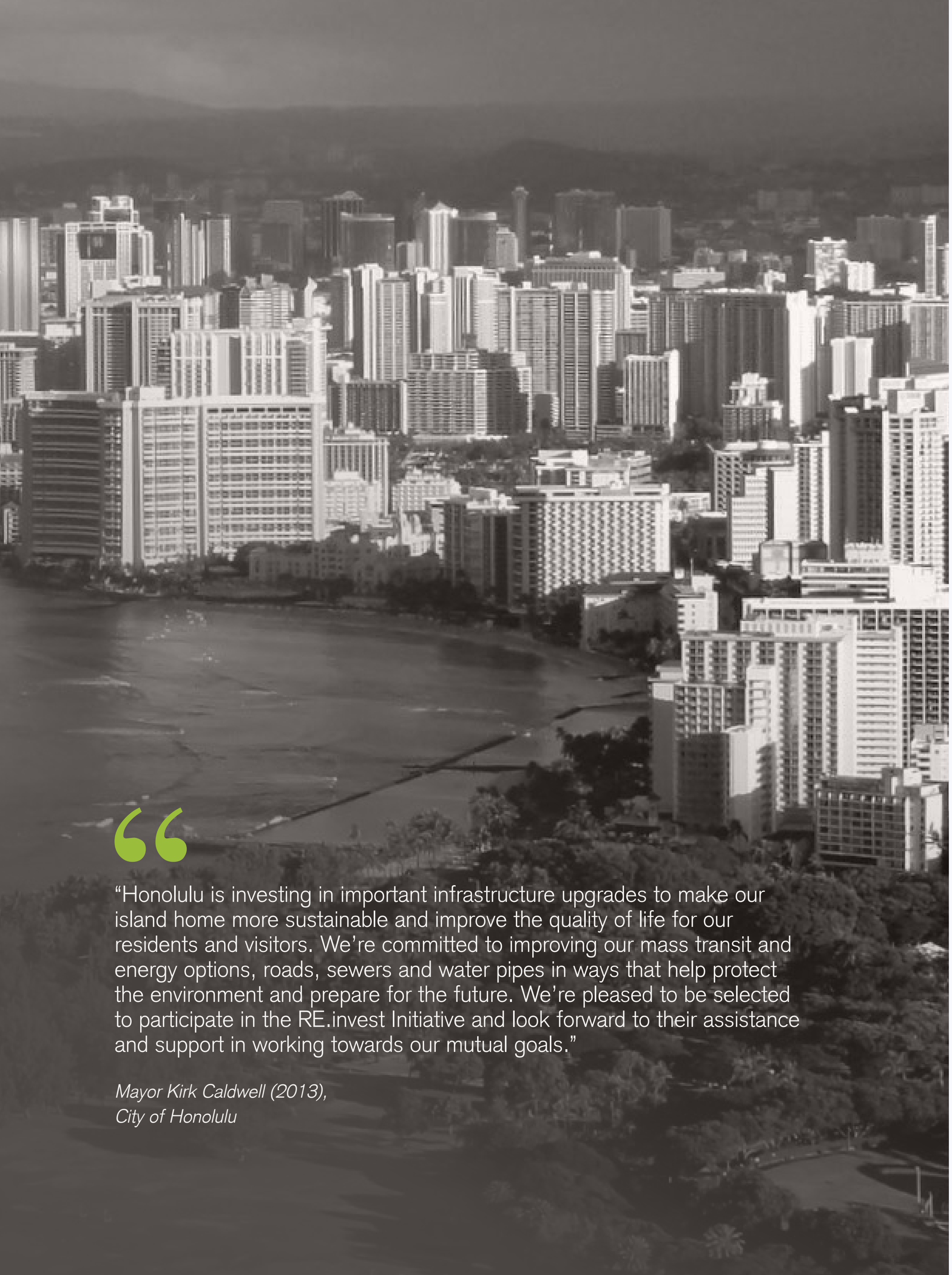
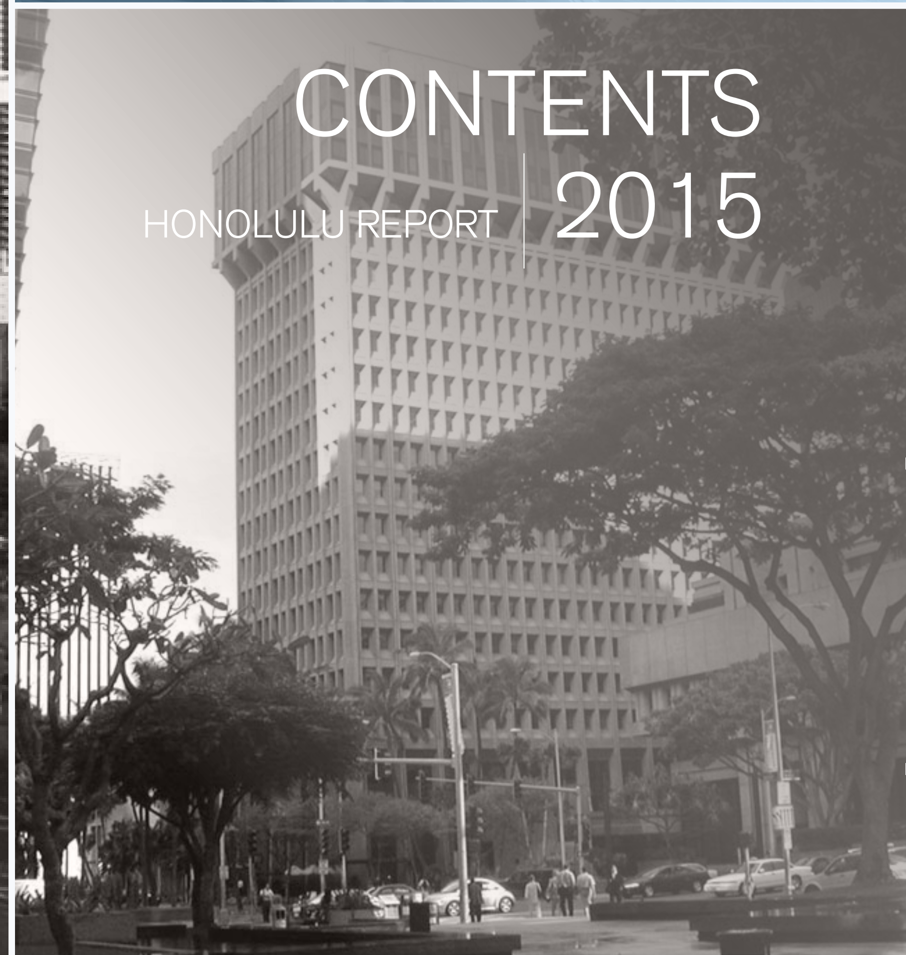
RE invest

CITY REPORT 2015

HONOLULU





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HONOLULU REPORT 2015

“Honolulu is investing in important infrastructure upgrades to make our island home more sustainable and improve the quality of life for our residents and visitors. We’re committed to improving our mass transit and energy options, roads, sewers and water pipes in ways that help protect the environment and prepare for the future. We’re pleased to be selected to participate in the RE.invest Initiative and look forward to their assistance and support in working towards our mutual goals.”

Mayor Kirk Caldwell (2013),
City of Honolulu

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RE.invest

Introduction

The RE.invest Initiative focused on rethinking city infrastructure systems -including stormwater, energy, and communications among others - to enhance community resilience. By looking beyond individual projects to target city priorities, this initiative was structured to fill the gaps between planning and large-scale project delivery. There has been significant coverage in the national media about chronic underinvestment in urban infrastructure. It is clear that governments alone cannot be expected to meet all future infrastructure needs, especially with increasingly constrained public budgets. This is especially true in the face of emerging climate impacts, like more severe storms, that mean our future infrastructure systems need to look and function differently than our current systems.

In the face of these challenges, RE.invest recognized that designing new types of projects – not just building more of the same – is essential. To this end, RE.invest was based on three core ideas. First, resilience is about systems, not just projects. Careful integration, coordination, and sequencing are essential to make sure that when one structure fails it doesn't take down a whole system. In practice that means that green, resilient, and sustainable infrastructure systems are not made up of a few large projects, but many small pieces and parts. Second, finding new ways to align public and private interests to help cities plan large systems of small projects to invest at scale is necessary. Costs and benefits associated with resilient infrastructure systems are often spread across sectors – therefore coordination among sectors during project design is critical – not just for government agencies, but also for investors. Third, when it comes to green and resilient systems, success is often something that doesn't happen. The city didn't flood, the power didn't turn off, even though the storm hit. Capturing those benefits and savings over time requires thoughtful design and advance planning.

To date, the field of sustainable infrastructure investment has focused largely on developing the financial instruments to deliver resources more effectively. This is essential; however, it is only one part of the solution. Cities and communities must also put forward viable, large-scale projects. To that end, the RE.invest team focused on providing the support necessary to translate city needs to financeable projects through a rapid, structured, and replicable project preparation and delivery process for integrated resilient infrastructure systems.

In Honolulu, the RE.invest team focused on recycled water solutions to reduce or replace the use of potable water used for irrigation of Ala Moana Regional Park. Beyond site-specific recommendations, the RE.invest team also focused on providing integrated analysis and recommendations to help the City of Honolulu promote privately owned recycled water systems in the Ala Moana transit oriented development (TOD) neighborhood and beyond.

Overview

Although the name "Honolulu" refers to the urban area on the southeastern shore of the island of Oahu, the city and county are consolidated as Honolulu County, which covers the entire island. The population of the City of Honolulu was 390,738 at the 2010 census, while the population of the consolidated city and county was 953,207.

Honolulu is a major financial and trading center of the islands of the Pacific Ocean – with large military installations, research and development and manufacturing. In addition, Honolulu is the home to the University of Hawaii at Manoa and the largest Hawaiian bank First Hawaiian Bank. Seven million visitors are drawn to Hawaii each year to the beautiful beaches and coastal waters. There are 11 military bases in Hawaii utilizing the islands' resources for training and family housing for over 20,000 personnel.

The City extends to the watershed boundary in the Koolau Range to the northeast and encompasses Honolulu International Airport to the west. However, the dense urban area is located in a strip along the south coast and the valleys between the steep sided mountains. Figure 1 shows the island of Oahu and the location of downtown Honolulu and Ala Moana Park. Although comprising only 10 percent of the land area in the State of Hawaii, Oahu has a population of almost one million people, 70% of the State's population of 1.4 million in 2013. Due to its location on the fringe of the tropics and its steep backbone of rugged mountains, Oahu is able to intercept moisture-laden tradewinds, coming from the northeast, which recharge its aquifers and support the large population.

Kirk Caldwell, was elected Mayor of Honolulu in November 2012 after serving as Acting Mayor since 2010. Caldwell also served as Managing Director of Honolulu during consent decree negotiations with US EPA in 2010, which resulted in a clean water agreement that Honolulu will convert the Sand Island and Honouliuli treatment facilities to full secondary wastewater treatment by 2035 including $3.4 billion to upgrade the collection system – the sewers, pipes, pumping stations, and $1.7 billion to upgrade the treatment plants. Upgrading and replacing aging water and sewer systems on time and on budget was one of his campaign platforms.

Climate

Honolulu has a tropical climate with a mostly dry summer. Average high and low temperatures are 80-90°F and 65-75°F while average annual rainfall ranges between 20-25 in, falling mostly in October to April with light showers in summer and heavier showers in winter and about 90 wet days a year. Figure 2 taken from the Rainfall Atlas of Hawaii by Giambelluca et al. (2013), shows the mean annual rainfall for the Island of Oahu. The contrast in rainfall between the windward side on the northeast and the leeward southwest is apparent.

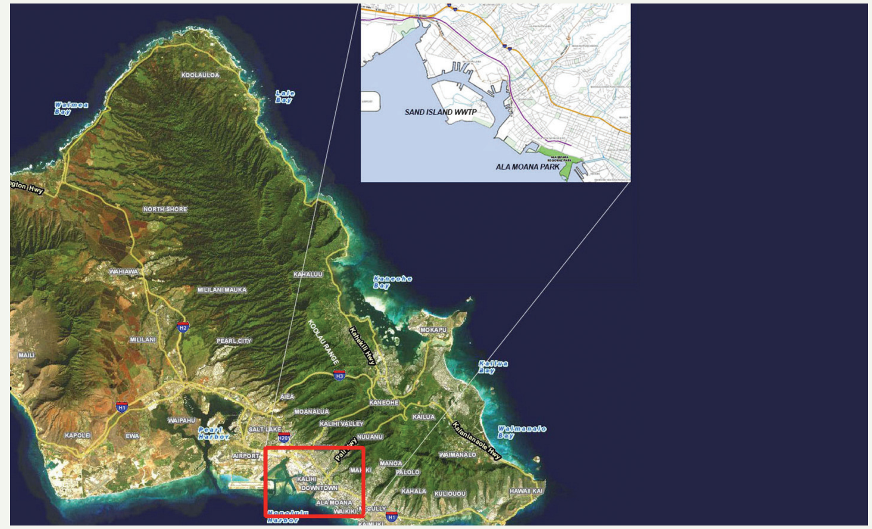

Figure 1. Island of Oahu (Source: HoLIS, DPP)

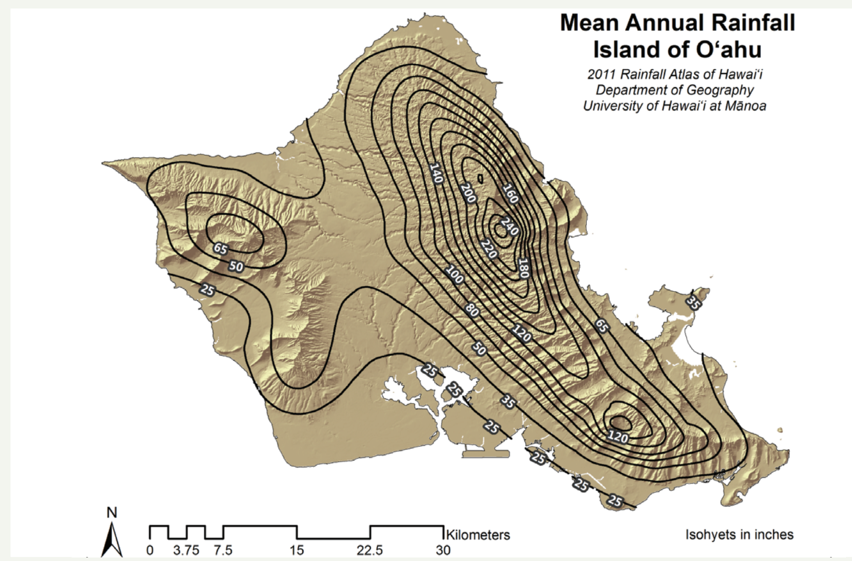

Figure 2. Mean Annual Rainfall, Island of Oahu (Source: Rainfall Atlas of Hawaii)

Hydrology

The Oahu Water Management Plan describes Oahu's aquifers. Basal water bodies (groundwater floating on sea water below the lowest water table), which underlie Oahu's coastal plain, contribute to more than 90 percent of the water supply. The remaining 10 percent of the water supply is contributed by caprock water (leakage from the basal aquifer into permeable aquifers within the caprock), dike water (impounded in volcanic conduits that typically cut across existing older lava flows in the mountains), and perched water. Non-potable brackish water abounds in the aquifers, where some mixing is inevitable despite differences in density, making careful extraction necessary to insure water quality.

The Board of Water Supply (BWS) prefers to distribute water containing less than 125 parts per million (ppm) of chloride ion, although consider 250 ppm the upper limit. The flow of perennial streams on Oahu occurs largely on the windward side, leeward side streams are more intermittent. No large quantities of surface water development are considered from these streams since groundwater development has proved to be more advantageous. The amount of stream flow reaching the sea is minimal because of the permeability of the volcanic rocks and residual soils that make up the island - meaning most stream flow percolates to become groundwater.

The sustainable yields (i.e. the amount of water that can be withdrawn indefinitely without affecting either the quality of the water or the pumping rate) of the various hydrologic units on Oahu were determined by the Commission on Water Resource Management and reproduced below in Figure 3.

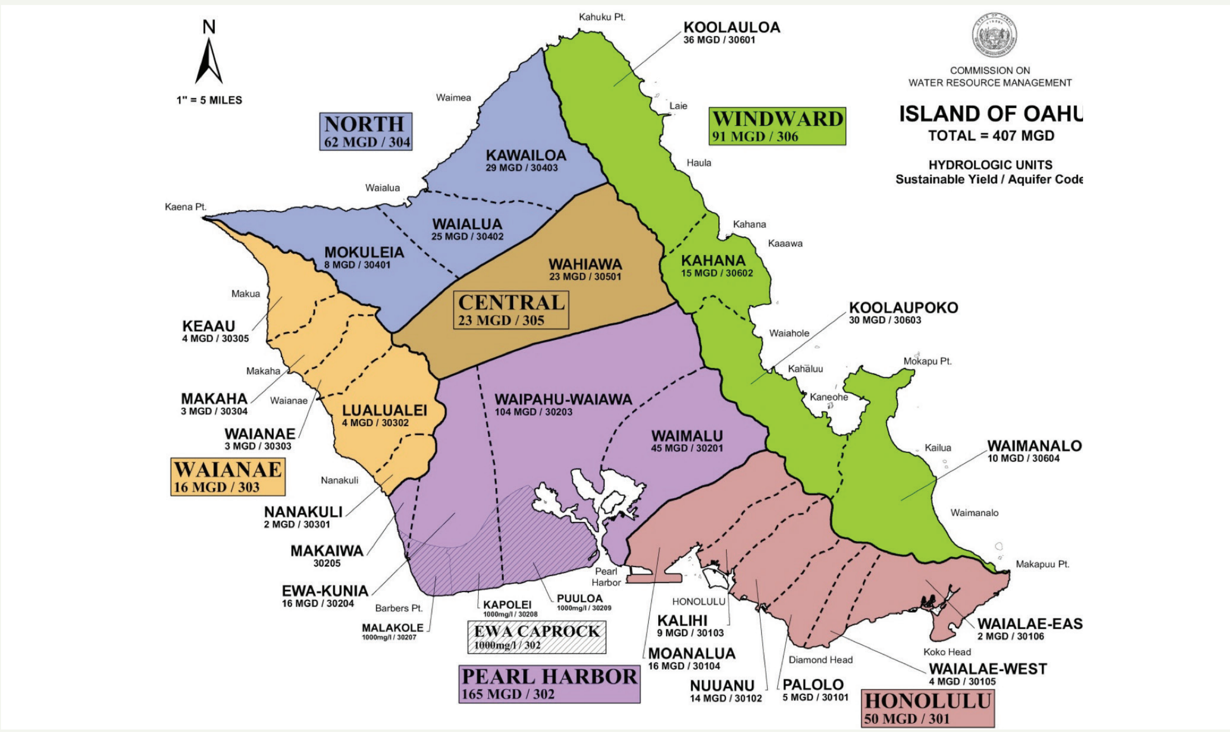

Figure 3. Oahu Hydrologic Units (Source: Commission on Water Resource Management, State of Hawaii)

Existing Infrastructure

As the largest municipal water utility in the State, the Board of Water Supply is responsible for supplying water to the island of Oahu serving approximately 145 million gallons of water a day to roughly one million customers. To keep the water flowing, the BWS must carefully and proactively manage and invest in its intricate system, consisting of 94 active potable water sources, 172 reservoirs, and nearly 2,100 miles of pipeline servicing nearly every community on Oahu.

The BWS is a financially self-sufficient, semi-autonomous agency of the City and County of Honolulu. Its operations and projects are financed with revenues generated by water transmission and distribution fees.

Although there is available water in Oahu, a significant portion of the remaining untapped supplies exist in remote areas of the island where growth is limited, infrastructure does not exist or pumping may affect stream flows. The Honolulu aquifer system has a sustainable yield of 50 mgd and a consumption of 44 mgd. The Pearl Harbor aquifer system has a sustainable yield of 165 mgd and a consumption of 103 mgd. Thus recycled water is an important conservation strategy to reduce potable water consumption and preserve water resources for future generations. BWS currently produces reliable and drought proof recycled water for irrigation and industrial uses. Recently, the Honouliuli Water Recycling Facility , located in Ewa (west of Pear Harbor), averaged 8.5 million gallons per day (mgd) production. It takes secondary level effluent from the neighboring Honouliuli Wastewater Treatment Plant and provides tertiary treatment and disinfection. Recycled water from the facility is used for irrigation, agriculture and industry. Because of the requirement to have a separate "purple" pipe system to distribute recycled water, to date only large industrial, agricultural and irrigation (e.g. golf courses) customers are served.

The Department of Environmental Services (ENV) manages the stormwater and wastewater for Oahu, collecting 105 mgd of wastewater, which is conveyed to nine wastewater treatment plants. Wastewater and stormwater are collected in separate systems. The Sand Island Wastewater Treatment Plant serves the metropolitan area of Honolulu, processing an average of about 60 mgd, with a capacity of 82 mgd. Figure 4 shows the Oahu wastewater system.

As described above, the City and County of Honolulu needs to preserve its groundwater resources as the level of water consumption from the Honolulu aquifer is close to its sustainable yield. Making Honolulu's biggest future challenge meeting demands of anticipated growth while adapting to climate change and providing a clean, safe, and reliable water supply.

To be successful, the city needs to continue developing and implementing diversified approaches to conservation and efficiency, and has progressively identified pursuing water-recycling strategies that provide a series of environmental benefits including reduced withdrawals, reduce discharges, and expand the City's long-term sustainability and resilience to climate changes. But the City cannot solve this long-term resilience challenge on its own. Beyond environmental benefits, recycled water use can also provide savings on water and energy bills system-wide and for individual property owners.

For this reason, the RE.invest team provided integrated analysis, recommendations and funding strategies to help the City of Honolulu explore publicly owned recycled water treatment at Ala Moana Park and promote privately owned non-potable water systems in the Ala Moana TOD neighborhood.

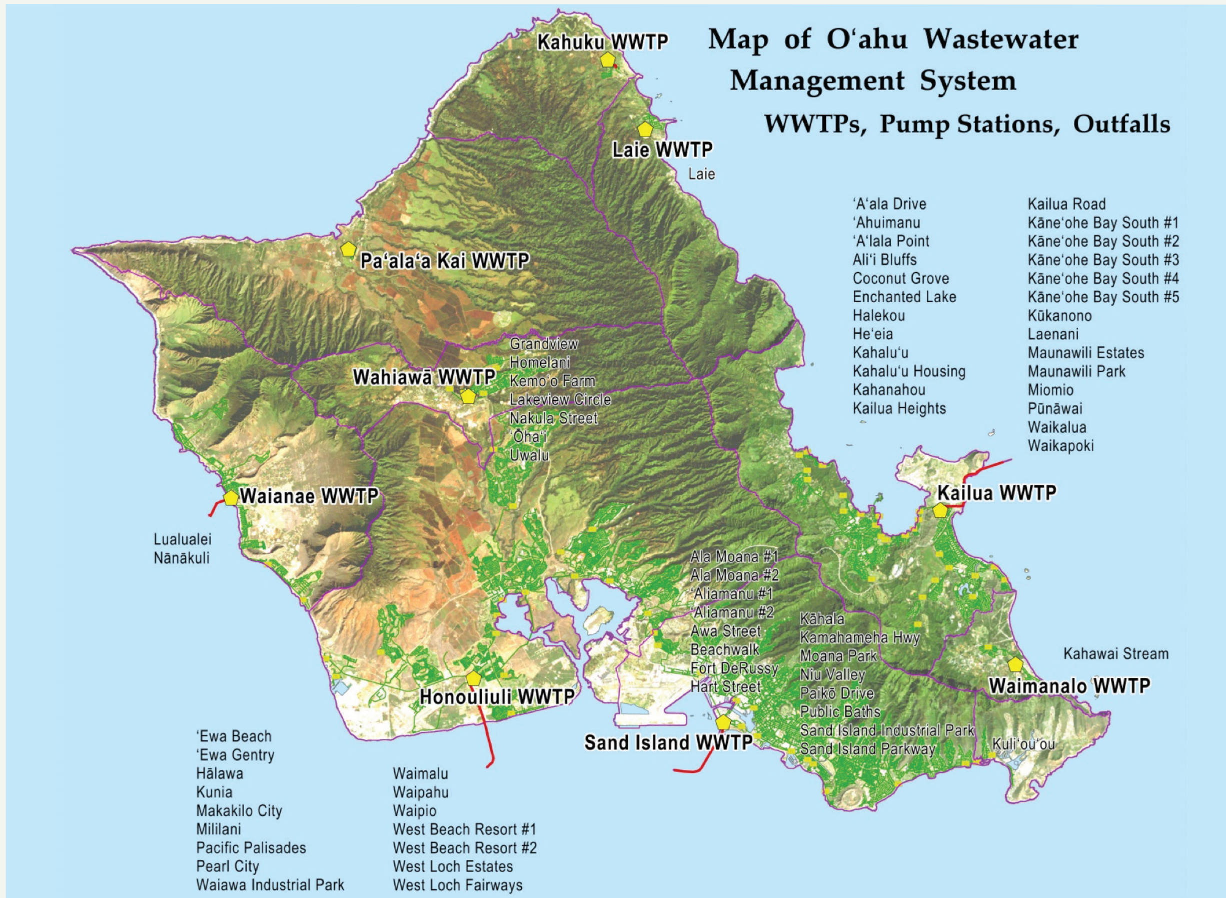

Figure 4. Oahu Wastewater System (Source: ENV)

Non-potable Water Demand

Ala Moana Park

Ala Moana Regional Park is located on the south coast between Waikiki and Sand Island and encompasses nearly 119 acres of prime real estate. Adjacent to the park is the Ala Moana Center, the largest shopping mall in Hawaii, fifteenth largest in the US, and the world's largest open-air shopping center. The Ala Moana Center is also home to a stop on the future rail line that will run the length of Oahu's southern shore – making it a priority transit oriented development area for the city.

Examination of aerial photographs suggests that approximately 79 acres of the park are landscaped and require irrigation. The Rainfall Atlas of Hawaii and the associated evapotranspiration estimating tool were used to determine the monthly average rainfall and potential evapotranspiration for a grass reference surface located at 21.290°N, and 157.848°W in the park. Potential evapotranspiration (PET) represents the amount of evapotranspiration that would occur, given the climatic conditions, if there was a sufficient supply of water. It is thus an indication of the total water needed, and the irrigation required is the difference between potential evapotranspiration and rainfall.

Figure 5 shows the PET at Ala Moana. The yearly total PET is 104 inches, with a maximum of 10.1 inches in August. Figure 6 shows the rainfall at the park, with a yearly total at 26 inches with a maximum of 3.9 inches in December and a minimum of 0.9 inches in August. The difference between the yearly PET and rainfall is 78 inches, an average of 6.5 inches per month, or 0.47 mgd over the estimated 79 acres. This figure represents the average

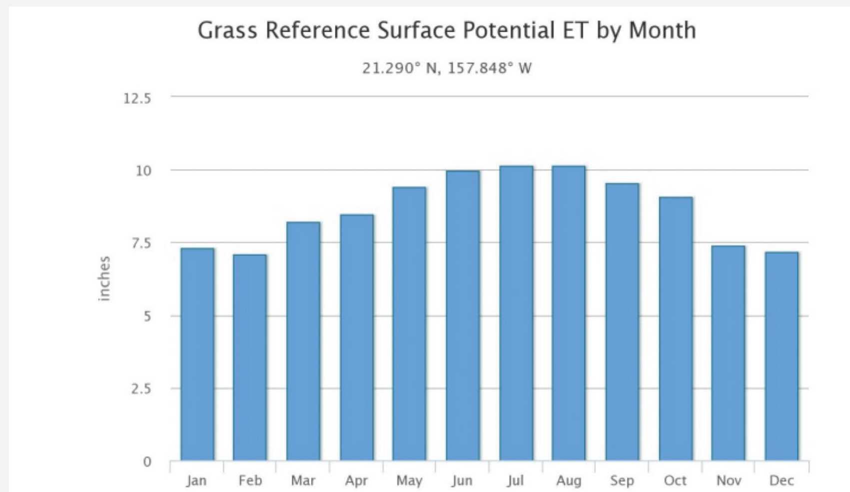

Figure 5. Potential Evapotranspiration at Ala Moana (Source: Evapotranspiration tool for Hawaii)

irrigation required. The billing records from the BWS for potable water used at Ala Moana Regional Park show an average consumption of 0.42 mgd for irrigation, showers and toilets; this value aligns with the estimate based upon landscaped area and climatic data.

Figure 7 shows the PET, rain, and rain plus irrigation (assumed to be supplied by recycled water) plotted on a monthly basis. It can be seen from the figure that if the irrigation supply is sized for the average flow required, then storage is needed to meet flow requirements in the driest months. This storage requirement is a function of the production capacity of the irrigation supply but can be reduced by providing capacity in excess of the average requirement. In this case there would be under-utilization of the recycled water production for those months when the required irrigation is less than the provided plant capacity. Alternatively, storage can be reduced if the recycled water supply can be supplemented by the potable supply during the driest months.

As calculated above, 24 mg of storage is required. This quantity is so large because the irrigation required for tropical grassland in an area of low rainfall is very large. Storing 24mg of water would require a storage tank that was 50 ft deep and have a footprint of 700 ft square. This scale of storage tank, while feasible, is not consistent with the recreational purposes of the park. Instead, the RE.invest team recommended the treatment system capacity be sized to match the minimum irrigation demands (in December) of 3.3 in, or 240,000 gpd over 79 acres. During the peak month of August, an additional flow of 5.9 in, 420,000 gpd over the park would have to be provided by the potable system.

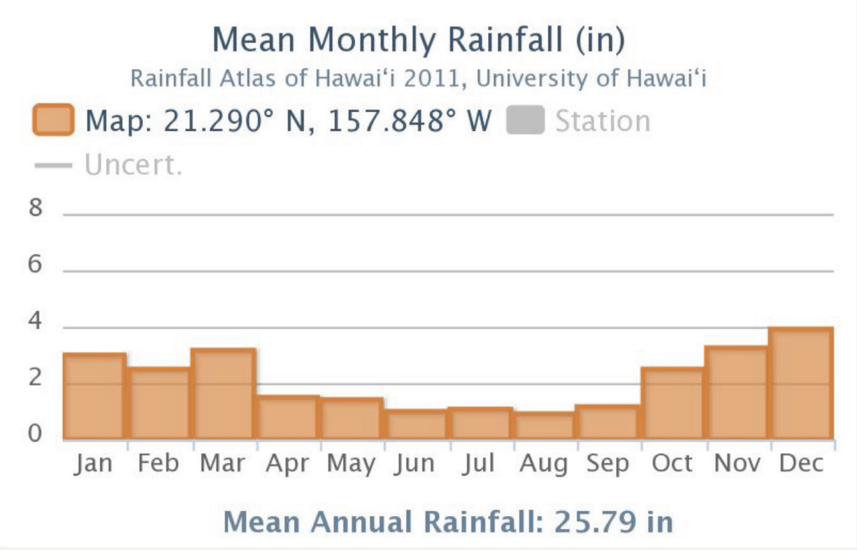

Figure 6. Rainfall at Ala Moana (Source: Rainfall Atlas of Hawaii)

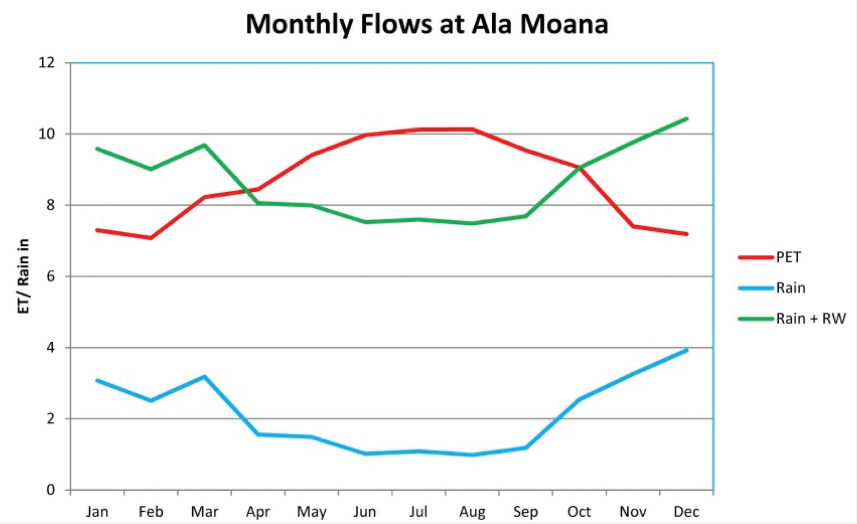

Figure 7. Monthly Rainfall and Irrigation at Ala Moana

Flow Quantity	Monthly Average, in	Daily Flow, mgd
Potential Evapotranspiration	8.7	0.62
Rain	2.1	0.15
Recycled Water	6.5	0.47
	Acre ft	mg
Storage	74	24

Table 1. Ala Moana Irrigation Requirements (assuming 79 acres landscaped area)

RE invest

Solutions

Ala Moana Park

Treatment Scenarios

There are a variety of treatment technologies and systems that could be utilized by the City to produce reusable non-potable water for park operations and maintenance. In order to analyze capital along with operations and maintenance costs, this report evaluated the following options:

- Membrane bioreactor
- Engineered wetland

In many of these systems, the sludge produced from onsite treatment can be discharged to the sewer system for ultimate disposal to the wastewater treatment plant (i.e. a "scalping" plant). If connection to the sewer system is not available, a septic hauler may come and remove the biosolids on a regular basis. Maintenance requirements depend on the size and design of the system, for example onsite membrane bioreactor plants tend to have limited maintenance and staffing requirements that can be provided on a part-time basis.

Membrane Bioreactor

Membrane bioreactor technologies are known for providing higher quality effluent with smaller space requirements than conventional biological systems. By combining a suspended growth biological reactor with solids removal via a microfiltration membrane, the MBR system replaces the secondary clarifier and sand filtration often used in conventional activated sludge wastewater treatment. Often MBR treatment trains integrate additional processes including reverse osmosis and disinfection. The treatment train for a 300,000 gpd plant, as needed to meet non-potable demand in Ala Moana Park, requiring approximately 10,000 sq ft. is shown in Figure 8.

The primary disadvantage of MBR systems is the typically higher capital and operating costs than conventional systems for the same output. This is based mostly on the need for additional maintenance including membrane cleaning, fouling control, and relatively high energy demands. However, in certain situations MBR systems can realize lower or at least competitive capital costs when compared with alternatives based on minimal space requirements and smaller tanks that can reduce construction costs in addition to limiting any opportunity costs from losing revenue-generating space.

Engineered Wetland

Constructed wetlands are artificial wastewater treatment systems consisting of shallow (usually less than 1 m deep) ponds or channels which have been planted with aquatic plants, and rely on natural microbial, biological, physical and chemical processes to treat wastewater. Typically, engineered wetlands have a series of impervious clay and/or synthetic liners along with man-made structures to control the flow direction, detention time and level. Constructed wetlands have been used to treat a variety of wastewaters including urban runoff, municipal, industrial, and agricultural drainage.

The RE.invest team looked specifically at the Living Machine technology, which has been piloted to treat agricultural wastewater in Ewa Beach, as an example. This trademarked process uses the same basic processes (e.g. sedimentation, filtration, clarification, anaerobic and aerobic decomposition) as are applied in conventional biological treatment within a medium of wetland cells filled with special gravel. The cells are alternately filled and emptied as the wastewater flows in, and the process is completed by disinfection prior to reuse. Figure 9 shows a site schematic diagram for a 300,000 gpd system that would require 50,000 sq ft is required of space.

The Living Machine system provides a unique and aesthetically pleasing environment while treating and recycling wastewater, which is ideal in a park and high-density areas like Ala Moana. However, because of the living elements, the system requires a reliable climate in addition to ongoing maintenance.

Regardless of the technology train, systems would need to comply with the Department of Health guidelines that describe three classes for treatment and use of recycled water in Hawaii. R-3 water is secondary treated recycled water without disinfection, R-2 is disinfected secondary treated recycled water, and R-1 is disinfected, tertiary treated (oxidized and filtered) recycled water. Table 2 presents a summary of suitable uses for recycled water. It can be seen that R-1 recycled water has the greatest range of suitable uses. In particular, only R-1 water is permitted in public parks, and also for the flushing of toilets and urinals where dual plumbing is provided. Since the recycled water is intended to offset irrigation water at Ala Moana Regional Park, the RE.invest team focused on the requirements for R-1 recycled water to support analysis.

The U.S. EPA also provides guidance on water quality parameters for use of recycled water for irrigation. The most significant limitation is that total dissolved solids (TDS) should be less than 450 mg/l. The location of Ala Moana Regional Park adjacent to the beach suggests that shallow groundwater and saline intrusion into the wastewater system may be a factor. Accordingly, in the absence of water quality data for the sewer flows, it is assumed that some facility (e.g. electrodialysis reversal) for removal of dissolved solids would likely be required. Additionally while chlorine residuals below 1 mg/l usually pose no problem to plants, they may

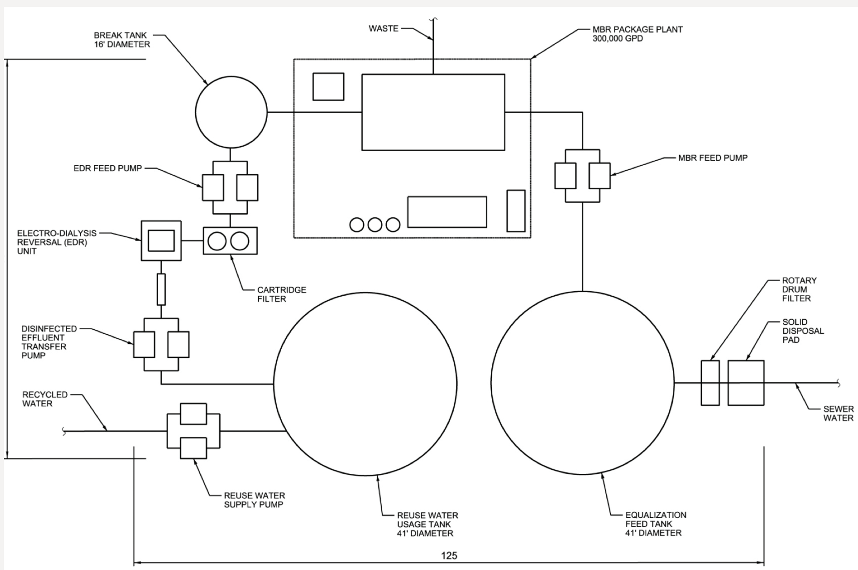

Figure 8. 300,000 GPD Site Schematic for a Membrane Bioreactor

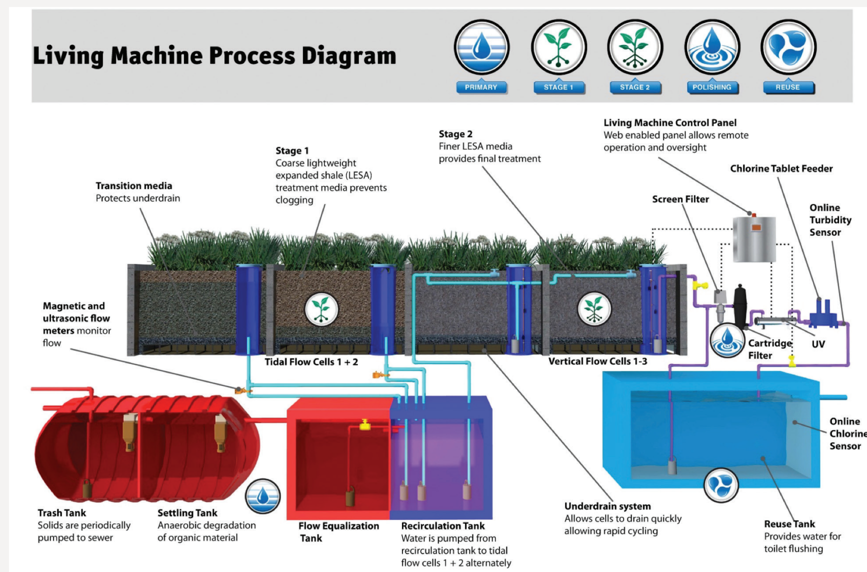

Figure 9. Living Machine Process Diagram (Source: Living Machine)

be harmful in excess of 5 mg/l. The existing potable supply has a chlorine residual of 0.2 mg/l according to the BWS water quality report. RE.invest analysis assumed that chlorine residuals can be kept below 1 mg/l, alternatively ultraviolet disinfection may be applied.

SUITABLE USES OF RECYCLED WATER	R1	R2	R3
IRRIGATION: (S)pray, (D)rip & Surface, S(U)bsurface, (A)LL=S D & U, Spray with (B)uffer, (N)ot allowed, /=or			
Golf course landscapes	A	U/B	N
Freeway and cemetery landscapes	A	A	N
Food crops where recycled water contacts the edible portion of the crop, including all root crops	A*	N	N
Parks, elementary schoolyards, athletic fields and landscapes around some residential property	A	U	N
Roadside and median landscapes	A	U/B	N
Non-edible vegetation in areas with limited public exposure	A	AB	U
Sod farms	A	AB	N
Ornamental plants for commercial use	A	AB	N
Food crops above ground & not contacted by irrigation	A	U	N
Pastures for milking and other animals	A	U	N
Fodder, fiber, and seed crops not eaten by humans	A	AB	DU
Orchards and vineyards bearing food crops	A	D/U	DU
Orchards and vineyards not bearing food crops during irrigation	A	AB	DU
Timber and trees not bearing food crops	A	AB	DU
Food crops undergoing commercial pathogen destroying process before consumption	A	AB	DU
SUPPLY TO IMPOUNDMENTS: (A)llowed (N)ot allowed			
Restricted recreational impoundments	A	N	N
Basins at fish hatcheries	A	N	N
Landscape impoundments without decorative fountain	A	A	N
Landscape impoundments with decorative fountain	A	N	N
SUPPLY TO OTHER USES: (A)llowed (N)ot allowed			

Table 2. DOH Summary of Suitable Uses for Recycled Water

Table 3 lists the treatment trains, influent and effluent water quality, treatment processes, and estimates the area required for each facility.

Siting Options

Table 4 lists factors in site selection of the identified technology options. Based on these factors, the 69-inch sewer line connected to the Moana Park Wastewater Pump Station to the east of Ala Moana Park (average flow of 0.61 mgd and a peak flow of 2.2 mgd) could be an excellent source of wastewater influent to one or more recycled water treatment plants in Ala Moana Park. The sewer could also take the returned waste streams from the recycled water treatment plants, which would then be operating as "scalping" plants. Another option is to connect the recycled water treatment systems directly to the Ala Moana Center, which could serve a potential source of wastewater and rainwater for treatment as well as a potential recycled water customer. The scale of such a system, based on flows and demand from the Ala Moana Center, would need to be analyzed to better understand the value of this option.

TREATMENT TRAIN	INFLUENT			EFFLUENT			
	HIGH/LOW TDS	TDS MG/L	TURBIDITY NTU	TDS MG/L	TURBIDITY NTU	FLOW GPD	AREA SQ.FT.
MBR	Low	<450	5-10	<450	<0.5, 0.2 average	300,000	10,000
MBR	High	>450	5-10	<450	<0.5, 0.2 average	300,000	10,000
Engineered Wetland (Living Machine)	Low	<450	5-10	<450	<10, 2 average	300,000	50,000
Engineered Wetland (Living Machine)	Not able to process wastewater with high TDS as defined	N/A	N/A	N/A	N/A	N/A	N/A

Table 3. Comparative Analysis of Identified Treatment Trains

FACTORS IN SITE SELECTION	POSSIBLE SITES FOR FURTHER EVALUATION
• Proximity to influent source and recycled water consumers • Open space of about 2,000 sq. ft. for a MBR and 5,000 sq. ft. for a Living Machine excluding access to the street • Power and potable water supply • Connection to sewer system if used as a source of influent ("sewer mining") and sewer TDS less than 450 mg/l (for irrigation end use) • Connection to sewer system for depositing waste stream	• Ala Moana Regional Park • Ala Moana Boulevard • Storm channel just south of the boulevard

Table 4. Factors in Site Selection and Possible Recycled Water Plant Sites

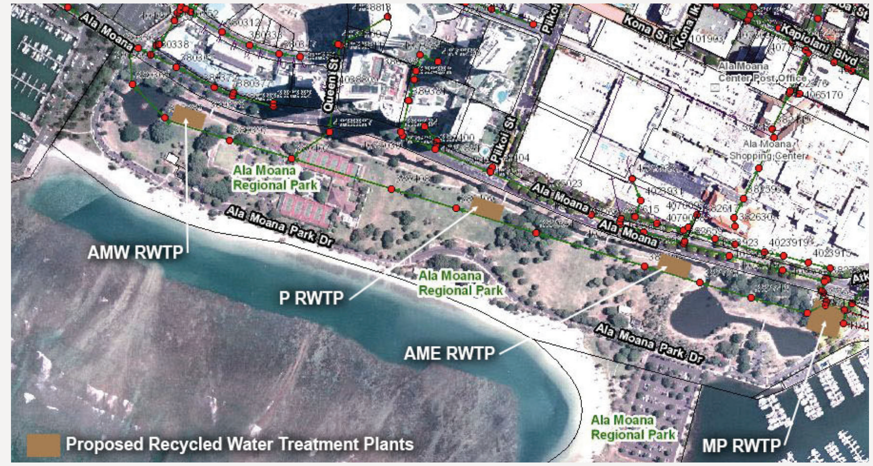

Figure 10. Ala Moana Regional Park and Proposed Recycled Water Treatment Plants (Source: HoLIS, DPP)

Based on data provided by the city specifically on flows and demands for Ala Moana Park, two configurations are proposed: a single plant at the east of the park with a capacity of 240,000 gpd, or three smaller ones within the park, each of capacity 80,000 gpd. The proposed installations are listed in Table 3 and identified in Figure 10. As previously described, no seasonal storage would be provided as the recycled water treatment plants would only meet the minimum monthly irrigation demand and be supplemented by potable water, or another source as needed. Additional water quality sampling would be required before any of these sites could be confirmed.

Relative Costs

Relative capital investment along with operations and maintenance costs for both a MBR plant and a Living Machine have been estimated based on the two proposed configurations (three plants within Ala Moana Park, or one plant at the east end adjacent to Moana Park Pump Station). The costs have been developed using information supplied by vendors and adjusted based on needed capacity in Ala Moana. The savings have been estimated based on the current cost for supplying potable water for park operations and maintenance.

LIVING MACHINE PLANT	CAPACITY GPD	CAPITAL COST	ANNUAL O&M COST	POTENTIAL SAVINGS
Ala Moana West RWTP, Piikoi RWTP, Ala Moana East RWTP	80,000	$1.6-2.0M	$0.05M	$120,000—$150,000 $/yr
Moana Park RWTP	240,000	$3.1-4.0M	$0.12M	$530,000—$590,000 $/yr
MBR Plant	CAPACITY GPD	CAPITAL COST	ANNUAL O&M COST	POTENTIAL SAVINGS
Ala Moana West RWTP, Piikoi RWTP, Ala Moana East RWTP	80,000	$1.7-2.2M	$0.07M	$98,000—$130,000 $/yr
Moana Park RWTP	240,000	$2.9-3.8M	$0.15M	$515,000—$570,000 $/yr

Table 5. Recycled Water Treatment Plant Options for Ala Moana Regional Park

RE invest

Solutions

Ala Moana Neighborhood

Beyond installation of a recycled water treatment system exclusively for Ala Moana Park, the City of Honolulu should consider promoting privately owned non-potable water systems in the Ala Moana neighborhood. Water-recycling technologies have improved significantly in recent years and are now being deployed at large and small scales in cities across the country. These improved technologies can be integrated into both new construction and retrofitted to support an existing building stock.

Currently, Honolulu's centralized wastewater treatment system, managed by BWS, collects and treats stormwater and wastewater from a relatively large area. However, given the development projections in the Ala Moana TOD neighborhood – the City has an opportunity to support privately distributed, and therefore significantly smaller, recycled water treatment facilities. In contrast to more centralized systems, distributed treatment is designed to work at the scale of a large high rise apartment building, a cluster of residential homes, or a commercial or industrial park - oftentimes, reusing the treated effluent onsite or at adjacent properties to offset potable water use. The treated wastewater and/or rainwater can be used for a variety of uses, including toilet flushing, irrigation of parks or gardens, and/or heating and cooling systems.

Within the Ala Moana neighborhood the projected water demands are assumed to increase incrementally as development occurs. For purposes of this report, the RE.invest team focused on the viability of privately owned distributed recycled water treatment facilities for fulfilling increasing water demand with non-potable sources.

Private non-potable water systems can be implemented at a variety of different scales. The RE.invest team identified three ways individual property owners could feasibly achieve economic scale in Ala Moana neighborhood: (1) an individual building owner could install a non-potable water treatment system and sell any treated water not used onsite to nearby customers, (2) individual property owners can join together in a cooperative program, (3) municipality can install a district-level system.

Building Level

At this level, an individual property owner can install a non-potable water system onsite to treat their captured stormwater/wastewater. As an extension of traditional building-scale implementation approaches, provided permitting was secured, individual property owners could sell excess treated water not used onsite to other nearby non-potable consumers.

Block Level

At this level, a non-potable water system consisting of an underground cistern with integrated an treatment system could be designed to hold captured stormwater/wastewater for a set of buildings, creating a closed-loop non-potable water reuse system for anywhere from one city block to multiple city blocks. The implementation strategy at this scale is similar to a savings-sharing model used on college and business campuses to aggregate savings from energy efficiency investments in multiple-buildings.

District Level

At the district-level, the City and/or BWS have the option to create a publicly owned recycled water distribution system for the entire Ala Moana area, including the park and broader TOD neighborhood. This option was evaluated for its technical feasibility, but given that scale of the project has the potential to put a private owner into a position of serving as a "utility" under statute it was not pursued in depth by the RE.invest team. The option could be evaluated further to establish viability based on willingness of the Board of Water Supply to participate and assess relevant legal authorities under local statute.

The treatment trains described for implementation at Ala Moana park can be scaled to meet the needs of individual buildings, city blocks and/or an entire district as described above. The RE.invest team used a modular plan with 10,000 gallons per day (11 afy) capacity - which could feasibly serve two high-rise office buildings - to establish overall cost estimates. Analysis at this scale allowed the RE.invest team to cost out a variety of treatment scenarios that could be scaled as demand increased. The estimates provided in Table 6 outline the costs required for construction and annual operation of the various systems identified above.

If the intention were to connect either system to an existing building, of which there are many in Ala Moana neighborhood, each treatment system would need to be connected to an expanded piping system. The retrofit process includes the installation of an alternate water source collection and non-potable distribution system. An alternate water source collection system includes infrastructure such as rainwater gutters, foundation drainage sump pumps, or graywater piping systems. This may also include equalization storage to help level flow prior to treatment as supplies vary throughout the day. Dual plumbing is also necessary to distribute the treated non-potable water to users. Also referred to as purple pipe, this separate distribution system must be colored or marked purple to distinguish it from the potable water system to protect against contamination of the potable water supply.

Retrofitting a developed urban area like Ala Moana with a reclaimed water distribution system can be expensive. That is both because of the cost related to dual-plumbing existing individual buildings and for updating the broader municipal infrastructure for carrying recycled water within the area. In some cases, however, the benefits of conserving potable water may justify the cost. For example, a water reuse system may be cost-effective if the reclaimed water system reduces the need to obtain additional water supplies from considerable distances, treat a raw water supply source of poor quality, or treat wastewater to stricter surface water discharge requirements.

In developing urban areas like Ala Moana, substantial cost savings may be realized for both the municipality and individual building owners by installing a dual distribution system as developments are constructed. A successful way to accomplish this is to stipulate that connecting to the system is a requirement of the community's land development code.

TREATMENT SYSTEM	FLOW GPD	CONSTRUCTION COST	ANNUAL OPERATING COST
Membrane Bioreactor	10,000	$1.6M	$140,000
Living Machine	10,000	$1.0M	$8,500

Table 6. Relative Costs of Identified Recycled Water Systems

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Implementation Strategies

It's clear that water reuse is relatively expensive in terms of direct financial cost of installing and operating the required treatment process and related infrastructure, especially in a situation where retrofitting buildings and systems is required. In addition, anticipated revenue streams may appear relatively low because recycled water is often priced low in relation to potable water supplies, which are often underpriced to begin.

While financial analyses are important, they typically provide too limited a context to evaluate the real value of a water reuse project. Financial analyses focus only on cash stream and revenue, and neglect indirect financial benefits along with broader environmental and social benefits. A broader economic analysis captures benefits to both individual property owners and the municipality more broadly including reducing stress on potable water resources, reducing nutrient loading to waterways, putting less strain on failing septic tanks or treatment plants, using less energy and chemicals and costing less than potable water - all of these benefits add up to savings in both water and energy. For example, an economic analysis for a recycled water project in Ala Moana should capture (1) avoided and deferred wastewater costs, (2) avoided and deferred water supply costs, (3) increased water supply reliability, and (4) decreased energy usage for normal building operations. Translating these benefits into real sources of revenue requires adequate data to define cost allocations between parties and projected current and future savings, and also structures that make those cash flows more secure.

There are a wide range of potential direct and indirect beneficiaries among Honolulu's property owners and system operators. Monetizing the value of recycled water and willingness-to-pay of beneficiaries is a prerequisite for project developers and investors looking to finance and install recycled water systems. In the case of Honolulu, both private property owners and the municipal government will accrue economic benefits as described below:

- Private Property Owners – The costs associated with pumping and treating stormwater and wastewater fall directly onto private property owners through utility rates. Transitioning to onsite or more localized wastewater treatment and use can produce not only reduced wastewater bills for large residential properties but can also help to reduce system operating costs more broadly. Quantifying these financial benefits for private property owners is an important piece of increasing the adoption of more localized recycled water treatment solutions.

- City Government – The City of Honolulu is the primary party responsible for building and maintaining stormwater and wastewater infrastructure. Given the recognized environmental and economic benefits of transitioning to reusable water systems, Honolulu has pursued large-scale options. However, encouraging building, block or even district level recycled water systems would provide additional savings to system operating costs through reduced energy for pumping and treatment. The City does not have the public funding available or sufficient revenue from their tax base to support the installation of smaller recycled water treatment systems throughout the City. However, the City would be a direct beneficiary of coordinated upgrades to private property that increase the use of recycled water. Providing incentives based on these operational and maintenance savings could provide private property owners with the up-front capital to invest in building, block and district-level recycled water systems.

Capturing Value

In Honolulu there are multiple potential benefits that could be monetized, captured as revenue, and used for repayment based on the benefits accrued to both private property owners (e.g. reduced wastewater rates and energy operating costs associated with pumping water) and the City (reduced volume in wastewater treatment facilities which means savings in both energy and treatment costs). Translating these benefits into real sources of revenue requires additional data to model or forecast current and future savings, and also develop the contract structures necessary to secure these diffuse cash flows and payment streams.

Conceptually, based on the system-wide benefits described above, the City could promote the utilization of aggregated user fees and/or aggregated savings to support the installation of recycled water systems. Both options are explored in more detail below.

- Aggregated User Fees – While traditional infrastructure upgrades are often covered by one set of user fees, wastewater fees cover wastewater treatment upgrades or tolls pay for toll-road upgrades, integrated resilient infrastructure systems allow for capturing multiple user fees to pay for the same projects. For example, if a block or district level recycled water system is installed, the City could allow user fees generally collected by the city for stormwater collection and wastewater treatment be redirected towards paying back that infrastructure investment.
- Aggregated Savings – Integrated resilient infrastructure upgrades create benefits that are distributed across sectors and both public and private entities. While the savings to one property owner or one utility may not be sufficient to cover costs associated with system upgrades, the savings to the system as a whole are likely sufficient. This is why the RE.invest team is focused on identifying entities that are not only likely to save in the future based on upgrades but also those entities that are currently losing significant amounts of money because of system inefficiencies or gaps. For example, savings associated with energy and water from private properties around Ala Moana and the city could be directed into a fund to support not only the installation of new recycled water treatment structures but ongoing operations and maintenance as well. In the case of recycled water systems, many of the benefits are most evident in reductions of energy use or savings on energy bills. For these savings, the City could also consider using a PACE bond model to capture aggregate energy and water savings. For Ala Moana Park specifically, the installation of a recycled water system with capacity to meet the minimum monthly irrigation demand as proposed would produce cost savings of between $515,000-$590,000 $/year and save approximately 0.24 mgd of water annually (see Table 3). These savings are based on a capital cost of $4.8M to $2.9M with yearly O&M costs of $0.12M to $0.21M. In addition, should the city pursue a system that utilizes the sludge for producing biogas - a wastewater plant operating at 240,000 gpd could generate 55,000 kWh annually, an estimated $16,000 in additional revenue.*

The scale of savings for a single building can be significant as well. For example, a Living Machine installed at SFPUC Headquarters is expected to reduce water consumption by some 60% compared to similarly sized office buildings. Aggregating those collective savings can make privately owned systems viable at the building or block scale in areas with high demand. For income properties (commercial properties not individual homes) these reduced utility costs translate into increased Net Operating Income (NOI) , which in turn improves the various operating ratios and profitability indicators – this is because many major cost components in real estate ownership (e.g. property taxes, insurance, and management) are not directly controllable.

While the savings are real, the challenge to financing privately owned recycled water systems is capturing those savings and turning them into viable revenue streams. The following section describes structures and mechanisms that could be project financing viable and easier to access.

What Private Property Owners Can Do

While the engineering solutions identified by the RE.invest team vary, all of the options are based on the following core assumptions:

1) Technology exists that allows for greater retention and treatment of stormwater and wastewater on-site.
2) Owners lack upfront capital to invest in retrofits but are willing and able to finance retrofits through savings on their water bills, or avoidance/reduction of fees that might be levied on them for non-compliance with regulations.
3) Owners typically do not want to be in the business of doing the retrofits on their own, but

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** This is based on a factor of 624 kWh per million gallons of sewage and a rate of $0.30 per kWh for*

[1] Net Operating Income (NOI) = Realized Income - Expenses (incl utilities)

would rather prefer a third party handle all the development, operations and maintenance of the water retention and treatment, as well as the measurement of water savings/efficiency.
4) Increased water reuse provides an economic and environmental benefit to the City.

If those key factors are met, the following strategies are tools that individual property owners can use to help finance the installation of recycled water treatment systems on site.

New Construction

Assuming owners lack the capital and motivation to pay for the retrofits upfront, the easiest way to finance them is as a component of a larger development. If the property is new construction, the new water systems could be designed, developed and absorbed into the total project financing via the senior debt, whether loan or bond.

Existing Buildings

If the project is a major renovation or a refinancing, the same could hold true. There would have to be enough value in the property to exceed the total loan amount, i.e. the loan-to-value ratio (LTV) would have to be acceptable to the financier. This method allows the owner to take advantage of the real estate asset as collateral for the retrofits. Essentially, this means that the additional capital required to dual-plumb an existing building could be financed as a part of reconstruction through a traditional loan or refinanced loan if the increased overall value of the property exceeds the cost to retrofit – this is because the lender will hold title to the property until the loan is paid off in full.

Credit Enhancement

If the loan-to-value ratio is too high, meaning the value of the building once retrofitted is not greater than the cost to retrofit, another option is to find a lender who is willing to make subordinate debt available to the owner. Examples of second mortgages abound in the affordable housing and community development field. Usually, the lender is a government entity or a nonprofit CDFI. In this scenario, the lender could take a second lien on the property. Another option for a high LTV is for another entity, like a public entity or foundation, to provide credit enhancement. These instruments can take many forms, from loan guarantees to letters of credit, or first loss reserves. These credit enhancements can be extended to senior lenders or subordinate lenders to reduce the risk of absorbing the cost to retrofit a building.

Savings-based Financing

Theoretically, another option is to fund water retrofits separately, with all repayment coming from savings. In this scenario the property owner would continue to pay the same monthly rate as before, thus creating the tangible cash flow to repay the financing. Much like an energy efficiency upgrade or solar energy financing, this option requires that a third party do the structural design and construction, while signing a performance contract to capture the additional savings accrued to the property owners over time. This is occasionally a risky proposition because if the savings don't materialize, there is no collateral for the lender to fall back on. An agreement would have to be reached upfront regarding who assumes the risk if the savings do not materialize. In this option, it is critical to have a sound methodology for establishing a baseline water usage number so that the monthly payment made by owner can be established. Equally important is a reliable, trusted way to measure changes over time so that all parties know if the program is working. If the data collection methodology, or the data itself, is not high quality, the project is unlikely to attract investors. The fact that there is little to no data currently available on water efficiency savings associated with new technologies will make the case to investors harder to build.

Within the options described, there are numerous variations and financing models for savings based programs that could be restructured to support investment in building, block, or district-level recycled water systems in Ala Moana. All of these tools could be presented to property owners as strategies for pursuing privately owned recycled water projects. However, private property owners are unlikely to act without sufficient incentives offered by the City to increase dual-plumbing, on-site retention and water reuse.

What Public Institutions Can Do

While capital costs for installation and retrofitting are significant, they are not the only hurdle to implementation of distributed wastewater treatment systems. To date, many cities have looked for ways to reduce capital cost expenditures with grant programs and other incentive structures. That said, similar to energy efficiency programs, reducing transaction costs - or all the costs associated with aligning stakeholders - is another way to reduce the overall cost of retrofitting and motivate action by private property owners.

The following are examples of incentives and programs that the City could offer to make recycled water projects more attractive and financially viable.

Local Policy Changes

In order to drive future growth to be more sustainable, particularly in the areas of water and energy conservation and waste reduction the City of Honolulu could pursue a series of policy tools to support greater water efficiency.

- Commercial water conservation ordinance: An ordinance that requires properties to repair

plumbing leaks and replace inefficient plumbing fixtures including toilets, urinals, faucets, and showerheads with high- efficiency models. Retrofits for commercial properties could be required by a certain or upon major improvements.
- Residential energy and water conservation ordinance: An ordinance that requires properties to repair plumbing leaks and replace inefficient plumbing fixtures including toilets, faucets, and shower- heads with high-efficiency models. Residential retrofits could be required upon sale of the property or at the time of major improvements.
- Non-potable water ordinance: A non-potable water program could help streamline the process for new commercial, multi-family, and mixed-use developments in Honolulu that choose to collect, treat, and reuse alternate water sources for toilet flushing, irrigation and other non-potable uses. Alternate water sources include: rainwater, stormwater, graywater, foundation drainage, and blackwater.
- Recycled water ordinance: An ordinance that requires new projects located within designated recycled water use areas to install recycled water systems for irrigation, cooling, and/or toilet and urinal flushing. San Francisco's poliy requires that all new construction, subdivisions, or major alterations with a total cumulative area of 40,000 square feet or more, and any new, modified, or existing irrigated areas of 10,000 square feet or more are required to comply with a recycled water ordinance.
- Water efficient irrigation ordinance: An ordinance to ensure the efficient use of water for the City's landscapes. For example, the City of San Francisco requires all projects with 1,000 square feet or more of new or modified landscape area to design, install, and maintain efficient irrigation systems, utilize low water- use plantings, and calculate a water budget.

Beyond passing new ordinances, the definition of greywater and allowable reuse in existing policies may also impact the economic viability of greywater systems in several ways. Beyond traditional development impact fees and incentives, the RE.invest team has identified a few important to policy clarifications that may be helpful in making the development of recycled water systems more attractive to private property owners.

On the cost side, greywater and reuse policies most obviously can influence the type, and therefore cost, of technology needed for adequate treatment. It may also determine the quantity of greywater available onsite, thereby influencing the minimum scale of production for an onsite system, which will determine the unit cost of treatment. Clarifying these aspects for private property owners and the broader retrofit market will make uptake easier. In addition, should the City want to support block-level or co-op structures, it would be important to streamline the minor and major encroachment permitting process to allow for broader distribution.

On the revenue side, it must be clear to private property owners that any recycled water produced can be sold to adjacent properties and/or that the City will credit recycled water producers/consumers for reducing the quantity of wastewater that must be treated by the sewerage system. This will help to clarify the revenue generation potential of a privately owned recycled water system.

Value Capture Instruments

The City of Honolulu's ability to create a special assessment authority or district that can levy taxes and/or fees offers a unique opportunity for financing comprehensive resilience upgrades like retrofitting the auxiliary water supply system for recycled water distribution as previously mentioned. Across the country, local governments have used these value capture mechanisms and borrowing against future tax revenues (i.e. tax-increment financing, TIF) or Development Impact Fees to incentivize, if not directly finance, investments in areas with high private investment risk. These value capture mechanisms use special district-level taxes and community improvement fees to capture a portion of the value created for private property owners and developers as a result of public investments.

The same mechanisms used to capture value created for private entities by public investment in transport or drainage systems could, in principle, be applied to private investments that reduce disaster or insurance risks to both public and private property-owners. Tax-increment financing is a form of value capture based on borrowing against future increases in market based land values and associated increases in tax revenues in order to finance investments in higher-risk areas. In Honolulu, by establishing that climate and/or disaster risks are directly impacting property values - TIF or similar types of value capture mechanisms should be available to finance both public and private recycled water solutions that would reduce those risks.

As the Honolulu TOD area will be subject to development impact fees, the City could dedicate some portion of the fees collected to support sustainable infrastructure systems like private recycled water projects or to provide incentives for implementation of water recycling and re-use facilities. Most likely, those funds would be best suited to support block-level or co-op structures that would have a greater impact. While typically these TIF and/or development impact fees are only allowed to be used to finance publicly-owned infrastructure, further analysis should consider whether these types of financing could be used to support privately owned systems that provide a public benefit.

More generally, other value capture and savings based financial instruments such PACE bonds for energy efficiency retrofits and upgrades have been deployed with great success to support large-scale investments in private property, such as rooftop solar energy systems. In contrast to TIF mechanisms, PACE and similar instruments do not require the designation of any specific geographic area or district for funding eligibility, giving a city more flexibility to administer a broad program of upgrades. The State of Hawaii has existing legislation that can facilitate the use of PACE bonds, a special type of revenue bond, the proceeds of which can be used by property owners to make water efficiency improvement to their property (both residential and commercial). While private property owners can use the proceeds of the bonds, they cannot be issuers of them. The issuing agency would have to be the city or even the Board of Water Supply. Since bond transactions are only efficient at a certain scale (usually at least $5 million per bond) the public entity would likely want to put together a program that aggregates many projects into one bond where property owners agree to repay the bond through an assessment on their property taxes. That means the owner is not sharing the risk of water efficiency savings actually materializing to offset the higher tax payments. If the property changes hands, however, repayment stays with the property, not the owner.

As the Ala Moana Neighborhood area will be subject to development impact fees, the City could dedicate some portion of the fees collected to create a non-potable water grant program to support sustainable infrastructure systems like private recycled water projects or to provide incentives for implementation of water recycling and re-use facilities. Most likely, those funds would be best suited to support block-level or co-op structures that would have a greater impact.

Pooled Funds

As noted, the challenge with investing in any structural retrofit is that working within existing properties and building stocks is complicated and often more costly. Beyond that, financial savings are frequently distributed across multiple beneficiaries (e.g. owners, occupants and tenants) and can only be accrued over a long period of time. Traditionally, public financing has leveraged taxing authority, through TIF and other structures, to capture distributed benefits. However, since the 1970s, the private sector has created other mechanisms to capture sector-specific savings effectively – particularly through the energy efficiency and renewable energy sectors via ESCOs and the PACE program. Now that the practice is well understood it is starting to be applied more broadly to support infrastructure investments that generate significant longer-term financial value, and the City of San Francisco could leverage this market interest to support recycled water retrofit investments that similarly produce broader benefits.

In fact, the City of San Francisco has already leveraged this expanding market interest to structure a pooled fund to support seismic retrofitting of private buildings to implement their Community Action Plan for Seismic Safety – a $1 million study to understand regional earthquake risk.

One of the first steps take by San Francisco under the Earthquake Safety Implementation Program was to sign into law the Mandatory Soft Story Retrofit Ordinance, which requires evaluation and retrofit for multi-unit soft story buildings. To support both mandatory and voluntary retrofits, the City created a grant fund to support earthquake retrofit upgrades, but learned quickly that funding, even when coupled with an ordinance was not enough to compel action. Because any retrofit project comes with high up-front analytical and transaction costs, the grant funds to support construction were seen as too little too late for many private property owners. Interested in motivating both mandatory and voluntary retrofits, the City of San Francisco approached Alliance NRG, an energy service company, and Deutsche Bank to restructure their grant funds into a public financing option.

Launched in the Fall of 2014, the program has a simple structure – Deutsche Bank provides the upfront capital guarantee to Alliance NRG, who then accepts applications from individual property owners and manages the upgrade process from design through construction. Alliance NRG has a contractual relationship with the City to recoup their investment plus interest via an additional line item on each participating property owners' regular property tax invoice from the city.

In order to pursue this financing model to support dual-plumbing retrofits, the City of Honolulu would need to first define project types and structure a mandate to cover retrofits and coordinate relevant contractors who could provide the retrofit services. In addition, the City must be able to credit recycled water producers/consumers for energy and water efficiency savings via property tax assessments. Such a credit system may appear at first glance difficult to accomplish administratively as most wastewater charges are calculated as multipliers on the quantity of water sold to a homeowner or business. However, the permitting process represents an opportunity to calculate the quantity or percentage of wastewater diverted into the non-potable water system. In this case, the utility would need to work with the City to quantify the individual property's wastewater multiplier and calculate the scale of the cost savings that the property provides the wastewater utility. Unlike on-bill savings, which accrue to property owners directly in the form of reductions to water or electricity bills, the savings created in this model accrue to the wastewater utility and the system more broadly. While any single property may not make a large impact, the collective impact has the potential to be significant for the City.

The City could follow a similarly simple structure to support the financing of non-potable water system retrofits. Transferring management to a private bank would help provide the necessary upfront capital guarantee to a private contractor. Like the soft-story pooled fund, the selected wastewater treatment contractor would then accept applications from property owners, and manage the upgrade process from design through construction. This contractor would require a series of contractual relationships to recoup their investment plus interest. The first would obligate property owners to pass-through energy and water savings, and a second agreement with the City and/or BWS would ensure the contractor receive an annual or semi-annual payment that scales based on system-wide savings accruing to the City. This pooled fund would go beyond providing financing to help streamline the retrofit process and reduce transaction costs in a way that can also increase project uptake.

Corporate Investment (iPark)

In addition to fostering direct investment in distributed recycled water systems, the City could also explore a third-party investment strategy that leverages corporate interest in testing and demonstrating new green and/or resilient infrastructure technologies and economic development funds. By integrating “park-lets” into the broader Ala Moana Park masterplan, the City of Honolulu can create an opportunity to test and analyze cutting-edge natural resilience systems that could be integrated into future capital improvement plans and system retrofits, while also revitalizing public spaces for new community uses. For example, one “park-let” could feature native Hawaiian fishponds to clean water while another highlights air-conditioning units that utilize deep seawater for heat exchange. Funds collected from companies for the right to sponsor or demonstrate on these sites could be directed towards implementation and long-term maintenance of high-priority municipal land or for infrastructure upgrades in and around Ala Moana.

Given this opportunity, the RE.invest team considered how to integrate small platforms for corporate technology demonstrations into Ala Moana Park to make the entire system more attractive to private sources of capital to finance construction, operations, and maintenance for a recycled water treatment system, while attracting new economic development to the city. These exhibits (similar to museum/public art exhibits) could rotate annually and be geared toward whatever themes the City of Honolulu is interested in showcasing at the time, including local art installations and educational features. Power to these sites could be generated by small independent solar panel systems at each location to minimize utility connections and expenses.

Included in Figure 11 is a basic demonstration area siting-map with proposed locations these platforms. These have been located in areas expected to have large volumes of pedestrian traffic to enjoy the installations without interrupting the open space value of the park.

Data Collection & Public Participation

In order to pursue any of the financing strategies included above, data collection and public participation will be key to motivate action. Providing baseline data, projecting savings and identifying partners or customers for individual property owners interested in designing onsite recycled water facilities reduces some of the upfront capital costs. The city should consider systematically engaging the hundreds of private property owners and managers in Ala Moana in the planning, implementation, and financing of new resilient infrastructure projects, including recycled water treatment facilities.

The City should consider partnering with technology firms and local businesses to build a new platform for collecting localized data on baseline water and energy costs.
Crowdfunding and crowdsourcing platforms have been used for over a decade to successfully engage individuals in projects and causes. Some examples are Wikipedia (collaborative encyclopedia), Kiva (microfinance), Kickstarter (project funding), FoldIt! (games for health and science), and Kaggle (data analysis prizes and competitions). Government agencies including NASA have also used crowdsourcing tools to engage communities in participatory monitoring and citizen science programs to creatively fill budget shortfalls.

Because there are few property-level sources of data, the RE.invest team recommends that the City explore partnerships with one or more small technology firms that have been successfully crowdfunding small scale community projects, to crowdsource data on building level water and energy related costs and losses. Using technology to engage property owners will help the City build a data-backed representation of the potential recycled water market localized in Ala Moana. By constructing a detailed profile, the City can systematically support the development of private owned recycled water systems while also packaging the benefits to property owners clearly enough to pursue savings based financing through a pooled fund more effectively.

While none of the proposed strategies will produce wholly private financing options for recycled water construction and retrofit in the short term, when combined they can offer a menu of options for the City to support long-term resilient infrastructure investment.

Figure 11. iPark Demonstration Area Siting Map

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Innovations

To reduce demand on potable water supplies, the City of Honolulu can explore recycled water solutions for use in Ala Moana Regional Park and the broader Ala Moana transit oriented development (TOD) neighborhood.

- Explore innovative recycled water treatment options for park spaces, individual buildings, or co-located buildings within a city block based on system-wide energy and water savings from reduced pumping and leakage

- Create incentives for local government agencies to actively support the development of privately-owned recycled water systems
    - Clarify in statute that recycled water produced on-site can be sold to adjacent properties and/or that the City will credit recycled water producers/consumers for reducing the quantity of wastewater that must be treated by the sewerage system
    - Structure a pooled fund, using energy efficiency retrofits as a model, to help provide financing for distributed recycled water treatment
    - Partner with technology firms and local businesses to collect baseline data and analyze projected efficiency benefits and savings from recycled water to reduce transaction costs for private developers

References

Board of Water Supply (2007). Central Oahu Watershed Study

Board of Water Supply (2009). Oahu Water Management Plan Overview

Board of Water Supply (2013). 2012-2013 BWS Report to Departmental and Agency Reports of the City and County of Honolulu.

City and County of Honolulu, Department of Environmental Services. Map of Wastewater Management System website http://www.honolulu.gov/cms-env-menu/site-env-sitearticles/1150-wwm_about_our_ww_plants.html accessed 09/22/14

City and County of Honolulu, Department of General Planning. (1990) Oahu Water Management Plan

City and County of Honolulu, Department of Planning and Permitting. (2014) Honolulu Land Information System (HoLIS)

Commission on Water Resource Management (2008). Island of Oahu, Hydrologic Units. State of Hawaii, Department of Land and Natural Resources

Department of Health (2002). Guidelines for the Treatment and Use of Recycled Water. State of Hawaii, Department of Health, Wastewater Section

Environmental Protection Agency (2002). The Living Machine, Wastewater Technology Fact Sheet, October 2002

Environmental Protection Agency (2007). Membrane Bioreactors, Wastewater Management Fact Sheet, September 2007

Environmental Protection Agency (2011). Opportunities for Combined Heat and Power at Wastewater Treatment Facilities: Market Analysis and Lessons from the Field, EPA Combined Heat and Power Partnership

Environmental Protection Agency (2012). Guidelines for Water Reuse, EPA/600/R-12/618 September 2012

Giambelluca, T.W., Q. Chen, A.G. Frazier, J.P. Price, Y.-L. Chen, P.-S. Chu, J.K. Eischeid, and D.M. Delparte, 2013: Online Rainfall Atlas of Hawai‘i. Bull. Amer. Meteor. Soc. 94, 313-316, doi: 10.1175/BAMS-D-11-00228.1.

Giambelluca, T.W., X. Shuai, M.L. Barnes, R.J. Alliss, R.J. Longman, T. Miura, Q. Chen, A.G. Frazier, R.G. Mudd, L. Cuo, and A.D. Businger. 2014. Evapotranspiration of Hawai‘i. Final report submitted to the U.S. Army Corps of Engineers—Honolulu District, and the Commission on Water Resource Management, State of Hawai‘i.

Living Machine Systems Honolulu Public Utilities Commission Case Study website http://www.livingmachines.com/Services/Case-Studies/SF-BWS-Case-Study-080913.aspx accessed April 24, 2014

Lohan, E., Muñoz, P.A., Salthouse, G., Fisher C., and K. Reid Black, (2011). “Performance of decentralized wastewater systems for green building projects in North America and Australia”, Greenbuild International Conference and Expo Research Track Conference Proceedings, 2011, Toronto, Canada, Oct. 4-7.

National Research Council (2012). Water Reuse: Potential for Expanding the Nation's Water Supply Through Reuse of Municipal Wastewater. The National Academies Press: Washington, D.C. (2012).

US Census Bureau 2014. County Population Facts for the State of Hawaii.

Water Reuse Foundation (2007). Honolulu MBR Feasibility Study.