Wastewater Treatment and Recycling

General project description: This project assesses the geography and resources available, and the residential population expected at Palamanui to find a sustainable and efficient wastewater treatment system. The lack of receiving waters, nearby landfill, or developed soil make this a particularly challenging site to service with any type of conventional system. Although the site developers are calling Palamanui a year-round community, it’s high price and resort-influenced style lead us to expect a very variable population, which also restricts the type of wastewater treatment system that will function efficiently there. To satisfy these parameters we are proposing either a wastewater treatment wetland or wastewater filtration coupled with solids composting. The compost and treated effluent would then be used locally in landscaping and a potential nursery to provide landscape plants for the development. In addition we are recommending greywater treatment to take place at the development’s hotel to provide irrigation water for the regional park. Individual homes would address landscaping needs through xeriscaping and additional lawn irrigation can happen with rainwater collected from their roofs.

Goals: To provide a sustainable and efficient system to fully treat wastewater on-site with zero discharge. To reduce water needs & landscape maintenance costs

Strategies: Utilize the hot climate with relatively rainfall to favor evaportranspiration as a means of wastewater treatment and effluent reduction. In landscaped areas, use native plants, and maximize use of rainwater/greywater for irrigation.

Site-Based Design Challenges:
- The Palamanui site is a relatively young lava flow (ca. 200 years), and therefore has no soil development. The ground is also very porous, which would allow effluent to recharge any local sources before being treated via percolation. This eliminates percolation or ground discharge methods for effluent disposal.
- The site is located on a steep gradient down the side of a central mountain. This gives one downhill location for gravity-fed sewers to reach. While having one spot is convenient for selecting a treatment location, it would require a lot of energy to pump treated water back uphill for reuse.
- There are no receiving waters on the site to discharge effluent into. Effluent must be reused and/or disposed of in some other fashion on site.
- Landfill space on the Big Island is limited, and located on the other side of the island from the development. Trucking solids to landfill would be costly and unsustainable for many reasons.
- Water is an increasingly rare & valuable resource on the Big Island as development increases & stresses a limited supply. County water is expensive, and occasionally shortages are declared.
- With only an average of 25” per year, rainfall is scarce in this region.
- Luxury developers tend to want lush lawns, and exotic plants. The challenge is to develop pride in the beauty of native plants, already adapted to grow in this climate and geology with minimal watering requirements once established.

Potential Solutions:
- The site developers have proposed a turnkey package plant for wastewater treatment. They envision using subterranean holding wells to keep efficient, until it can be used for irrigation. It is unclear what they planned to do with solids from the treatment plant.
- To handle potentially fluctuating loading from the community, a wastewater wetland could be used as a sustainable option for wastewater treatment. The wetland would have to be roughly the size of 4 football fields to accommodate the projected wastewater flow at the end of development. There is enough space to extend this system from the site currently allotted for the wastewater treatment plant without moving any infrastructure.
- Wastewater filtration is the second proposed system because it is more inapplicable and easier to hide than a wetland. Microfilters remove solids from the waste stream, treating the effluent to a very high standard. The system would also be adaptable to changing influents by changing the filter cleaning schedule. Solids removed by the filters would then be transported to a neighborhood aerated stack composting facility. Both the plant and the composting facility would fit in the space already allotted by the developers for wastewater treatment.
- Compost from the plant can be used around the development, or exclusively in a landscaping nursery. Effluent from the plant can also be used to irrigate plants in the nursery. These plants can then be transplanted around the development, including its large park, which will be especially critical important during the building of the first three phases.
- Greywater harvesting and treatment of the hotel’s wastewater may provide enough water for irrigation of the regional park. This is a new idea that we will be looking into more in the upcoming weeks. The beauty of native plants, already adapted to grow in this climate and geology with minimal watering requirements once established.

Proposed System Images:

Xeriscaping:
- Xeriscaping refers to landscaping in ways that do not require supplemental irrigation. It is promoted in areas that do not have easily accessible supplies of water.
- Xeriscaping requires some irrigation in order to establish young plants, but once established, natural rain events are generally enough to sustain the planting.
- One area of the site is the original Lowland Dry Forest ecosystem, which is still intact. The dry forest remnant is both ecologically and culturally valuable because over 95% of the state’s dry forests have been destroyed and the rest are severely degraded. Many of the native plants found in this lowland dry forest can be found on nurseries on the Big Island, and furthermore, could be propagated at a nursery onsite.
- These plants, once mature, are valued for their aesthetic and cultural qualities, creating a rich native ecosystem & habitat that enhances the native landscape without taxing its resources.

Reusing Water for Irrigation (Residential Scale):
- With an average of 25 inches of rain per year, water harvesting may not seem substantial. However, calculations show that enough rain actually may be harvested from rooftops and stored in cisterns to irrigate a sustainably planted yard, including minimal lawn and native xeriscaping.
- Certain grass types, such as Buffalo grass, Bermuda Grass, and Zavalia Grass are particularly drought tolerant and require less maintenance than other more popular varieties.
- Residential-scale cisterns provide an efficient, gravity-based system for filtering and collecting rainwater from the rooftops, where it can then be used for irrigation. There are many types, ranging from traditional “swimming pool catchment systems,” to modular components that can be implemented under specific downspouts.

Charts/Images for Rainwater Collection/Irrigation:

Conclusive Thoughts:
Established conclusion thus far: The Palamanui development should design its wastewater treatment systems to handle variable and constant loads, since it is still unclear how the population will be fluctuating with the seasons. There is enough space on the development to support either a wetland or a filtration plant, so these two options, which can handle fluctuating loads, should be seriously considered. Furthermore, the wetland is a low-cost option for the developers, and both systems produce effluent that is clean enough to be reused with minimal further treatment. In terms of landscaping, enough rainwater can be collected to sustain a small lawn area (2000 sq ft) for each individual home, assuming a low-maintenance, drought-tolerant turfgrass is selected. Xeriscaping is the most cost effective & sustainable option, as many native plants have already been identified growing on the site. Additionally, there are several nurseries on the island that supply native plants. With the potential for having a native plant nursery on site, this would further emphasize a sustainable, healthy community.

Goals to be completed by the end of the term: It still needs to be determined whether or not the hotel produces enough greywater to support irrigation for the regional park. Other options may be to include treated runoff from impervious paving surfaces. Additional calculations are needed to verify that rainwater can support hotel & retail landscaped areas. More research also must be done on the filtration plant for wastewater treatment to determine its feasibility. These systems are currently in use on a smaller scale, and we need to collect more information on them before firming up our conclusions for a development like Palamanui.