Cesspool Replacement on O'ahu

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O'AHU RESOURCE CONSERVATION & DEVELOPMENT COUNCIL

This summary is intended to educate and guide residents of O'ahu on current information and opportunities available regarding cesspool replacement.

What is a cesspool and why does it matter?

In areas where sewers are not available to collect wastewater and deliver it to treatment facilities, the use of On-site Sewage Disposal Systems (OSDS) is common all over the world. In the U.S., roughly 25% of the population utilizes an OSDS for wastewater disposal, and in Hawai'i this number is even higher at 38% [1]. By far the most common type of OSDS in Hawai'i is the cesspool, which, simply put, is **a hole in the ground that receives raw, untreated sewage** (Figure 1). Cesspools do not have a tank or any other way of containing the solids in the waste stream, and they are not designed to provide treatment of sewage, only disposal. For this reason, there are **serious concerns about the impacts of cesspools on the surrounding environment and human health,** given the long history of disease outbreaks associated with sewage-tainted drinking water.

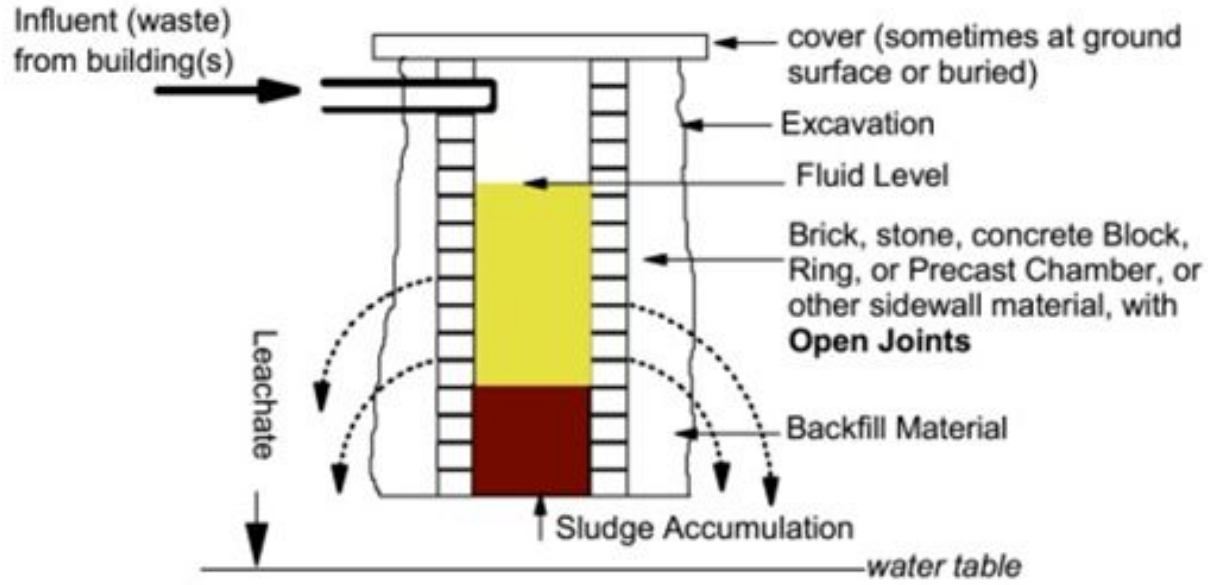

Figure 1. Cesspool schematic

Cesspools would not be as large a concern if they were few and far between, however, there are estimated to be about 88,000 cesspool units in the Hawaiian Islands that are actively used. Of this total, **roughly 11,300 cesspools are located on the island of O'ahu**, and they collectively discharge about 7.5 million gallons of untreated sewage into the environment every day[2]. The sheer number of cesspools drives the concern that this method of waste disposal is polluting our waters in Hawai'i, especially when combined with contributing factors like Hawai'i's geology that includes fast-draining, sandy soils in many coastal plains and fractured, underlying bedrock. In many cases, this **allows for pollutants in cesspools to move underground to drinking water aquifers and surface waters** used for swimming and other recreation through a process called leaching.

While the main contaminants of concern in our wastewater are the many pathogenic microorganisms that can make us sick (such as E. coli, Salmonella, etc.), there are several other **potential pollutants in the human waste stream that can also cause negative impacts to us or the environment that supports us**. High levels of nitrate-nitrogen in drinking water (> 12 mg/L) suppress the human body's ability to deliver oxygen in the bloodstream, which can cause a fatal condition in infants commonly called Blue Baby Syndrome. A University of Hawai'i study used groundwater modeling to show that that the maximum potential nitrate increase from OSDS to groundwater on O'ahu is roughly 11 mg/L above background levels [3], which may already be elevated in places due to legacy chemicals from previous agricultural land use (Figure 2). This potential increase is higher than the EPA Maximum Contaminant Level of 10 mg/L for nitrate in drinking water. Other constituents of concern in wastewater may include toxic organic chemicals, heavy metals disposed of as household waste, and endocrine disruptors which mimic human hormones and can affect growth and reproduction. Basically, any substance that goes down the drain may end up in the environment when a cesspool is used for sewage disposal!

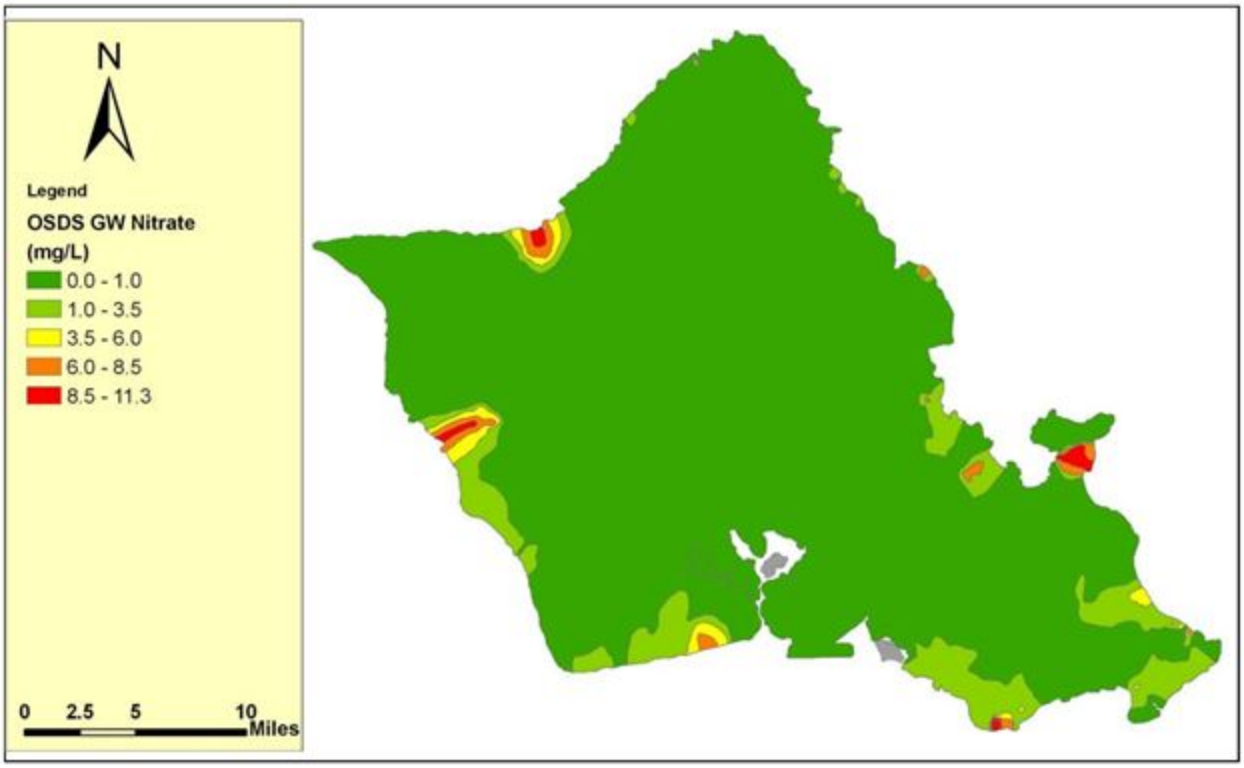

Figure 2: Simulated concentration of OSDS-derived nitrate in groundwater [3]

In addition to potential effects on human health, wastewater contaminants can also cause problems to our environment. For example, excess nutrients like nitrogen and phosphorus in aquatic ecosystems often lead to increased plant growth. Such shifts can cause imbalance among algae species in coral reef environments and can cause harmful algal blooms in freshwater systems as well. Studies by the US Geological Survey showed that treated sewage disposed of by injection wells nearly doubles the nitrogen load in groundwater discharge along eight miles of coastline near Kihei, Maui [4]. University of Hawai'i studies concluded that sewage disposal is a significant factor in algal blooms off of Kihei and Lahaina[5], **causing degraded water quality and habitat conditions in the nearshore marine environment**. While this situation is for treated sewage, it demonstrates the potential for untreated sewage in cesspools to impact ocean waters through the same pathways.

What are the options to replace a cesspool?

First off, and ideally, if a sewer system exists nearby, **a sewer connection is a relatively simple solution that will ensure the entire wastewater stream is diverted from the cesspool to a treatment plant for proper processing and disposal**. More often, without the sewer option available, an on-site upgrade is needed to replace the cesspool with another type of OSDS that will provide treatment of the sewage before discharging the treated liquid into the ground. A **septic system is another common type of OSDS that combines an enclosed septic tank** (Figure 3) with a soil absorption system (often called a drainfield or leachfield). The benefits of this type of system when compared to a cesspool are substantial.

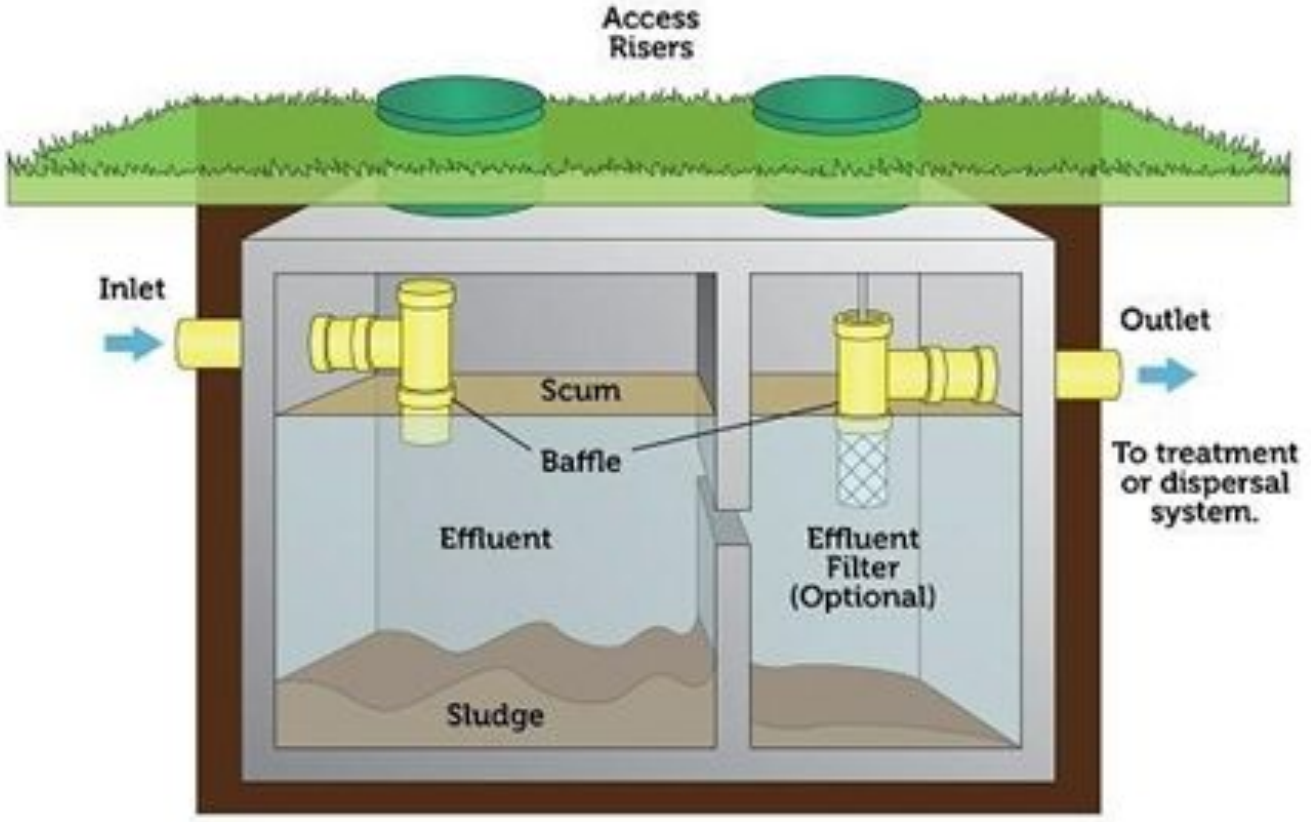

Figure 3: Septic tank schematic

Inside a septic tank, processes occur that reduce the strength of raw sewage. Primary treatment involves the settling of heavy solids and the skimming of lighter waste components like oils and fats. It also involves some biological breakdown of organic matter in the waste stream, carried out by anaerobic bacteria that thrive in environments without oxygen. Because some of the nastiest parts of the waste stream are contained in the tank (sinking sludge and floating scum), the leftover liquid that leaves the tank is already much cleaner than raw sewage. This liquid, called effluent, is then delivered through underground pipes to an absorption bed which is an area usually excavated to 2-5 feet below ground where the effluent can spread out and slowly percolate into the soil below the bed. The soil matrix between the bottom of the bed and the water table also allows for substantial further treatment of the wastewater, by filtering out pathogens along with some nutrients and other chemicals.

While septic systems represent an upgrade over cesspools in level of treatment, there are also other types of on-site systems that have the ability to treat wastewater even further. An **Aerobic Treatment Unit (ATU) is very similar to a septic system in that it utilizes a contained tank to capture solids and an absorption bed for disposal**, but it has one important difference: it is aerated with an electric blower (Figure 4). This allows for digestion of the organic matter in the wastewater by oxygen-loving aerobic bacteria instead of the anaerobic bacteria in a septic tank. This **aerobic digestion is generally more efficient and results in a cleaner effluent** leaving the ATU than typical septic tank effluent (as measured by Total Suspended Solids, or TSS). Some ATUs also use processes that can substantially reduce nitrogen levels in the wastewater, something that neither cesspools or septic systems are very efficient at.

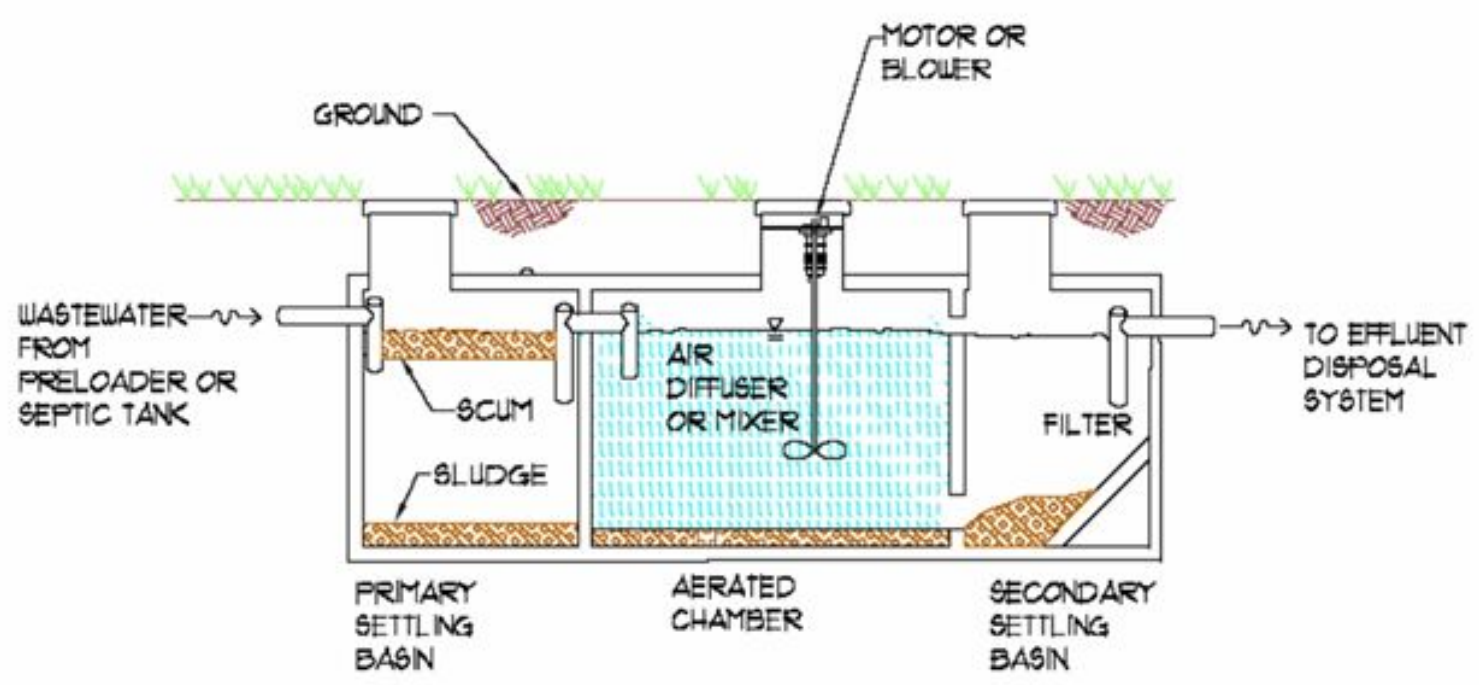

Figure 4: Example Aerobic Treatment Unit (ATU) schematic

While the benefits of ATUs over conventional septic systems in level of treatment are notable, there are some drawbacks to be aware of. First, ATUs generally cost more than septic systems to install. Estimated installation costs for a 3-bedroom home (including absorption disposal systems) are $21,000 - $25,000 for traditional septic systems, $25,000 - $33,000 for septic tank-based systems with high nitrogen removal, and $27,000 - $32,000 for an ATU[6] (Figure 5). Aerobic systems generally require more maintenance than standard septic systems, and the Hawai‘i Department of Health currently requires continuous maintenance contracts for all ATUs. Because of the more efficient processing of wastewater in an ATU compared to a conventional septic system, some ATUs can generate sludge more quickly, requiring more frequent pump-out. While a standard septic system should be inspected annually and pumped out every 3-5 years, an ATU will require more frequent inspections and pumping which results in a higher operation and maintenance cost. These factors must be weighed against the benefits of enhanced treatment by ATUs when deciding the type of system to replace a cesspool.

	OSDS Treatment and Disposal Systems	Total Installed Cost including Fees				
		1BR	2BR	3BR	4BR	5BR
Treatment Options	ATU-N	$22,000	$22,000	$23,500	$25,000	$28,000
	ATU-N/DN	$23,500	$23,500	$25,000	$26,000	$30,000
	Septic Tank	$15,500	$16,000	$16,000	$17,000	$17,000
	Passive Biofilters (in-ground, medium, FL)	$21,100	$23,800	$25,000	$27,200	$28,400
	Passive Biofilters (in-ground, high, FL)	$24,100	$25,800	$27,000	$29,200	$30,400
	Composting toilets (also use for incinerating)	$2,800	$2,800	$5,600	$5,600	$8,400
Disposal Options	Absorption System (bed or trench)	$3,750	$4,450	$5,050	$5,650	$7,150
	Constructed Wetland	$6,250	$7,250	$8,250	$10,250	$12,250
	Disinfection	$2,000	$2,000	$2,000	$2,000	$2,000
	Drip Irrigation	$7,900	$8,000	$8,800	$8,900	$9,000
	Seepage Pit (new)	$8,650	$12,650	$16,650	$20,650	$24,650
	Evapotranspiration	$5,250	$6,250	$7,250	$8,250	$9,250
	NITREX *	$8,050	$9,650	$10,450	$12,250	$13,050
	Presby Advanced Enviro-Septic & De-Nyte *	$5,550	$6,950	$8,450	$9,950	$11,450
	Recirculating Sand Filter	$5,250	$5,250	$8,250	$8,250	$8,250
	Eliminite *	$10,250	$10,250	$10,250	$10,250	$10,250
	Layered Soil Treatment System (MA)	$8,250	$8,250	$8,250	$8,250	$8,250
	Gray Water system	$4,100	$4,800	$4,800	$4,800	$4,800

Figure 5: Typical OSDS Installation Costs [6]

Areas of concern, maintenance, and upcoming regulation

The state Department of Health commissioned a study by the University of Hawai‘i to develop a risk ranking system for all OSDS on the island of O‘ahu which can be helpful resource in selecting a cesspool replacement system. The risk analysis included weighing potential OSDS contamination factors like location in relation to receiving waters, soil characteristics, flooding, depth to groundwater, OSDS density, etc., to generate a risk score for each OSDS (including cesspools, septic systems, and ATUs). The 2009 report[3] from this study identified a **concerning prevalence of high-risk OSDS in some O‘ahu communities** (Figure 6). Overall, ten communities on O‘ahu account for 71% of the total OSDS on the island. Approximately 77% of the OSDS on the island are cesspools, but they contribute 96% of the nitrogen released. Groundwater modeling for the study identified four areas where nitrate increases from OSDS could come close to the 10 mg/L drinking water limit set by the Environmental Protection Agency: Waianae, Waialua, Diamond Head, and the Mokapu‘u Peninsula (Figure 6). The study also notes that the Waimanalo and Waialua areas both have a good amount of agricultural land use and a heavy dependence on OSDS, and both have perennial streams where nitrate-laden groundwater contributes to the nutrient load. While the study found that most soils on O‘ahu are suitable for filtering OSDS effluent, the notable exceptions include coastal areas and stream valleys (along with a few inland areas: Tantalus, Mokuleia, Mokapu‘u Peninsula), many of which also containing high numbers of existing cesspools.

Whether choosing a septic system or ATU system to replace a cesspool, **the importance of continued maintenance of the system to ensure proper function over its lifetime is crucial.** A survey of OSDS in Hawai‘i performed by the University of Hawai‘i found that roughly 80% of OSDS systems were not being maintained or serviced at all, and the same study found that while 68% of the 181 systems inspected were in good working condition, the remaining 32% were “failing or in danger of failing”, likely due to a lack of maintenance[7]. If either septic or ATU systems are not maintained (including pump-out), they will eventually become overloaded with solids that can flow from the ATU or septic tank into the disposal system, causing damage that require costly repairs. In addition to this unwanted outcome, a poorly-maintained system will also be less efficient at treating wastewater which will result in more contaminants being discharged to the environment.

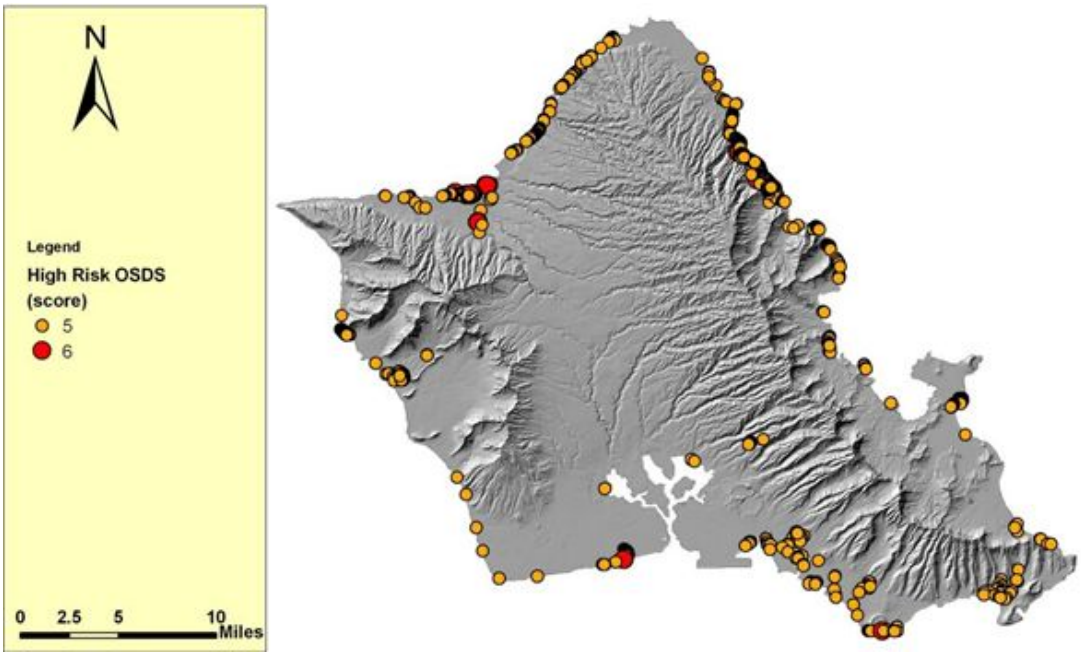

Figure 6: High Risk OSDS on the Island of Oʻahu [3]

In 2005, rules went into effect that prohibit the use of any Large-Capacity Cesspool in the State of Hawaiʻi, defined as a cesspool that serves multiple dwellings or more than 20 people per day. In 2017, the State passed Act 125 relating to cesspools. Under this legislation, **all cesspools in the state must be replaced by the year 2050, including cesspools used for residential wastewater**. This applies to all of the 88,000 cesspools estimated to be active in the islands today. Properties currently using cesspools for sewage disposal will need to be upgraded to sewer connections or other on-site replacement systems like those described here by 2050. In 2015, the state made a tax credit available (through Act 120) for cesspools replaced that are within 500 feet of surface waters or wetlands, but this program is scheduled to expire at the end of 2020. To qualify for the tax credit, homeowners submit a form found in the DOH tax credit link listed below and are notified of approval. The receipts of an approved installation are submitted to DOH, and a tax credit form is prepared for the homeowner to use when filing for their state tax return. While it is unknown if the tax credit program will be extended beyond 2020, Act 125 directed the state Department of Health to work with the Department of Taxation on possible funding mechanisms to reduce the financial burden of cesspool replacement on homeowners, so upgrade subsidies may become available again.

To start the process of replacing an existing cesspool on Oʻahu, it is recommended to contact WAI: Wastewater Alternatives and Innovations at info@waicleanwater.org or fill out their interest form at tinyurl.com/CesspoolConversion. Help is available for identifying appropriate replacement options, making referrals to licensed system designers and installers, and possibly to help find financial assistance. **Upgrade prices vary greatly**, but homeowners should expect to pay about $2,500-$4,000 for straight-forward design services ($4,000-$7,000 if complications with site conditions or special requests), $20,000-40,000 for construction of a standard septic system ($40,000-$50,000 if complications) with an additional $10,000 if for an aerobic system. Note that these examples are based on executed projects, and many proposed projects may not have been included in this estimate if costs exceeded available funds and an upgrade was not executed. Annual operation and maintenance costs for these systems will likely be in the $400-700 range.

<u>You can learn more about cesspools and available tax credits in Hawaiʻi at:</u>
health.hawaii.gov/wastewater/cesspools
health.hawaii.gov/wastewater/home/taxcredit
oahurcd.org/cesspools
waicleanwater.org

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