DAVID Y. IGE
GOVERNOR OF HAWAII

VIRGINIA PRESSLER, M.D.
DIRECTOR OF HEALTH

DEPT. COMM. NO. 116

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HI 96801-3378

In reply, please refer to:

December 15, 2017 ***REVISED***

The Honorable Ronald D. Kouchi,
President and Members of the Senate
Twenty-Ninth State Legislature
State Capitol, Room 409
Honolulu, Hawaii 96813

The Honorable Scott K. Saiki, Speaker
and Members of the House of
Representatives
Twenty-Ninth State Legislature
State Capitol, Room 431
Honolulu, Hawaii 96813

Dear President Kouchi, Speaker Saiki, and Members of the Legislature:

For your information and consideration, I am transmitting a copy of the

Relating to Cesspools and Prioritization for Replacement, Act 125 relating to HB1244, HD1, SD2. CD1.

In accordance with Section 93-16, Hawaii Revised Statutes, I am also informing you that the report may be viewed electronically at:

http://health.hawaii.gov/opppd/department-of-health-reports-to-2018-legislature/

Sincerely,

Virginia Pressler

VIRGINIA PRESSLER
Director of Health

Enc.

c: Senate
House
Legislative Reference Bureau
SOH Library System (7 copies)
University of Hawaii

REPORT TO THE TWENTY-NINTH LEGISLATURE

STATE OF HAWAIʻI

2018 REGULAR SESSION

RELATING TO CESSPOOLS AND PRIORITIZATION FOR REPLACEMENT

Prepared by

THE STATE OF HAWAIʻI

DEPARTMENT OF HEALTH

ENVIROMENTAL MANAGEMENT DIVISION

In response to Act 125, 2017 Regular Session (House Bill 1244, HD1, SD2, CD1)

December 2017

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Executive Summary

Hawai‘i has nearly 88,000 cesspools that put 53 million gallons of raw sewage into the State’s groundwater and surface waters every day. Cesspools are an antiquated technology for disposal of untreated sewage that have the potential to pollute groundwater. The State relies on groundwater for over 90% of its drinking water. Cesspools also present a risk of illness to island residents and a significant harm to streams and coastal resources, including coral reefs. Further information about the risks cesspools pose to human and environmental health can be found in the appendix.

The Legislature has begun to address the serious health and environmental impacts of cesspool pollution. During the 2017 regular session, the Legislature passed Act 125, which required the replacement of all cesspools by 2050 and directed the Hawai‘i Department of Health (DOH) to:

> …. investigate the number, scope, location, and priority of cesspools Statewide that require upgrade, conversion, or connection based on each cesspool’s impact on public health. The department of health shall also work in collaboration with the department of taxation to assess the feasibility of a grant program to assist low-income property owners with cesspool upgrade, conversion, or connection. The department of health shall submit a report of its findings and recommendations, including any proposed legislation and recommended administrative action, to the legislature no later than twenty days prior to the convening of the regular session of 2018.

This report is in response to that directive. This report discusses 14 critical areas with high concentrations of cesspools that should receive priority for replacement, which together represent approximately half of all inventoried cesspools in the state.

Addressing cesspools can be costly for homeowners and thorough review of available funding and financing options is needed to assist homeowners with what is the most challenging aspect. Community engagement and partnerships will be key to the success of this broad effort. The DOH stands ready to work with the Legislature, counties, homeowners and others to achieve the goal of eliminating cesspools in an economically feasible way.

Number of Cesspools in Hawaii

There are nearly 88,000 inventoried cesspools in the State. The following table includes estimates of the number of cesspools by island, as well as the estimated total discharge represented by those cesspools. This data was generated in 2009 and 2014 through a joint effort of the University of Hawai‘i (UH), DOH and the U.S. Environmental Protection Agency (EPA). Housing data is estimated from the Census taken that same year.

Island	Housing Units	Number of Cesspools	Cesspool Effluent Discharges (million gallons per day)
Hawai‘i	82,000	49,300	27.3
Kaua‘i	29,800	13,700	9.5
Maui	65,200	12,200	7.9
O‘ahu	336,900	11,300	7.5
Moloka‘i	3,700	1,400	0.8
Total		**87,900**	**53.0**

Prioritizing Cesspools for Upgrade or Closure

Two major considerations for prioritizing cesspools for corrective action are the risk the cesspools pose and existing infrastructure such as nearby sewer mains. This report's prioritization relies upon an analysis of risk factors including: the density of cesspools in an area; soil characteristics; proximity to drinking water sources, streams, and shorelines; other groundwater inputs including agriculture and injected wastewater; and the physical characteristics of coastal waters that may compound the impacts of wastewater in bays and inlets. The DOH proposes that cesspool replacement efforts be focused by geographic area, and prioritized using the following broad categories:

- ***Priority 1: Significant Risk of Human Health Impacts, Drinking Water Impacts, or Draining to Sensitive Waters.*** Cesspools in these areas appear to contribute to documented impacts to drinking water or human health, and also appear to impact sensitive streams or coastal waters.
    - Action to address these cesspools represents a significant reduction in risk to public health, and should be achieved as soon as possible using any means available.

- ***Priority 2: Potential to Impact Drinking Water***. Cesspools in these areas are within the area of influence of drinking water sources, and have a high potential to impact those sources.
    - DOH should act before 2020 so homeowners can utilize tax credits in upgrading eligible cesspools (sited within 500' of waters).
    - Action to address these cesspools should be taken simultaneous to or following actions under Priority 1.

- ***Priority 3: Potential Impacts on Sensitive Waters.*** Cesspools in these areas cumulatively represent an impact to an area that includes sensitive State waters or coastal ecosystems (coral reefs, impaired waterways, waters with endangered species, or other vulnerabilities).
    - DOH should act before 2020 so homeowners can utilize tax credits in upgrading eligible cesspools (sited within 500' of waters).
    - Action to address these cesspools should be taken simultaneous to or following actions under Priority 2.

- ***Priority 4: Impacts Not Identified.*** Comprehensive health and environmental risks has not yet been assessed, or the risk of affecting public or environmental health currently appears low.
    - Action to address these cesspools should be taken as possible (if homeowners independently initiate action or if a supporting agency has available funds to target a community or individual home).

Initial Priority Upgrade Areas

DOH and UH have been considering health and environmental risks of cesspools for several years, with studies presented in 2009 for O'ahu and in 2014 for Kaua'i, Moloka'i, Maui, and Hawai'i. DOH and UH evaluated several factors including: proximity to sensitive receptors, groundwater transport of contaminants, the ability of the soil to mitigate contamination, and the type of onsite wastewater disposal, with cesspools evaluated as posing the highest risk. These studies, plus documented incidents of adverse health or environmental impacts, provide the initial basis for prioritizing cesspools for upgrade.

The adverse impact from cesspools is cumulative, so the relative risk and priority attached to upgrading is identified by area rather than by identifying individual cesspools. Priorities given in this report are subject to change as additional information is incorporated into DOH analyses in the future. The following 14 areas are currently priorities:

Name	Priority Level Assigned	Number of Cesspools	Effluent Discharge (million gallons per day)
Kea'au Area of Hawai'i Island	2	9,300	4.9
Hilo Bay Area of Hawai'i Island	3	8,700	5.6
Coastal Kailua/Kona Area of Hawai'i Island	3	6,500	3.9
Puako Area of Hawai'i Island	3	150	0.6
Kapoho Area of Hawai'i Island	3	220	0.12
Kapaa/Wailua Area of Kaua'i	2	2,900	2.2
Poipu/Koloa Area of Kaua'i	2	3,600	2.6
Hanalei Bay Area of Kaua'i	3	270	0.13
Upcountry Area of Maui	1	7,400	4.4
Kahalu'u Area of O'ahu	1	740	0.44

Name	Priority Level Assigned	Number of Cesspools	Effluent Discharge (million gallons per day)
Diamond Head Area of O‘ahu	3	240	0.17
Ewa Area of O‘ahu	3	1,100	0.71
Waialua Area of O‘ahu	3	1,080	0.75
Waimanalo Area of O‘ahu	3	530	0.35
Total:		42,730	

Cesspool Upgrade Area Maps and Descriptions

Hawai‘i Island Priority Upgrade Areas

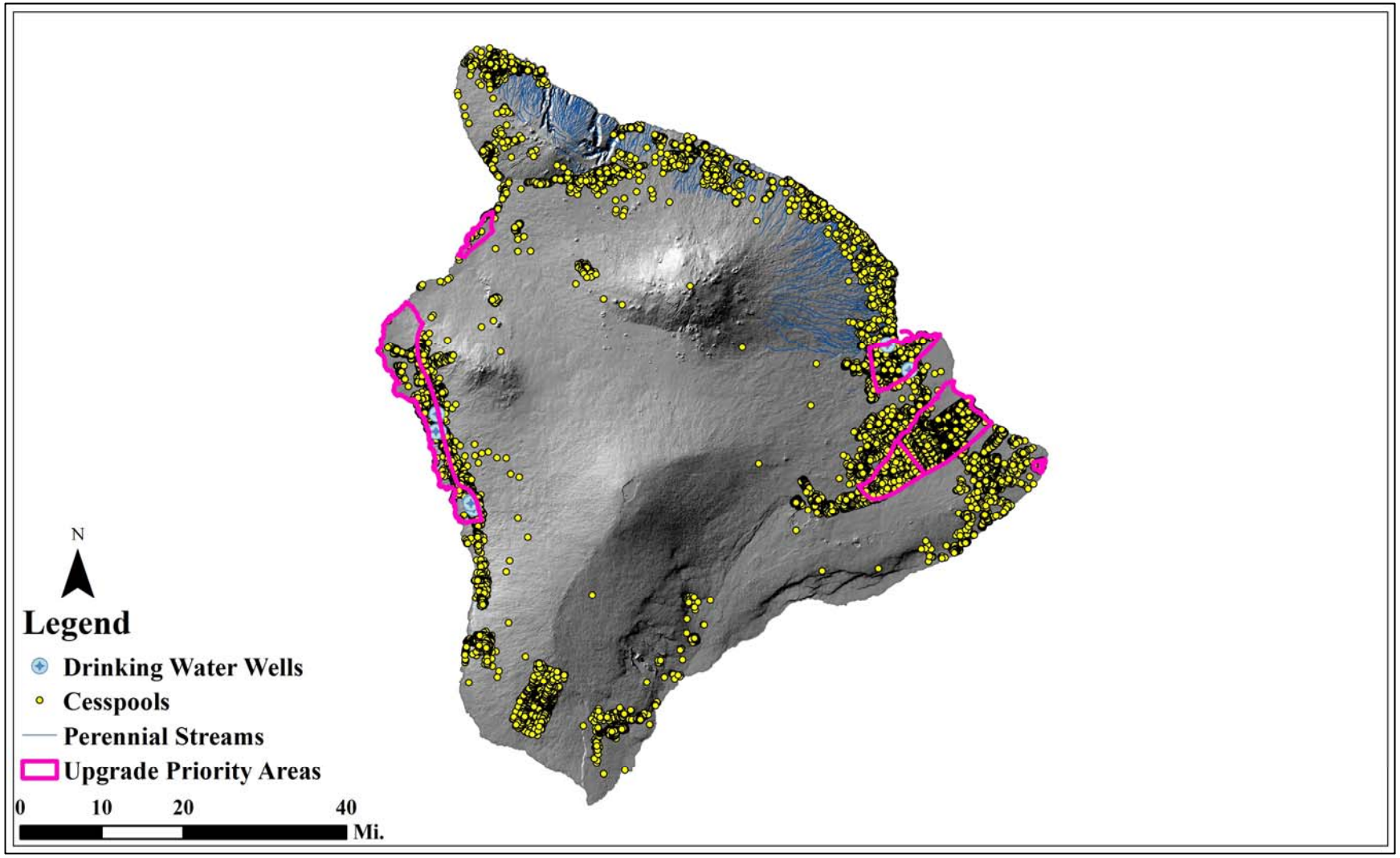
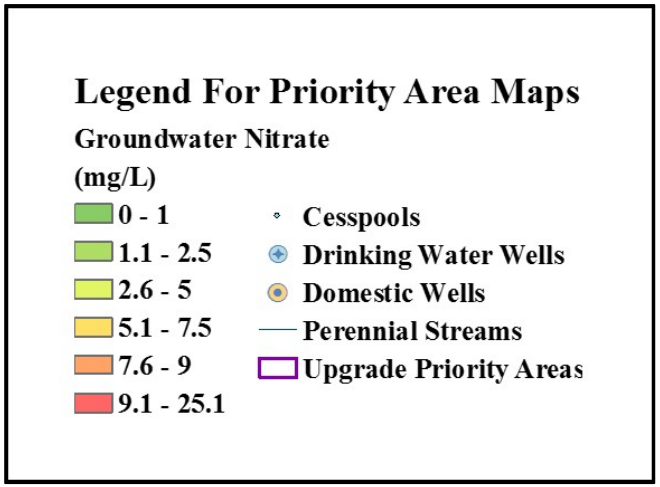


Figure 1 Hawai‘i cesspool locations, priority areas for upgrade, potentially affected drinking water sources, and perennial streams



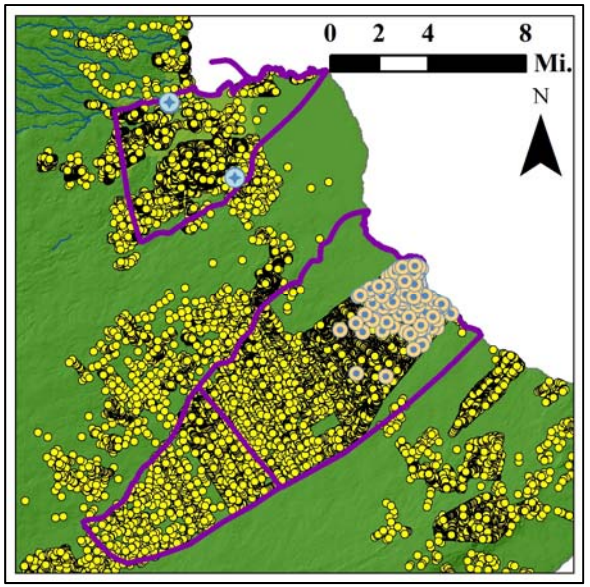


Figure 2 Hilo and Kea'au priority areas and cesspool nitrate

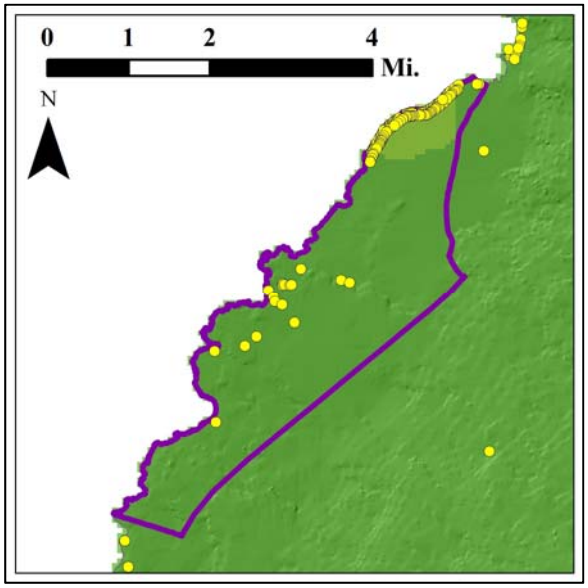


Figure 3 Puako priority area and cesspool nitrate

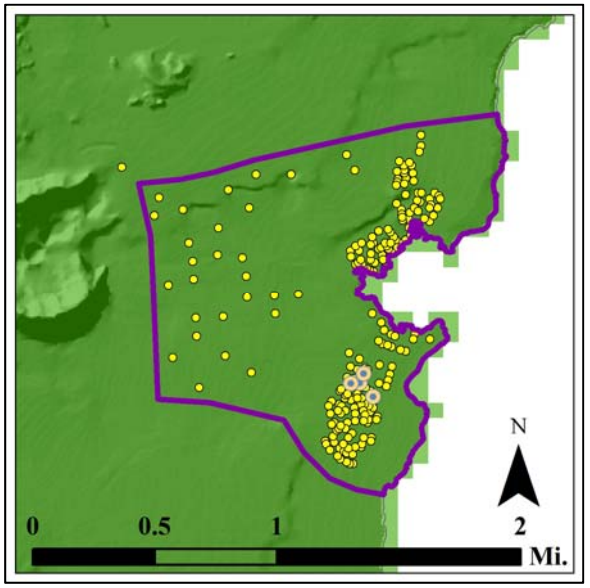


Figure 4 Kapoho priority area and cesspool nitrate

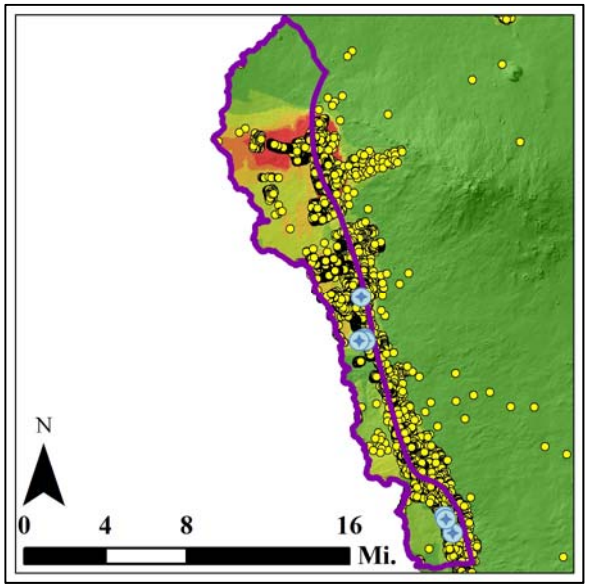


Figure 5 Kona priority area and cesspool nitrate

Priority 1: Significant Risk of Human Health Impacts, Drinking Water Impacts, or Draining to Sensitive Waters
There are no Priority 1 areas identified on Hawai‘i Island.

Priority 2: Potential to Impact Drinking Water

- Kea‘au Area of Hawai‘i Island: In this area of the Puna District, many residents rely on privately owned wells for domestic water, and there is little soil to mitigate the impact of 9,300 cesspools. A DOH investigation found that 25 percent of domestic wells sampled in this area tested positive for wastewater indicator bacteria, demonstrating the potential for disease transmission.

Priority 3: Potential Impacts to Sensitive Waters

- Hilo Bay Area of Hawai‘i Island: Heavy rainfall upslope of Hilo Bay results in significant amounts of stream and groundwater discharge to Hilo Bay, where a breakwater prevents that discharge from mixing with ocean waters. There are 8,700 cesspools discharging to the streams and groundwater that flow into Hilo Bay.

- Coastal Kailua/Kona Area of Hawai‘i Island: The groundwater in this area discharges to the economically important coral reefs and nearshore waters of west Hawai‘i. Wastewater injection combined with discharge from 6,500 cesspools may contribute to degradation of coral reefs.

- Puako Area of Hawai‘i Island: Puako residents rely on 150 cesspools for wastewater disposal. Coral reefs here may be degraded by cesspool discharge; community concern about coral reef health is high.

- Kapoho Area of Hawai‘i Island: The Kapoho community, with 220 cesspools, is fronted by tide pools in the Wai‘opae Marine Life Conservation District that have only a limited connection to the ocean, making the tides pools and the abundance of coral therein susceptible to degradation due to land based pollution.

Priority 4: Impacts Not Identified
A further 24,430 cesspools on Hawai‘i Island require data review and prioritization as of the date of this report.

Kaua‘i Priority Upgrade Areas

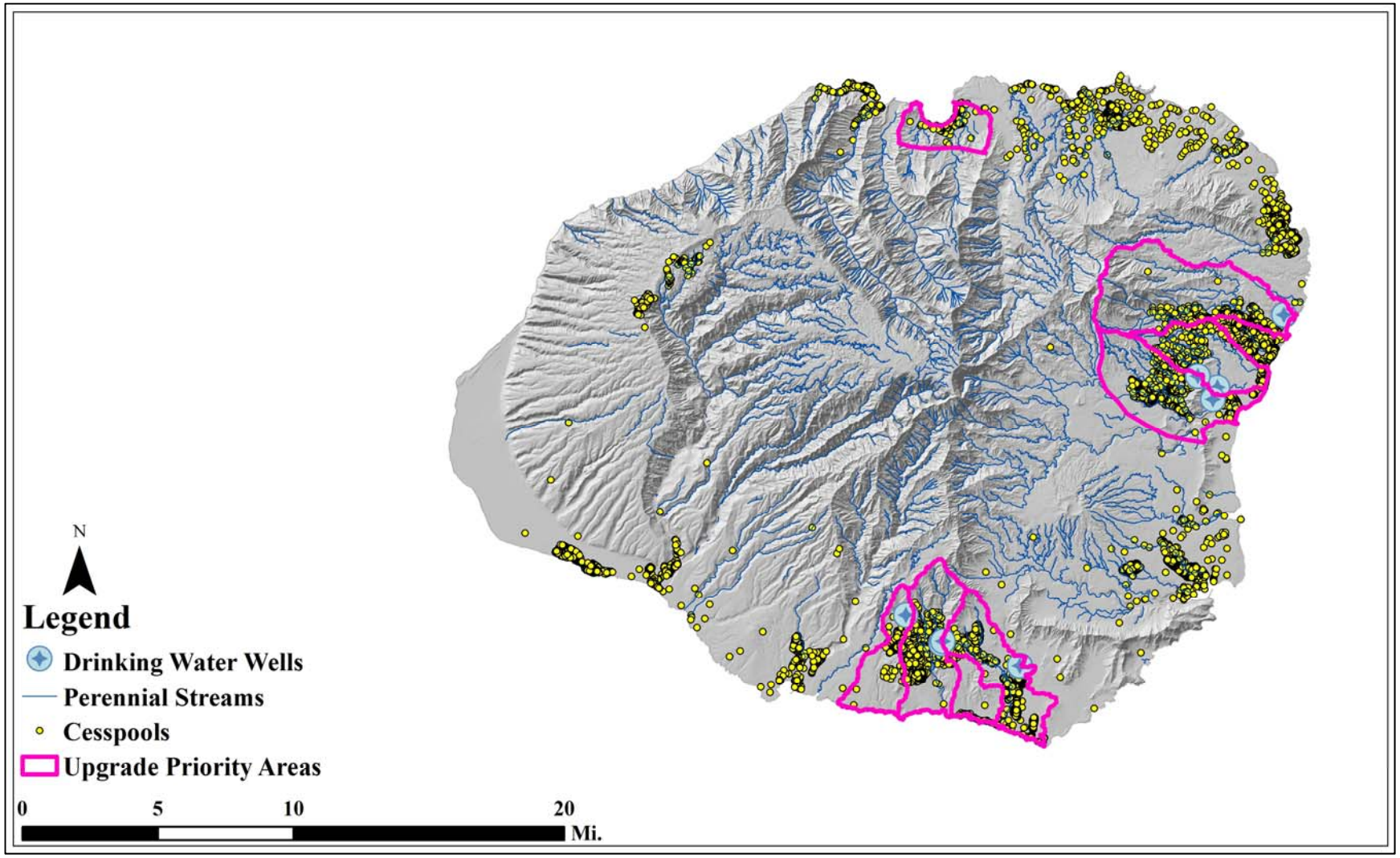
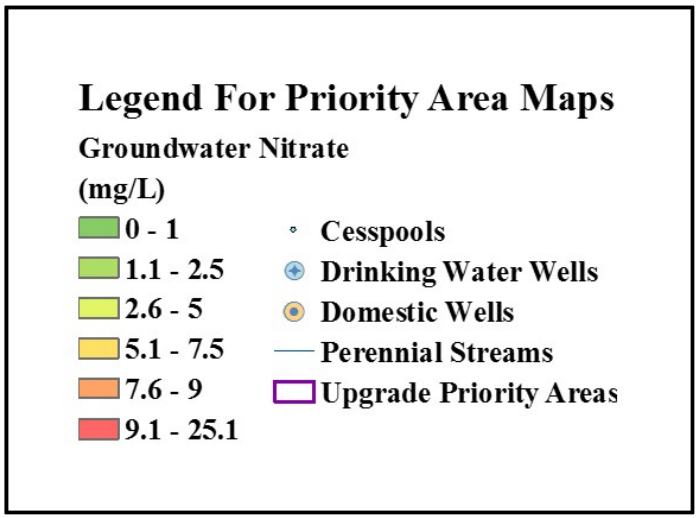


Figure 6 Kaua‘i cesspool locations, priority areas for upgrade, potentially affected drinking water sources, and perennial streams



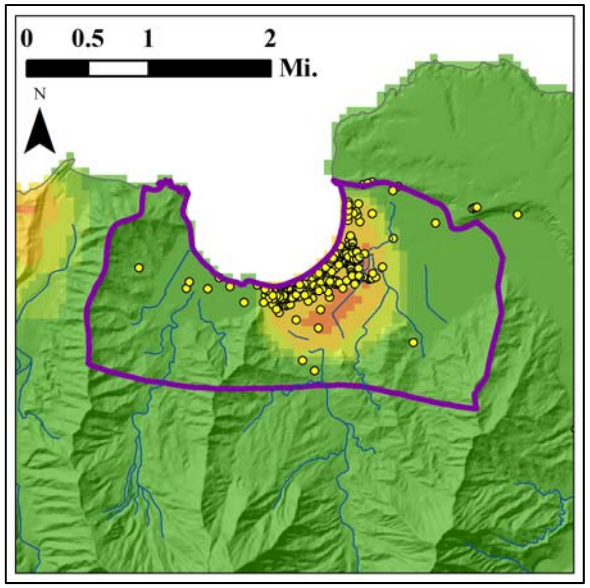


Figure 7 Hanalei priority area and cesspool nitrate

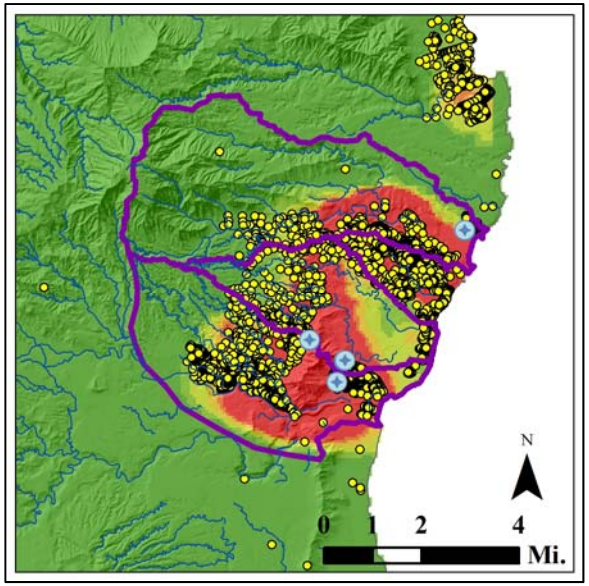


Figure 8 Kapaa/Wailua priority area and cesspool nitrate

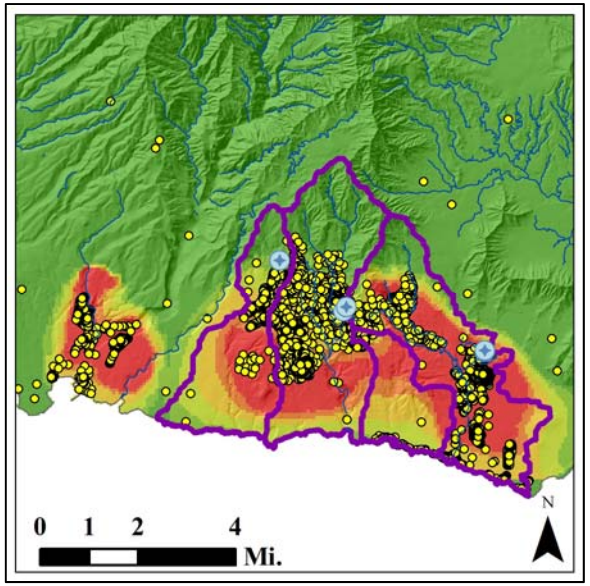


Figure 9 Poipu/Koloa priority area and cesspool nitrate

Priority 1: Significant Risk of Human Health Impacts, Drinking Water Impacts, or Draining to Sensitive Waters
There are no Priority 1 areas currently identified on Kauaʻi.

Priority 2: Potential to Impact Drinking Water

- Kapaa/Wailua Area of Kauaʻi: The 2,900 cesspools in this area are densely sited, resulting in a significant cesspool contamination load to the groundwater and the perennial streams in this area. There are nine public drinking water wells in this area that could potentially become contaminated by cesspool discharge.

- Poipu/Koloa Area of Kauaʻi: In this area, 3,600 cesspools combine with injection of treated wastewater and contribute to elevated groundwater concentrations and discharge into a sheltered bay and coral reef ecosystem with little mixing of bay and ocean waters, putting reefs at risk. There are seven public drinking water wells in this area that could potentially become contaminated by cesspool discharge.

Priority 3: Potential Impacts to Sensitive Waters

- Hanalei Bay Area of Kauaʻi: Community members in this area have expressed support for conversion of 270 existing cesspools to alternate treatment. Many of these cesspools are close to surface water bodies used for recreation and affecting coral reefs, and all discharge to ground water, resulting in a high probability for contamination.

Priority 4: Impacts Not Identified
A further 6,930 cesspools on Kauaʻi require data review and prioritization as of the date of this report.

Maui Priority Upgrade Areas

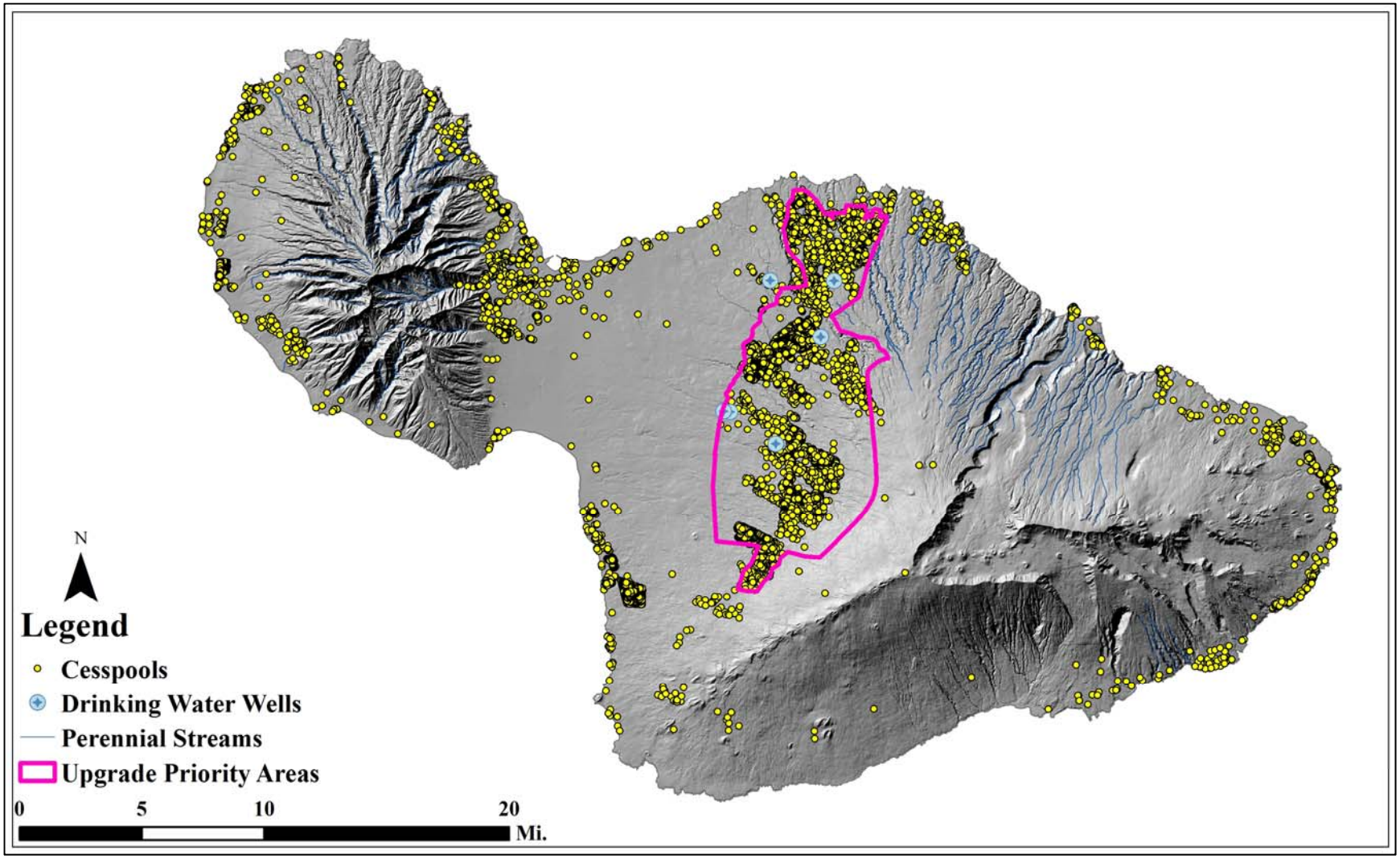
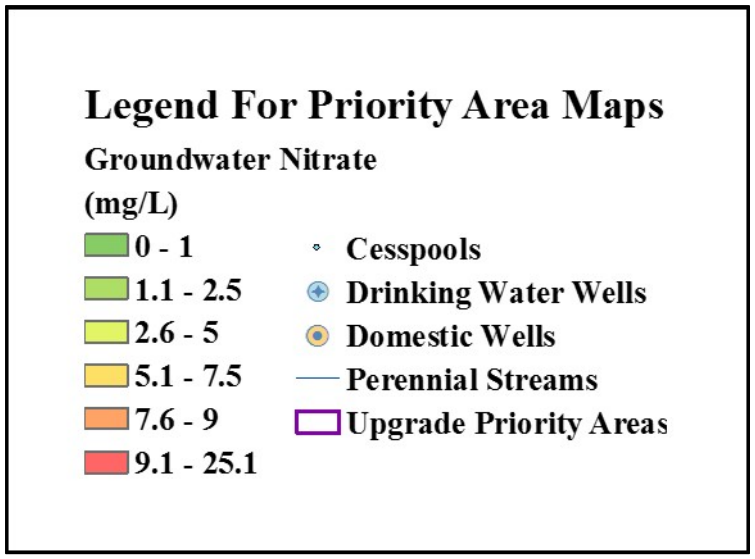


Figure 10 Maui cesspool locations, priority areas for upgrade, potentially affected drinking water sources, and perennial streams



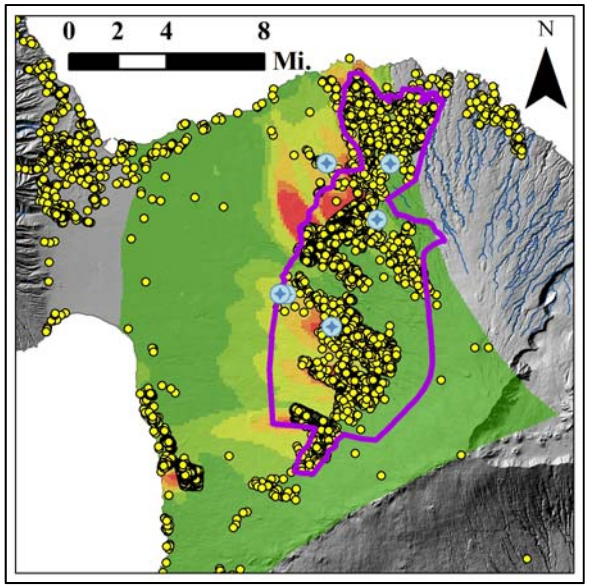


Figure 11 Upcountry Maui priority area and cesspool nitrate

Priority 1: Significant Risk of Human Health Impacts, Drinking Water Impacts, or Draining to Sensitive Waters
Upcountry Area of Maui: 7,400 cesspools contribute to significantly elevated groundwater nitrate concentrations beneath and down gradient of the cesspools. The elevated nitrate levels recorded in drinking water sources do not exceed the federal contaminant levels and, absent elevated bacteria indicators, are not an immediate health concern. The elevated nitrate levels, however, are a concern because they indicate that cesspool wastewater is affecting some public drinking water and may be problematic for future drinking water development in the area. There are five public drinking water wells in the area that are impacted by cesspool discharge. There are an additional three wells that are in the process of becoming public drinking water sources.

Priority 2: Potential to Impact Drinking Water
There are no Priority 2 areas currently identified on Maui.

Priority 3: Potential Impacts to Sensitive Waters
There are no Priority 3 areas currently identified on Maui.

Priority 4: Impacts Not Identified
A further 4,800 cesspools on Maui require data review and prioritization as of the date of this report.

O‘ahu Priority Upgrade Areas

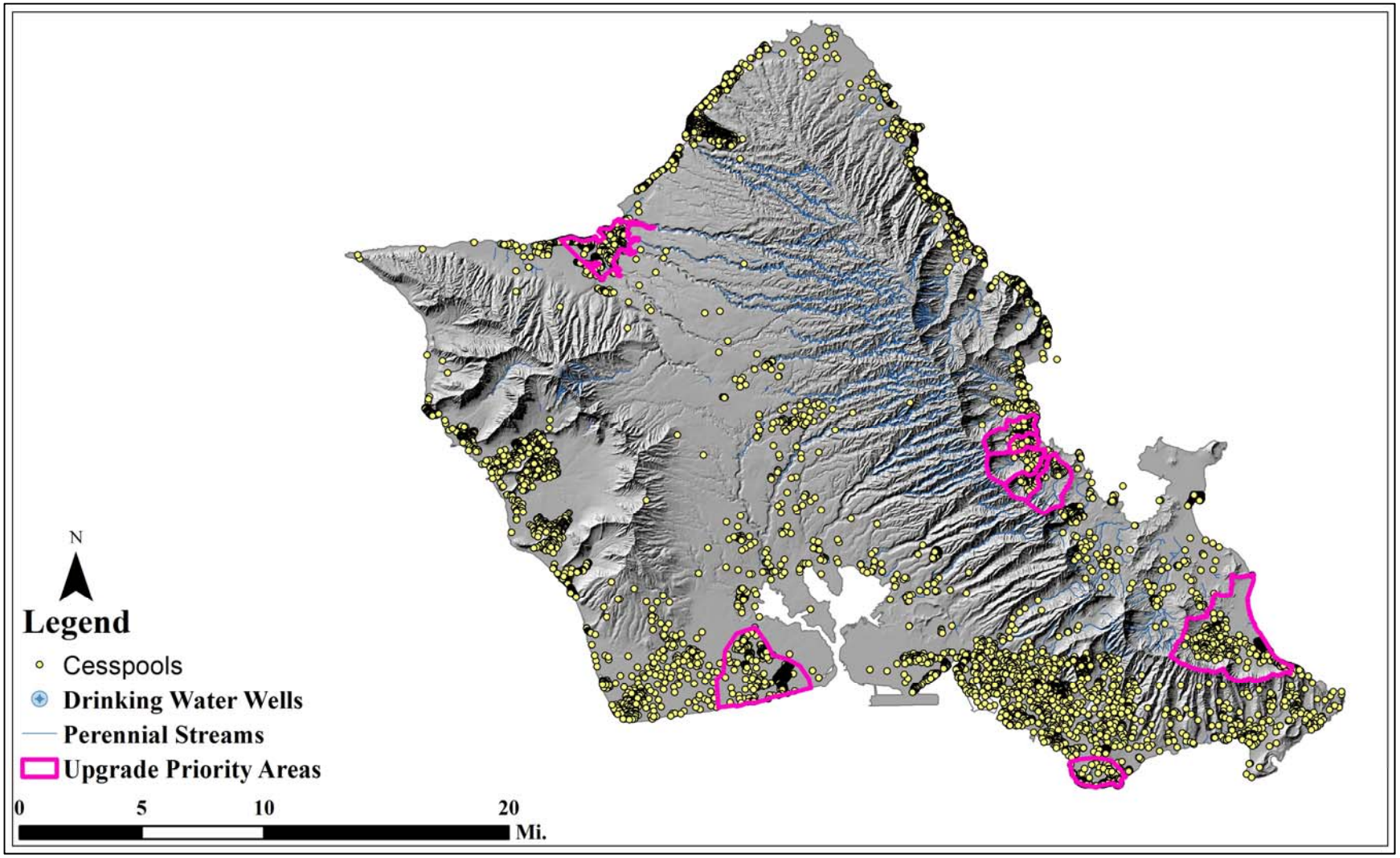
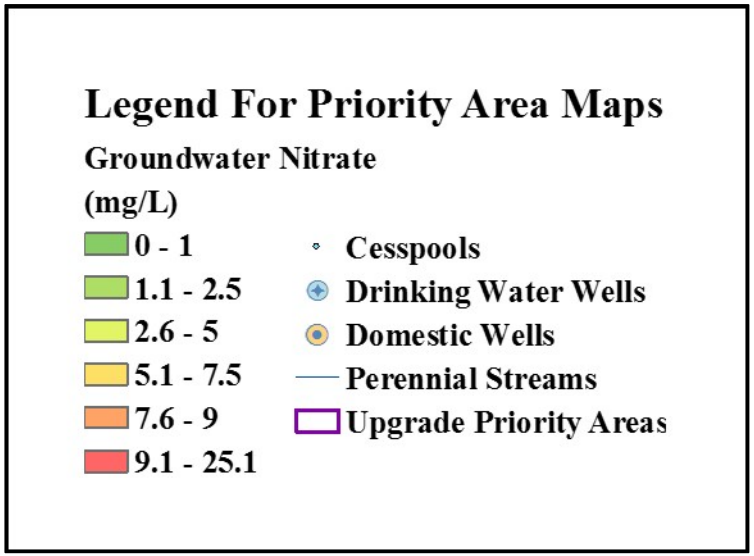


Figure 12 Oahu cesspool locations, priority areas for upgrade, and perennial streams



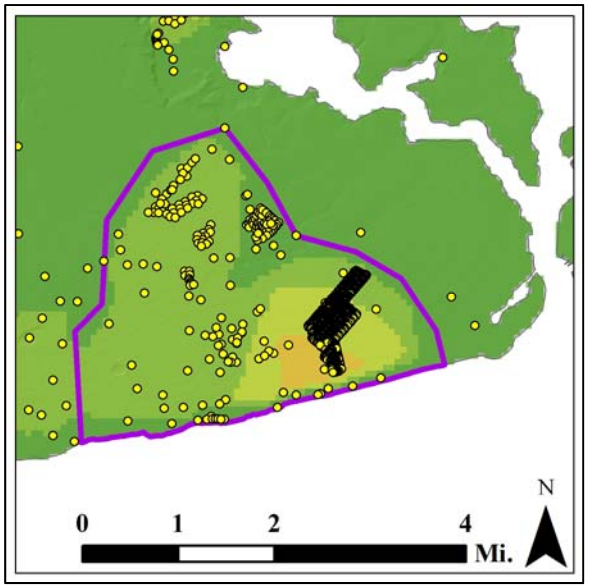


Figure 13 Ewa priority area and cesspool nitrate

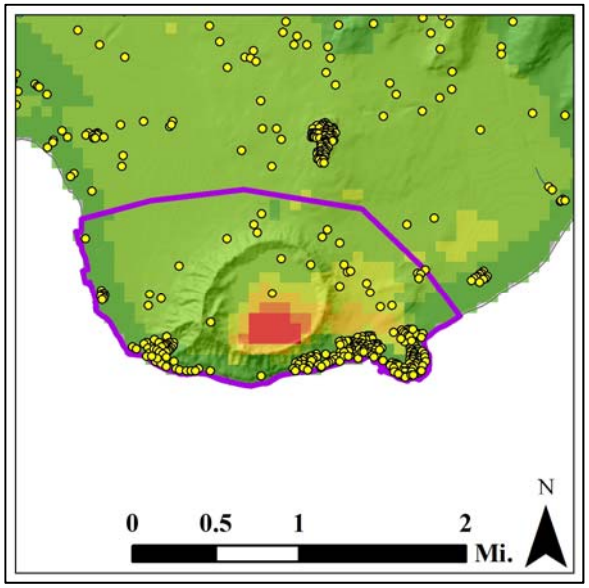


Figure 14 Diamond Head priority area and cesspool nitrate

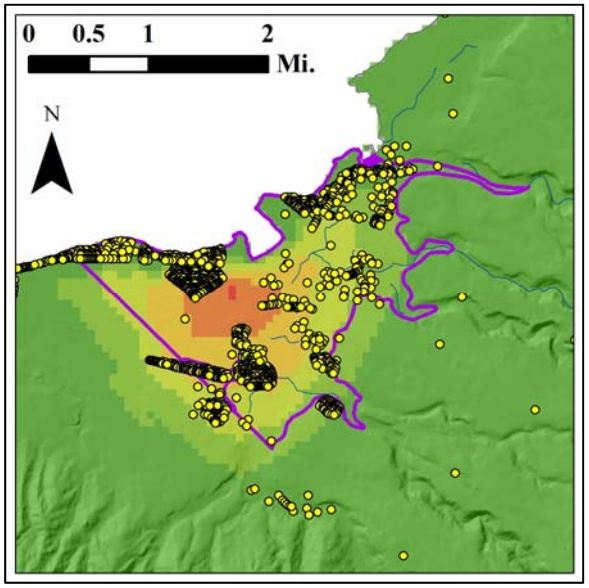


Figure 15 Waialua priority area and cesspool nitrate

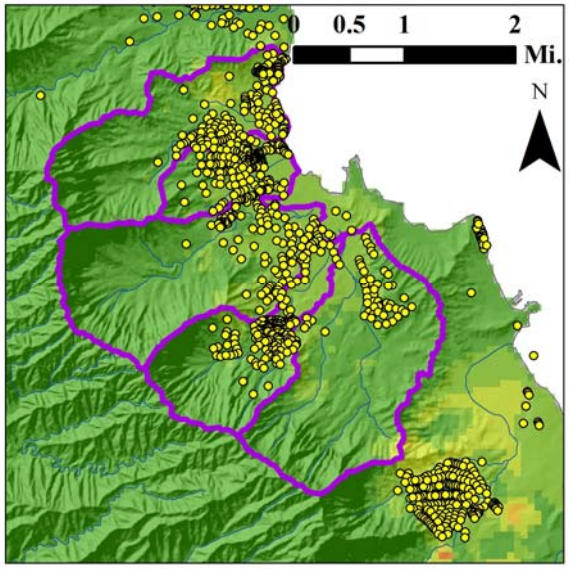


Figure 16 Kahaluʻu priority area and cesspool nitrate

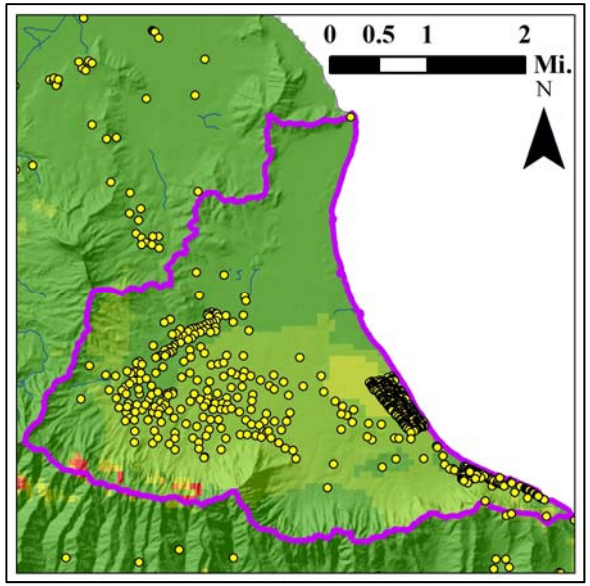


Figure 17 Waimanalo priority area and cesspool nitrate

Priority 1: Significant Risk of Human Health Impacts, Drinking Water Impacts, or Draining to Sensitive Waters

- Kahaluʻu Area of Oʻahu: Draining to Kahaluʻu Lagoon and the economically important coral reefs and nearshore waters of Kaneohe Bay via several perennial streams, 740 cesspools contribute to high bacteria counts and coral-harming nutrients in the surface water. Incidents of skin infections consistent with sewage-contaminated surface waters have been documented in this area. Many of these cesspools are located near perennial streams and subject to overflow due to the wet climate and shallow depth to groundwater.

Priority 2: Potential to Impact Drinking Water

There are no Priority 2 areas currently identified on Oʻahu.

Priority 3: Potential Impacts to Sensitive Waters

- Diamond Head Area of O‘ahu: In this area, 240 cesspools are installed into bare rock very near a shoreline popular with recreational users. This area is also very close to existing sewer infrastructure, and connection to that system appears possible.

- Ewa Area of O‘ahu: While near sewer infrastructure, the Ewa area of O‘ahu still has 1,100 legacy cesspools in operation. This concentration of cesspools near the coast and existing sewer infrastructure make Ewa a priority area for cesspool replacement.

- Waialua Area of O‘ahu: There are 1,080 cesspools concentrated in the lower watersheds that discharge to Kaiaka and Waialua Bays. This is a popular recreational area, bringing swimmers and surfers into contact with waters influenced by wastewater. The combined nutrient load from agricultural and cesspool runoff have the potential to degrade the reefs in these two bays.

- Waimanalo Area of O‘ahu: There are 730 cesspools in the watersheds draining to the Waimanalo coastline. About 230 of the cesspools in close proximity and located near a sewer main that parallels Kalanianole Highway. The proximity of these cesspools to the coast and existing infrastructure make them a priority for upgrade.

Priority 4: Impacts Not Identified

A further 7,610 cesspools on O‘ahu require data review and prioritization as of the date of this report.

Moloka‘i Priority Upgrade Areas

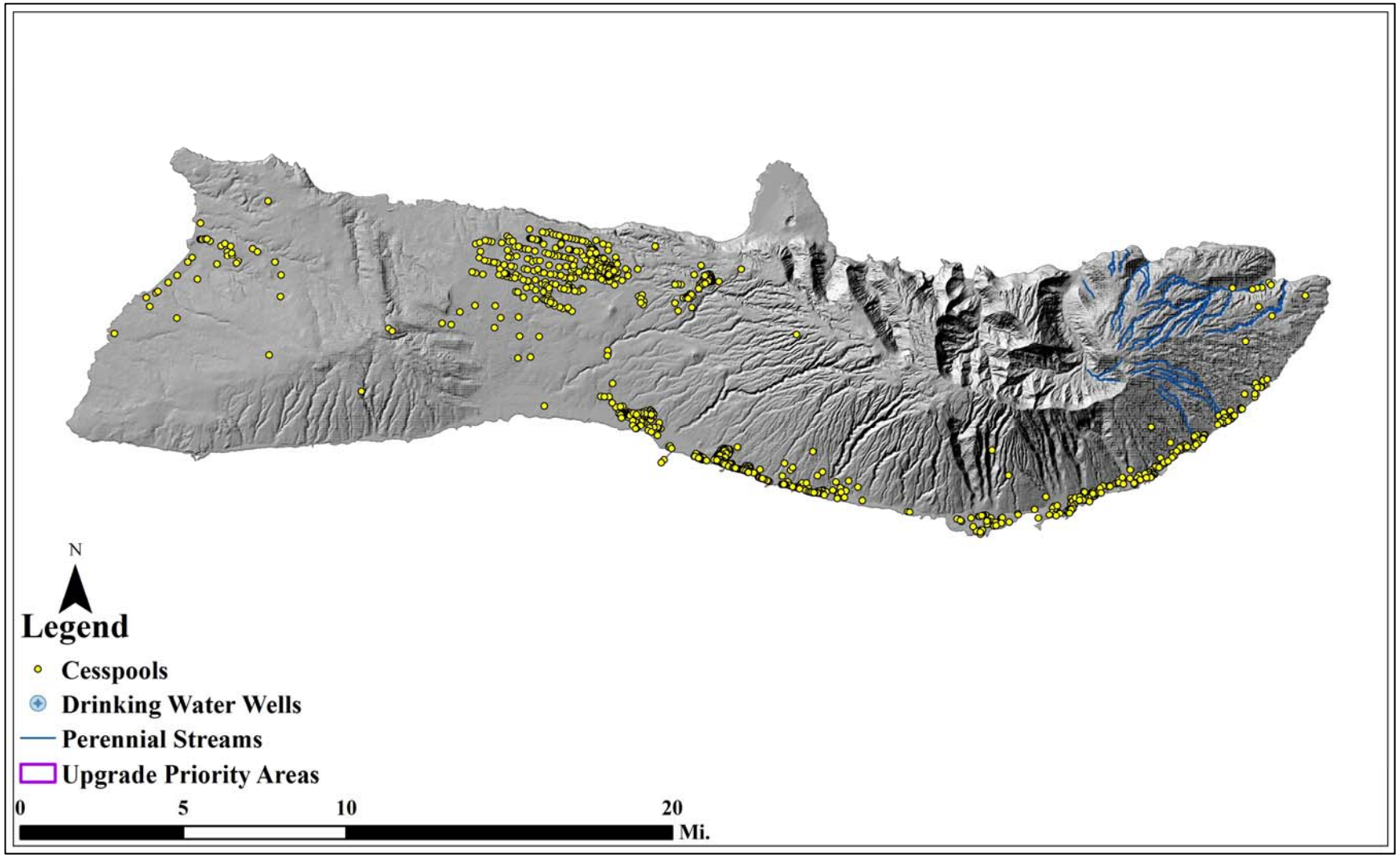


Figure 17 Moloka‘i cesspool locations and perennial streams. There are no priority areas on Moloka‘i.

Priority 1: Significant Risk of Human Health Impacts, Drinking Water Impacts, or Draining to Sensitive Waters

There are no Priority 1 areas currently identified on Molokaʻi.

Priority 2: Potential to Impact Drinking Water
There are no Priority 2 areas currently identified on Molokaʻi.

Priority 3: Potential Impacts to Sensitive Waters
There are no Priority 3 areas currently identified on Molokaʻi.

Priority 4: Impacts Not Identified
1,400 cesspools on Molokaʻi require data review and prioritization as of the date of this report.

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Cesspool Upgrade or Closure Options

Generally, options for upgrade or closure include:

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

Resources Required

Replacement of each existing cesspool with an improved treatment method could cost $20,000 or more per system, for a total cost around **$1.75 billion** for the 87,900 currently inventoried cesspools (an average construction investment of $54.7 million per year from 2018 through 2049). However, costs may vary from this amount if other options such as connecting to existing sewage treatment systems, joining multiple homes in small-scale community package sewer or joint septic systems, or constructing new larger-scale sewage treatment systems are considered.

Proposed Approach

DOH recognizes the value of partnerships and the need for early collaboration with communities. DOH commenced this process by working with several state and county agencies, collecting and evaluating data, and issuing this legislative report. These issues are complex, involving access to municipal sewer systems, local geology, cesspool density, receiving waters, and most appropriate treatment technology. DOH will continue to work with communities, their respective legislative and county representatives, state and county agencies, and stakeholder groups to receive input on, and discuss possible solutions to, the problems identified in this Report. DOH proposes to engage in further discussions with various communities in different parts of the state. To further this goal, DOH proposes to begin holding community engagement meetings in Priority 1 areas in early 2018.

Operating Resources Needed

To support community, partner, and stakeholder engagement and begin developing area-specific upgrade options, DOH will need at least one supported senior staff position for 2018.

APPENDICES

Appendix 1: Cesspool Risks to Health and Environment

Cesspool effluent poses significant threats to human health and sensitive ecosystems. Cesspool wastewater is untreated and contains pathogens, bacteria and viruses that may spread disease. Additionally, cesspool effluent contains nutrients, like nitrogen and phosphorous, that can disrupt the sensitive ecosystems of Hawai‘i, including harming nearshore coral reefs. Individual cesspools have the potential to impact the environment, and, where many are located in close proximity, the cumulative impact on the environment and human health increases.

Cesspool effluent and the contaminants it contains migrate from the cesspool to a human or environmental receptor by one of two primary processes:

- ***Overflow*** of a cesspool results in overland flow of the effluent and allows direct contact with receptors. This pathway is almost always of short distances, reducing the receptor population that may be exposed to the contaminant.

- ***Leaching*** of effluent into the groundwater through the subsurface soil or rock can transport effluent via groundwater flow to the receptors. This pathway can transport cesspool contamination over significant distances. However, migration in this path is very slow, on the order of a few feet per day, allowing time for pathogens to die and other contaminants to degrade or become locked in the soil or diluted by more pure groundwater from elsewhere in the watershed. Over 90% of Hawai‘i’s public drinking water sources are groundwater wells, and dense concentrations of cesspool are present over many drinking water aquifers, posing a threat to new drinking water sources.

There are three main areas of risk associated with cesspools:

- ***Contaminated drinking water sources*** may allow pollutants, including pathogens, to enter the human body. Additionally, cesspools introduce excess nitrogen into the environment; elevated nitrate levels in drinking water is a known human health risk in drinking water, and, as such, all public water systems are required to monitor for nitrate and take action when elevated levels of nitrate are observed. From both a pathogenic and chronic health risk perspective, cesspools near drinking water sources are of greatest concern. The DOH Source Water Assessment and Protection Program has identified at least 2,500 cesspools located within the capture zone delineated around a public drinking water well.

- ***Recreation in polluted streams*** can affect the health of those entering streams contaminated by cesspool effluent. Additionally, polluted streams may recharge drinking water aquifers and can also carry pathogens, nutrients, and other wastewater contaminants to coastal waters.

- ***Coastal waters and coral reefs*** are harmed by cesspool pollution. Nutrients including nitrogen and phosphorus in cesspool effluent can promote algae growth that degrades water quality and clarity. The natural ecosystem of Hawai‘i is low in nutrients, and coral

reefs specifically thrive in low-nutrient waters. The cumulative loading of nitrogen and phosphorous from all cesspools in a watershed is delivered to nearshore waters and can result in ecosystem shifts from a coral-dominated ecosystem to one dominated by macroalgae. The impacts to coral reefs affects the State's economy, shoreline protection, recreation and habitat for important marine life.

Risk from cesspools is greater than that of other types of onsite wastewater disposal:

- ***The total wastewater contaminant load is released to the environment.*** There is no removal of solids from a cesspool's wastewater stream as there is with a septic tank. Detention time in a septic tank allows for settling of solids that can later disposed at an advanced wastewater treatment facility. The septic tank detention time also allows for die-off of pathogens and some degradation of the wastewater contaminants.

- ***The wastewater is discharged below the zone of plant uptake, bypassing potential for natural remediation of wastewater contaminants.*** Leach fields discharge septic effluent about 12 to18 inches below the ground surface, which is a more biologically active zone where plant uptake and microbial remediation can reduce the wastewater contaminant load. The soil in the leach field also physically filters contaminants and pathogens from the septic effluent. Cesspools discharge the total wastewater load 15 feet or more below the ground surface. This depth is well below the zone of plant uptake and lower than where the most vigorous microbial activity occurs. In many cases, cesspool effluent discharge occurs below the soil zone resulting in no natural filtering of discharged wastewater.

Two major considerations for prioritizing cesspools for corrective action are the risk the cesspools pose and existing infrastructure such as nearby sewer mains. Previously drafted risk-based analyses estimated the number and location of onsite sewage disposal systems including cesspools in the State and assigned a risk score that considered numerous factors such as; dense clustering of OSDS, type of wastewater disposal, soil characteristics, proximity of the OSDS to sensitive receptors such as drinking water sources, streams and shorelines, and the transport of wastewater effluent in groundwater to the sensitive receptors.

This report considers the previous risk evaluations, recent evidence of cesspool related health impacts, and active community involvement in addressing the cesspool problem. This report identifies four broad categories for prioritizing cesspool closures based on an evaluation of factors including: documented impact to human health; presence of nearby drinking water sources; the scale of documented drinking water impact; the presence and sensitivity of a receiving water body; the presence or absence of nearby sewage collection and treatment systems; and the presence or absence of protective land use planning that would avoid further degradation of the watershed.

However, most of the watersheds, aquifers, and coastal environment in the State have not been fully evaluated, and data gathered in ongoing and future studies, may elevate or alter the areas of focus in this report. Analyses not currently considered include the characteristics of the sensitive receptors. Examples of these characteristics that influence the severity of the cesspool impact

include; whether the shoreline is sheltered from or exposed to the prevailing tradewinds, the slope of the nearshore bathometry, whether the shoreline forms a bay or a peninsula, and synergy with other sources of contamination such as wastewater injection and agriculture. Over the past two years DOH and the University of Hawaii (UH), College of Tropical Agriculture and Human Resources have collaborated on methodologies to quantitatively evaluate the impact of terrestrial nutrients, including cesspool effluent, on the nearshore environment and do cost benefit analysis of various corrective actions. As we address our legacy of cesspools expanding on the current UH/DOH research can ensure that cesspool replacements efforts for the remaining 45,000 cesspools are focused in the areas of the most immediate needs.

Appendix 2: Detailed Information about Priority Upgrade Areas

Name	Priority	Area (Square Miles)	Cesspools (Quantity)	Effluent Discharge (million gallons per day)	Nitrogen Flux (kilograms per day)	Phosphorus Flux (kilograms per day)
Upcountry Area of Maui	1	72	7,400	4.4	980	280
Kahaluʻu Area of Oʻahu	1	8.4	740	0.44	110	30
Keaʻau Area of Hawaiʻi Island	2	91	9,300	4.9	970	270
Kapaa/Wailua Area of Kauaʻi	2	36	2,900	2.2	430	120
Poipu/Koloa Area of Kauaʻi	2	27	3,600	2.6	550	150
Hilo Bay Area, Hawaiʻi Island	3	31	8,700	5.6	1,300	340
Coastal Kailua/Kona Area, Hawaiʻi Island	3	79	6,500	3.9	550	150
Puako Area of, Hawaiʻi Island	3	0.6	150	0.09	17	4.9
Kapoho Area of, Hawaiʻi Island	3	1.4	220	0.12	25	6.9
Hanalei Area of Kauaʻi	3	4.3	270	0.13	24	6.8
Diamond Head Area of Oʻahu	3	2.0	240	0.17	35	10
Ewa Area of Oʻahu	3	7.6	1,100	0.71	160	45
Waialua Area of Oʻahu	3	3.3	1,080	0.79	170	49
Waimanalo Area of Oʻahu	3	16.2	530	80.2	80	22

Hawaiʻi

Keaʻau Area of Hawaiʻi Island – About 17 percent of the cesspools in the State are located in 4.3-mile wide corridor along the groundwater flow path on east slope of the Kilauea Volcano. This area of the Puna District is not served by public water so many of the residents rely on privately owned wells for their domestic water needs. Additionally, there is little to no soil cover to mitigate the impact of cesspools or slow the drainage of cesspool effluent to the water table. A UH study found the infiltration travel time from the ground surface to the groundwater could be as short as a fraction of an hour (Novak, 1995). The high density of cesspools and short leachate infiltration time pose a significant health risk in an area where residents rely on domestic wells for drinking water. A DOH investigation found that 25 percent of domestic wells sampled in this area tested positive for wastewater indicator bacteria demonstrating the potential for disease transmission.

Hilo Bay Area of Hawai‘i Island –Hilo Bay is on the windward side of Hawai‘i Island resulting in large flows of groundwater and surface water into the bay. The bay itself is sheltered from the oceanic waters by a breakwater, reducing the rate of water turnover in the bay. There are nearly 9,000 cesspools discharging to the streams and groundwater that flow into Hilo Bay. This results in a significant wastewater contaminant load to this sheltered body of water. Research by University of Hawai‘i at Hilo (Wiegner et al., 2013) shows elevated nutrient and fecal indicator bacteria concentrations in Hilo Bay and in the rivers discharging to this bay.

Coastal Kailua/Kona Area of Hawai‘i Island – The groundwater in this area discharges to the economically important reefs of West Hawaii. Groundwater modeling indicates that nitrate concentrations in the aquifer from OSDS may exceed 10 mg/L, resulting in a significant nutrient contamination load to the coral reefs of west Hawai‘i Island. Wastewater injection further increases the coastal wastewater contaminant load, likely resulting in degradation of coral reefs. A survey of reef health for the leeward coast of Hawaii (Couch et al., 2014) found steep coral declines in multiple locations. Many of the locations with coral decline correlate to high densities of OSDS or points of wastewater injection.

Puako Area of Hawai‘i Island – Puako is a small community in the north of Kailua-Kona. The residents of this community are reliant on OSDS for wastewater disposal. Community concern about the health of the reef and potential adverse impacts from wastewater disposal have prompted scientific and State Agency evaluation of coastal impact from current wastewater disposal practices. The Hawai‘i Department of Land and Natural Resources, Division of Aquatic Resources found that the Puako reefs are in dire straits, with coral cover decreasing 35 percent and overgrowth of turf and macroalgae increasing 38 percent in the last 30 years. Research done by the University of Hawaii at Hilo found elevated concentrations of nutrients along the shoreline with chemical signatures consistent with sewage. A tracer dye study verified the hydraulic connection between OSDS and shore line with travel times varying from 13 to 250 feet per day (NOAA, 2017).

Kapoho Area of Hawai‘i Island – The Kapoho community is fronted by tide pools in the Wai‘opae Marine Life Conservation District with only a limited connection to the ocean. This shielding from oceanic waves reduces the water turnover rate making the tides pools and the abundance of coral therein susceptible to degradation due to land based pollution. A study by the University of Hawaii at Hilo (Wiegner et al., 2016) estimated that sewage contributed about 27 percent of the nutrient load to the tide pools reducing the ability of the coral to resist algae overgrowth.

Kaua‘i

Kapaa/Wailua Area of Kaua‘i – This watershed has a high cesspool density resulting in a significant cesspool contamination load to the groundwater and the perennial streams in this area. Groundwater modeling indicates that concentrations significantly greater than the Maximum Contaminant Limit (MCL) may be present in the drinking water aquifer. There are nine public drinking water wells in this area that can potentially become contaminated by cesspool discharge. This is also an area where an elevated water table results in discharge of groundwater

to important streams. The Kapaa and Moikeha Streams, and the Wailua River pass through this area's receiving groundwater that is contaminated by cesspool discharge.

Poipu/Koloa Area of Kaua‘i – Similar to the Kapaa/Wailua area, groundwater modeling indicates that OSDS contamination, predominantly from cesspools, has likely elevated the groundwater nitrate concentrations above drinking water limits. This high nitrate groundwater discharges at the coast, placing the coastal reefs at risk. The waters off of Poipu are on the leeward side of the island, reducing the rate at which coastal water turnover can dilute the contamination. The coastal wastewater contamination problem is compounded by injection of wastewater, which in combination with the OSDS/cesspool input results a significantly elevated contaminant load to the marine environment. There are seven public drinking water wells in this area that can potentially become contaminated by cesspool discharge.

Hanalei Area of Kaua‘i – This area has about 270 cesspools in close proximity to the shoreline or the Hanalei River, degrading surface and coastal water quality. The nutrient load from cesspools combined with that from agriculture can provide a significant nutrient load to the Hanalei Bay. Wastewater also reduces the coral's ability to resist disease. Recent occurrence of the Black Band Coral disease in Hanalei Bay (Aeby et al., 2007 and 2012) demonstrates the need to improve the quality of surface and groundwater flowing to Hanalei Bay.

Maui

Upcountry Area of Maui– Upcountry Maui – the Makawao, Pukalani, and Kula areas on the western flank of Haleakalā have more than 7,000 cesspools and measured groundwater nitrate concentrations as high as 8.7 mg/L, which is very close to the drinking water MCL of 10 mg/L. DOH conducted an investigation to determine the extent, magnitude and source the of the nitrate contamination in the area. Nearly all of the wells sampled had nitrate concentrations higher than what could be accounted from natural and agricultural sources. Of the 12 wells sampled, 25 percent had nitrate concentrations equal to or greater than 5 mg/L, half of the MCL. The wells sampled are located at the edge or upslope of the major agricultural zones, leaving OSDS as the only logical source of the elevated groundwater nitrate. A groundwater model of OSDS nitrate in the groundwater, validated by the well sampling, indicates it is likely that the MCL for nitrate is exceeded in parts of the drinking water aquifer of east-central Maui. The conclusion of the DOH investigation is that while nitrate in the groundwater captured by the current drinking water sources is significantly less than the MCL, parts of the aquifer are degraded enough by OSDS contamination that water from a well installed in these locations would require expensive treatment to meet drinking water standards.

O‘ahu

Kahalu‘u Area of O‘ahu – High bacteria counts in the surface water and incidents of skin infections consistent with sewage contaminated surface waters have been documented following contact with waters in this area. Many of these cesspools are located near perennial streams and are subject to overflow due to the wet climate and shallow depth to groundwater. All wastewater from these cesspools flows to the Kahalu‘u Lagoon or to Kaneohe Bay as contaminated stream or groundwater discharge. The waters of the Kahalu‘u Lagoon and Kaneohe Bay are sheltered, so there is less exchange with offshore water that could dilute, and thus reduce, the severity of the cesspool contamination. The high density cesspool areas are near existing sewer

infrastructure that could be extended, possibly facilitating cesspool closure of nearly 70 percent of these cesspools by connecting to the municipal sewage collection system.

Diamond Head Area of O‘ahu – This is an area where cesspools are installed in bare rock very near the shoreline. This is also an area that is frequented by swimmers and surfers, bringing the ocean users in direct contact with cesspool contaminated marine water. Research done by the University of Hawaii showed that the groundwater discharge to the ocean at this location was significantly elevated in nutrients relative to a similar location not affected by cesspools (Richardson et al., 2017). The cesspools in the Diamond Head area of O‘ahu are near existing sewer infrastructure, possibly facilitating cesspool closure by connecting to the municipal sewage collection system.

Ewa Area of O‘ahu –Parts of the Ewa area of O‘ahu still have an abundance of legacy cesspools that are near sewer infrastructure. This concentration of cesspools near the coast and existing sewer infrastructure make these parts of Ewa a priority area for cesspool replacement.

Waialua Area of O‘ahu – The Kaiaka and Waialua Bays of north Oahu receive surface water and groundwater containing cesspool, wastewater injection, and agricultural contamination. The streams that flow into Kaiaka and Waialua Bays drain four major watersheds with a combined area of 79.8 square miles. Groundwater modeling indicates that nitrate concentration in groundwater resulting from cesspool and other OSDS leachate approaches the drinking water limit of 10 mg/L. While there are no drinking water sources on this Waialua priority upgrade area, this high nutrient groundwater discharges to the bays. Compounding the coastal pollution from cesspools are 14 wastewater injection wells, and agricultural nutrients where surface water mixed with treated wastewater is applied to the fields. Approximately 10 percent of the 1,080 cesspools in the Waialua area are located with 200 ft of the shoreline, increasing the health risk to swimmers and surfers.

Waimanalo Area of O‘ahu – The cluster of cesspools near the shoreline and proximity to existing infrastructure make Waimanalo a priority upgrade area. This is also an area with municipal wastewater injection and upslope agriculture. UH researchers confirmed chemical signatures in the coastal algae community that were consistent with wastewater discharge to the marine environment (Amato et al., in prep). The distribution of the wastewater chemical signature showed that cesspools in addition to wastewater injection were contributing the coastal contaminant load. These factors taken together make Waimanalo an attractive location for cesspools replacement.

Appendix 3: History of DOH and Cesspools

Year(s)	Activity Description	Program
1992	HDOH revised the Wastewater Regulations designating all of Kaua‘i and O‘ahu, most of Maui, Lāna‘i, and portions of Moloka‘i and Hawai‘i Critical Wastewater Disposal Areas, prohibiting new cesspools.	Wastewater Branch
2008	HDOH and Department of Business, Economic Development and Tourism (DBEDT) commissioned a study by University of Hawai‘i, Water Resources Research Center to provide guidance as to the various onsite wastewater treatment and disposal technologies.	Coastal Zone Management Program
2009	HDOH commissioned a study by the University of Hawai‘i – Water Resources Research Center to develop a maintenance and inspection program for onsite wastewater systems.	Source Water Protection Program, 15 % Drinking Water State Revolving Fund (DWSRF) 15 % Set-Aside, Safe Drinking Water Branch
2009	HDOH commissioned a study by the University of Hawai‘i –Dept. of Geology and Geophysics to estimate the number, location, effluent and contaminant discharge rates, and human health and environmental risk posed by wastewater disposal systems including cesspools on Oahu.	Source Water Protection Program, DWSRF 15 % Set-Aside, Safe Drinking Water Branch
2009 – Present	HDOH partners with Hanalei Watershed community organizations to upgrade 20 cesspools near surface and coastal waters.	Polluted Run-off Control Program, Clean Water Branch
2011	HDOH commissioned a study by the University of Hawai‘i –Dept. of Geology and Geophysics to estimate the number, location, effluent and contaminant discharge rates, and human health and environmental risk posed by onsite wastewater disposal systems including cesspools on the islands of Kauai, Molokai, Kaua‘i, Moloka‘i, Maui, and Hawai‘i.	Source Water Protection Program, DWSRF 15 % Set-Aside, Safe Drinking Water Branch
2011-2012	HDOH and the University of Hawai‘i – Water Resources Research Center conduct inspections of 213 onsite wastewater disposal system finding that 32 percent of the OSDS inspected were either failing or had deficiencies that could result in failure.	Source Water Protection Program, DWSRF 15 % Set-Aside, Safe Drinking Water Branch
2012 – 2015	HDOH partners with Hawai‘i County, Hawaiian Beaches public water system, and the Maui Department of Water Supply to upgrade or connect to sewer 15 cesspools located near public drinking water wells	Source Water Protection Program, DWSRF 15 % Set-Aside, Safe Drinking Water Branch
2013 - present	HDOH and University of Hawai‘i at Hilo conduct studies on wastewater pollution in the surface waters of Hawai‘i Island. Cesspools are identified as a significant source of the contaminant load.	Clean Water Branch
2014	HDOH proposes revisions to the Wastewater Regulations to require conversion of cesspools to higher level wastewater treatment within six months after sale. This revision was later amended to require point of sale upgrades in designated sensitive areas. No rules were promulgated.	Wastewater Branch
2014 - present	HDOH partners with the University of Hawai‘i – College of Tropical Agriculture and Human Resources to develop quantitative models to assess the impact that land based nutrients, including those from cesspools, in the coastal groundwater discharge have on the nearshore ecosystems. This partnership further investigates protocols to cost optimize efforts to reduce the coastal nutrient load.	Source Water Protection Program, DWSRF 15 % Set-Aside, Safe Drinking Water Branch
2015	The legislature and Governor with assistance from HDOH enact a tax credit of $10,000 to upgrade cesspools in designated sensitive areas.	Wastewater Branch
2015-2017	HDOH has processed 47 applications for the Act 120 tax credit.	Wastewater Branch

Year(s)	Activity Description	Program
2016	HDOH proposes and Governor amends the Wastewater Regulations to prohibit the construction of new cesspools throughout the State of Hawaii.	Wastewater Branch
2016	The Legislature and Governor with assistance from HDOH pass Act 125 requiring that all cesspools be upgraded by 2050 and directing HDOH to submit a report to the Legislature investigating the number, scope, location, and priority of cesspools Statewide that require upgrade, conversion, or connection based on each cesspool's impact on public health.	Wastewater Branch

Appendix 4: Reference Material

Aeby, G., 2007. Coral disease in Hanalei Bay. In: Field, M.E., Berg, C.S., Cochran, S.A. (Eds.), Science and Management in the Hanalei Watershed: A Trans-Disciplinary Approach; Proceedings from the Hanalei Watershed Workshop: USGS Open File Report 2007-1219, 87 p. https://pubs.usgs.gov/of/2007/1219/of2007-1219.pdf

Aeby, G.S., Work, T.W., Callahan, S.M. 2012. Outbreak of *Montipora* banded Tissue loss on the reefs of Kauai. http://www.hcri.ssri.hawaii.edu/files/research/pdf/2012-12-18_kauai_disease_outbreak_report.pdf

Amato DW, Dulai H, Whittier RB, Smith CM, and CR Glenn (in prep). Wastewater in the watershed: A multi-tracer study of sewage-derived nitrogen in coastal waters of O'ahu, Hawai'i. Intended for submission to Environmental Science and Pollution Research

Amato DW, and RB Whittier (in prep). Algal bioassays detect modeled loading of wastewater-derived nitrogen in coastal waters of O'ahu, Hawai'i. Intended for submission to Ecohydrology

Couch, C. S., et al. 2014. Spatial and temporal patterns of coral health and disease along leeward Hawai'i Island. Coral Reefs 33: 1-12.

NOAA. 2017. Spatial distribution and effects of sewage on Puakō's (Hawai'i) coral reefs - NOAA Coral Reef Conservation Program; Final Project Report. Prepared by Marine Science Department, University of Hawai'i at Hilo. March, 2017. http://www.southkohalacoastalpartnership.com/uploads/2/5/7/1/25718612/noaa_final_report_march_2017.pdf

Novak, E. 1995. A Conceptual Model of Shallow Groundwater Flow Within the Lower East Rift Zone of Kilauea Volcano, Hawaii. Master's Thesis, University of Hawaii, Dept. of Geology and Geophysics. May, 1995

Richardson, C.M., Dulai, H., and Whittier, R.B. 2017. Sources and spatial variability of groundwater-delivered nutrients in Maunalua Bay, Oahu, Hawai'i. Journal of Hydrology: Regional Studies. Volume 11, June 2017, Pages 178-193. http://www.sciencedirect.com/science/article/pii/S2214581815001214

Wiegner, T.N., Mead, L.H., and Molloy, S.L. 2013. A comparison of water quality between low- and high-flow river conditions in a tropical estuary, Hilo Bay, Hawai'i. Estuaries and Coasts 36: 319-333.

Wiegner, T.N., Mokiao-Lee, A., and Johnson, E.E. (2016). Identifying nitrogen sources to thermal tide pools in Kapoho, Hawai'i, U.S.A, using a multi- stable isotope approach. Marine Pollution Bulletin 103:63-71.

Whittier, R.B., El-Kadi, A.I., 2009. Human and Environmental Risk Ranking of Onsite Sewage. Disposal Systems. Final report submitted to State of Hawai'i Department of Health, Safe Drinking Water Branch, Honolulu, Hawai'i. https://health.hawaii.gov/wastewater/files/2015/09/OSDS_OAHU.pdf

Whittier R.B., and A.I. El-Kadi. 2014. Human health and environmental risk ranking of on-site sewage disposal systems for the Hawaiian Islands of Kauai, Molokai, Maui, and Hawai‘i. Prepared for the State of Hawai‘i Department of Health, Safe Drinking Water Branch, by the University of Hawai‘i, Dept. of Geology and Geophysics. Honolulu, Hawai’i. http://health.hawaii.gov/wastewater/files/2015/09/OSDS_NI.pdf