3 m at periods of 5-8 seconds. Winter conditions are generally from October into March and consist of north Pacific swells generating wave heights of 3-6 meters at periods of 10-18 seconds (Storlazzi, Field, Bothner, Presto, & Draut, 2009). The fringing reefs of ʻAnini were formed in an old volcanic caldera. The Army Corps of Engineers stated that ʻAnini reef is "one of the longest, widest, and most extensive fringing reefs in the state" (AECOS, 1982).

Compared to other beaches on Kaua'i, ʻAnini's beach sediments are composed of higher than average (~75%) reefal carbonate constituents, including coral and coralline algae. Other carbonate constituents include foraminifera and mollusks. The volcanic lithic material in ʻAnini's beach sediments are associated with Koloa volcanism and contain volcanic rock fragments and olivine (Blay, 2002). The Koloa volcanic series covers much of the eastern half of Kaua'i island, and its lava flows are laid down at a thickness of about 1000 feet. The Koloa lava flows were part of a secondary large eruption event on the island during the Pleistocene geologic epoch and are associated with ʻa'a and pahoehoe flows comprised of basalt and basanite (MacDonald, Davis, & Cox, 1960).

The offshore reef occupies the surf zone, protecting the nearshore reefs and marine lagoon from high surf. The nearshore area acts as a nursery for many young fishes, including ʻoama, or juvenile goatfish. Monk seals, both adults and juveniles are seen in the waters and on the shore. Honu (Hawaiian green sea turtles) and the critically endangered honu'ea (hawksbill turtles) utilize the nearshore lagoon for feeding grounds and cleaning stations. In August of 2020, Reef Guardians Hawai'i documented a honu'ea in the nearshore lagoon of ʻAnini. Honu'ea are one of the most rare and endangered populations in the world. The Hawaiian Hawksbill Conservation project has been cataloging honu'ea individuals since 1998 and have currently identified 325 individuals statewide (Hawaiian Hawksbill Conservation, 2022). The honu'ea that Reef Guardians discovered and photographed was an individual not yet identified through the Hawaiian Hawksbill Conservation project. Reef Guardians hosted a public voting process to name the honu'ea and settled on the name Sawyer, named after one of the keiki (children) in the Reef Guardians' Reef Camp group that discovered and photographed the honu'ea (Reef Guardians Hawai'i, 2020).

2.2.1 Oceanographic Characteristics

The elevated topography of the Hawaiian Islands interrupts the passage of the northeasterly trade winds. This interruption splits the trade winds creating leeward (weak winds) and windward (strong winds) sides of the islands. On Kaua'i, as with most of the Hawaiian Islands, the northeast shores are in the windward zone. 'Anini is situated within this windward side, and the strong winds create a climate of generally higher precipitation as compared to the leeward side (Schmidt, 2003).

Ocean currents and longshore transport around Kaua'i island are highly variable and not well studied. Marine waters around 'Anini can travel along the island southeastward or northwestward, depending on other variables such as wind direction and velocity. Similarly, waters in areas north or south of 'Anini could travel to mix with 'Anini's waters. 'Anini beach recesses into a slight embayment, so some degree of retention of waters in the nearshore lagoon is expected. The Pacific Islands Ocean Observing System (PacIOOS) forecasts currents around the Hawaiian Islands by combining models of atmospheric and tidal forcing, as well as various satellite-based data (PacIOOS, n.d.). Figure 6 demonstrates the dynamics of ocean current velocity and direction around the north shore of Kaua'i based on PacIOOS current forecasting. The potential connectivity of waters on local and meso-scales, as well as variability of currents is why this report encompasses a geographic scope beyond 'Anini beach and watershed.

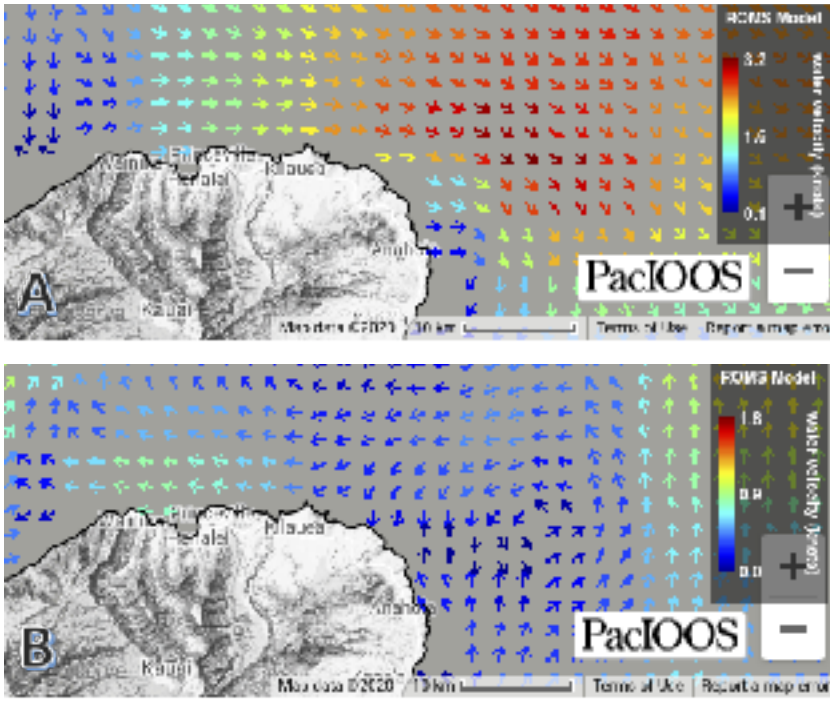


Figure 6: Ocean current forecasting maps of north shore Kaua'i courtesy of the Pacific Islands Ocean Observing System (PacIOOS). Arrow direction represents water current direction, and arrow color represents water velocity in knots, with red representing the highest velocities and dark blue representing the lowest velocities. Figure 4A shows ocean current forecasting for February 17, 2020, at 08:00 AM, and Figure 4B shows forecasting for August 18, 2020, at 08:00 AM. PacIOOS current forecasting can be found at: http://www.pacioos.hawaii.edu/currents/model-hawaii/

2.2.2 Submarine Groundwater Discharge

Submarine groundwater discharge (SGD) enters the ocean through porous substrates. SGD is believed to be on the same magnitude as riverine discharge worldwide (Moore, 2010). Research shows that SGD can alter hydrographic parameters of the marine environment, including temperature and salinity (Taniguchi, Burnett, Cable, & Turner, 2002). Leached pollutants associated with stormwater, land runoff, wastewater systems, and injection wells are recognized sources of contamination to groundwater (United States Geological Survey, n.d.). This means that contaminated SGD can introduce pollutants into the marine environment, including nutrients, pathogens, and other contaminants (Oberle, et al., 2019). The connectivity of terrestrial systems to submarine groundwater is demonstrated in Figure 7.

There is anecdotal evidence of SGD for ʻAniniʼs marine waters. Snorkelers can visually see freshwater seeping from the ocean floor, and nearby locations have had SGD volumes measured and studied (Oberle, et al., 2019). SGD volumes are highly dynamic with both terrestrial and marine drivers, and SGD volumes have been found to reach maximum values just after low tide. Variability in groundwater levels and conductivity levels are found to be significantly lower during neap tides (a tide of minimum range occurring at the first and the third quarters of the moon), as compared to high range of variability during spring tides (tides of greater-than-average range around the times of new moon and full moon. There can be hourly changes in SGD levels due to semidiurnal tidal pressure waves, a dynamic that can be utilized as a SGD signal (Oberle, Swarzenski, & Storlazzi, 2017).

There are several additional methods of identifying and tracing SGD. Groundwater in Hawaiʻi tends to be colder in temperature as compared to nearshore waters, which makes temperature profiles a signal for groundwater as well (Oberle et al., 2019). In contrast, SGD vents located in Maui had discharge that was warmer in temperature as compared to the ambient marine water and was rich in nitrogen gas bubbles (Swarzenski, et al., 2017). When using temperature as a tracer of SGD, it is important to identify localized temperature patterns. Salinity is often used to trace SGD levels in marine environments, since the SGD is freshwater that enters a marine environment (Sugimoto, 2016). Radon-222 is recognized as another tracer of SGD due to its short half-life (3.8 days) and its high enrichment levels within groundwater as compared to coastal surface waters (Swarzenski P. , 2007). Many studies utilize a combination of these efforts when identifying and tracing SGD.

2.2.3 Residence Times

Residence time refers to the amount of time a parcel water is retained in a set volume, and it is affected by a variety of factors including turbulence, mixing, current velocity, and current direction. If there are pollutants in a water parcel, then the pollutants would remain more concentrated in areas of high residence time and minimal mixing. Bathymetry is also a driver of residence times. Water can be generally expected to move at higher velocities in deeper areas of the reef, such as the channels at ʻAnini, and slower in more shallow areas, such as the nearshore lagoon. Waves can assist in mixing and flushing of nutrients in shallow areas,

but the nearshore lagoon does not receive as much wave action as compared to the reef further offshore in the surf zone or coastal areas without a lagoon. Wave forcing can cause high velocities over shallow reefs during winter swells. For these reasons, it is expected that the nearshore lagoon would experience less mixing, leading to higher residence times of nutrient loading from freshwater, including SGD. This effect is likely exacerbated during low tides, when more shallow sea surface heights can concentrate nutrient loading and SGD around corals. Note also that SGD volumes are generally at a maximum during low tide. At Makua reef, a reef north of ʻAnini, research shows nutrient concentrations to be up to a highly significant order of magnitude higher during low tides as compared to measurements taken at high tides (Oberle et al., 2019).

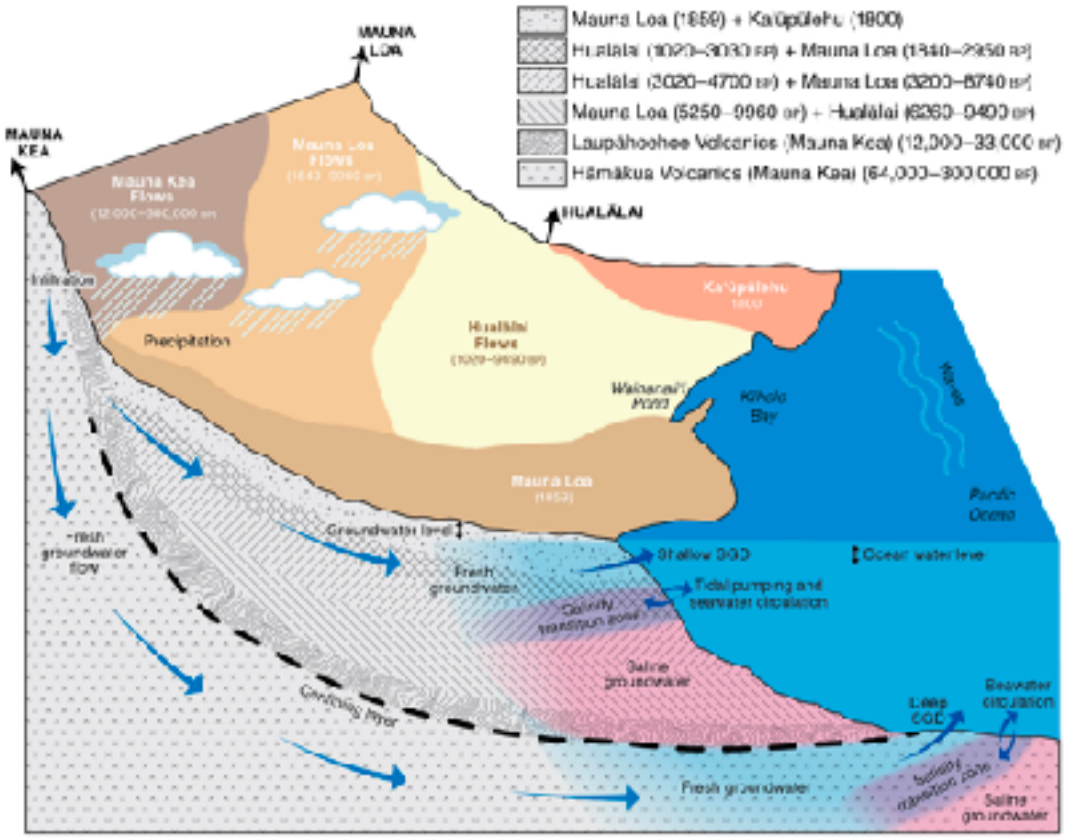


Figure 7: A conceptual model of freshwater flowing from rainfall to offshore marine environments, based on the island of Hawai'i. This figure shows how submarine groundwater discharge (SGD) can enter marine environments at shallow and deep depths. The legend shows different sediment types and the age at which these sediments were deposited in years before present (BP). Figure retrieved from the School of Ocean and Earth Science and Technology (SOEST), figure designed by SOEST Publication Services and Brooks Bays, illustrator (https://www.soest.hawaii.edu/soestwp/announce/news/ocean-tides-are-gatekeepers-of- groundwater-discharge-to-hawaii-coastal-zone/).

2.2.4 ʻAnini Reef and Black Band Disease

Recent DAR reports of the fringing reefs at ʻAnini show widespread coral bleaching, overgrowth of macroalgae and cyanobacterial algal mats, low fish abundance, warmer sea surface temperatures, and high amounts of sediment both in the water column and on the reef (M. Melamed, Kaua'i DAR, personal communication, November 30, 2020). These combined factors create an environment where diseases can take hold. Black band disease affects rice corals (*Montipora spp.*) on Kaua'i, with notable outbreaks studied in 2012-2015 and 2019. In 2019, a whopping 11.5% of the *M. capitata and M. patula* rice coral species were affected by black band disease (Hawai'i Department of Aquatic Resources, 2020). This is significant compared to a previous study in nearby Hanalei Bay, which found a baseline prevalence of black band disease to be <1% (Aeby, et al., 2015). DAR monitoring during February-March of 2020 at ʻAnini reef found that the disease outbreak prevalence dropped to just 0.3%, which is viewed as an appropriate level of the disease. Signs of recovery and regrowth of some affected corals were noted, while others showed signs of coral death. The DAR believes that the recovery was in-part due to seasonal swells that aided in flushing of the waters surrounding the reef and lowering sea surface temperatures (Hawai'i Department of Aquatic Resources, 2020). Research at nearby Makua reef found that areas affected by black band disease correlated with areas of stagnant water parcels, high levels of SGD nutrient loading, and low salinities. These environmental factors are stressors to coralline health and make the reef vulnerable to disease (Oberle, et al., 2019).

The DAR surveys ʻAnini reef for black band disease, coral bleaching, fish and invertebrate densities, and cyanobacteria cover. Their 2020 survey scope stretched for roughly 1 mile, from the eastern stretch of ʻAnini reef to the western stretch near the end of ʻAnini road and included 41 randomized survey spots (Figure 8). Their future survey efforts will utilize new randomized survey points. Planned monitoring assessments for the future at this location will utilize a YSI multimeter monitoring sonde (devise) to assess water quality, including temperature, salinity, dissolved oxygen, turbidity, chlorophyll, phycoerythrin (red pigment of algae), nitrate, and phosphate. They hope to assess permanent survey plots of black band disease-affected coral on a seasonal basis, along with Structure from Motion (SfM) technology to produce 3D models and 2D photomosaics in order to capture the changes of disease prevalence, growth, and/or mortality over time (M. Melamed, personal communication, November 30, 2020).

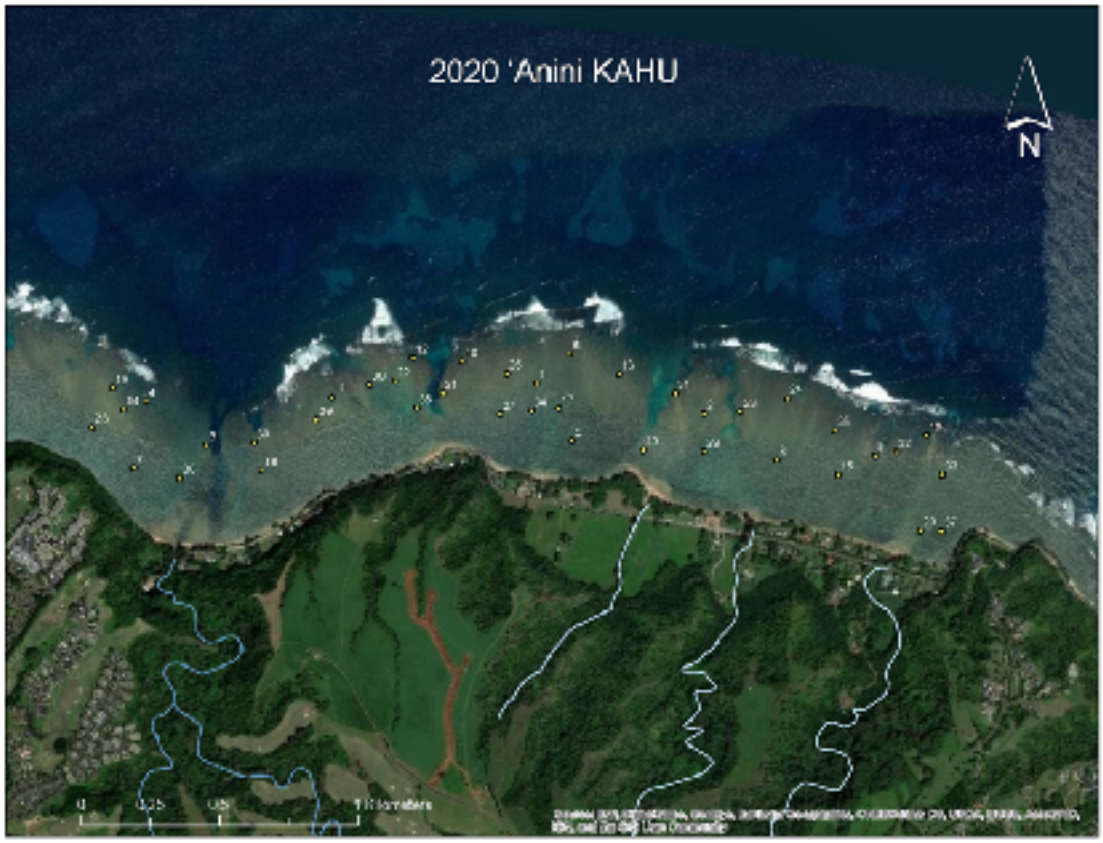


Figure 8: Randomized survey locations for the Department of Aquatic Resources (DAR) black band disease surveys at 'Anini reef, Kaua'i. The survey was completed in the summer of 2020 and was integrated with the DAR fish and benthic surveys (KAHU).

2.3 Population and Land Use

Most of the Anini watershed shoreline is located in State of HI Conservation and County of Kaua'i Special Management Area (SMA) zoning district. The DAR lists the land use parcels within the 'Anini watershed as 64.3% agricultural, 11.1% conservation, and 24.6% urban. Regarding land stewardship, 14.2% of the land is controlled by the state, and 85.8% is private (Hawaiian Division of Aquatic Resources & Bishop Museum, 2008). The first governmental documentation of land ownership in 'Anini is associated with The Kuleana Act of 1850, which awarded 11 land plots around the Kowali and Kalihikai streams to Hawaiian families with lineal ties to the area. In 1988, the first urban residential plot was purchased on the ocean side of 'Anini Road. As of 2016, there are 60 tax map key parcels around 'Anini Road, the majority of which (70%) are utilized as transient vacation rental properties (Koethe, 2017).

West of 'Anini beach is the town of Princeville. There are multiple resorts located in Princeville, and according to the 2010 census, Princeville has a population of 2,158 individuals and 2,226 housing units over 2.39 square miles of land area (U.S. Department of Commerce, 2012). There are two golf courses in the area, including the Princeville Makai Golf Club and The Prince Golf Course. The Prince Golf Course has been closed to golfing since 2008, but a private club on the property is currently maintained. Under an agreement with the Princeville Resort Group and Colorado-based East West Partners, there are plans to reopen The Prince Course alongside the development of 700 acres into 75 ranch sites. The development plans also include a spa, retail center, new landscaping, and a network of walking and biking paths (Magin, 2017).

East of ʻAnini are the towns of Kalihiwai and Kilauea, with respective populations of 428 and 2,803 individuals. Princeville and Kilauea towns have experienced steady population growth since 1990 (U.S. Department of Commerce, 2012).

As of 2017, there are approximately 13,700 active cesspools on Kaua'i (Hawai'i State Department of Health, 2017). Specific information on wastewater systems for the ʻAnini area can be found in section 3.6.3 Individual Wastewater Systems and Wastewater Treatment Plants.

2.3.1 ʻAnini Beach Park

ʻAnini Beach Park is managed by the county of Kauaʻi and covers 12.5 acres. The main parking lot, bathroom, showers, boat launch, and pavilions of the park are located outside the eastern border of the ʻAnini watershed, in between the mouths of Honu and Kalihikai streams (Figure 9). Westward of the main parking lot, the coastal lands are utilized as a campground and have been used heavily by houseless families during the 2020 COVID-19 pandemic. There are two bathrooms associated with the campground. ʻAnini Beach Park camping permits are managed by Kauaʻi county and are free for Hawaiʻi residents, and $3 per adult, per night for nonresidents. In 2002, ʻAnini Beach Park was designated by the Department of Business, Economic Development, and Tourism (DBEDT) of the state of Hawai'i as Category 1, representing ʻAnini as a beach of extremely high use. Regarding future development plans, the DBEDT recommends the building of additional parking lots and bathrooms at ʻAnini Beach Park (Carter & Burgess Inc., 2002). County led planning is underway for Americans with Disabilities Act (ADA) and boat washdown area improvements.

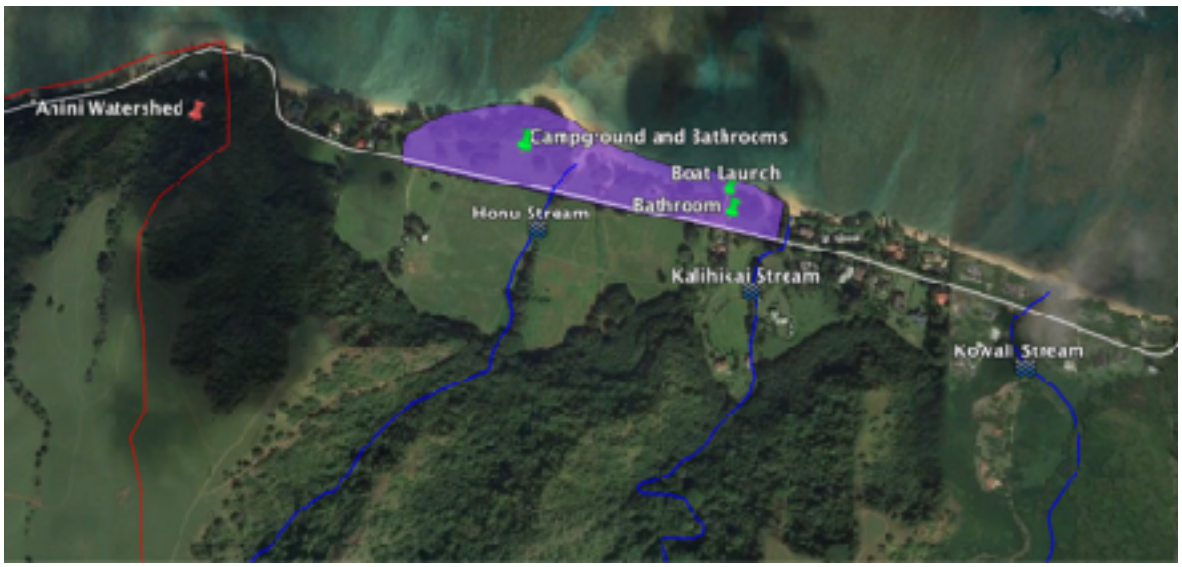


Figure 9: ʻAnini Beach Park is represented with a purple polygon, with locations of the campground, bathrooms, and boat launch labeled. The ʻAnini watershed, as delineated by the Department of Aquatic Resources (DAR), is outlined in red courtesy of the DAR Watersheds layer for Google Earth. Streams are outlined in dark blue courtesy of the Environmental Protection Agency's WATERS layer for Google Earth.

There is a waterline that runs under ʻAnini Road to supply ʻAnini Beach Park with enough water for the park's high use. The waterline begins in Princeville at the end of Wylie Road, crosses under ʻAnini stream, and runs eastward along ʻAnini Road. The waterline is also utilized to service Hawaiʻi Department of Water (DOW) customers in ʻAnini. The DOW contracts with Princeville Utilities to supply this area with an adequate supply of water. The water is sourced from two deep wells located in the Kilauea area (Fukunaga and Associates, Inc., 2011). A waterline replacement project along ʻAnini Road was completed in 2014. Due to overuse of the waterline in ʻAnini prior to replacement, backflows and overflows occurred on a regular basis, and the replacement was listed as a high priority project for the county (The Garden Island, 2014).

2.4 Reconnaissance Efforts

Areas of the ʻAnini watershed accessible by public roads, including all areas where roads are known to cross ʻAnini, Honu, Kalihikai, and Kowali streams, were assessed by reconnaissance on December 2, 2020. This reconnaissance effort was completed during Kauaʻi's rainy season, and the weather was sunny and calm, though the few days prior had rainy weather. Reference Figure 4 for a map of areas where roadways cross ʻAnini stream. Much of ʻAnini stream, both mauka and makai of Kuhio Highway, runs through privately owned land and is not publicly accessible. The most accessible areas of ʻAnini, Honu, Kalihikai, and Kowali streams are located near each of their muliwai (stream mouths), where ʻAnini road crosses over each stream. Additional photo analysis associated with reconnaissance can be found in Appendix F: Reconnaissance.

There are two locations where Kuhio Highway crosses ʻAnini stream, but it is not safely accessible to pull off the highway to assess these areas. The main reported alterations to ʻAnini stream include an elevated culvert and canal ditch (Figure 4), but both locations are located within private land and are not easily accessible. The most upstream area of ʻAnini stream where a public road crosses the stream is Ahonui Road. Ahonui Road is located within a large complex of private land parcels, mixed with private homes and agricultural land use. ʻAnini stream flows through the yards of many of these homes, and there were several active home construction projects throughout the neighborhood. Commercial and agricultural land use within this area includes cacao bean farming, plant nurseries, and botanical gardens. The stream at the Ahonui Road crossing could not be visually seen amidst vegetative overgrowth, but streamflow was audible. There were sections of the road margin along the crossing where water trickled downslope and collected in small pools while the rest of the road was dry (Figure 10).

Figure 10: The location of Ahonui road crossing ‘Anini stream, photographed on December 2, 2020.

Further downstream, makai (ocean side) of Kuhio Highway, there is an area where the old highway crosses ‘Anini stream. This road is accessible via Kapaka Street makai of the highway. The stream was not visible at this location due to vegetative overgrowth, but streamflow was audible. The vegetative area around this road for hundreds of feet in diameter was damp and had very steep slopes leading down to the stream. Adjacent to the stream crossing, there was a land clearing site as part of a construction project (Figure 11). There are no National Pollutant Discharge Elimination System (NPDES) permits associated with this location.

Figure 11: Land clearing as part of a construction project adjacent to ʻAnini stream, as photographed on December 2, 2020. The old highway can be accessed off of Kapaka Street makai of Kuhio Highway. Reference Figure 4 for a mapped location of this road crossing.

The following areas where the road crosses the streams are located near the muliwai (mouths of the streams) on ʻAnini Road. There are the mainstream crossings as well as other ditches where water flows and crosses under the road. Reference Figure 12 for a map of each location. East of Kowali stream mouth on ʻAnini Road is the easternmost main crossing, though there are areas prior to this where freshwater seeps from the slopes of the mountains and trickles across the road to the ocean. The crossing just east of Kowali stream on ʻAnini road at this time had extremely low flow and debris buildup in a ditch adjacent to residential homes. At the Kowali stream mouth, the stream was roughly 10 feet wide, and its waters were very turbid. The stream ran adjacent to residential homes before crossing under ʻAnini road (Figure 13).

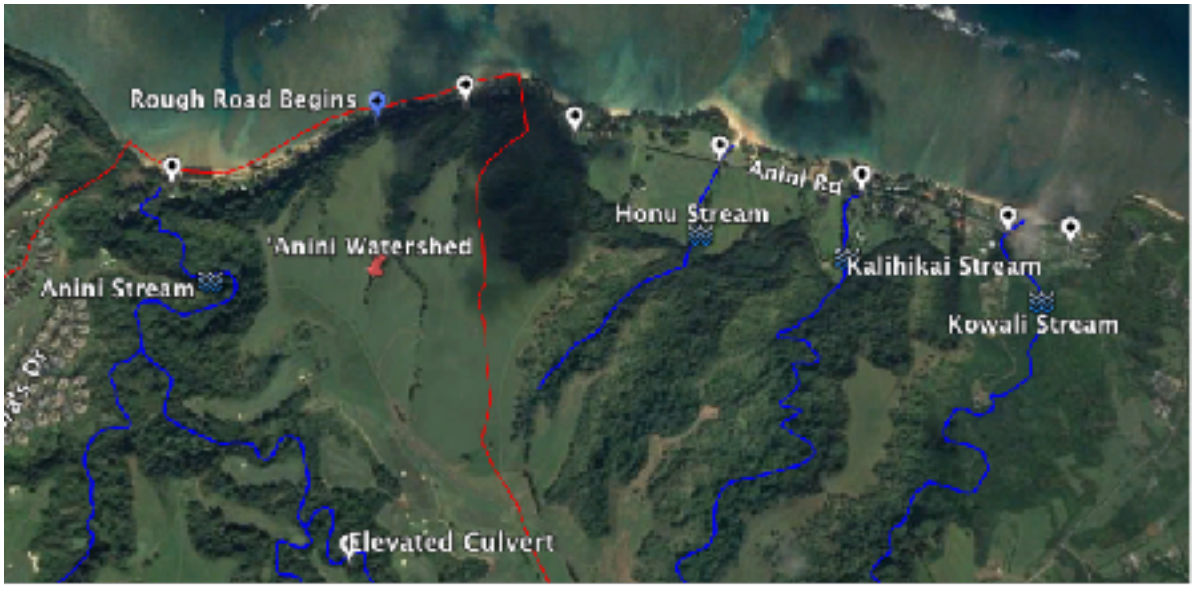


Figure 12: Mapped locations of areas on 'Anini road where streams and ditches cross under the road (marked with white place markers), and the area where the paved road ends and rough road begins (blue place marker), as determined through reconnaissance efforts on December 2, 2020. The 'Anini (Stream) watershed, as delineated by the Department of Aquatic Resources (DAR), is outlined in red courtesy of the DAR Watersheds layer for Google Earth. Streams are outlined in dark blue courtesy of the Environmental Protection Agency's WATERS layer for Google Earth.

Figure 13: Kowali stream flowing past residential homes toward 'Anini Road, photographed December 2, 2020.

The Kalihikai stream mouth was very turbid and had debris and rubbish building up under the crossing (Figure 14A). The Honu stream mouth was much more narrow and lower flow as compared to Kalihikai and Kowali streams and had debris buildup under the crossing. West of Honu stream and the ʻAnini campground, there was a ditch that crossed under the road that had very low flow and debris buildup on the mauka (mountain) side of the road. On the makai (ocean) side of the road at this crossing, there was more water flow due to mixing from the ocean. The water was very turbid, contained some debris, and crossed directly through residential properties (Figure 14B).

Figure 14: Figure A represents Kalihikai stream flowing past residential homes toward ʻAnini Road, photographed December 2, 2020. Figure B represents a ditch west of Honu stream as it flows under ʻAnini road and toward residential homes, photographed December 2, 2020.

West of Honu stream and crossing into the boundary of the ʻAnini watershed, there were many private home construction projects that were associated with more sediment on the pavement of ʻAnini Road. Further west of this, the pavement ends, and the road becomes unmaintained sand and gravel. There are more private homes and vacation rentals leading west to the ʻAnini stream mouth. Public access to ʻAnini road ends right at the stream mouth, but the narrow dirt road continues alongside the stream toward more private homes. The ʻAnini stream muliwai (stream mouth) is wide, and its waters are turbid. There was rubbish and debris packed along the stream edge (Figure 15). Multiple encampments of houseless residents and debris have been observed.

Figure 15: Rubbish and debris lining ʻAnini muliwai (stream mouth), photographed December 2, 2020.

Figure 16: Storm water flowing from property at east end of the ʻAnini lagoon from Anini Vista area entering the lagoon directly crossing the ʻAnini Road or entering through a culvert. March 12, 2021.

2.4.1 Drone Footage

A drone was utilized on December 8, 2020, to gain perspective of ʻAnini stream at locations where the stream is not publicly accessible or not easily viewable due to vegetation. The drone filmed at the ʻAnini stream mouth and near the northern Kuhio Highway road crossing (Figure 4). From the ʻAnini stream mouth, the homes of Princeville and the Prince Golf Course can be seen on a plateau above the steep slopes leading down to ʻAnini stream. It is likely that runoff from these home sites and the golf course could easily flow down to the stream. There was what appeared to be a small landslide in the slope above the stream (Figure 17), as well as a land clearing site adjacent to the stream (Figure 18). At the land clearing site, there was a piece of heavy machinery adjacent to the river, but it was not possible to discern if it was an excavator or some other piece of equipment. These two locations likely contribute sediment-laden runoff that can elevate turbidity levels of the stream.

At the location near the northern area where Kuhio Highway crosses ʻAnini stream, we were able to see how the forested wetland extends around several small tributaries and ditches of ʻAnini stream. This location was adjacent to the Prince Golf Course and its facilities. This golf course is not currently in operation, but it is now under redesign construction and there are plans for it to reopen alongside new home sites in the future (Reference section 2.3 Population and Land Use). ʻAnini stream splits into many distributaries and ditches that flow around the golf course (Figure 19), which makes the stream highly susceptible to runoff associated with golf course irrigation and land management practices. Figure 20 shows the same land clearing location near Kapaka Road (Figure 9) photographed by the drone. Figure 19A and 19B show the extensive golf course reconstruction above ʻAnini stream photographed August 31, 2022. Figure 20 shows the ʻAnini muliwai (stream mouth), the route of the stream through the valley and the bare dirt of the construction site above. For additional still images from drone reconnaissance, reference Appendix F: Reconnaissance.

Figure 17: An erosion-caused landslide in the steep slope above ʻAnini stream near the stream mouth, as photographed by a drone on December 8, 2020.

Figure 18: A land clearing site using heavy equipment adjacent to ʻAnini stream near the stream mouth, as photographed by a drone on December 8, 2020. Heavy machinery is only allowed to be used by streams with proper permitting.

Figure 19: A wetlands tributary of ʻAnini stream flowing alongside the Prince Golf Course, as photographed by a drone on December 8, 2020.

Figure 20: The same land clearing site from Figure 11, as photographed by a drone on December 8, 2020. ʻAnini stream can be seen as it flows under Kuhio Highway adjacent to the land clearing site.

Figure 21A: Princeville Prince Golf course grading and grubbing work as photographed by drone August 31, 2022. The drainage way is a tributary of ʻAnini stream.

Figure 21B: Princeville Prince Golf course grading and grubbing work as photographed by drone August 31, 2022. The drainage way is a tributary of ʻAnini stream.

Figure 22: Path of construction discharge (Figure 21A & 21B) into ʻAnini waters where ʻAnini Stream meets the coastal beach and lagoon. Photographed Aug. 31, 2022

3. Water Quality

With little reported monitoring efforts of water quality and flow, it is difficult to evaluate the condition of the ʻAnini stream and watershed. States are required under Section 305(b) of the Clean Water Act to submit to EPA a biennial Water Quality Inventory that assesses whether the quality of jurisdictional waters meets the criteria and supports the designated uses found in the water quality standards. In addition, under Section 303(d), states are required to identify those waters where pollution control has not been adequate to implement water quality standards, prioritize those waters and establish a Total Maximum Daily Load for the pollutants causing impairment of uses. The Hawaii Water Quality Standards at HAR §11-54 designates water body types (§11-54-2, Classification of State Waters), uses/class (§11-54-3, Classification of Water Uses), and criteria (§11-54-4, Basic Water Quality Criteria Applicable to all Waters; §11-54-5 Uses and Specific Criteria Applicable to Inland Waters; and §11-54-6 Uses and Specific Criteria Applicable to Marine Waters). (Department of Health, 2014).

Based on the most recent report, ʻAnini stream is not included in the 305(b) list of assessed waters in Kauaʻi. This means that ʻAnini stream is also not included under Kauaʻi's inland waters 303(d) list of impaired waters. Honu, Kalihikai and Kowali streams are also not listed in the 305(b) or 303(d) lists. The marine waters of ʻAnini are monitored as part of the 305(b) list of assessed marine waters and are also listed as impaired under the 303(d) list of impaired marine waters. Assessments of 305(b) and 303(d) marine waters include criteria similar to that of inland waters. Water quality standards for 305(b) and 303(d) listed waters are set by the Hawai'i Department of Health (DOH) Clean Water Branch (CWB) and are outlined in the sections HAR §11-54-4, 5, and 6 (Department of Health, 2014). Details pertaining to water quality standard criteria are briefly outlined in the sections below.

3.1 Water Quality Monitoring and Assessment Reports

The Clean Water Branch (CWB) is responsible for the monitoring of state waters and the biannual water quality reporting on the 305(b) list of assessed state waters, and 303(d) list of impaired state waters. This biannual report is called the Water Quality Monitoring and Assessment Report, and archived reports for 2006-2020 can be found on the CWB website (State of Hawaii Department of Health, n.d.).

3.1.1 Data Acceptance Criteria

For acceptance of watershed quality assessment by DOH, a minimum of 30 samples are required for a decision unit over a two-year period in order for the waterbody to be assessed for water quality criteria in the state's integrated report. If less than 30 samples are obtained for a waterbody, the water quality cannot be accepted for a decision for the state DOH to adopt a monitoring program for that waterbody, but the data is acceptable by the Clean Water Branch (CWB) for record keeping and other potential uses (Hawai'i Department of Health, 2020).

For the CWB, water quality testing typically includes *Enterococcus*, nitrite/nitrate, ammonia, total nitrogen, total phosphorus, turbidity, and chlorophyll-a. In order for water quality monitoring data to be considered sufficient and valid by the CWB, there are data acceptance criteria that must be followed. The HAR §11-54 outlines the administrative rules, waterbody classification criteria, and accepted units of measurements for data collection protocol (Department of Health, 2014). EPA-approved laboratory analysis procedures for pollutants are listed under the 40 CFR 136, *Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act* (Environmental Protection Agency, 2020).

Regarding runoff of sediments into waters and shorelines on Kaua'i, submitting Tax map keys and aerial photos to the attention of the Dept. of Public Works and the Coastal Zone Manager of the Planning Dept. County of Kaua'i is a first step.

3.1.2 Inland Waters

In order to be assessed for attainment of water quality criteria, there must be data sets meeting the data acceptance criteria. The inland streams of ʻAnini, Honu, Kalihikai and Kowali do not currently have datasets meeting the acceptance criteria. If there were adequate readily available data, the DOH would be required to assess the streams when developing the 305(b) list. If any of the listed criteria is found to not attain water quality standards, the location would be listed on the 303(d) list of impaired inland waters (Hawai'i Department of Health, 2020).

Based on the current DOH Water Quality Standards map of Kaua'i (Water Quality Standards, n.d.; Hawai'i Department of Health, 2014 June), ʻAnini, Honu, Kalihikai, and Kowali streams are classified as Class 2, indicating that the waterbody must be protected for recreational use, agricultural use, and general health of aquatic life (Department of Health, 2014). Under Class 2, stormwater discharge from industrial sources and NPDES permitted sites cannot cause or contribute to non-attainment of water quality criteria in order to operate. The area around the mouth of Kaweonui stream is listed as Class 1 (Water Quality Standards, n.d.). Waste water is prohibited in Class 1 waters, with exceptions listed out within the source document section 11-54-4(e). Class 1 waters must "remain in their natural state as nearly as possible with absolute minimum of pollution from any human-caused source" (Department of Health, 2014). More information regarding NPDES and other permit locations in the ʻAnini area can be found in 3.6 Clean Water Branch Permits.

3.1.3 Marine Waters

Based on the current DOH Water Quality Standards map of Kaua'i, ʻAnini marine waters are classified as Class A, indicating that their recreational uses and aesthetic enjoyment must be protected, and all discharge introduced into the system must receive the highest degree of treatment and control compatible with the relative criteria. The neighboring marine waterbody of Hanalei Bay and marine waters to the west of Hanalei Bay are classified as Class AA, which requires waters to remain in their natural and most pristine state with an absolute minimum of

water quality impairment from anthropogenic and other land-based sources (Hawai'i State Department of Health, 2020).

The marine waters of the ʻAnini area are classified by the CWB as Open Coastal waters (marine waters from the shoreline to the 183-meter depth contour and within 3 nautical miles from shore) and Wet criteria (marine waters receiving more than 3 million gallons of freshwater discharge per day per shoreline mile), and therefore must meet the criteria summarized in Table 1. Marine Open Coastal waters characterized as Dry criteria (marine waters receiving less than 3 million gallons of freshwater discharge per day per shoreline mile) have lower values for each criterion within the water quality standards list as compared to waters characterized as Wet criteria (Department of Health, 2014).

Parameter	Geometric mean not to exceed the given value	Not to exceed the given value more than 10% of the time	Not to exceed the given value more than 2% of the time
Total Nitrogen (µg N/L)	150.00	250.00	350.00
Ammonia Nitrogen (µg NH_4/L)	3.50	8.50	15.00
Nitrate/Nitrite (µg NO_3+NO_2/L)	5.00	14.00	25.00
Total Phosphorus (µg P/L)	20.00	40.00	60.00
Light Extinction Coefficient (k)	0.20	0.50	0.85
Chlorophyll-a (µg/L)	0.30	0.90	1.75
Turbidity (N.T.U.)	0.50	1.25	2.00

Table 1: Water quality standard criteria for Open Coastal and Wet criteria waters from the State of Hawai'i's Clean Water Branch, as outlined in the HAR §11-54. Open Coastal waters are classified as marine waters from the shoreline to the 183-meter depth contour and within 3 nautical miles from shore, and a Wet criterion in Open Coastal waters represents an average freshwater inflow of more than 3 million gallons per day per shoreline mile.

The marine waters of the ʻAnini area are listed under the 305(b) list of assessed marine waters and the 303(d) list of impaired marine waters. In the State of Hawai'i Water Quality Monitoring and Assessment reports for 305(b) and 303(d) waters, there are two CWB sampling locations for the marine waters in the ʻAnini area, named ʻAnini Beach and ʻAnini Beach Park (Figure 23). Under the 305(b) assessments, the CWB determines the priority level of procuring a total maximum daily load (TMDL) assessment for the assessed waterway (State of Hawaii Department of Health, n.d.). A TMDL, as defined by the Clean Water Act, is utilized to restore impaired waterways by identifying the maximum amount of pollution that can enter the

waterway before it is considered impaired (Hawai'i State Department of Health, 2020). The ʻAnini Beach CWB sampling location has had insufficient data for all testing criteria of water quality standards since 2006, and therefore has insufficient data to evaluate the need for a TMDL. The ʻAnini Beach Park sampling location currently has attained criteria standards for water quality related to *Enterococcus* sampling and has not attained criteria standards for water quality related to turbidity sampling, since 2006. There has been insufficient data to assess water quality at this location in relation to total nitrogen, nitrite/nitrate, ammonia nitrogen, total phosphorus, and chlorophyll-a since reporting in 2006. Due to turbidity sampling not meeting water quality criteria, the ʻAnini Beach Park location is categorized as impaired and in need of a TMDL assessment. This location has been categorized as in need of a TMDL since reporting in 2006, though the need for this TMDL is listed as low priority (State of Hawaii Department of Health, n.d.). A brief summary of the data found in the state's Water Quality Monitoring and Assessment reports since 2006 can be found in Table 2.

Figure 23 A & B: Mapped locations of the two Clean Water Branch (CWB) sampling stations for the ʻAnini area, titled CWB Sampling Station "Anini Beach" and CWB Sampling Station "Anini Beach Park". Figure 23A shows the sampling locations in relation to inland waterways. The ʻAnini watershed boundary, as delineated by the Department of Aquatic Resources (DAR), is outlined in red courtesy of the DAR Watersheds layer for Google Earth. Figure 23B focuses on the locality of the two CWB ʻAnini sampling sites.

Reporting Year	Water Body	Water Body ID	Water Body Type	Wet/Dry Criteria	Attaining Criteria	Impairment(s)	TMDL Priority
2006	ʻAnini Beach	HI338804	Open Coastal	Wet	-	-	-
	ʻAnini Beach Park	HI418744	Open Coastal	Wet	Enterococcus	Turbidity	Low
2008/2010	ʻAnini Beach	HI338804	Open Coastal	Wet	-	-	-
	ʻAnini Beach Park	HI418744	Open Coastal	Wet	Enterococcus	Turbidity	Low
2012	ʻAnini Beach	HI338804	Open Coastal	Wet	-	-	-
	ʻAnini Beach Park	HI418744	Open Coastal	Wet	Enterococcus	Turbidity	Low
2014	ʻAnini Beach	HI338804	Open Coastal	Wet	-	-	-
	ʻAnini Beach Park	HI418744	Open Coastal	Wet	Enterococcus	Turbidity	Low
2016	ʻAnini Beach	HI338804	Open Coastal	Wet	-	-	-
	ʻAnini Beach Park	HI418744	Open Coastal	Wet	Enterococcus	Turbidity	Low
2018	ʻAnini Beach	HI338804	Open Coastal	Wet	-	-	-
	ʻAnini Beach Park	HI418744	Open Coastal	Wet	Enterococcus	Turbidity	Low
2020	ʻAnini Beach	HI338804	Open Coastal	Wet	-	-	-
	ʻAnini Beach Park	HI418744	Open Coastal	Wet	Enterococcus	Turbidity	Low

Table 2: Summary of assessment decisions of ʻAnini from the State of Hawai'i Water Quality Monitoring and Assessment Report for 305(b) and 303(d) listed waters from 2006-2020. The 2008/2010 reports were combined with approval of the EPA. Under Water Body Type, Open Coastal waters are classified as marine waters from the shoreline to the 183-meter depth contour and within 3 nautical miles from shore. For Wet/Dry Criteria, a Wet criterion in Open Coastal waters represents an average freshwater inflow of more than 3 million gallons per day per shoreline mile. Water quality criteria that are reported as attaining water quality standards are listed under Attaining Criteria, and criteria that do not attain water quality standards are listed under Impairment(s). The total maximum daily load (TMDL) Priority criteria represents TMDL assessment priority level and can be listed as either High, Medium, or Low priority. Under Impairment(s) and TMDL Priority, a "-" represents insufficient data to assess the criteria. More information on water quality criteria and sufficient/insufficient data can be found in section 3.1.1 Data Acceptance Criteria.

3.1.4 Nutrients, Chlorophyll-a, and Turbidity

The minimum data acceptance criteria of 30 samples for a decision unit or watershed over a two-year period is uniform for all water quality data including nutrients, chlorophyll-a, and turbidity (Hawai'i Department of Health, 2020). For the ʻAnini Beach Park and ʻAnini Beach CWB sampling sites, there has been insufficient data to determine the water quality of these locations in relation to total nitrogen, nitrite/nitrate, total phosphorus, and chlorophyll-a. At the ʻAnini Beach location, there has also been insufficient data to determine water quality in relation to *Enterococcus* and turbidity (Hawai'i State Department of Health, 2020). Due to limited resources, the CWB chooses to focus their resources on Tier 1 beaches for fecal indicator bacteria (*Enterococcus*). Though the ʻAnini Beach Park location has been classified as impaired for turbidity and in need of a total maximum daily load (TMDL) since 2006, procuring a TMDL for any location is highly resource intensive. For this reason, the CWB must focus TMDL assessments on areas where the assessment is believed to be the most effective, including areas with known point source pollution where the TMDL can be enforced through the discharger's NPDES permit. The CWB states that due to the large number of Hawai'i's impaired waterways, they cannot focus on enforcing TMDLs in areas of only nonpoint source pollution (Clean Water Branch, personal communication, November 05, 2020). Reference Table 1 for water quality standards listed by the HAR §11-54-3 (Department of Health, 2014).

3.1.5 *Enterococcus*

Enterococcus measurements refer to *Enterococci* bacteria, a bacterium that lives in the intestinal tracts of warm-blooded animals, and it also occurs in native soil environments on Hawai'i. *Enterococcus* is not sourced from a single pollutant. Rather, *Enterococcus* can be introduced into a waterway from animal feces or wastewater. Measurements of *Enterococcus* levels are utilized by the EPA as a proxy for the potential presence of other microbial pathogens that can cause human and animal illness (US EPA, 2013). It is important to note the limitations of *Enterococcus* as a proxy for other pathogens, since it can also be found in the natural environment. If sewage or fecal pollution are present in waters, then it should correlate with a spike of *Enterococcus*, but these bacteria cells are sensitive to die-off from ultraviolet sunlight. An alternative measurement of fecal pollution would be to measure levels of *Clostridium perfringens*, but this is not within EPA protocol for water quality management.

Since the one stream in the ʻAnini area is listed as Class 1, four streams are listed as Class 2, and the marine waters of ʻAnini are listed as Class A, the state's CWB water quality standards state that recreational uses of these waters must be protected. Recreational criteria standards are set to protect the public users of the waterway from harmful levels of pathogens. Monitoring *Enterococcus* levels is utilized as an indicator of potentially harmful microorganisms and is measured either in colony forming units (CFU) per 100 milliliters, or as most probable number (MPN) per 100 milliliters, depending on the analytical method utilized. The two units are equivalent on a 1:1 scale. Water quality standards state that *Enterococcus* levels must not exceed a geometric mean of 35 CFU per 100 milliliters over any 30-day interval, and that a statistical threshold value (STV) of 130 MPN per 100 milliliters is used. The STV is not to exceed

more than 10% of samples taken within the same 30-day interval utilized for the geometric mean. Water samples that do not meet these criteria do not attain water quality standards for *Enterococcus* (Department of Health, 2014). The CWB ʻAnini Beach Park sampling location is reported as attaining water quality criteria pertaining to *Enterococcus* since 2006, and the ʻAnini Beach sampling location has had insufficient data to assess the same criteria since 2006 (State of Hawaii Department of Health, n.d.).

State water quality standards state that warning signs pertaining to *Enterococcus* will be posted in areas where human sewage is identified as temporarily contributing to the *Enterococcus* levels. In addition, there is a Beach Action Value (BAV) set by the CWB at 130 CFU/100 mL, where a single exceedance of this value prompts the CWB to take immediate action to notify the public. When a monitored beach has samples that exceed the BAV, the system alerts local CWB monitoring staff to prepare for needed response, including additional sample collection. Table 3 shows all recorded instances of *Enterococcus* levels above the BAV at the ʻAnini Beach Park sampling station, as reported by the CWB water quality monitoring efforts (State of Hawaii Department of Health, n.d.). Note that water quality criteria states that turbidity measurements should not exceed 2.00 NTU more than 2% of the time (Hawai'i Department of Health, 2020). The system also posts an alert to the CWB website with a map of the impacted area. ʻAnini Beach Park is listed as a Tier 2 beach location by the CWB, signifying that the beach is less heavily used as compared to beaches classified as Tier 1, and therefore is not monitored on a routine basis. Through the Clean Water Act and Beaches Environmental Assessment and Coastal Health (BEACH) Act, states must monitor coastal recreational waters for water quality standards and have a system in place to alert the public of dangerous water quality conditions. The Hawaiʻi Beach Monitoring Program states that Tier 1 beaches on Kauaʻi are monitored once a week, and there are no specific sampling frequency protocols in place for Tier 2 or 3 beaches (Hawai'i Department of Health, 2017). Tier 2 and 3 beaches on Kauaʻi are typically monitored by the CWB once per month (Clean Water Branch, personal communication, November 05, 2020). Routine and frequent monitoring of *Enterococcus* levels is pertinent in regard to protecting the recreational value of the state's waterways.

Location Identifier	Date	Enterococcus (MPN/100 mL)	Turbidity (NTU)
801	07/24/18	192	3.49
801	04/04/18	324	2.91
801	10/29/14	2005	12.2
801	02/12/14	150	11.5
801	02/08/12	222	13.1
801	06/22/11	238	15.6
801	04/07/10	137	2.96
801	06/25/09	220	1.63

Table 3: Water quality data from the Hawai'i Clean Water Branch for 'Anini Beach Park sampling station on Kaua'i. Data is sourced from the Clean Water Branch Water Quality Database located on their website (http://cwb.doh.hawaii.gov/CleanWaterBranch/WaterQualityData) and has data for 'Anini Beach Park Data dating back to July 2008. There are 209 listed data entries for this location, and sampling occurred roughly 1-2 times per month. Data for this table is filtered to show all recorded instances where Enterococcus levels exceed the beach action value of 130 MPN/100 mL. More information pertaining to Enterococcus sampling can be found in section 3.1.5 Enterococcus.

3.2 Toxic Substances

The leaching of toxic metals into 'Anini stream is of great concern. Potential toxic inputs in 'Anini include glyphosate from herbicide use, and the leaching of metals from the Hanalei Refuse Transfer Station (see section *3.6.2 Hanalei Refuse Transfer Station*). Toxic metals leach into 'Anini stream during reported cesspool overflow events. Studies show that toxic metals found in environments are often sourced from poor effluent disposal and management. Metals that are leached from the Transfer Station, including zinc, lead, aluminum, and iron can contaminate both surface and groundwater, and affect the biological functions, endocrine systems, and overall growth of organisms that interact with the contaminated environment (Okereafor, et al., 2020).

3.2.1 Glyphosate

Testing for glyphosate, a compound associated with some herbicides, is not part of the standard testing through the state of Hawai'i's water quality monitoring and assessment program. However, glyphosate is known to disturb coral metabolism, meiosis, and calcification, as well as the cell cycling and nutrient transport associated with the coral's algal symbionts (Zhou et al., 2022). There is currently no data on the presence of glyphosate for the 'Anini area. However, it is generally understood to be used by private homeowners, landscaping companies, and Princeville Utilities Company, and may be utilized by golf courses.

3.3 Water Quality Advisories

Though the ʻAnini Beach Park sampling location is listed as attaining water quality standards related to *Enterococcus* , the beach has experienced closures due to high bacteria counts and brown water advisories. Brown water advisories are related to high amounts of stormwater entering the marine waters, including overflowing cesspools, sewers, and manholes. The runoff can include pesticides, fecal matter, dead animals, pathogens, chemicals, and other flood related debris. The Hawai'i State Environmental Health Administration database, EHAConnect, lists four occasions of high bacteria counts or brown water advisories at ʻAnini beach between May and December of 2018. All water quality advisories associated with ʻAnini reported in the EHAConnect database (2017-2019 reported on database) are summarized in Table 4. Regarding high bacteria counts, *Enterococcus* levels measured by the Clean Water Branch (CWB) were utilized to instate the water quality advisory. The EHAConnect database states that *Enterococcus* testing could indicate the presence of potentially harmful microorganisms, including bacteria, viruses, protozoa, and parasites (Hawai'i State Environmental Health Administration, 2020).

Advisory Type	Issue Date	Cancellation Date	Cause of Advisory
Brown Water	01/08/2019	01/14/2019	High turbidity from stormwater runoff entering coastal waters (associated with possible overflowing cesspools, sewers, manholes, pesticides, animal matter, chemicals), wave action, and boat launching/ retrieval activity
Brown Water	12/11/2018	12/19/2018	Stormwater runoff entering coastal waters (associated with possible overflowing cesspools, sewers, manholes, pesticides, animal matter, chemicals)
Brown Water	10/30 /2018	11/21/2018	Stormwater runoff entering coastal waters (associated with possible overflowing cesspools, sewers, manholes, pesticides, animal matter, chemicals)
High Bacteria Count	07/25 /2018	07/26/2018	Stormwater runoff entering coastal waters
Brown Water	05/10 /2018	05/11/2018	Stormwater runoff entering coastal waters (associated with possible overflowing cesspools, sewers, manholes, pesticides, animal matter, chemicals)
Brown Water	04/24 /2018	05/10/2018	Stormwater runoff entering coastal waters (associated with possible overflowing cesspools, sewers, manholes, pesticides, animal matter, chemicals)
High Bacteria Count	04/05/2018	04/06/2018	Stormwater runoff entering coastal waters
Brown Water	11/08 /2017	11/24/2017	Stormwater runoff entering coastal waters (associated with possible overflowing cesspools, sewers, manholes, pesticides, animal matter, chemicals)

Table 4: Water quality advisories for the ʻAnini area in Kaua'i, as listed by the Hawai'i State Environmental Health Administration (EHAConnect) database, listed from 2017-2019. Water quality monitoring and reporting, as well as water quality advisories and beach closures, are managed by the state of Hawai'i's Clean Water Branch. More information regarding harmful bacteria and water quality advisories can be found in section 3.1.5 Enterococcus and section 3.3 Water Quality Advisories.

3.4 Surfrider Foundation

Kaua'i's Surfrider Foundation Blue Water Task Force (BWTF) collects water samples to test for *Enterococcus* with EPA-approved methodology (Hawai'i Department of Health, 2020), focusing on estuaries and popular surf breaks. Surfrider does not have a regular sampling location at ʻAnini. To the south of ʻAnini, the mouth of the Kalihiwai river and Kalihiwai surf break have been monitored by Surfrider. Since March of 2018, only 5% of samples taken at the Kalihiwai river mouth location have met state water quality standards criteria (Figure 24A). Since September of 2007, 83% of samples collected at the Kalihiwai surf location have met state water quality standards criteria (Figure 24B). To the north of ʻAnini, the Hanalei River at Weke

Road, near its mouth, and the Bowl surf break in Hanalei have also been monitored. Since March of 2018, only 12% of the samples taken at the Hanalei River at Weke Road have met state water quality standards criteria (Figure 24C). Since September of 2007, 83% of samples taken at The Bowl surf break in Hanalei have met water quality standards (Figure 24D) (Surfrider Foundation Kaua'i, n.d.).

Though the ʻAnini area is not part of the BWTF monthly monitoring efforts, they have recorded data from the ʻAnini surf break from May-November 2009 (Table 5). This sampling location, located at 22° 13' 38.91" N, 159° 26' 26.50" W, is roughly 0.30 miles offshore from the Kowali stream mouth, outside the eastern edge of the ʻAnini watershed boundary. The sampling efforts at this location recorded *Enterococcus* levels to be generally around 2.3 MPN/100 mL, with a geometric mean of 2.84 MPN/100 mL (C. Berg, personal communication, November 07, 2020), which is well below the thresholds for beach closure

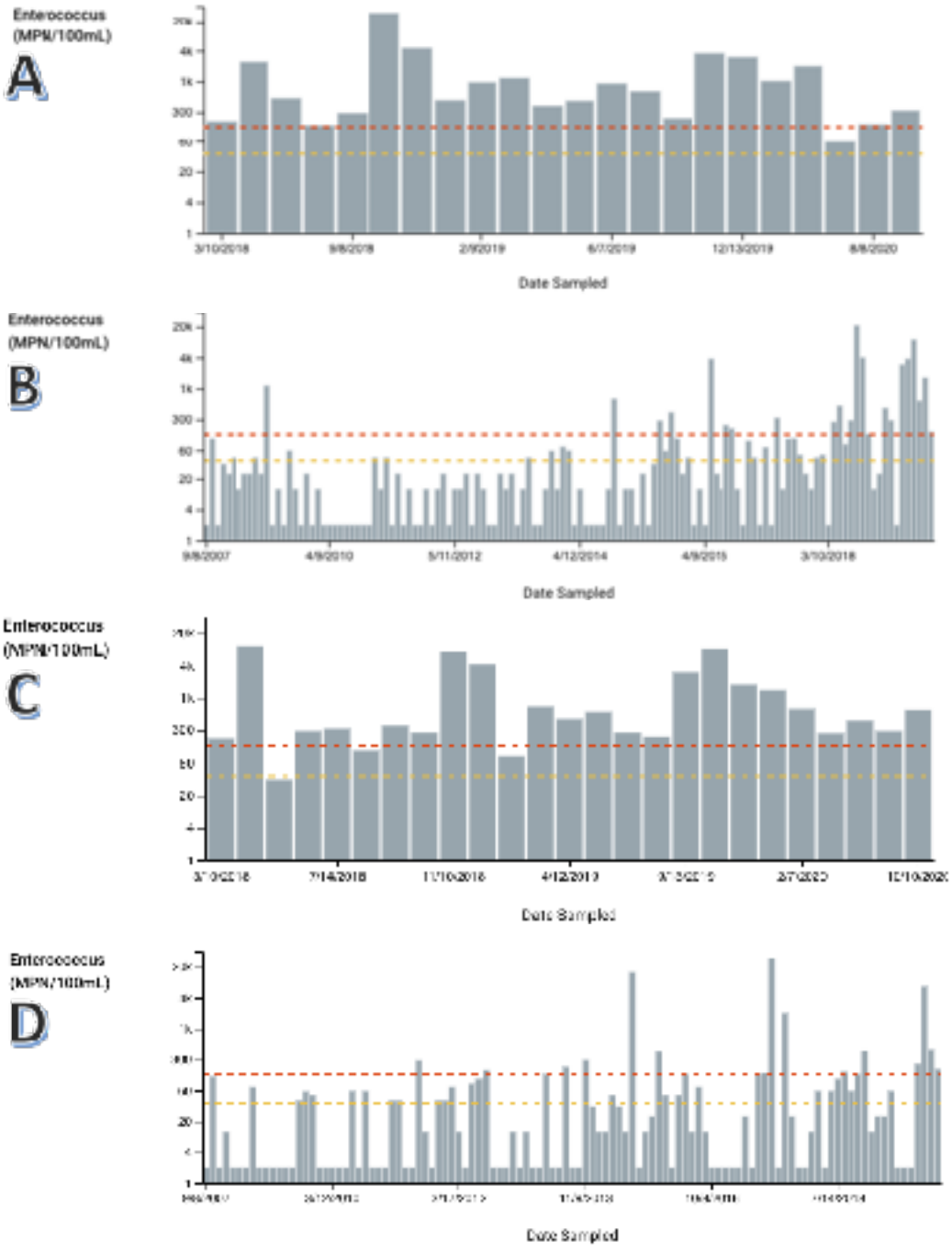


Figure 24: Graphs courtesy of the Blue Water Task Force, part of the Surfrider Foundation Kaua'i Chapter. Figure 24A represents the Kalihiwai river mouth sampling location, Figure 24B represents the Kalihiwai surf break, Figure 24C represents the Hanalei River at Weke Road, and Figure 24D represents the Hanalei Bowl surf break. Analysis of each location utilizes all data available for each location listed on the Surfrider online database. The dashed lines running horizontal across the graphs represents water quality standards criteria set by Hawai'i's Department of Health, the yellow dashed line representing "medium" levels of Enterococcus bacteria (36-130 MPN/ 100mL) that are higher than the 35 MPN/100 ml criteria for geomean over 30 day interval , and the red dashed line representing "high" levels of Enterococcus, (>130 MPN/100mL) exceeding the Statistical Threshold Value not to be exceeded by more than 10% of samples during the same 30 day interval as the geomean value.. The Surfrider online database can be found at: https://kauai.surfrider.org/what-we-do-old/blue-water-task-force-map/

Date	Time	Salinity	Enterococcus Level (MPN/100mL)
05/09/09	0800	36	2.3
06/13/09	0730	36	2.3
07/11/09	0730	36	2.3
08/15/09	0845	36	10
09/12/09	0730	35	2.3
10/10/09	0800	35	2.3
11/07/09	0748	36	2.3
Geometric Mean			2.84

Table 5: All available Enterococcus sampling data on the 'Anini surf break, courtesy of the Blue Water Task Force with the Surfrider Foundation, Kaua'i chapter. The latitude and longitude of the sampling location are 22° 13' 38.91" N, 159° 26' 26.50" W.

3.5 Safe Drinking Water Branch Permits

Injection wells on Kaua'i are managed by the Underground Injection Control (UIC) program through the Safe Drinking Water (SDW) branch of the Hawai'i DOH. The Hawai'i DOH lists injection wells and wastewater treatment plants as potential sources of groundwater contamination. Injection wells are associated with biological, chemical, physical, and radioactive contamination of groundwater, and the UIC program monitors permitted well sites to mitigate pollution levels. UIC wells can be classified as Class I-VI. Class I wells are utilized to inject hazardous and nonhazardous waste into rock formations beneath all underground drinking water sources. Class II wells inject fluids related to oil and gas production, including recovery of oil and gas, and disposing of wastewater associated with oil and gas production. Class III wells are utilized to inject fluids to assist in the extraction of minerals, including salt and copper. Class IV wells utilized to inject hazardous and radioactive waste material into or above drinking water sources. Class V wells are utilized to inject nonhazardous fluids not covered in the other classes, including stormwater. Class VI wells are utilized to inject carbon dioxide for deep, long-term storage. About 70% of the national UIC permitted wells are Class V, and about 25% are Class II (Environmental Protection Agency, 2020). Table 6 lists UIC permitted sites in and surrounding the 'Anini area, including the towns of Kilauea and Princeville. The information listed about well sites was provided by the SDW branch.

All expired UIC permits listed in Table 6 have well sites that are either inactive or abandoned. Regarding the permits that are currently in effect, the Princeville Wastewater Treatment Plant (WWTP) permit location is listed as Class V-E, with subclass E signifying that the site is an injection well. This permitted location has two active well sites, the discharge is listed as sewage, and the permit expired in April 2022. The majority of effluent disposal for this

location is treated for reuse and utilized to irrigate the Princeville Makai Golf Course, though the wells were built on site for backup disposal capacity. More information on the Princeville WWTP can be found in section 3.6.3 Individual Wastewater Systems and Wastewater Treatment Plants. The Kilauea Elementary School location is listed as Class V-AB, with subclass AB signifying the well injects into exempted aquifers, or aquifers that are not and will not be used as sources of drinking water. The location has 2 active well sites, the discharge is listed as sewage, and the permit expires August 2025. The Kilauea Lighthouse Village location is listed as Class V-AB, discharge listed as sewage, and has a permit in effect through April 2024. Mapped locations of both active and expired permits can be found in Figure 25.

Name of Facility or Property Owner	Address	UIC Permit Number	Total # of Wells	Well Classification	Permit Status
Hale Ho'olulu Elderly Public Housing	4264 Ala Muku Place, Kilauea, HI 96754	UK-2774	2	V-AB	Expired
Princeville Wastewater Treatment Plant	4261 Kekuanaoa Lane, Princeville, HI 96722	UK-2926	2	V-E	Expired
Kilauea Elementary School	2440 Kolo Rd, Kilauea, HI 96754	UK-2646	2	V-AB	In Effect
Kilauea Industrial Wastewater Treatment	4-1579 Kuhio Highway, Kilauea, HI 96754	UK-1759	1	V-AB	Expired
Kilauea Lighthouse Village	2555 Ala Namahana Parkway, Kilauea, HI 96754	UK-3052	2	V-AB	In Effect
Princeville Wastewater Pump Station	Multiple locations throughout Princeville	UK-1964	4	V-AB	Expired
Kilauea Point National Wildlife Refuge	Kilauea Road, Kilauea, HI 96754	UK-2341	1	V-AB	Expired

Table 6: Permitted injection well data from the Underground Injection Control (UIC) program with the Safe Drinking Water branch of Hawai'i. Data is provided from the Safe Drinking Water branch, as well as through the Hawai'i State Environmental Health Administration database (EHAConnect database) and is current as of November 2020. Data is filtered for permitted sites within and surrounding the 'Anini area of Kaua'i, including the towns of Kilauea and Princeville. Well classification types are listed by class (number) and occasionally subclass (letter). Details on well classifications can be found at: https://www.epa.gov/uic/underground-injection-control-well-classes. A map of listed UIC locations can be found in Figure 25.

Figure 25: Locations of Underground Injection Control (UIC) program permitted locations in and surrounding the 'Anini area, including both in effect and expired permits . Watershed, as delineated by the Department of Aquatic Resources (DAR), are outlined in red, courtesy of the DAR Watersheds layer for Google Earth. Detailed information on UIC sites can be found in Table 6.

Additionally, the United States Geological Survey (USGS) has three injection well and test hole sites listed in the 'Anini area, all of which are inactive and are not currently monitored by USGS (Table 7, Figure 26). There is little information published on these sites. The location named "Anini Str .2mi US from stream mouth" has two published stream discharge measurements in the 1963 Surface Water Records of Hawai'i and other Pacific Areas reports (United States Geological Survey, 1963). No additional information pertaining to these USGS sites can be located.

Site Name	Site Number	Site Type	Site Status
Anini Str .2mi US from stream mouth	221315159274901	Well	Inactive
2-1327-01 TU1 ANINI	221332159274701	Well	Inactive
2-1327-02 ANINI	221317159271901	Test Hole	Inactive

Table 7: United States Geological Survey (USGS) well and test hole sites in the 'Anini area of Kaua'i. Mapped locations of listed sites can be found in Figure 26.

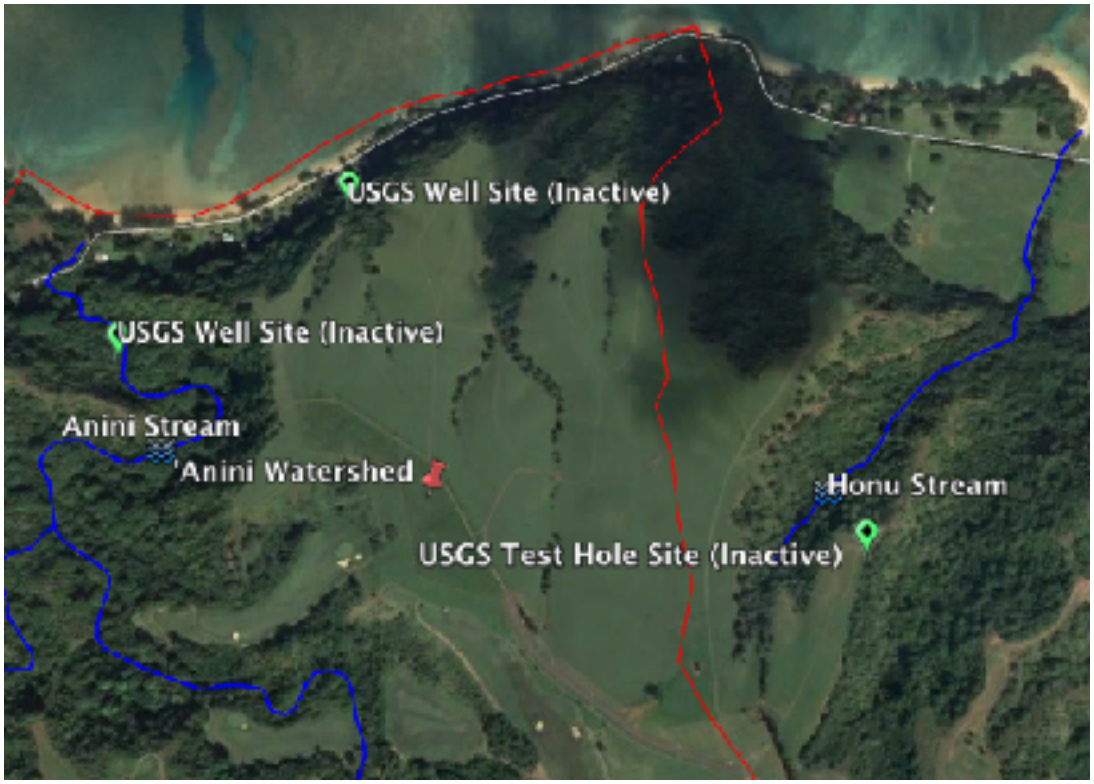


Figure 26: Three inactive well sites once managed by the United States Geological Survey, located within and near the ʻAnini Watershed. The ʻAnini watershed, as delineated by the Department of Aquatic Resources (DAR), is outlined in red courtesy of the DAR Watersheds layer for Google Earth. Detailed information on these well sites can be found in Table 7.

3.6 Clean Water Branch Permits

3.6.1 National Pollutant Discharge Elimination System Permits

The Clean Water Branch (CWB) of Hawai'i manages all NPDES permits, with permitting information available for public access. The CWB provided a list of all current and pending NPDES permits for the island of Kaua'i (current as of October 2020). Current and pending NPDES permits that are filtered to those located in and around the ʻAnini area of Kaua'i can be found in Table 8. There are currently two active or pending NPDES permits within the ʻAnini watershed boundary, including Kaua'i County Hanalei Refuse Transfer Station and Princeville Makai Ranch Road. The Hanalei Refuse Transfer Station permit is currently expired, but there is an in-process renewal status listed for this location. The Makai Ranch Road location is part of a development plan of 75 ranch homesites on 700 acres bordering The Prince Golf Course (Magin, 2017). More information on the Makai Ranch Road location can be found in section 2.3 Population and Land Use. The other permitted locations are within the towns of Kilauea, Princeville, and within the Kalihiwai watershed (Figure 27).

Site Name	Site Address	Permit Number	Permit Type	Permit Status
Kaua'i County Hanalei Refuse Transfer Station	5-3781 Kuhio Hwy, Princeville, HI 96722	HIR50D148	Form B	Expired/In-Process Renewal
Princeville Well No. 5 Pump Outfitting and Connecting Pipeline	Vicinity of Kahiloholo Rd, Kilauea, HI 96754	HIR10F823	Form C	In Effect
Makai Club Resort Access Road & Parking Lot Improvements	180 Lei O Papa Road, Princeville, HI 96722	HIR10F818	Form C	In Effect
Kilauea Lighthouse Village	4244 Kilauea Road, Kilauea, HI 96754	HIR10E213	Form C	In Effect
Secret Beach	Kauapea Beach, Kilauea, HI 96754	HIR10F954	Form C	In Effect
Princeville Makai Ranch Road "B", "B" Place, and Road "F"	Hihimanu Rd, Princeville, HI 96722	HIR10F499	Form C	In Effect
Kuhio Hwy Emergency Slope Stabilization in Vicinity of Kalihiwai Bridge	Kuhio Highway in the Vicinity of Kalihiwai Bridge (Approximately MP 25)	HIR10G077	Form C	In Effect
1 Hotel Hanalei	5520 Ka Haku Rd, Princeville, HI 96722	HIR10F991	Form C	In Effect

Table 8: National Pollutant Discharge Elimination System (NPDES) current and pending permits listed from the Clean Water Branch of Hawai'i for the areas in and surrounding the 'Anini watershed area of Kaua'i (towns of Princeville and Kilauea), as of 28 October 2020. Form B permit types represent stormwater associated with industrial activity, Form C types represent stormwater associated with construction activities, and Form M types represent pesticide application. A map of permit locations can be found in Figure 27.

Figure 27: Locations of current and pending Clean Water Branch National Pollutant Discharge Elimination System (NPDES) permits within the 'Anini area. The 'Anini, Kalihiwai, and Hanalei watershed boundaries are outlined in red, courtesy of the Department of Aquatic Resources Watershed boundaries layer for Google Earth. Inland streams and rivers are outlined in blue, courtesy of the Environmental Protection Agency's WATERS layer for Google Earth. Detailed information on each NPDES permitted location can be found in Table 8.

'Anini Beach is on the EPA 303(d) list of impaired waters, and there are two active/pending NPDES permits within the 'Anini watershed, indicating that the watershed is subject to pollution. However, without water quality monitoring the degree of point and non-point-source pollution is not known. The area is recommended for a total maximum daily load (TMDL) based on turbidity measurements, but resource limitation precludes assessing the TMDL.

The Water Pollution Control (WPC) viewer database is an interactive map generated by the CWB with information on NPDES permitted locations (Hawai'i State Department of Health, n.d.). Appendix G: Water Pollution Control Viewer Permits contains a list of NPDES permits filtered for the towns of Hanalei, Princeville, and Kilauea. The majority of these permits are expired or terminated, and the Hanalei Refuse Transfer Station permit location is the only permit that is listed in both the list of current and pending permits provided by the CWB (Table 8) and the list generated by the WPC viewer. Most permits in both lists are permit type Form C, representing permits for stormwater associated with construction activities. Other permit types listed include Form B (stormwater associated with industrial activities), Form M (pesticide application), Form L (circulation water from decorative ponds or tanks), and WQC (water quality certifications) (State of Hawai'i Department of Health, n.d.). It is pertinent to assess past permitting efforts even if they are now expired. Old construction projects could continue to produce sediment-laden runoff into stream systems.

Regarding the current and pending NPDES permits for the broader ʻAnini area (Table 8), the Kaua'i County Hanalei Refuse Transfer Station, one of four refuse transfer stations on Kaua'i with stormwater discharge, is listed as permit Form B. Discharge from this permitted location includes aluminum, copper, iron, and zinc, and exceedances of these nutrients in the discharge following rain events have been reported by county monitoring efforts. Additional details pertaining to this site can be found in section 3.6.2 Hanalei Refuse Transfer Station. The Princeville Well No. 5 permit location, operated by Princeville Utilities Company, Inc., is listed as Form C and does not have public documents pertaining to the well site available. According to Princeville Utilities Company, the well is not currently operating, but there are future plans to get the well operating in the near future (B. Suizu, personal communication, November 05, 2020). The Makai Club Resort Access Road & Parking Lot Improvements permit location is listed as Form C and does not have any public documentation available. The Kilauea Lighthouse Village permit location is listed as Form C has been renewed to operate through February of 2024. The site contains two gulches where stormwater is discharged into the receiving waters of Niu stream, which drains to Kauapea Beach (Secret Beach). The Kauapea Beach permit site does not have a specific address attached to it, nor does it have any public documentation, though the site name refers to Kauapea Beach. The site is listed as Form C, is managed by Pranava Properties Inc., and is valid through February 2024. The Princeville Makai Ranch Road permit site is listed as Form C and is operated by North Shore Preserve, Inc. Documentation from this site states that the existing project site was once used as a plantation and cattle ranch before becoming the current golf course, resort, and residential area. The Kuhio Highway Emergency Slope Stabilization permit site is listed as Form C, is effective through February 2024, and does not have any public documentation available. The work on this site is related to slope stabilization construction work above the Kalihiwai river. The 1 Hotel Hanalei site is listed as

form C, is effective through February 2024, and does not have any public documentation available.

3.6.2 Hanalei Refuse Transfer Station

Refuse transfer stations in Hawai'i are managed by the counties and utilized for the recycling of many materials, including metal, oil filters, propane tanks, appliances, tires, green waste, and general residential recycling. The four transfer stations on Kaua'i, located in Lihue, Hanapepe, Kapa'a, and Hanalei have all been fined by the DOH for exceedances in permit limits for pollutants in their effluent discharge (Carpenter, 2016). The Hanalei transfer station is located within the 'Anini watershed and discharges effluent adjacent to the 'Anini stream. The permit for this location pertains to the discharge of stormwater associated with industrial activity. There are several effluent reports that note exceedances of permit limits for metals, and they cite the cesspools that overflow during rain events as the source of stream contamination. The WPC Viewer database lists 9 reports of exceedances of nutrients, metals, and total suspended solids from 2014-2018, as well as multiple complaints and fines. Frequent heavy rains and inadequate pumping of the cesspool are listed as causes of the cesspool overflowing leachate into 'Anini stream. Table 9 lists exceedances of pollutants in stormwater discharge as listed from a Clean Water Branch (CWB) notice of exceedances on August 6, 2018. Pollutants in the overflowing leachate include aluminum, copper, iron, lead, zinc, phosphorus, nitrogen, and total suspended solids.

Location	Parameter	Unit	Result	Effluent Limitation	Basis for Limit
Discharge Point	Total Aluminum	µg/L	83,000	750	HAR 11-54-4(c)(3), acute freshwater [a]
	Total Copper	µg/L	180	6	HAR 11-54-4(c)(3), acute freshwater [a]
	Total Iron	µg/L	93,000	1,000	NGPC HI R50D148 [b]
	Total Lead	µg/L	98	29	NGPC HI R50D148 [b]
	Total Zinc	µg/L	470	32	HAR 11-54-4(c)(3), acute freshwater [a]
	Total Suspended Solids	mg/L	1,400	10	HAR 11-54-5.2(b) [b]
	Total Phosphorus	mg/L	2.1	0.03	HAR 11-54-5.2(b) [b]
	Total Nitrogen	mg/L	5.5	0.180	HAR 11-54-5.2(b) [b]
	Nitrate + Nitrite Nitrogen	mg/L	0.054	0.03	HAR 11-54-5.2(b) [b]

µg/L microgram per liter
mg/L milligram per liter

[a] Per the NGPC, the permittee shall test for the total recoverable portion of all metals; however, the limitations for metals specified in HAR 11-54-4(c)(3) are for the dissolved fraction.

[b] An acute freshwater numeric standard for iron is not provided in HAR 11-54-4(c)(3) November 2014 update. Therefore, the effluent limitation provided in the original NGPC (File No. HI R50D148) is used as the discharge limit

Table 9: Hanalei Refuse Transfer Station storm water discharge exceedances from June 14, 2018. The table is from a notice of exceedances from the Clean Water Branch sent to the Hanalei Refuse Transfer Station on August 6, 2018. The Result column lists measured levels of each respective pollutant, and the Effluent Limitation column lists the maximum allotted levels of each pollutant, and the Basis for Limit column lists the source of each effluent limitation, either through the HAR §11-54 or other listed source.

The Discharge Monitoring Report (DMR) for Hanalei Refuse Transfer Station, from January 1, 2018-December 31, 2018, lists an average discharge flow of 15 gallons per minute with a maximum of 20 gallons per minute. Throughout this period, there were 3 total exceedances of zinc, iron, copper, total suspended solids, phosphorus, nitrogen, and aluminum. Other exceedances included pH and lead (Department of Public Works, County of Kaua'i, 2018). The 2017 DMR listed a maximum of 1 reported exceedance for each of the monitored pollutants, and the 2016 DRM listed a maximum of 2 reported exceedances for each criterion (Department of Public Works, County of Kaua'i, 2017; Department of Public Works, County of Kaua'i, 2016).

3.6.3 Individual Wastewater Systems and Wastewater Treatment Plants

Businesses and homes in Kaua'i that are not managed by centralized wastewater collection and treatment systems must rely on privately owned systems. All of Kilauea, Princeville, and Hanalei must operate on privatized and individual wastewater systems (Carter & Burgess Inc., 2002). Individual wastewater systems (IWS), including cesspools and septic systems, are managed by the Wastewater department of the CWB. There are 74 tax map key locations containing 87 total IWS within and surrounding the ʻAnini watershed (Table 10). Mapped locations of each IWS can be found in Figure 29. The state of Hawai'i was one of the last states to allow the building of new cesspools, but the passage of Act 120 in 2017 prohibits new cesspools and mandates upgrades of all existing cesspools by 2050. As of 2017, there are approximately 13,700 active cesspools on Kaua'i (Hawai'i State Department of Health, 2017). Act 120 was passed in order to protect the contamination to drinking water and coastal waters that cesspools are recognized to cause. The DOH has a priority system in place to assess all existing cesspools for upgrade and replacement based on their potential impact to sensitive waters. Most discharges from small-scale IWS are not monitored by any agency, and therefore can pose a risk to water resources. Septic systems are a slight improvement on cesspools, since they reduce the risk of introducing pathogens to groundwater and surface waters and reduce the total suspended solids in the effluent, but they still allow substantial nutrient pollution to groundwater and coastal waters.

With the large number of septic systems on the island, it is difficult to monitor and manage them properly due to limited resources,which decreases their effectiveness further (Hawai'i Wastewater Department, n.d.). According to the Hawai'i Wastewater department, cesspools located in the towns of Hanalei and Kilauea all discharge into groundwater (Kaua'i District Health Office, n.d.). This is of great concern in regard to water quality because IWS, including septic systems and cesspools, do not have specific disinfectant or nutrient removal processes. With the large concentration of IWS adjacent to coastal waters at ʻAnini, it is pertinent to monitor the marine waters and streams for wastewater indicators, such as nutrients, bacteria, and chemical tracers.

The Princeville Waste Water Treatment Plant (WWTP), a location listed previously for its UIC permit, operates as an extended air activated sludge plant. This WWTP is owned and operated by the private company, Princeville Utilities. This system utilizes 6 lift stations (moves wastewater from lower to higher elevation), 4 aeration tanks (utilizes aerobic biodegradation of

pollutants), 3 aerobic digesters (reduces volume of sewage sludge), 2 Somat dewatering units (removes water from solids), a chlorine contact tank, a sodium hypochlorite disinfection system, and 5 sludge drying beds. All of the effluent associated with this system is classified as R-2 recycled water and is utilized to irrigate the Princeville Makai Golf Course, though the WWTP also has injection wells for back up disposal capacity. Reference Figure 30 for a map showing the irrigation area, as well as surrounding private homes and resorts. The Makai Golf Course extends to the coast on the western edge of ʻAnini's marine waters and reef.

All wastewater from the homes and resorts in the Princeville area, 26 tax map key plots in total, is collected and sent to the WWTP via sewer lines. Some of the R-2 effluent is also stored in ponds associated with the Makai Golf Course (L. Vetter, personal communication, November 18, 2020). R-2 water refers to recycled water that is disinfected and oxidized to a degree but is not potable. Fecal coliform densities in R-2 water must not exceed a median density of 23 units per 100 mL, or more than 200 units per 100 mL in more than one sample in any 30-day period.

The water reuse classifications do not include nutrient limitations. The stormwater utilized for dilution and R-2 water is recognized to contain nutrients and other toxic compounds that could spread to groundwater and runoff that can flow to the ocean. R-2 water is not permitted for use on food crops where water contacts the edible portions of the crop/root crop, basins at fish hatcheries, decorative fountains, flushing toilets and urinals, commercial and public laundries, washing yards, lots, and sidewalks, industrial process with exposure of workers, and additional restrictions (Hawai'i Wastewater Department, 2002).

Figure 28: Makai Golf Course R-2 effluent storage ponds.

Type of IWS	Number of IWS Units per Parcel	Notes
Cesspool	6	
Septic System	77	
Other	4	Unknown if septic system or cesspool, or signifies the parcel is vacant

Table 10: Individual wastewater systems (IWS), including septic systems and cesspools, in the 'Anini area on Kaua'i. Information is sourced from the Hawai'i Department of Health Wastewater department. Due to some residential locations not having their IWS file up to date with the Department of Health, some IWS are listed as "unknown". For a map of these IWS locations, reference Figure 29.

An additional area of concern involving IWS in the coastal 'Anini area is sea level rise. Depending on the depth of the groundwater in the area, sea level rise can raise the groundwater levels and compromise local septic systems (Miami-Dade Department of Regulatory & Economic Resources, 2018). Without proper monitoring of the 'Anini waters for pollutants, any compromised septic systems releasing pollutants will not be observed. Additional information on sea level rise can be found in section 4.4.2 Best Management Practices.

Figure 29: Mapped locations of all individual wastewater systems (IWS), including cesspools and septic systems, within and surrounding the 'Anini watershed. Listed IWS are registered with the Hawai'i Department of Health Wastewater department. The 'Anini and Kalihiwai watershed boundaries, as delineated by the Department of Aquatic Resources (DAR), are outlined in red and labeled courtesy of the DAR Watersheds layer for Google Earth. 'Anini, Honu, Kalihikai, and Kowali streams are outlined in blue courtesy of the Environmental Protection Agency's WATERS layer for Google Earth. Further information regarding IWS can be found in section 3.6.3 Individual Wastewater Systems and Wastewater Treatment Plants.

Figure 30: Mapped locations of the areas that Princeville Wastewater Treatment Plant (WWTP) services, including resorts, the Princeville Makai Golf Club, and residential homes in Princeville. Wastewater from resorts and residential homes in Princeville are pumped to the WWTP via sewer lines, and treated water is recycled to irrigate and fill water features of the Princeville Makai Golf Course. The Makai Golf Course is shaded in light green, and major water features of the course are marked with light blue place markers. The 'Anini and Hanalei watershed boundaries, as delineated by the Department of Aquatic Resources (DAR), are outlined in red and labeled courtesy of the DAR Watersheds layer for Google Earth. Streams are outlined in blue courtesy of the Environmental Protection Agency's WATERS layer for Google Earth. Further information on the Princeville WWTP can be found in section 3.6.3 Individual Wastewater Systems and Wastewater Treatment Plants.

4. Summary, Management Recommendations, and Goals

With this report, it is Reef Guardians' goal to serve the Kaua'i community by educating the general public and stakeholders on the current state of the 'Anini watershed, its sources of water pollutants, and locations of water quality impairment. We aim to assist this effort by making informed management recommendations to mitigate the consequences of impairment and develop a plan for water quality monitoring. By enhancing the water quality of the streams that empty into 'Anini reef, the streams and marine waters will continue to be sources of recreation and sustenance for generations to come. 'Anini watershed is a relatively small watershed that is home to endemic aquatic fauna, which makes the ecosystem sensitive to ecological degradation. The nearshore coral reefs of 'Anini are within a slight embayment and protected lagoon, which may concentrate pollutants from streams and groundwater around the corals. The streams within and surrounding the 'Anini watershed, as well as the marine waters, are historically understudied. This puts the 'Anini area at an extreme disadvantage for future research and funding, since ecological research tends to focus on areas that have been previously studied. Characteristics of 'Anini's waters where research should be focused include water quality data on marine and inland waters (3. Water Quality), submarine groundwater

discharge tracer studies (2.2.2 Submarine Groundwater Discharge), and coral reef health assessments (2.2.4 ʻAnini Reef and Black Band Disease).

4.1 Turbidity, Nutrients, and Enterococcus

ʻAnini's marine waters are classified by the Clean Water Branch (CWB) as "impaired". Turbidity and the sources of turbidity should be identified and mitigated. ʻAnini drainage ways are bringing sediment to the ʻAnini reef through drainage runoff. Runoff from private property maintenance, construction projects and other soil disturbances contribute to the ʻAnini reef contamination reaching the natural design runoff paths to ʻAnini waters, also settling on the reef. Reconnaissance surveys, section 2.4 Reconnaissance Efforts, showed that more than 80% of ʻAnini stream runs through "privately owned lands". These lands are golf courses, agriculture and residential. Several active construction projects not practicing best management are noted during reconnaissance resulting in irreversible disturbances of polluting soils in runoff to ʻAnini waters, reef and the ocean, elevating marine turbidity levels. Feral pigs and other wildlife living in forested areas of the watershed also pollute and cause soil erosion of streams. Law mandated and properly applied and properly regulated "Best Management Practices'' on all land can mitigate polluting death-causing turbidity levels. "Best Management Practices'' include detaining stormwater, sediment trapping, stormwater infiltration and more. Enforcing options for private and all other land would minimize sediment loading. Adding feral ungulate fencing and planting of native vegetation mitigates erosion. These practices will also assist in mitigating nutrient pollution associated with soil runoff and ungulates (State of Hawai'i Department of Transportation, 2015).

Sources of nutrient pollution in the ʻAnini area include:

1. Runoff point and nonpoint source pollution from private and agricultural lands.
2. Point source pollution from permitted discharge sites.
3. Nitrogen and phosphorus leached into ʻAnini stream from cesspool overflow and septic system overloads. Science shows these items above can acidify waters which then deplete dissolved oxygen levels starving the marine life of needed oxygen. (National Ocean Service, n.d.). Hanalei Refuse Transfer Station's cesspools are adjacent to ʻAnini stream, and have improved their environment polluting watchguards, yet it is pertinent for the station to upgrade and further maintain its equipment and cesspools in order to protect the sensitive watershed. Princeville Utility's utilization of R-2 recycled water to irrigate the Princeville Makai Golf Course is an additional area of concern. This golf course extends to the coast on the western edge of ʻAnini reef, and irrigation water and overflow from water features can generate runoff into the marine environment. R-2 water is associated with high nutrient contents, including nitrogen, phosphorus, and potassium (Hawai'i Wastewater Department, 2002). Levels of these nutrients are not tested for or monitored in Princeville Utility's semiannual effluent reports, which makes monitoring of adjacent waters for nutrients a high priority for Reef Guardians. The

streams adjacent of ʻAnini stream that are of interest for water quality testing include Kaweonui, Honu, Kalihikai, and Kowali streams. Since all of these streams empty into the lagoon of ʻAnini, it is pertinent to monitor them for pollutants that enter the reef and to minimize or remove any sources of pollution.

The DOH Water Quality Standards map of Kaua'i lists ʻAnini, Honu, Kalihikai, and Kowali streams as Class 2, indicating that the waterbody must be protected for recreational use, agricultural use, and general health of aquatic life. To protect the diverse uses of these streams, it is pertinent to regularly monitor the streams for *Enterococcus* levels. *Enterococcus* can cause negative health effects in humans, including irritated skin, eyes, ears, respiratory tract, and gastrointestinal tract. High measurements of *Enterococcus* levels will cause managing authorities to temporarily close access to waterways in order to protect human health (Environmental Protection Agency, 2016). The CWB currently does not monitor the marine waters of ʻAnini for *Enterococcus* on a regular basis and does not monitor the streams around ʻAnini at all.

We propose programs and bills to be now implemented to monitor, control, and oversee regulations for clean water runoff. With the large density of IWS in ʻAnini, including septic systems and cesspools that can leach pollutants (Figure 29), monitoring of the waters for *Enterococcus* and nutrients is pertinent. Monitoring of the streams and marine waters around ʻAnini for *Enterococcus* (EPA) and nutrients would be ideal in order to assess water quality levels over time. Monitoring nutrients and *Enterococcus* is valuable water quality data, particularly because it aligns with EPA Clean Water Act thresholds and the criteria for designating Impaired Bodies of Water.

A delta-15 N isotopic signatures in Ulva spp. algae study is able to show whether the primary source of Nitrogen to the system is agriculture, sewage, or natural. Monitoring d15N of algal tissue right after *Enterococcus* (EPA) study is recommended because there is a large statewide dataset for comparison.

A wish list of further study: Nutrients and *Enterococcus* can come from sewage, but they can also come from agriculture, invasive animal feces, pet feces, or sediment (where native populations of *Enterococcus* can thrive in tropical conditions). It is recommended to add one or more of the following parameters: Clostridium perfringens, human-specific bacteroides, sucralose, ibuprofen, or sulfamethoxazol. C. perfringens and human-specific bacteroides are microbial methods that will provide better indication of wastewater in particular; sucralose, ibuprofen and sulfamethoxazole are chemical tracers found only in wastewater;

With the lack of a total maximum daily load (TMDL) for ʻAnini stream, sources of point and nonpoint source pollution need to be monitored and mitigated, especially with National Pollutant Discharge Elimination System (NPDES) permitted sites within the watershed. Assessing these listed factors will work toward enhancing the quality of ʻAnini's waters and reef. Reef Guardians would like to take initiative in identifying homeowners near ʻAnini, Honu, Kalihikai, and Kowali streams, and seek their support in implementing soil erosion mitigation and pollution reduction or prevention practices. Homeowners may also be able to assist Reef Guardians with stream access points on their properties. These stream access points would be utilized to obtain water samples to assess for water quality criteria.

4.1.1 Water Quality Data

In order to have ʻAnini's inland waters assessed by the CWB, the streams would need to be included on the 305(b) list of assessed inland waters. The CWB states that in order to get these streams on this list, credible data regarding various characteristics of the streams are needed. However, the CWB is not currently focusing regular monitoring efforts on inland waters due to resource constraints. Though ʻAnini stream is subject to point source pollution through two NPDES permitted locations within the watershed, including the Hanalei Refuse Transfer Station with many recorded exceedances of toxic metals in their effluent discharge, these resource constraints limit the CWB's ability to procure needed total maximum daily load (TMDL) assessments (Clean Water Branch, personal communication, November 05, 2020).

Of the five streams studied in this report, including ʻAnini, Honu, Kalihikai, Kowali, and Kaweonui streams, ʻAnini is the largest and therefore should receive priority for monitoring efforts. However, the CWB sampling locations for ʻAnini's marine waters are located closer to the mouths of Kalihikai and Honu streams. Monitoring of these smaller streams for water quality could show potential impacts the streams have on the quality of the marine waters, thus enhancing the water quality data collected in the marine waters of ʻAnini. Since the four smaller streams of the lagoon empty into the marine waters surrounding the fringing reef, it is pertinent to assess the water quality of these streams in addition to ʻAnini stream.

In order to gain understanding of the impacts of ʻAnini stream on the reef and marine water quality, the CWB should include a marine sampling station near the muliwai (mouth) of ʻAnini stream. Though the marine waters of ʻAnini are listed under the 305(b) list of assessed marine waters and the 303(d) list of impaired marine waters for turbidity, the CWB does not sample this area for nutrients or chlorophyll-a. Due to resource constraints, the CWB chooses to focus monitoring efforts on *Enterococcus* and turbidity. Regular monitoring efforts for nutrients and turbidity in ʻAnini's marine and inland waters is needed in order to understand current pollution levels and potential future consequences of the reef due to water quality.

4.1.2 Third Party Sourcing of Water Quality Data

The DOH and CWB accepts water quality data gathered by third parties for their biannual water quality assessment reports, as long as data acceptance criteria is met, the data are readily available to DOH, and the quality control and quality assurance meet requirements of the DOH Quality Assurance Project Plans (QAPP). A copy of data acceptance criteria can be found in Appendix H: Department of Health Data Acceptance Criteria. A minimum of 30 samples for each water quality parameter must be gathered over a 2-year period in order for the CWB to make an assessment for the waterbody. For bacterial standards, there needs to be 5 samples within 30 days totaling at least 30 samples of two years. If 30 samples over 2 years is not achieved, the data is still recorded by the CWB for reference and any potential future uses (Hawai'i Department of Health, 2020). In order to start compiling water quality data for the ʻAnini area, third party sourcing would be a time-effective method.

Samples for nutrients can be sent to university or commercial laboratories for analysis. The Surfrider Foundation BWTF samples for *enterococci* following DOH data acceptance criteria. They utilize an IDEXX Enterolert overnight test system and analyze water samples at the Kaua'i Island School. Reef Guardians could create a similar setup to analyze samples from 'Anini (C. Berg, personal communication, November 07, 2020). A portable turbidimeter, such as the Hach 2100Q, can be utilized for turbidity readings. Basic water quality (dissolved oxygen, salinity, pH and temperature) can be done with a handheld or towed multi-probe meter. Chlorophyll-a levels are typically completed with a laboratory-based fluorometer, though *in situ* fluorometer probes can also be purchased and used with the multi-probe meter. Wherever practicable, methods approved by EPA for Clean Water Act programs should be used.

4.2 Groundwater

Submarine springs and discharge are directly connected to the terrestrial watershed and contain nutrients, trace elements, and other constituents derived from terrestrial sources. The rate and scale of SGD flow, as well as hydrographic parameters including temperature, salinity, pH, and chemical constituents, are unique to individual locations of groundwater discharge (Swarzenski, et al., 2017). Leached pollutants associated with stormwater, land runoff, wastewater systems, and injection wells are recognized sources of contamination to groundwater (United States Geological Survey, n.d.). Depending on discharge rates and volumes, SGD may be a significant source of nutrient loading into the marine waters of 'Anini reef. There is anecdotal evidence of SGD at 'Anini reef, and with SGD tracer studies completed at nearby locations on Kaua'i, Reef Guardians recommends similar studies to be completed at 'Anini. A SGD tracer study, completed at Makua Reef by Oberle, et al., utilized many methods to analyze SGD. These methods include Eulerian and Lagrangian oceanographic measurements, salinity and temperature profiles, electrical resistivity tomography surveys to examine freshwater and saltwater interfaces, Radon-222 water mass tracers, nutrient concentration measurements, and coral disease surveys (Oberle, et al., 2019).

Identifying and testing the water quality directly at groundwater seeps on the reef is a good method for identifying sewage contamination. Testing for chemical tracers works best before it is more diluted in the environment. This involves collecting water samples and using ELISA tests to identify certain chemical constituents. Testing SGD for pharmaceuticals or sucralose or caffeine is used for effectively identifying sewage pollution. These methods, if applied at 'Anini, would provide invaluable insight into the volume and quality of SGD input into the marine system.

4.3 Coral Reef Health

Healthy coral reefs sustain marine biodiversity and continued sustenance practices, including fishing. Sedimentation and turbidity are areas of concern regarding coral reef health at 'Anini. When sedimentation occurs at high rates for extended periods of time, corals are smothered by sediments, and high turbidity levels lower the available UV light. This negatively

impacts the corals' ability to feed on floating plankton and photosynthesize UV light, which can eventually lead to population collapse. Wave action can flush out sedimentation and turbidity, but protected areas such as the lagoon at ʻAnini receive minimal wave action. At nearby Pila'a reef, extensive remedial action on land to minimize erosion over the reef significantly reduced sediment flow and quickly resulted in improved reef conditions. Large winter surf in 2002-2003 also assisted in flushing Pila'a reef of accumulated sedimentation. Surveys in 2002 reported nearly half of the encountered corals as stressed or dying, while 2003 surveys showed recovery and rapid growth from the corals that survived the sedimentation event. There was also an increased influx of juvenile fish noted between 2002-2003. The 2004 survey showed a significant increase of coral colonies at the site affected by sedimentation, though total coral cover was calculated at a 30% decrease between 2002-2004 (Jokiel & Brown, 2004).

A 2009 report from Hanalei Bay assessed oceanographic properties, including winds, ocean surface waves, and water column properties, as well as sedimentation levels in Hanalei River with sediment traps and assessing river plume dynamics over time. These combined factors allowed the researchers to understand current flow and sedimentation rates on the reefs around Hanalei Bay (Storlazzi, Field, Bothner, Presto, & Draut, 2009). Nutrient loading in coral reefs is an additional area of concern, for enhanced nutrient enrichment can cause coral health decline. The exact mechanisms by which excess nutrients disturb the symbiotic relationship between corals and algae is debated, but it is relatively agreed that excess nutrient enrichment has negative long-term effects on corals (D'Angelo & Wiedenmann, 2014).

Stable isotopes can be utilized to study nutrients in marine and freshwater environments. Wastewater and other pollutants carry signature stable isotopes that can be traced as they move through a system. A report from a community environmental study in Puako, Hawai'i utilized fecal indicator bacteria levels in conjunction with measurements of stable nitrogen isotopes to map the distribution of sewage in the environment. Their study found highest sewage concentrations along the shoreline, with spatial variability of sewage around the reef and in the benthic (ocean bottom) environment. Algae showed nitrogen stable isotope ratios known to be associated with sewage. Coral cover showed a negative correlation with stable nitrogen isotope ratios in algae, fecal indicator bacteria, and nutrient concentrations. These negative correlations indicate that sewage-related isotopes associated with algae, fecal indicator bacteria, and increased nutrient concentrations indicate the presence of sewage which may lead to a decrease in the amount of coral cover in a given area. Decreased coral cover may be related to degrading reef health (Abaya, et al., 2018).

In order to understand the dynamics of ʻAnini reef and coral health conditions, studies similar to those discussed in this section would need to be conducted at ʻAnini. With the lack of historical research at ʻAnini, it is pertinent to conduct surveys over the scope of many years for comparative purposes. The research that the DAR wishes to conduct regarding black band disease at ʻAnini (2.2.4 ʻAnini Reef and Black Band Disease) will provide excellent baseline research efforts regarding marine water temperatures, turbidity, nutrient levels, and coral reef health (M. Melamed, personal communication, November 30, 2020 and H. Ylitalo-Ward August 15, 2022).

4.4 Action Items

The following action Items should be undertaken to develop programs, activities and practices that will protect ‘Anini’s fresh and marine waters.

4.4.1 Develop Monitoring Program

A monitoring program should be designed and established which includes goals and objectives of monitoring, a Sampling and Analysis Plan including equipment, devices, site materials and laboratories, and a Quality Assurance Project Plan. At a minimum the plans should include monitoring for these purposes:

- gathering adequate data for DOH to use in 305(b) and 303(d) assessment and reporting.
- assessing overall water ecosystem health, identifying pollutant sources and impacts to protected uses (e.g., recreation and aquatic life support).

Recommendations for the scope of the monitoring to achieve these purposes include the actions discussed below:

<u>Marine and Inland Water Quality Monitoring Adequate for DOH Assessments</u>
Monitor in-situ for basic water quality using a multi-probe meter and other tools as needed. Collect 30 samples from the drainage waterways, streams and coastal segments flowing into the ‘Anini lagoon and conduct laboratory analysis for turbidity, *Enterococcus*, nutrients, and chlorophyll *a* over 2 years and submit to DOH for inclusion in Integrated 305(b) and 303(d) report. Monitoring of *Enterococcus* should include at least 5 samples per 30 days in order to assess whether geomean criteria is met.

<u>Nonpoint Source Pollution Monitoring</u>
Wet weather monitoring of turbidity, nutrients, *Enterococcus*, and glyphosate in stormwater, streams, and coastal waters. Additionally, monitor places having dry weather runoff (irrigated areas such as golf courses).

<u>Point Source Monitoring</u>
Testing of R-2 water for nutrients, turbidity, and *Enterococcus*
Testing of injection well injectates for nutrients, turbidity, and *Enterococcus*
Testing of discharge from Hanalei Refuse Station for toxic pollutants
Testing streams for sediment runoff and gathering point source soil evidence

<u>Submarine Groundwater Monitoring</u>
An SGD tracer study at 'Anini would provide insight into the sources and spatial extent of anthropogenic sources of nutrient and SGD input into the marine system.

Monitoring of Coral Reef Health

In order to understand the dynamics of ʻAnini reef and coral health conditions, additional studies of fisheries, algae, and coral health should be conducted.

4.4.2 Best Management Practices

File Letters of concern and Request for investigation with permitting and compliance agencies regarding land clearing non-compliance activities.

Prepare a set of Best Management Practices (BMP) recommendations that are more suitable for the sensitive aspects of the ʻAnini Watershed and its proximity to an endangered reef, and that are in compliance with National Pollutant Discharge guidelines and best practices.

Though BMPs are mandated for any grubbing or grading activity, they are generally only enforced if a permit is required, i.e. when the disturbed soil is over 100 CY or disturbed area over 1 AC, with the area under any house footprints being exempt - which leaves a lot of room for allowable disturbances that may not individually have any BMP mitigation applied. However, collectively such disturbances are no different than that caused by much larger projects.

Identify areas for the purpose of downstream pollution control and mitigation opportunities, especially if they sit on major outflow routes per drainage catchment assessment.

In addition to erosion mitigation, the ʻAnini Watershed is also subject to pollutant sources that collectively reduce outflow water quality, including cesspools and septic systems, sometimes located in flood prone areas, large impervious parking lots that lack detention basins to capture vehicular pollutants, as well as large land areas where fertilizers, herbicides, pesticides and other chemical additives are used in larger quantities, e.g. roadways, parks and golf courses, farming fields, etc.

Cesspools and septic systems that are near the coast should be upgraded to a nitrogen-reducing onsite disposal system (OSDS). There are several types of innovative OSDS that are approved or about to be approved to be installed in Hawaii, such as incineration units or an aerobic treatment unit (ATU, such as FujiClean), an Eljen Corporation enhanced septic system, or possibly a Ridge-to-Reefs bioreactor garden. These enhanced OSDS systems reduce the amount of pollutants that enter the ecosystem compared to a cesspool and even compared to a septic tank. All cesspools are required to be upgraded by 2050, and it is likely that deadlines will be earlier for high-risk areas such as coastal cesspools and regions where drinking water may be affected. Financial aid may be available for homeowners based on income. National programs such as USDA Rural Development Office and a new bill passed by the Hawaii State Legislature may be able to provide grants and low-interest loans to help with the costs of conversion.

Further work: The influence of sea level rise is another factor identified by this study that could introduce additional pollutants into this area by potentially impacting septic systems and raising groundwater levels. This topic will be investigated for the ‘Anini area (See Figure 31 for a map showing sea level rise scenarios for ‘Anini) in a supplement to this report.

Conduct an awareness/behavior change campaign to educate golf courses and other users about the problems with chemical usage and offer solutions

GIS Basemap for ‘Anini Drainage Catchment and Stormwater Flow and Drainage Catchment Assessment

The ‘Anini Watershed or “drainage catchment”, i.e. the land area that captures and directs storm and drainage water and to the proximal shoreline via surface flows, stream channels as well as any engineered drainage infrastructure is both large and complex. A Geographic Information System (GIS) Basemap is used to capture the relevant maps and data required for the analysis, assessment and tracking of drainage catchment conditions. Such GIS Basemap has already been created for the 1000 AC Princeville urbanized area situated at the westernmost portion of the ‘Anini Watershed, but the eastwards portion from the Princeville area to the Kalihiwai River is currently lacking, as are its southwards mauka extensions.

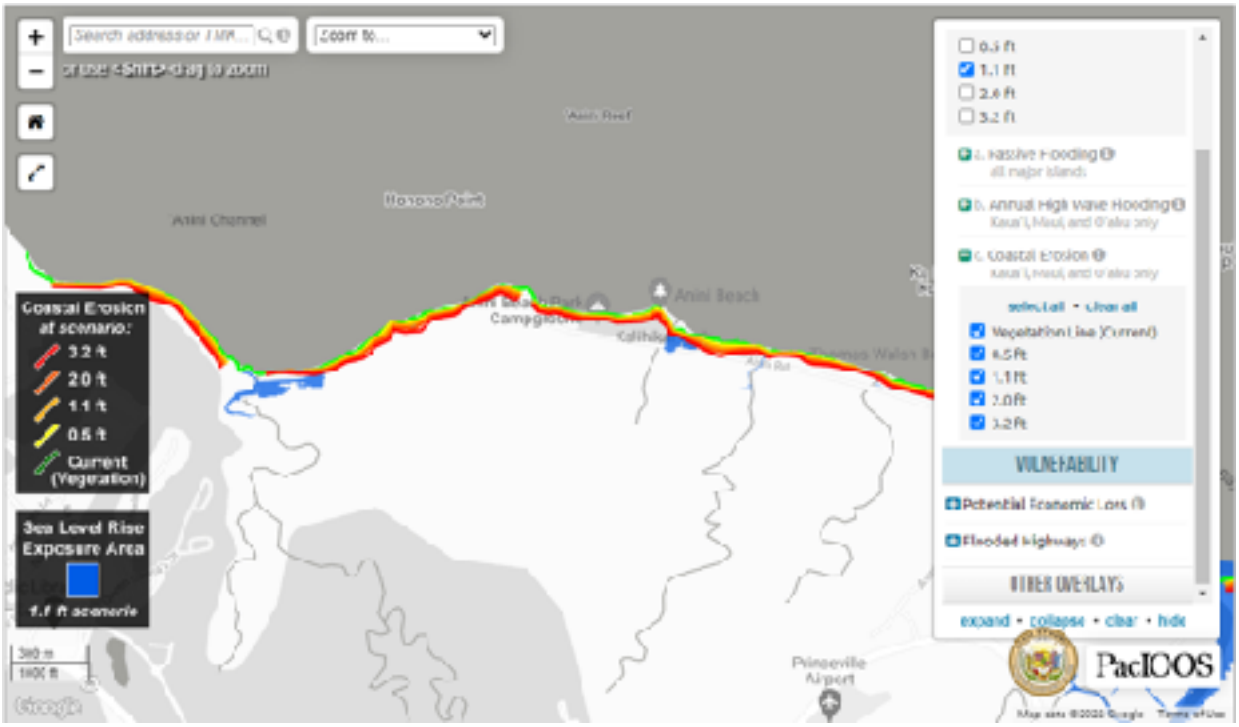


Figure 31: Map provided by the State of Hawai’i Sea Level Rise Viewer by the Pacific Island Ocean Observing System (PacIOOS). The colors represent different scenarios of coastal land loss due to sea level rise, with green representing the current vegetation at the coastline, yellow representing land loss at 0.5 feet of sea level rise, and red representing land loss at 3.2 feet of sea level rise. Blue areas represent the land that will be inundated with water at a 1.1 feet sea level rise scenario.

Further Work: Expand the current Princeville GIS Basemap to expand eastwards to Kalihiwai, and southwards into the mauka lands, which would include GIS map and data layers for gross topography and other major physical features such as mountains, valleys, streams, wetlands, estuaries and shorelines, as well as built features such as existing roads, bridges, drainage infrastructure, including larger impervious areas based on existing TMKs, File Plans, and other Registered Maps. This study would also include State and County Zoning District maps that inform allowable coverages, residential/commercial densities, etc. for future planning purposes. Assessment would follow.

4.4.3 Form a Stakeholder Group

Stakeholders are anyone who have direct interactions with this geographic area of concern. Stakeholders can include individuals, ohana, groups, religious organizations, businesses, associations and government agencies. Stakeholder groups would have the ability to perform education and outreach, recruitment of volunteers and civic engagement with regard to the area's environmental quality. Stakeholders such as Reef Guardians would have the ability to provide planning, research, monitoring, reports, education and assistance. Stakeholders can participate through monetary donations, community meetings and events, volunteer workdays and positions. Stakeholders who live in the area may be able to facilitate monitoring activities by allowing access to drainageways, wetlands and streams.

5. Conclusions

'Anini watershed and adjacent marine waters are habitat for important and essential plant and animal species, some of them threatened or endangered. These waters are highly used for recreation, fishing and traditional food gathering. Protecting water quality is critically important to protecting the integrity of these resources and their uses described and protected by federal, state and county water quality standards. There are, however, clear and present threats to water quality. Because there is limited water quality data at 'Anini, pollution sources are not sufficiently documented. 'Anini lagoon is listed as having impaired marine waters. Urgent actions are needed to improve 'Anini. Community-based monitoring needs to be implemented immediately to meet the criteria of the State Clean Water Branch (CWB), EPA regulations, Best Management Practice Guidelines, County of Kaua'i Coastal Zone Management (CZM) and other pollution controls. A program of monitoring streams, drainage and stormwater runoff, and marine waters will provide insights into the sources of pollution. A monitoring program and stakeholder group are needed to guide data collection and to provide information to the public and compliance agencies. Action steps must be taken now to prevent further pollution and degradation of this beautiful natural resource area and lead to its restoration.

Let’s protect what we love.

Volume II

Appendices and Citations
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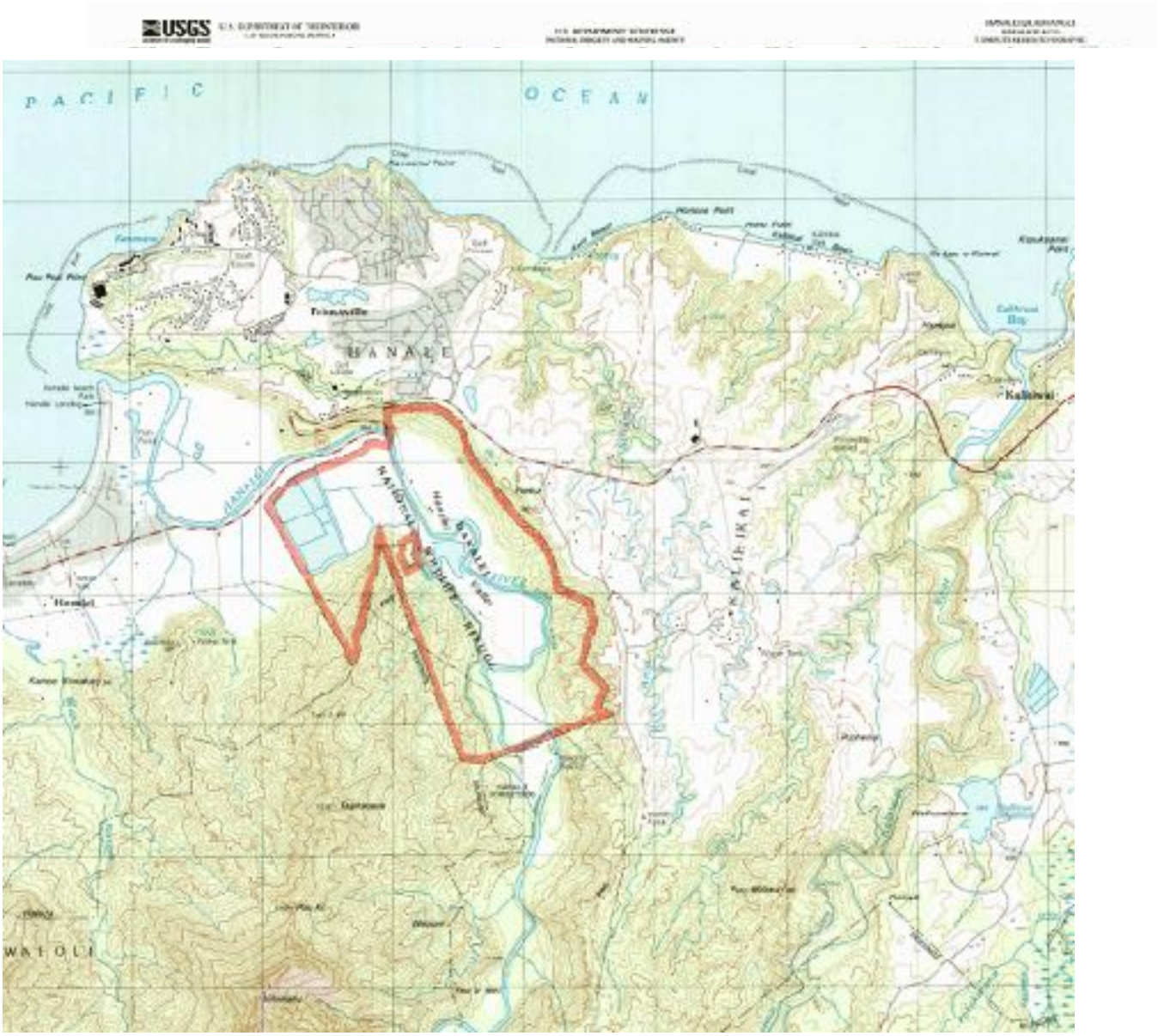
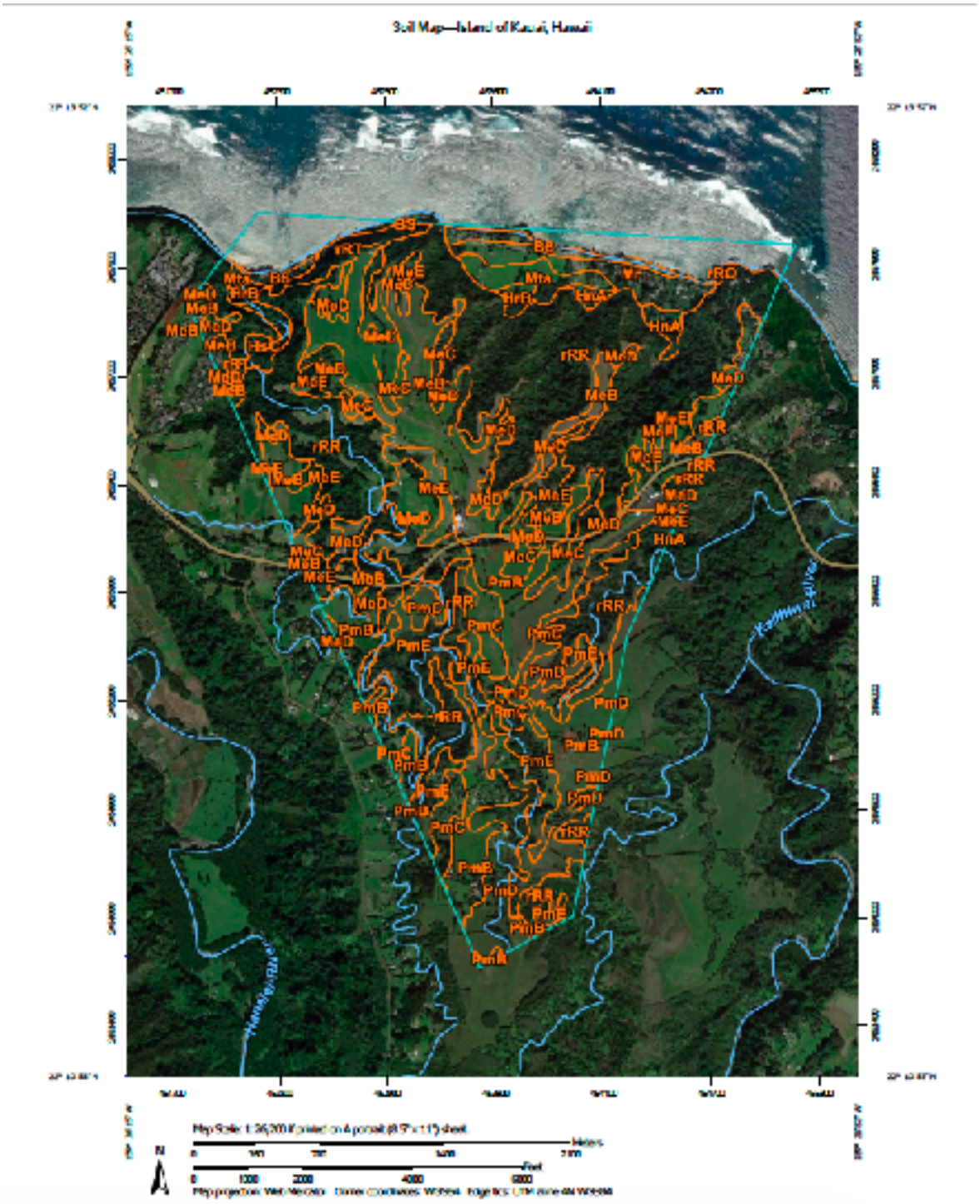
Contents

Appendix A: Topographic Map

Topographic map of the north shore of Kaua'i, courtesy of the United States Geological Survey. The map is zoomed in on the geographic scope of this report, including the 'Anini watershed and surrounding areas.



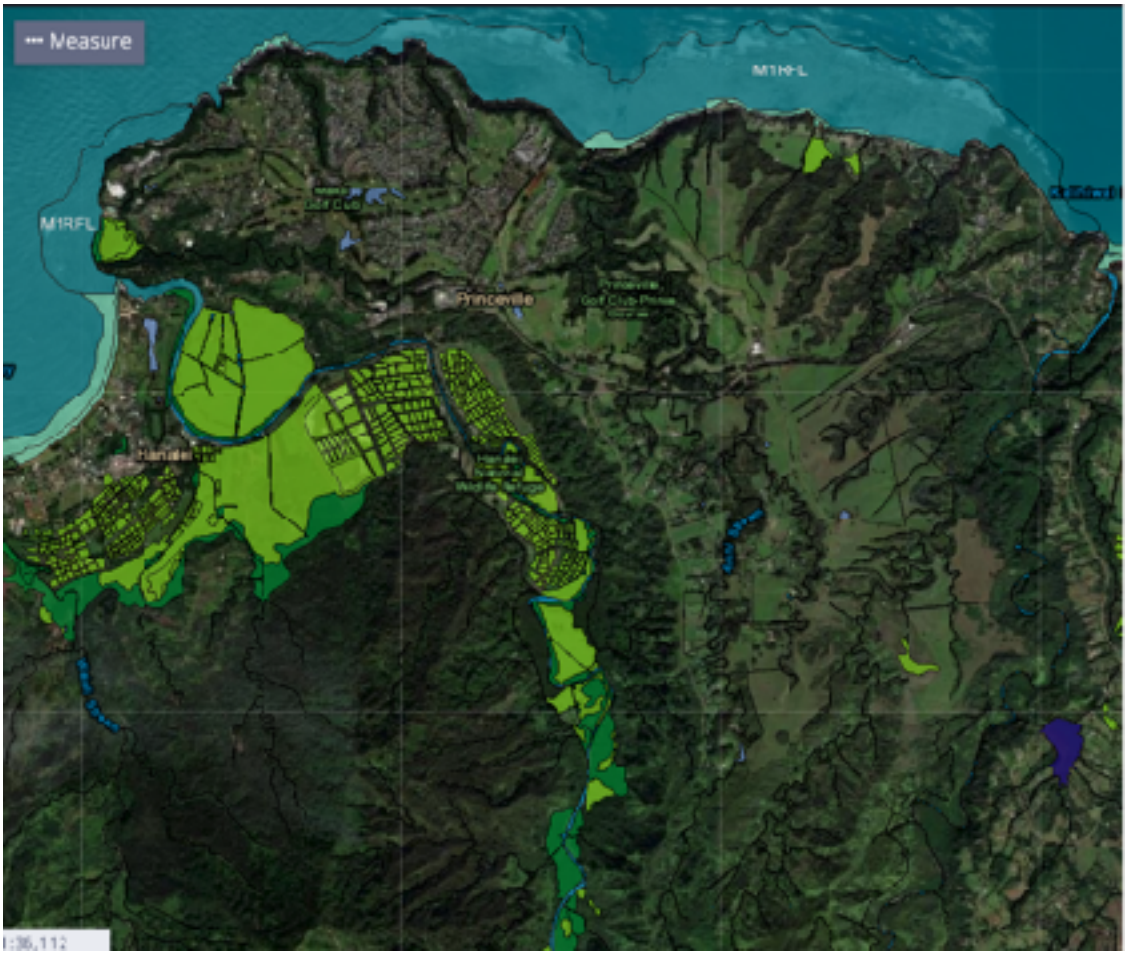
Appendix B: Soil Map



Map Unit Legend

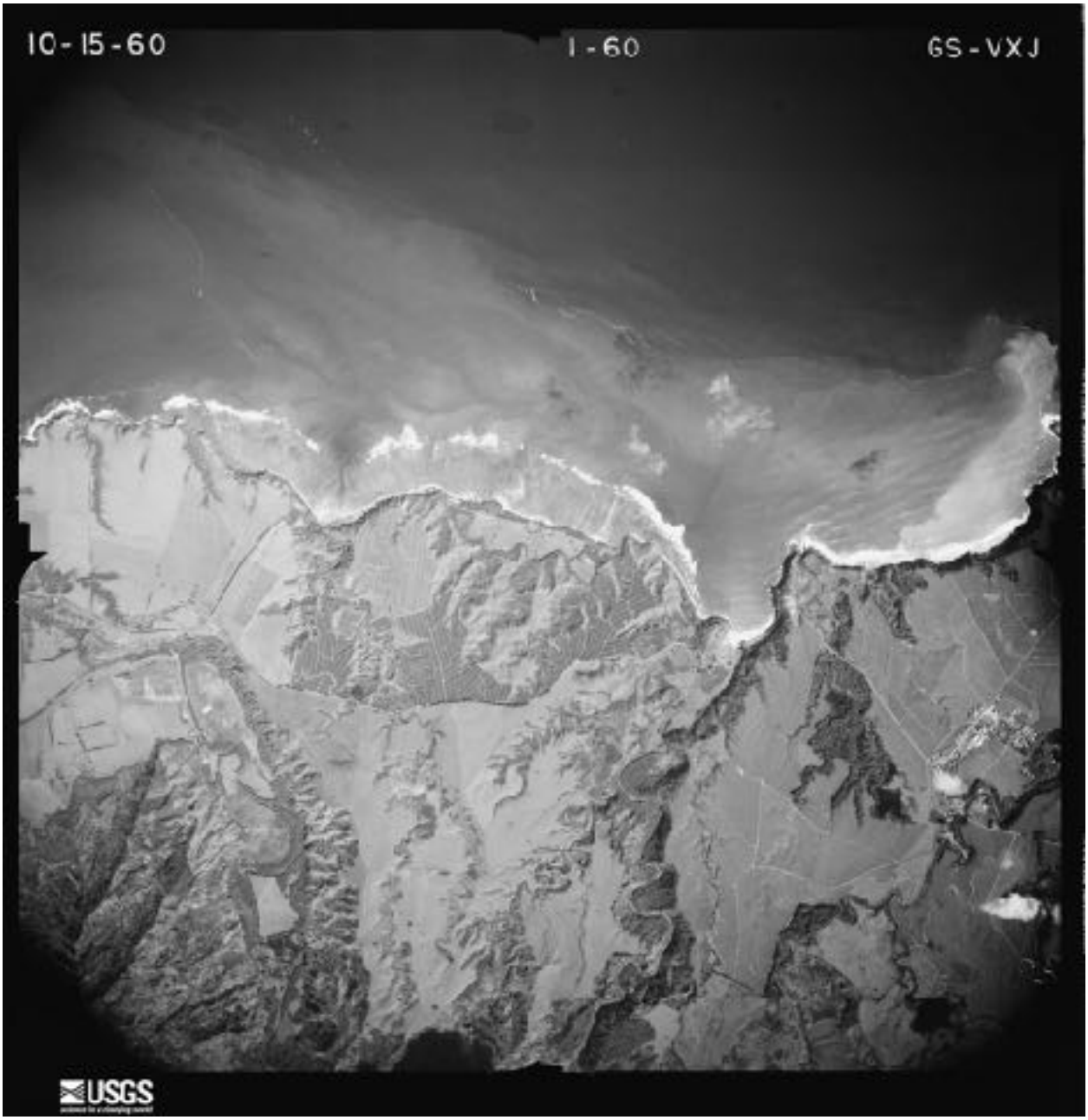
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BS	Beaches	22.0	1.2%
HnA	Hanalei silty clay, 0 to 2 percent slopes, MLRA 157	12.9	0.7%
HnB	Hanalei silty clay, deep water table, 0 to 6 percent slopes	10.8	0.6%
HsD	Hanamaulu silty clay, 8 to 15 percent slopes	14.5	0.8%
MeB	Makapili silty clay, 0 to 8 percent slopes	232.3	12.3%
MeC	Makapili silty clay, 8 to 15 percent slopes	59.9	3.2%
MeD	Makapili silty clay, 15 to 25 percent slopes	151.1	8.0%
MeL	Makapili silty clay, 25 to 40 percent slopes	63.1	3.3%
Mr	Mokuleia fine sandy loam	43.0	2.3%
Mta	Mokuleia clay loam, poorly drained variant	27.7	1.5%
PmB	Pooku silty clay, 0 to 8 percent slopes	203.9	10.8%
PmC	Pooku silty clay, 8 to 15 percent slopes	98.4	5.2%
PmD	Pooku silty clay, 15 to 25 percent slopes	83.0	4.4%
PmE	Pooku silty clay, 25 to 40 percent slopes	136.9	7.2%
rRO	Rock outcrop	1.3	0.1%
rRR	Rough broken land	594.6	31.4%
rRT	Rough mountainous land	41.4	2.2%
Totals for Area of Interest		**1,893.7**	**100.0%**

Appendix C: Wetlands Map



(U.S. Fish & Wildlife Service, National Wetlands Inventory, n.d.)

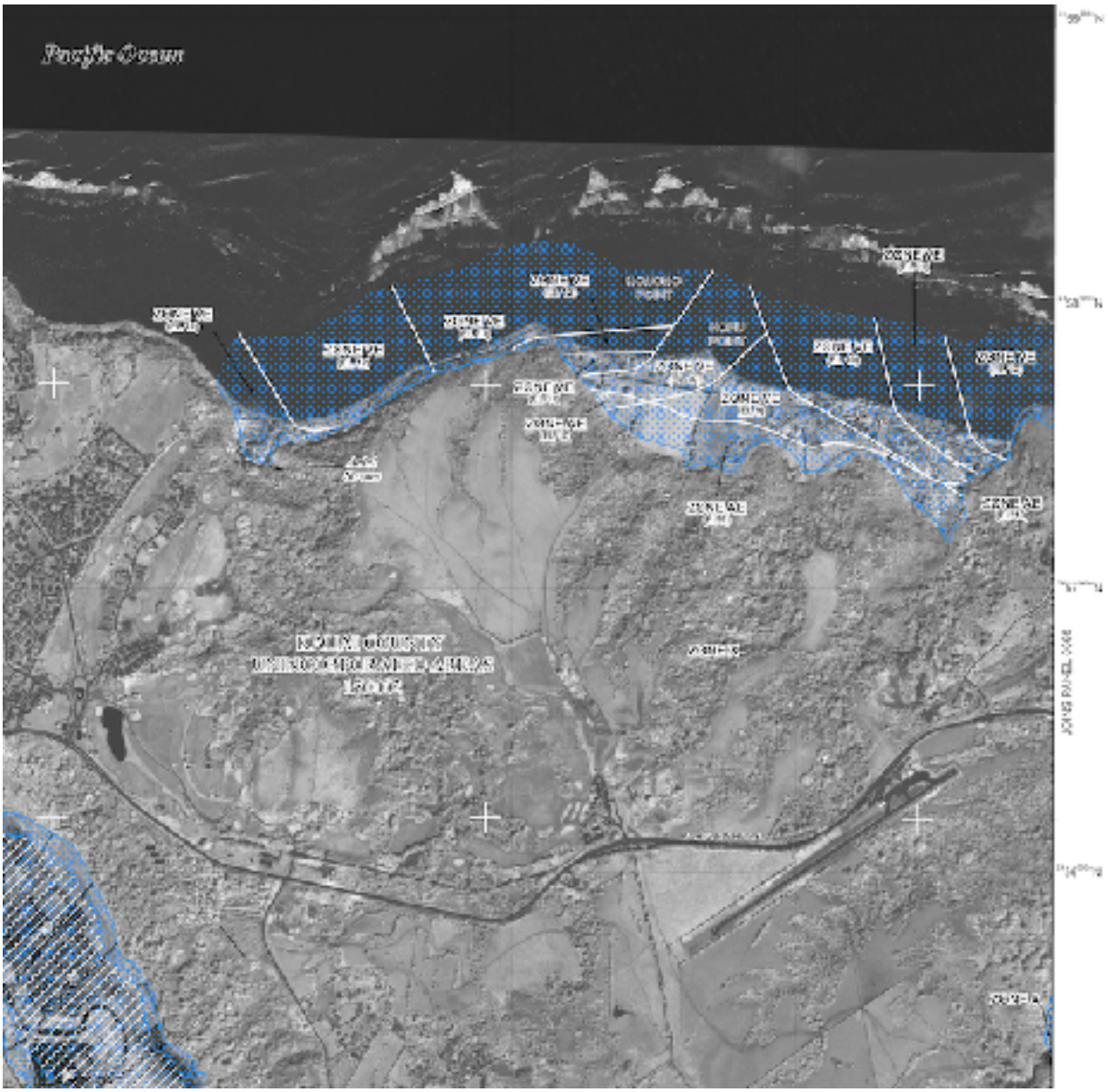
Appendix D: Aerial Photos



Aerial photo of the ʻAnini coastal area and middle watershed, 1960

Aerial photo of ʻAnini, 2000

Appendix E: Flood Map



Legend:

- Blue dotted areas: Special flood hazard areas subject to inundation by the 1% annual chance flood
- Zone VE: Coastal flood zone with velocity hazard (wave action); Base flood elevations determined
- Zone AE: Base flood elevations determined
- Zone X: Areas of 0.2% annual chance of flood; areas of 1% annual chance of flood with average depths less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance of flood
- White lines: Boundary dividing different base flood elevations
- Light blue lines: 1% annual chance floodplain boundary

(FEMA, n.d.)

Appendix F: Reconnaissance

Reconnaissance photos taken in and around the ʻAnini watershed on December 2, 2020. For maps of photographed locations, reference Figure 2 and Figure 9. The weather was sunny and calm, though the few days prior had rainy conditions.

1. ʻAnini stream running under Ahonui Road.

2. ʻAnini stream running under Ahonui Road. Same area as Photo 1.

3. ʻAnini stream running under Ahonui Road. Same area as Photos 1 and 2.

4. Land clearing near ʻAnini stream on Kapaka St., makai of Kuhio Highway.

5. Ditch running under ʻAnini Road, east of Kowali stream.

6. Same area as Photo 5. Debris piled up as ditch runs toward residential homes.

7. Kowali stream just before it crosses under ʻAnini Road.

8. Kowali stream running past residential homes and crossing under ʻAnini Road. Same area as Photo 7.

9. Kowali stream passing under ʻAnini Road. Same area as Photos 7 and 8.

10. Kalihikai stream passing under ʻAnini Road.

11. Rubbish and debris in Kalihikai stream as it passes under ʻAnini Road and flows to the ocean. Same area as Photo 10.

12. Debris piled up in Kalihikai stream before passing under ʻAnini Road. Same area as Photos 10 and 11.

13. Honu stream passing under ʻAnini Road.

14. Honu stream as it passes under ʻAnini Road. Same area as Photo 13.

15. Ditch running under ʻAnini Road west of Honu stream.

16. Debris piled up in a ditch before it flows under ʻAnini Road. Same area as Photo 15.

17. Ditch running under ʻAnini Road, flowing toward private homes. Same area as Photos 15 and 16.

18. High amount of sediment on ʻAnini Road near multiple private home construction sites.

19. Private home construction projects causing sediment runoff on ‘Anini Road, west of Honu stream.

20. ‘Anini muliwai (stream mouth).

A drone was utilized on December 8, 2020, to capture footage of ‘Anini stream that is not publicly accessible or easily seen due to vegetation. There were two filming locations, one near ‘Anini stream mouth and one near Kapaka Road where Kuhio Highway crosses over ‘Anini stream.

21. ‘Anini stream mouth as it enters the ocean.

22. What appears to be a small landslide on the steep slope above ‘Anini stream near the stream mouth.

23. A land clearing site adjacent to ‘Anini near the stream mouth.

24. A land clearing site adjacent to ‘Anini stream near Kapaka Road, same area as Photo 4.

25. ʻAnini stream as it flows adjacent to the Prince Golf Course near Kapaka Road.

26. A broad view of ʻAnini stream, showing the Prince Golf Course and land clearing site. Same area as Photos 24 and 25.

27. The Prince Golf Course and forested area surrounding small tributaries and ditches of ʻAnini stream. ʻAnini stream flows through the forested areas located in the center and left side of the photograph. A land clearing site can be seen toward the bottom left of the photograph. Photographed December 8, 2020

28. Land clearing site at The Prince Golf Course directly adjacent to waterways flowing into 'Anini stream. Photographed August 31, 2022.

29. Photos and videos shot along Anini Road on March 12, 2021. Water and sediment flowing from property above Anini Road onto the road, across it into the ocean and under the road through a culvert. The weather was rainy with calm winds.

Appendix G: Water Pollution Control Viewer Permits

National Pollutant Discharge Elimination System (NPDES) permits listed in the Water Pollution Control (WPC) viewer database for Hawai'i, with permits filtered for locations in and around the 'Anini area on the island of Kaua'i, Hawai'i (towns of Hanalei, Princeville, and Kilauea). Form B permit types represent stormwater associated with industrial activity, Form C types represent stormwater associated with construction activities, Form L types represent circulation water from decorative ponds or tanks, and WQC types represent water quality certifications.

Site Name	Site Address	Permit Number	Permit Type	Permit Status
Zimmerman Residence	2953 Kamookoa Road, Kilauea, HI 96754	HIR10D812	Form C	Expired
Kilauea Bridge Replacement	Kolo Road at Liliuokalani Street, Hanalei, HI 96714	WQC0692	WQC	Expired
Kilauea Bridge Replacement	Kolo Road at Liliuokalani Street, Hanalei, HI 96714	WQC0729	WQC	Expired
Kilauea Bridge Replacement	Kolo Road at Liliuokalani Street, Hanalei, HI 96714	HIR10C985	Form C	Expired
Dave Walters Auto Barn	Anini Vista Rd, Private Drive, Lot 2, Unit B, Princeville, HI 96722	HIR10C962	Form C	Expired
Anaina Hou	2723 Kuhio Highway, Kilauea, HI 96754	HIR10D351	Form C	Expired
Princeville Construction and Demolition Landfill	5-3500 Kuhio Highway, Princeville, HI 96722	HIR50D400	Form B	Expired
Villas of Kamalii	4171 Lei O Papa Road, Princeville, HI 96722	HIR10B353	Form C	Not Issued
Hanalei National Wildlife Refuge Construction of Three Wetland Management Impoundments	-	WQC0122	WQC	Not Issued
Hanalei National Wildlife Refuge Irrigation Pipeline Repair	-	WQC0462	WQC	Not Issued
HI DOE Kilauea Elementary School	2440 Kolo Road, Kilauea, HI 96754	HIR10C808	Form C	Not Issued

Nihilani at Princeville Resort	Corner of Ka Haku Road & Pepelani Road, Princeville, HI 96722	HIR10B946	Form C	Not Issued
Princeville Prince Golf Course	5-3900 Kuhio Highway, Princeville, HI 96722	HIR10D879	Form C	Terminated
River Ford Crossing Pohaku Honu Stream Repair	-	WQC0328	WQC	Terminated
Grading Plan for The Hromoko Residence	-	HIR10D434	Form C	Terminated
Kauai County Hanalei Transfer Station	5-3781 Kuhio Highway, Hanalei, HI 96714	HIR50D148	Form B	Terminated
Princeville Makai Golf Course, LLC	4080 Lei O Papa Road, Princeville, HI 96722	HIR10D191	Form C	Terminated
Princeville Makai Golf Course, LLC	4080 Lei O Papa Road, Princeville, HI 96722	HIR10D206	Form C	Terminated
Cliffs (The) at Princeville Parking & Site Improvements	3811 Edward Road, Princeville, HI 96722	HIR10C072	Form C	Terminated
Pohakuhonu Stream Crossing	2818 N Kamookoa Road, Kilauea, HI 96754	WQC0753	WQC	Terminated
Princeville C&D Landfill	Kuhio Highway across Princeville Airport, Princeville, HI 96722	HIR50A645	Form B	Terminated
Kuhio Highway Intersection Improvements at Waiakalua St. & North Waiakalua St., Project No. 56C-01-09	Kuhio Highway (Route 56), Kilauea, HI 96754-0000	HIR10D359	Form C	Terminated
Princeville Construction and Demolition Landfill	5-3500 Kuhio Highway, Princeville, HI 96722	HIR10D887	Form C	Terminated
Kalihiwai Ponds	5545 Kahiliholo Road, Kilauea, HI 96754	HI06LC602	Form L	Terminated
Hau Trimming Wetland Enhancement Project, Hanalei River Estuary	-	WQC0711	WQC	Terminated
Hanalei River Stream Gage Relocation	-	WQC0401	WQC	Terminated
Kauikeolani Fishpond Project	-	WQC0708	WQC	Terminated
Hanalei National Wildlife Refuge Irrigation System Expansion & Proposed Impoundments Construction Projects	-	WQC0217	WQC	Terminated
Hanalei National Wildlife Refuge - Refuge Wetland Enhancement	-	WQC0144	WQC	Terminated
Halulu Fishpond	5-5785 A Kuhio Highway, Hanalei, HI 96714-1189	HIR10C490	Form C	Terminated

Appendix H: Department of Health Data Acceptance Criteria

Hawaii Department of Health Clean Water Branch
Monitoring and Analysis Section

Data Acceptance Criteria

Data submitted to HIDOH Clean Water Branch (CWB) for the purpose of assessing state water quality may be used to fulfill various federal Clean Water Act requirements. Decisions and conclusions resulting from the data submitted to CWB can have broad and long-standing implications to the state water quality program. It is therefore imperative that only data of known and acceptable quality be used to assess waters for conformance with state water quality standards. Data of known and acceptable quality, also known as credible data, can be assured through a series of defined and systematic activities applied throughout the planning and data generating process. The elements listed below constitute the minimum requirements for data acceptance by the CWB for water quality assessment purposes. These elements help to assure that the data ultimately used by the CWB are known, credible, scientifically valid, and defensible, collectively referred to as "valid data." Data not meeting these requirements may not be used for state water quality assessments, however, may be used for other non-regulatory purposes.

1. All data submittals, to the extent feasible, should be in electronic format that is PC compatible, preferably in Office 2010 (or later) or PDF format. References to web sites will not be accepted in lieu of actual data submitted.

2. All data must be submitted in the units of measurement specified in HAR 11-54[1].

3. To expedite processing, all data and information submitted for consideration in the State's biennial Integrated Report should include a completed Integrated Report Data Submittal Information form containing the following information:
    a. Name and contact information of person or organization submitting data and information certifying the completeness and accuracy of the data and information
    b. Date of submission
    c. Whether Geographical Information System (GIS) data files (ArcGis mxd or ArcView shapefiles) are included
    d. Parameters (pollutants) for the submitted data
    e. HAR 11-54 waterbody classifications for which data are being reported
    f. Date range or time period of data
    g. Starting and ending dates of when data was collected, or time period which the submitted information represents
    h. Brief summary of submittal or list of submittal contents and any instructions required for assessment, which may include:
        i. Definitions for codes or abbreviations used
        ii. Whether additional summaries or instructions are attached to the cover sheet or where they are included in the submittal
    i. Whether electronic or hard copy/paper format is being submitted

[1] https://health.hawaii.gov/cwb/files/2013/04/Clean_Water_Branch_HAR_11-54_20141115.pdf

4. A minimum of 30 samples per decision unit or watershed over a two-year period is required to assess water quality in the State's Integrated Report. Assessments will be made for pollutants listed in HAR 11-54. The CWB will accept all valid data from individual submitters (including those submissions with less than 30 samples). All valid data may be assessed collectively for a decision unit or watershed. To be considered of sufficient quantity and quality to be used as a primary line of evidence in assessing water quality standards attainment, data being submitted should contain the following:
    a. A minimum of 30 samples per decision unit or waterbody. If less than 30 samples are received from all submitters, the decision unit or waterbody may not be assessed. However, the data may be used by the CWB for other purposes.
    b. Data submitted to the CWB to be included in the Integrated Report should have been collected within the two-year date range stated in the CWB call for data (unless the data is part of a continuous study showing historical trend). Note that data collected prior to the start of the CWB date range may not necessarily be used in the Integrated Report but may be used for other purposes.
    c. The location of the water body and monitoring sites, including:
        i. GIS metadata with detail of all parameters of the projection including datum
        ii. The name and exact area of the water body and monitoring sites the information concerns, including:
            1. Very clear electronic copy indicating the area the information pertains to (*e.g.* mark sample location on a USGS topographic map), and,
            2. The latitude/longitude and datum of the location
    d. Metadata for the field and laboratory data, including:
        i. Name of sampler, date and time of all sample collection and field measurements
        ii. Location of the specific field measurements or sample collection (unique site code, latitude and longitude) within the water body
        iii. Pollutant or condition measured
        iv. Number of samples collected, or field measurements made
        v. Name of laboratory, if applicable
        vi. Analyses performed, including date, time, and analyst
        vii. Units of measurement
        viii. Analytical methods (name and method number, if applicable) and detection limits
        ix. Other relevant factors such as data auditing confirmation (data audit/assessment results), field notes, laboratory comments or notations concerning deviations from standard procedures, including Quality Assurance/Quality Control factors that may affect data reliability, validity or interpretation
    e. Supporting or associated analytical data (*e.g.* hardness data with dissolved metals samples, temperature and pH data with ammonia measurements)

5. Quality Assurance must be documented

a. All sample collection and field measurements must be made under the guidance of an approved Quality Assurance Project Plan (QAPP) or equivalent quality assurance document (see EPA Quality Assurance Project Plan Development Tool https://www.epa.gov/quality/quality-assurance-project-plan-development-tool) for more information.
    i. The QAPP or equivalent quality assurance document must be developed by the submitting organization and signed by the highest authority in the organization and the person responsible for quality assurance in the organization.
b. An electronic copy of the QAPP must be submitted to CWB Monitoring and Analysis Section for review prior to data acceptance.
    i. Data submitted prior to approval of a QAPP may be excluded from water quality assessments.
    ii. Data not accepted for water quality assessment may be used for other purposes.

6. Laboratory analyses
    a. The person or organization submitting data to the CWB is responsible for all data that they submit including the data generated by their laboratories and is responsible for submitting all pertinent laboratory information specified in this document.
    b. Laboratories performing analyses must be certified in good standing[4] by a nationally recognized accreditation body (such as NELAP, or A2LA) for the analyses that are being reported, or
    c. The laboratory must participate in, and demonstrate satisfactory performance in, annual proficiency testing for all parameters being reported. Proficiency tests must be conducted by an accredited, independent proficiency testing provider. All performance evaluation results must be submitted directly to the CWB by the test provider, and,
    d. All laboratories performing analyses must submit to the CWB for evaluation Standard Operating Procedures (SOPs) for the analytes being reported (submitted), and,
    e. All laboratories performing chemical analyses must submit validation studies to the CWB for each analyte being reported for evaluation prior to data acceptance.
        i. Data submitted prior to the acceptance of the validation studies may be excluded from water quality assessments.
        ii. All issues identified in the validation studies must be resolved prior to data acceptance. Data submitted prior to resolution of validation issues may be excluded from water quality assessments.
        iii. Data not accepted for water quality assessment purposes may be used for other purposes.

7. Narrative and qualitative submittals
    a. Narrative and qualitative submittals must

[4] All certification/accreditation reports must be submitted to CWB

i. Identify the name and exact area of the water body, as described in 4d above
ii. Provide detailed description and documentation of the monitoring sites
iii. Include photographic documentation as supporting evidence, where applicable
iv. Provide detailed description and documentation of the monitoring/measurement methods used. EPA or industry-standard methods must be used
v. Identify the date(s) that the data were collected and dates that the assessments were made.
vi. Describe events or conditions (or provide documentation) that indicate impacts on water quality
vii. Demonstrate and document that the narrative and qualitative information being submitted adequately represents the water body being studied for the period in which they are submitted
viii. Include documentation of the analyst's credentials, including training, and proficiency documentation for the parameters being reported (this should be included in the QAPP)
ix. Provide a linkage between the measurement endpoint and the water quality standard of interest
x. Be scientifically defensible
xi. Be verifiable by HIDOH CWB

b. Assessments without supporting documentation may not be used for decision making purposes

Raw data, including instrument QC data (including, but not limited to, calibration data, control charts, spiked sample results, and maintenance records), complete field notes (including climate and information related to water flow, field conditions or documented sources of pollution) must be made available to CWB upon request to facilitate data credibility and assessment review. Raw data are defined as any original factual information from a measurement activity or study recorded in a laboratory notebook, worksheets, records, memoranda, notes, or exact copies thereof that are necessary for the reconstruction and evaluation of the report of the activity or study. Raw data may include photography, microfilm or microfiche copies, computer/instrument printouts, magnetic or digital media, including dictated observations, and recorded data from automated instruments. If exact copies of raw data have been prepared (and verified accurate by signature) then the exact copy or exact transcript may be substituted.

Data submissions not meeting these requirements may be excluded from water quality assessment purposes.

All data submitted will become public domain and may be used for any appropriate purpose identified by the CWB.

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