APPENDIX K

Mana Water Prepared "Water Reclamation and Reuse Report for Waikapū Country Town"

Water Reclamation and Education Facility
Water Reclamation and Reuse Report

Prepared For

Waikapū
Country Town

Waikapu Country Town
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Wailuku, HI, 96793

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Table of Contents

Index of Tables and Images

1.1. List of Definitions and Abbreviations

- Alarm: an instrument or device which continuously monitors a specific function of a treatment process, equipment or pump station and automatically gives warning of an unsafe or undesirable condition by means of an electronic, visual and/or audible signal.
- Biological Treatment: methods of wastewater treatment where bacterial or biochemical action is used as a means of producing oxidized wastewater.
- CAS: conventional activated sludge
- Chapter 62: The Hawaii Administrative Rules, Title 11, Chapter 62, Wastewater Systems.
- CoM: County of Maui
- Contact: the mode of transmission by which a person or animal has the opportunity to acquire an infecting agent or pathogenic organism, by means of inhalation, skin or skin lesions, mucus membrane exposure, ingestion, or other physical contact such as placing objects in the mouth.
- Director: The Director of the Hawaii State Department of Health or a duly authorized representative.
- Domestic wastewater: Defined in HAR Chapter 62, section 11-62-03.
- Disinfection: A process which inactivates or removes pathogenic organisms in water by chemical or physical means.
- DOH: The Hawaii State Department of Health.
- F-specific bacteriophage MS2: a strain of a specific type of virus which infects coliform bacteria, is obtained from the American Type Culture Collection (ATCC 15597B1), grown on lawns of E. coli (ATCC 15597) as described by Adams in 1959 (Adams, M. H. 1959. Bacteriophages. Inter science Publishers, Inc.), and is assayed by the plaque forming unit (PFU) method described by Adams in 1959 on Trypticase soy agar (Difco, Detroit, Michigan).
- Filter: a unit for carrying out the filtration process, consisting of both the filter medium and its housing.
- FCR: food chain reactor unique to Organica Water Inc.
- Gpd: gallons per day
- HAR: The Hawaii Administrative Rules.
- MBR: membrane bioreactor
- MGD: million gallons per day
- Nephelometric Turbidity Unit or NTU: A measurement of turbidity as determined by the ratio of the intensity of light scattered by the sample to the intensity of incident light as measured by the method 2130 B. in Standard

methods for the examination of Water and Wastewater, 20th ed.; Eaton, A.D., Clesceri, L.S., and Greenberg, A.E., Eds; American Public Health Association: Washington, DC, 1995; p.2-8.

- Non-Domestic Wastewater: that as defined in HAR Chapter 62, §11-62-03, §11-62-07.1.
- NWRI UV Guidelines: The latest Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse (prepared by the National Water Research Institute and Water Research Foundation) that has been accepted for use by the DOH.
- Oxidized Wastewater: Wastewater that has undergone an aerobic treatment process in which the organic matter has been stabilized, is non putrescible, and contains dissolved oxygen.
- Pathogen: means any agent, especially a microorganism, capable of causing disease.
- Peak Dry Weather Design Flow: the arithmetic mean of the maximum peak flow rates sustained over some period of time (for example three hours) during the maximum 24-hour dry weather period. Dry weather period is defined as periods of little or no rainfall.
- Potable water: water that is suitable for drinking by humans.
- Power Source: a source supplying energy to operate unit processes.
- PUC: public utilities comission
- PV: Photovoltaic solar electricity
- Recycled water: treated wastewater that by design is intended or used for a beneficial purpose. The three classes of recycled water are provided in sections D, E, and F.
- Reclamation or Treatment Facility: an arrangement of devices, structures, equipment, processes and controls which produce recycled water suitable for the intended reuse.
- SCADA: supervisory control and data acquisition
- Standby power source: an automatically actuated self-starting alternate energy source maintained in immediately operable condition and of sufficient capacity to provide necessary service during failure of the normal power supply.
- Turbidity: a measure of the ability of a solution to scatter light. Light scattering is usually caused by the presence of small particles.
- Unit Process: an individual stage in the wastewater treatment sequence which performs a major single treatment operation.
- WCT: Waikapu Country Town
- WWRD: Wastewater Reclamation Division
- WWPS: wastewater pump station

- WWRF: wastewater reclamation facility.
- WREF: water reclamation and education facility
- WRRF: water reclamation and resource facility

2. Project Background

Waikapu Country Town (WCT) is a proposed complete community, encompassing a mixture of single and multi-family residential units, commercial and civic uses. Waikapu Country Town will sit at the foothills of the West Maui Mountains with a country town planned as the core of a new community at the existing Maui Tropical Plantation. WCT aims to create a town based on the principles of responsible and sustainable development that will serve as a model for future growth and urban development by maximizing on-site use of renewable energy, water conservation, agricultural preservation and water reuse.

Mana Water LLC has partnered with Organica Water Inc. and Kennedy/Jenks Consultants Inc., to provide a unique and proven technology of sustainable wastewater treatment and water reuse. With over 50 operating references world-wide, i.e., Europe, Asia and North America, Organica has been a leader in wastewater treatment and reuse in an energy efficient and aesthetically pleasing manner by marrying state of the art technology with a natural systems approach.

3. Private Water Reclamation and Education Facility

3.1. Existing Conditions and Management Plan

Maui Tropical Plantation is serviced by a private wastewater collection system and WWPS that collects and conveys the wastewater to the County of Maui's (CoM)'s gravity line in Waikapu Gardens. The wastewater from Maui Tropical Plantation is treated at the Kahului Wastewater Reclamation Facility (WWRF) where the current treated flow is 5.4 MGD with the WWRF design capacity being 7.9 MGD. The County's WWRD has indicated that the cumulative wastewater flow allocated is upwards of 7 MGD. Although the remaining capacity allocation is based on a first-come first-served basis with multiple wastewater requests already submitted, the CoM has instructed WCT to construct and operate a private wastewater reclamation facility (WWRF) to address their wastewater treatment needs.

The planned WCT WWRF will be designed in compliance with the State of Hawaii, Department of Health Hawaii Administrative Rules 11-62. It is anticipated that the ownership and operation of the WCT's collection system, WWRF, and water reuse system will be regulated by the State of Hawaii Public Utilities Commission (PUC).

3.2. Ownership and Operating Structure

The water and wastewater infrastructure constructed to serve WCT will operate under the ownership of the Waikapu Country Town Water Company (Water Company). The Water

Company will provide the management and operations of both the water and wastewater systems. WCT WREF and water utility company are committed to provide the WCT residents, commercial centers, and agriculture farmers with the highest level of service in a sustainable and affordable manner.

The Water Company is expected to be regulated by the Hawaii Public Utilities Commission and adhere to the Hawaii DOH standards and Water Reuse Guidelines. Daily operations of the WCT Water Company will be performed by State of Hawaii certified operators as required by DOH. The utility operations team will be selected prior to commissioning.

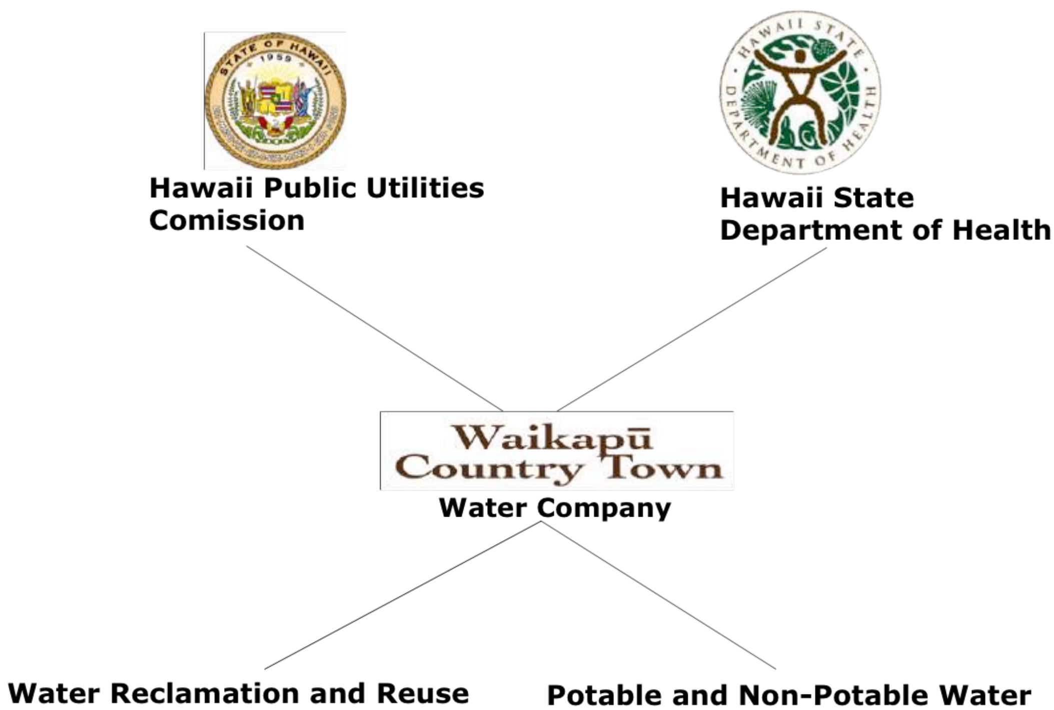


Image 1: WCT Ownership and Operating Structure

3.3. Wastewater Flow Projections

Flow projections are based on the County of Maui Wastewater Flow Standards (Feb 2, 2006), engineering report by Enviniti LLC., and adjusted per latest WCT plans.

COM Guidelines

Wastewater Flow Standards

Types of Use	Unit	Contribution (Gal/Unit/Day)
Residence, subdivision	home	350
Apartment/Condo	unit	225
Ohana (cottage)	unit	180
Office / Commercial	employee	20

Table 1: County of Maui Flow Standards

Experience has shown that the CoM Flow Standards are conservative and with modern low-flow fixtures it is anticipated that the actual flow will be lower than the listed Wastewater Flow Standards. However, a conservative approach is appropriate at this time in the planning process with the appropriate adjustments made during the planning and design phase of the project.

At full buildout, WCT will be a complete town that includes a variety of residential units, commercial units, employment uses, parks, school, other civic uses and agriculture. The following table summarizes the contributors to the WCT wastewater flow and provides the basis for wastewater flow calculations.

Basis for Wastewater Calculations at Full Buildout

Residential (Including Ohana, multi and single family homes)	1,517	Units
Office/Commercial	206,198	Square Feet
Civic (parks, church, elementary school)	50.41	Acres

Table 2: Basis for Calculations at Full Buildout

Flow Projection
(Average Dry Weather)

Residential	530,950	gpd
Office/commercial	70,300	gpd
Civic	12,800	gpd
Infiltration/Inflow	31,285	gpd
Total	**645,335**	**gpd**

Table 3: Flow Projections

CoM Flow Standard Dry weather infiltration/inflow is 5 gpcd (gallons per capita per day) based on the wastewater lines laid above the normal groundwater table and assuming a linear buildout rate to full buildout. Using a County-specified design peak flow factor of two (2) the projected peak flow is shown in the following table.

Peak Flow Projection

Peak Design Flow	1,290,670	gpd

Table 4: Peak Flow Projection

3.4. Influent Wastewater Characteristics

Wastewater characteristics are influenced by the service area and are critical in the proper design of liquid and solids treatment processes. WCT at full buildout will predominantly be residential wastewater along with commercial generated wastewater and infiltration/inflow. Some of the key metrics used in characterizing the raw wastewater are 5-day biochemical oxygen demand (BOD_5), total suspended solids (TSS), total nitrogen (TN) and Ammonia. These are important metrics in understanding the strength and nutrient content of wastewater.

The wastewater characteristics assumed for the wastewater system design will be based on County of Maui historic data and industry standards, including flow projections, and are dependent on the final buildout and master plan. The wastewater characteristics are to be adjusted accordingly during the design phase of the project.

Expected Influent
Wastewater Characteristics

Parameter	**Units**	**Value**
Flow		
Average	MGD	0.65
Peak	MGD	1.3
Influent BOD_5		
Average Day	mg/L	200
Maximum month	mg/L	250
Maximum month	lb/day	177
Influent TSS		
Average Day	mg/L	200
Maximum month	mg/L	250
Maximum month	lb/day	177
Influent Ammonia		
Average Day	mg/L	25
Maximum month	mg/L	20
Maximum month	lb/day	14

Wastewater Engineering Treatment, Disposal, and Reuse,
Metcalf & Eddy, 1991, Table 3-16 with adjustments

Table 5: Influent Characteristics

4. Water Reuse Management

4.1. WREF Effluent Quality

The effluent produced by the WREF is a valuable water resource that will be integrated into the WCT available water resource pool and used for its allowable and appropriate use. It is envisioned that the effluent disposal program for the WCT development will be a multifaceted program with three options for recycled water reuse.

- R-1 Recycled Water
- R-2 Recycled Water
- Soil Aquifer Treatment (SAT)

The R-1 recycled water is considered the primary effluent water resource that will serve as the irrigation water resource for the WCT agriculture development. Beyond just agricultural applications the R-1 water may be used for the irrigation of parks and open spaces as prescribed by the DOH reuse guidelines. Where acceptable, R-2 quality recycled water will be used as irrigation water for appropriate agricultural practices.

To meet the DOH requirement for recycled water effluent disposal an SAT network will be integrated into the effluent disposal program as a backup disposal system.

The WCT WWRF will be designed to produce State of Hawaii DOH-defined R-1 quality effluent as established by the Hawaii Administrative Rules, Tittle 11, Chapter 62 (HAR 11-62) and the State of Hawaii DOH Wastewater Branch, *Reuse Guidelines* (January, 2016). Recycled water irrigation is proposed as the primary method of disposal and used primarily for agricultural use and/or parks and open spaces. The WREF treatment process includes primary, secondary and tertiary treatment with filtration and UV disinfection.

The Waikapu Town Water Reclamation and Education Facility (WREF) will generate 0.65 MGD of R-1 recycled water upon full build out of the project. The following list per DOH Reuse Guidelines details the suitable uses for R-1, R-2 and R-3 water:

4.2. R-1 Suitable Uses:

A. Irrigation: All landscape and agricultural irrigation via spray, surface drip or subsurface drip irrigation.
B. Homes: Irrigation of a home on agricultural land or condominium property regimes provided there is a recycled water irrigation manager as described in Section K of the DOH Water Reuse Guidelines. Irrigation of single family residential homes without a recycled water manager is prohibited.
C. Farm Animals: Drinking water for livestock, and poultry with the exception of dairy animals that produce milk for human consumption.
D. Supply to impoundments:
    1. Restricted recreational impoundments such as golf course hazards, landscape water features, fountains, waterfalls
    2. Irrigation storage reservoirs and ponds
    3. Fish hatchery basins.
E. Dust control: Dampening, wet sweeping and/or wash-down of streets, roads, parking lots, walkways, etc.
F. Cleaning:
    1. Flushing toilets, urinals, and sanitary sewers where permitted by the applicable county plumbing code
    2. High pressure water cleaning of surfaces

3. Agricultural cleaning to wash down animals such as cattle, livestock, animal pens and housing.

G. Cooling of power equipment while cutting, coring or drilling pavements, walls and other hard surfaces;
H. Water jetting to consolidate backfill material around piping for recycled water, non-potable water, sewage, storm drains, gas and electrical conduits
I. Washing aggregate and concrete manufacturing
J. Boiler feed water
K. Industrial processes and industrial cooling
L. Cooling in air conditioning systems
M. Fire-fighting
N. Test water for gas pipeline testing.

4.3. R-2 Suitable Uses:

A. R-2 subsurface drip irrigation is allowed for the following:
   1. Golf course landscaping
   2. Parks, athletic fields, schoolyards, cemeteries
   3. Above-ground food crops (such as fruit trees) where the edible portion of the crop has minimal contact with the recycled water
   4. Impoundments without fountains or any other water features that generate spray or mist
   5. Landscapes around certain residential property such as condominiums that have a recycled water manager, as provided for in Section K, responsible for the landscape irrigation
   6. Freeway, roadside, and medial strip landscaping.
B. R-2 surface drip or subsurface drip irrigation is allowed for the following:
   1. Non-edible vegetation in areas with limited public access
   2. Sod farms
   3. Ornamental plants for commercial use
   4. Fodder, fiber, and seed crops not consumed by humans
   5. Timber and trees not bearing food crops.
C. Although R-2 spray irrigation is generally prohibited, R-2 spray irrigation may be allowed provided that an adequate buffer exists between the areas being sprayed and the adjacent residential or publicly accessible area. An adequate buffer can be accomplished by the following:
   1. Separation distance of 500 feet
   2. Physical barrier such as a wall or cliff
   3. Tall and dense vegetation
   4. Irrigating with potable water within the buffer area.

4.4. R-3 Suitable Uses:

A. R-3 drip or subsurface drip irrigation is allowed for the following:
   1. Non-edible vegetation in areas with limited public access
   2. Fodder, fiber, and seed crops not consumed by humans
   3. Timber and trees not bearing food crops.

4.5. Effluent Reuse for Agriculture

With approximately 1,077 acres of agricultural land available, along with approximately 32.44 acres of active/passive parks and 49.66 acres of proposed greenways and open spaces, the goal is to offset as much of the irrigation water demand with reclaimed R-1 water as possible. The near proximity of the agricultural lands allows for direct reuse of the reclaimed water for crop cultivation furthering the mission of a sustainable community. Another reason for utilizing recycled water for agricultural irrigation is that if the quality of recycled water degrades to R-2 quality (higher turbidity or bacterial levels), the recycled water can still be utilized (per DOH Reuse Guidelines) for the irrigation of many agricultural crops (energy crops, fruit trees etc.). Such a use will reduce the reliance of the alternate disposal system through the use of planned Soil Aquifer Treatment (SAT) basins.

Using a conservative estimate of 4,500 gallons of water required to irrigate each acre per day, it is estimated that approximately 139 acres of agricultural land will be required to utilize the entire volume of 0.65 MGD of recycled water during dry weather years. An alternative option for consideration is to use produced R-1 quality water for the irrigation of common areas and parks. This option would reduce the volume of recycled water available for agricultural irrigation and associated environmental benefits and may result in a more complicated and expensive recycled distribution system however, the optional use for open space irrigation is a proven and acceptable practice and is viable should demand warrant. The use of reclaimed water for agricultural irrigation will be done in the areas defined as "unrestricted" per the DOH Reuse Guidelines.

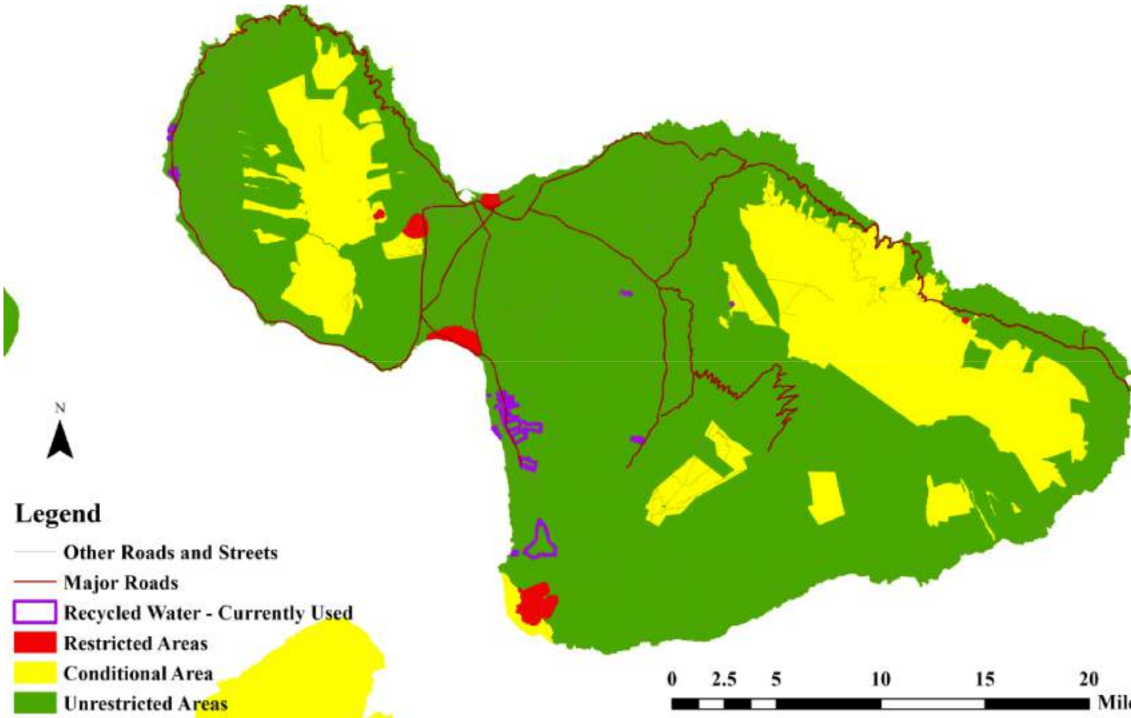


Image 2: Water Reuse Areas of Maui

As stated above, the expected 0.65 MGD of recycle water produced at buildout will irrigate at least approximately 139 acres of agricultural land during dry years. During wet weather years, more land will be required to utilize this volume. It is recommended that the area designated for recycled water use be doubled to approximately 278 acres to accommodate the entire 0.65 MGD of available recycled water during wet weather periods. Since approximately 1,077 acres of land are available for agricultural use, the area designated for recycled water use (278 acres) could be increased if needed to accommodate recycled water application as a means to reduce the use of SAT basins for wet-weather and backup effluent disposal. The rate of water demand is a function of the specific crop. In this analysis a conservative approach was selected assuming open field grass, however, the rate at which an agricultural crop is watered can be increased by selecting crops with greater water need (e.g. sorghum or sugar).

4.6. Alternative Disposal

Alternative disposal for excess reclaimed water and treated effluent which does not meet reuse standards must adhere to the Underground Injection Control Areas (UIC) or UIC lines. Areas below the established UIC lines are acceptable locations for effluent disposal practices (Image 3). This regulatory requirement is to ensure that the water percolating through the soil does not adversely affect the underlying potable water aquifer, irrespective of the method of disposal, such as injection wells or Soil Aquifer Treatment (SAT) (Image 4).

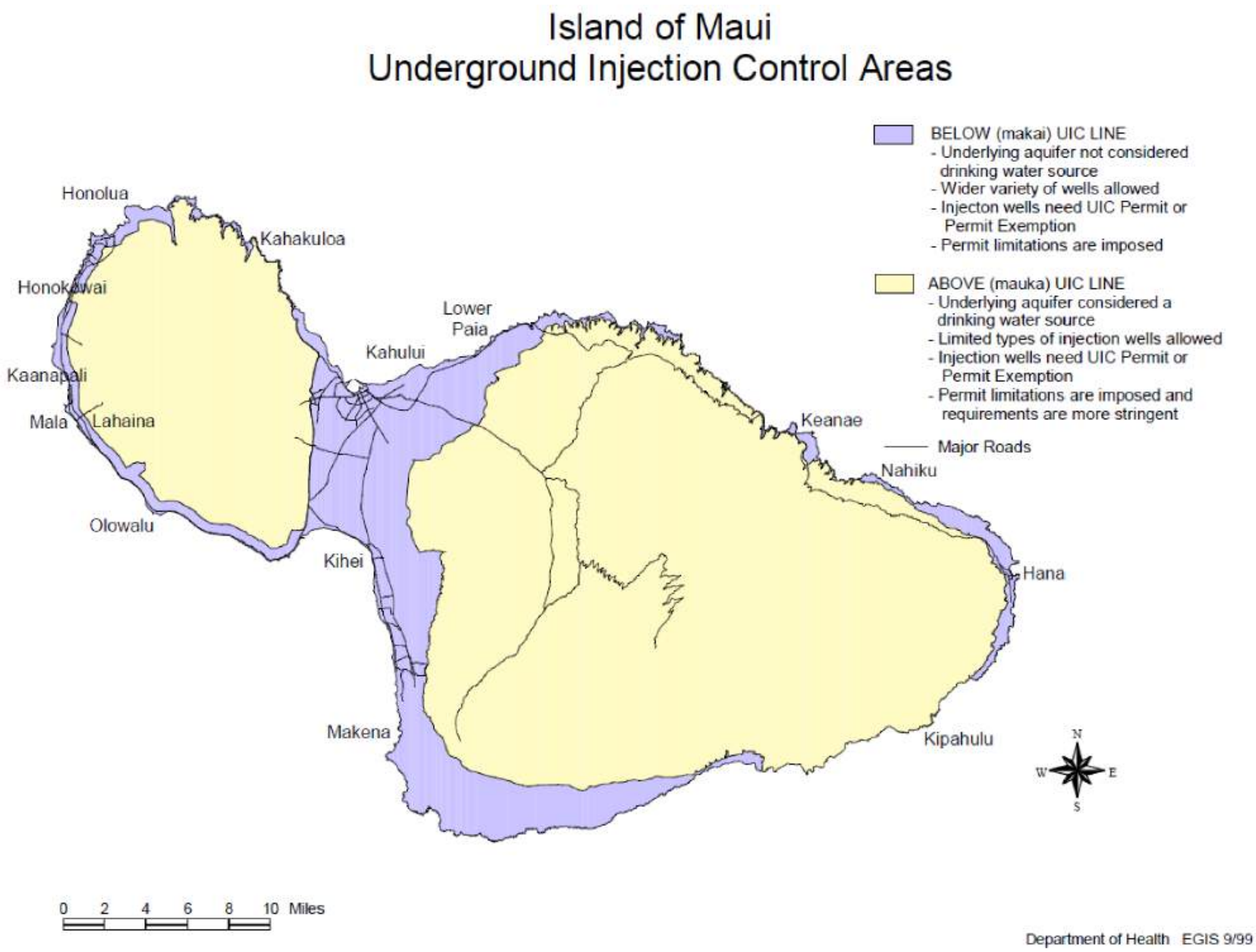


Image 3: UIC Line Maui

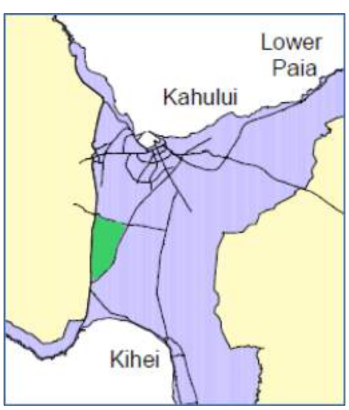


Image 4: Approximate Reuse and Alternative Disposal Area (in green)Below UIC Line

SAT basins are the preferred alternative disposal means as they provide additional buffer and further polish the water through slow percolation and reduce the possibility of contaminating the underlying aquifer when compared to injection wells. SAT basins use physical, chemical and biological treatment to wastewater/recycled water as it infiltrates and percolates through soil to groundwater. Nutrients (nitrogen, phosphorus), trace organics, heavy metals and endocrine disrupting compounds are removed thus making SAT basins a better choice than deep injection wells for disposing of excess recycled water. A SAT basin system consists of multiple basins that are built on soil that is porous. Recycled water that is not needed for irrigation or does not meet R-1 or R-2 standards and not suitable for water reuse would be intermittently applied to the basins over a period of several days. The preliminary required total basin area has been established at 5.6 acres ideally situated on site and/or adjacent, however, there will need to be geotechnical evaluations during the design phase to determine the actual final system size and exact location.

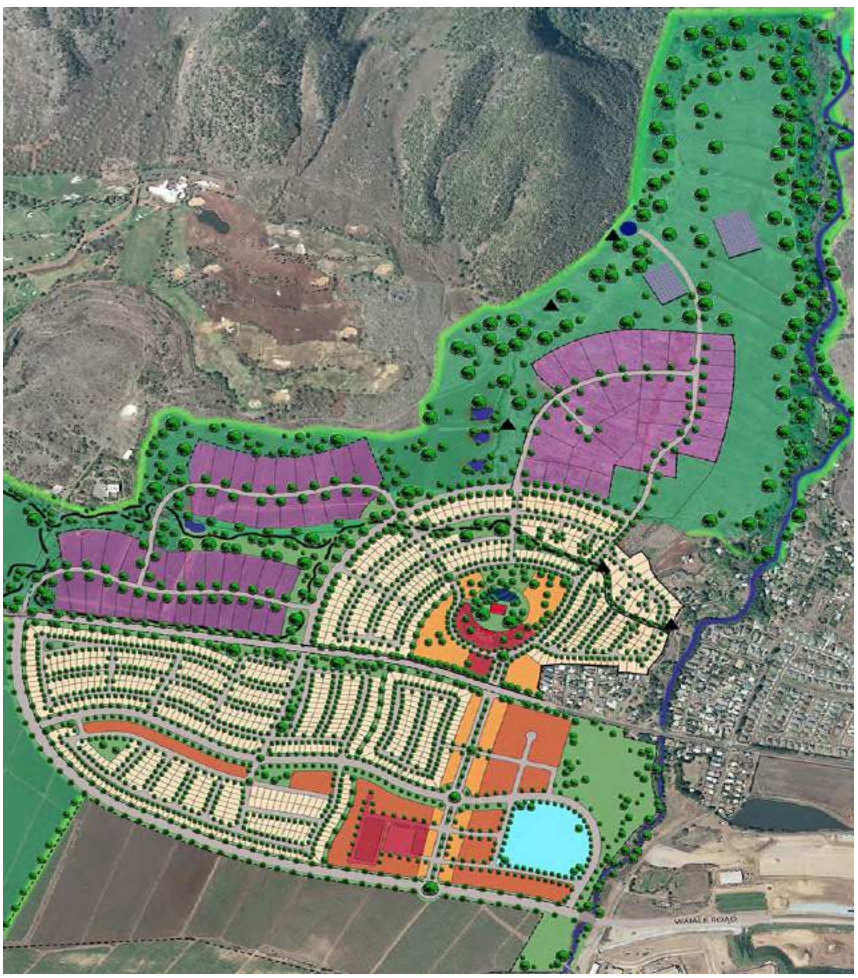


Image 5: Well Sites Approximate Locations (black triangles)

Soil Aquifer Treatment (SAT) refers to the process of treating wastewater effluent by percolating water through the unsaturated (vadoze) zone for the purposes of groundwater recharge and disposal. SAT utilizes physical, chemical and biological properties of the soil to improve the water quality of the wastewater effluent. The treatment benefits are initially attained during vertical infiltration of wastewater effluent through the vadoze zone and eventually during its horizontal movement in the saturated zone before it is extracted again from a recovery well for downstream irrigation. SAT has been used as a means of effluent treatment and groundwater recharge for hundreds of years throughout the world and is still a common methodology used in municipal and industrial applications.

Several factors are considered when determining the suitability for implementing a SAT system as well as selecting the type that is appropriate for a particular site. Factors that are considered include soil infiltration rates, aquifer characteristics, localized groundwater mounding, and plugging potential of the system. These factors are evaluated to assist SAT designers, operators, regulators, and the public in understanding the performance and compliance of a facility. There are a variety of different types of SAT systems including infiltration basins, leach fields, swales, and percolation ponds.

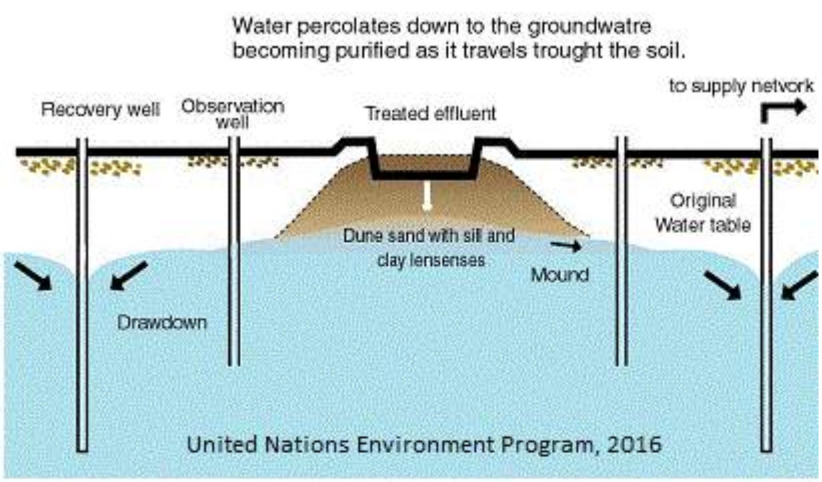


Image 6: SAT Basin Schematic

4.7. Supply Demand Analysis

Approximately 1,077 acres of land are available for cultivation of agricultural crops, along with approximately 32.44 acres of active/passive parks and 49.66 acres of proposed greenways and open spaces. At 4,500 gallons of water per acre per day during dry years, about 4.5 million gallons per day would be required to irrigate the entire 1,077 acres using a conservative crop uptake factor. Thus, the daily volume of 0.65 MGD of recycled water would fall far short of meeting the irrigation requirement of the entire agricultural site. Supplemental non-potable water would be required to satisfy the entire irrigation demand of the agricultural land and this fact provides the WCT with tremendous flexibility in managing its recycled water supply since the water demand of the agricultural area will greatly exceed the volume of recycled water produced. The reuse of R-1 water is preferable in the large area highlighted in blue (Image 7) due to proximity and on-site drainage pattern, however, can be applied to open park spaces as well should demand warrant.

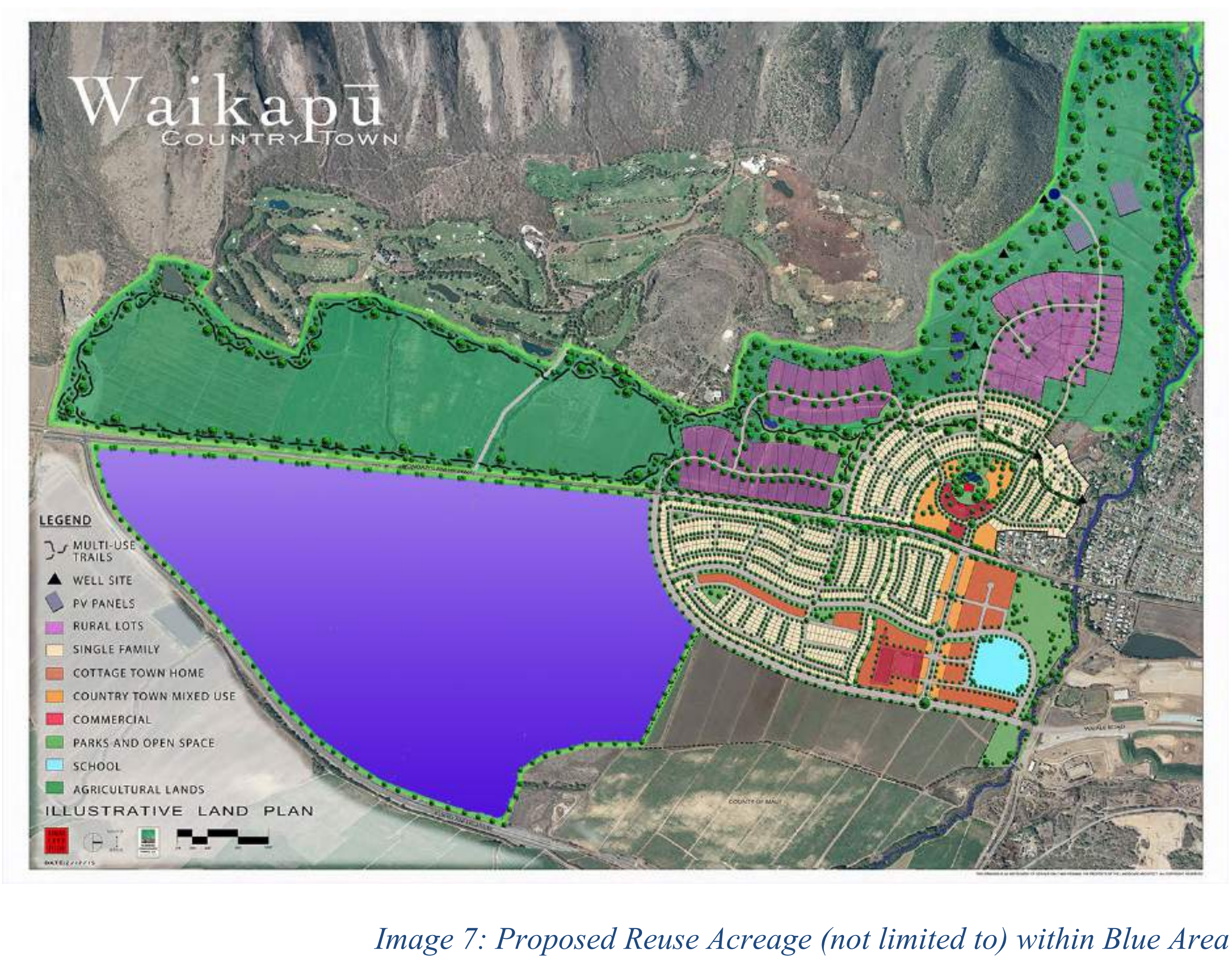


Image 7: Proposed Reuse Acreage (not limited to) within Blue Area

4.8. WREF Operating Cost and Revenue

Recycled water is a commodity governed by supply and demand with rate structures approved by the PUC and/or the CoM. The wholesale of recycled water can significantly offset operational costs of the WREF depending on who the buyer is. Despite current municipal recycled water rates on Maui being lower than rates on neighboring islands, they serve as a good metric to identify potential revenues that can be realized through the sale of recycled water.

User Categories	CoM Recycled Water Rates (per 1000 gallons)
Major Agriculture	$0.25
Agriculture (including Golf Courses)	$0.40
All Others	$1.50

Table 6: Recycled Water Rates

It is advisable to analyze the off-takers from an economic perspective in order to maximize potential revenues. Table 7 illustrates three (3) options assuming full buildout of WCT at 1,517 units, and a sewer fee of $80. Of this $80 we allocate $40 towards the operation of the facility with the other portion dedicated to the maintenance of the wastewater network. Recycled water revenue assumes 650,000 gpd sale of R-1 water and $40 revenue per unit.

	User Categories	Recycled Water revenue	Sewage Fees	Total Operating Revenue
Option 1	Major Agriculture	$59,313	$728,160	$787,473
Option 2	Agriculture	$94,900	$728,160	$823,060
Option 3	All Others	$355,875	$728,160	$1,084,035

Table 7: WREF Operating Income

Operating expenses are a function of wages, electrical cost, equipment maintenance, chemicals, biosolids disposal costs, materials and miscellaneous expenses such as permit filing fees, insurance and regulatory compliance costs. One of the most effective ways to decrease operational costs is to offset electricity purchase from the utility by generating electricity on site using solar photovoltaic renewable energy and or wind energy. Not only will this further the mission of sustainability but it provides a tangible cost benefit that can be enhanced by taking advantage of the available state and federal tax credits and/or rebates. It is estimated that the

650,000 gpd Organica FCR facility will use approximately 306,855 kWh of electrical power per year. The following table shows the estimated operating expenses over the course of one year at full buildout.

Cost Category	Total
Personnel cost	$610,500.00
Energy Cost	$116,605.09
Sludge handling	$106,758.24
Materials/Maintenance	$52,000.00
Misc. (insurance, permit fees, etc.)	$14,000.00
Total	**$899,863.33**

Table 8: WREF Operating expenses without solar

The types of personnel required to operate the facility are:

a. Superintendent or Supervisor - this person would oversee all operations and maintenance and could handle administrative functions including budget preparation and associated accounting/clerical duties along with educational responsibilities.
b. Plant operators - two full time certified operators are required. Besides operating the plant, the operators could perform basic preventative maintenance including pruning the FCR vegetation/yard work/janitorial duties, recycle water system monitoring and meter reading, and perform laboratory duties and guided tours included in educational responsibilities.
c. Mechanical and Electrical maintenance personnel (note: these positions may not need to be full time and they could be contracted out, however, for conservative cost estimation purposes both positions are calculated based on fulltime employment).

As an R-1 facility, 7 days per week bacteriological monitoring of the recycled water is required. This means that on weekends, an operator will need to be on duty at least 1/2 day to oversee the plant and perform the lab work. Salary estimates used for calculating labor are based on County of Maui Wastewater Division pay scales and assume one full time position for mechanical maintenance personnel and one full time position for electrical/instrumentation maintenance personnel.

Removal of the biosolids from the facility will not be needed every day; however, will likely be about once or twice per week. The dewatering of the biosolids will be handled by the plant operators. However, the hauling should be contracted out to a waste disposal company. Costs are based on 2 times off haul per week and Maui EKO cost of $103 per ton for processing.

The plant operators are to handle the yard work and pruning the FCR vegetation. The Education Facility is to be part of the job description of the Supervisor and/or plant operator. Educational duties will include guiding of school groups, private tours and basic introduction to the biological wastewater treatment process. Collaborating with outside companies to use the Educational Facility as a place to provide workshops and training to operators is an ancillary service the WREF would provide for a fee.

The following table illustrates the operational savings that can be realized by utilizing onsite renewable energy generation assuming the solar PV system offsets 75% of the power purchased from the utility company.

Cost Category w/ onsite solar energy	**Total**
Personnel cost	$610,500.00
Energy Cost	$29,151.27
Sludge handling	$106,758.24
Materials/Maintenance	$52,000.00
Misc (insurance, permit fees, etc.)	$14,000.00
Total	**$812,409.51**

Table 9: WREF Operating expenses with solar

When comparing operating costs with potential revenue streams, it is apparent that the sale of R-1 water coupled with optimized operating cost and sewage fees allow for the possibility of positive operating finances.

User categories	Total Operating Revenue	Operating Cost (w/ solar)	**Net Result**
Option 1	$787,473	$812,410	**-$24,937**
Option 2	$823,060	$812,410	**$10,650**
Option 3	$1,084,035	$812,410	**$271,625**

Table 10: Net Financial Operating Result

4.9. Nutrient Residuals in R-1 Recycled Water

The Organica FCR wastewater treatment process is designed to reduce nutrient concentrations of nitrogen and phosphorus as well as trace organic compounds. Total nitrogen will be reduced to below 10 mg/L and Total phosphorus will be reduced to below 3 mg/L. The nutrients that do remain will serve as a fertilizer source for the vegetation that is irrigated with the recycled water and thus reduce the overall fertilizer requirements of such vegetation. The SAT basins, when used for disposal of excess recycled water, will also be capable of removing nutrients, trace organic compounds, heavy metals and endocrine disrupting chemicals through natural processes as the recycled water percolates through the soil and landscape root zone.

4.10. Biosolids Management

Biosolids (sludge) removed from the WWRF will be dewatered at the facility with a biosolids dewatering unit and hauled to Maui EKO Systems located at the Central Maui Landfill. WCT will contract with Maui EKO Systems to process the biosolids into a usable soil amendment. The Environmental Protection Agency currently oversees biosolids for Hawaii. However, Hawaii plans to seek authorization of EPA's program in the future. Hawaii State Department of Health (DOH) places biosolids conditions in NPDES permits and tracks compliance through its wastewater branch.

4.11. WREF Site Location

During the initial analysis two locations were identified as potential WREF host sites. The following criteria were the primary drivers in selecting the ideal location:

- Proximity to planned wastewater collection system network
- Proximity to reclaimed water users
- Prevailing winds and possible odor impacts
- Pumping costs and network optimization
- Environmental impacts
- Drainage and flooding impacts
- Expansion and interconnection potential for offsite users
- Accessibility

Site Location A, located at the North-East corner of the development did provide enough acreage, however, it did not satisfy the the majority of the criteria listed above. Furthermore, the near proximity of the Waikapu stream raised concerns of the location being too close to a potential flood plain. The table below details attributes a score of -3 as the worst and +3 as the best.

Considerations	Location B	Location A
Proximity to planned wastewater collection system network	3	1
Proximity to reclaimed water users	3	1
Prevailing winds and possible odor impacts	1	0
Pumping costs and network optimization	2	0
Drainage and flooding impacts	3	-1
Expansion and interconnection potential for offsite users	2	2
Accessibility	2	2
Total	**16**	**5**

Table 11: Optimal Site Location Matrix

Site Location B is located near the South-East edge of the development. This location does satisfy the criteria listed while allowing for reclaimed water to be used for agricultural and/or open space irrigation. It is located adjacent to the agricultural site of reuse, reducing pumping and energy consumption which further reduces the carbon footprint of WCT.

Image 8: Mana Water Site Location A

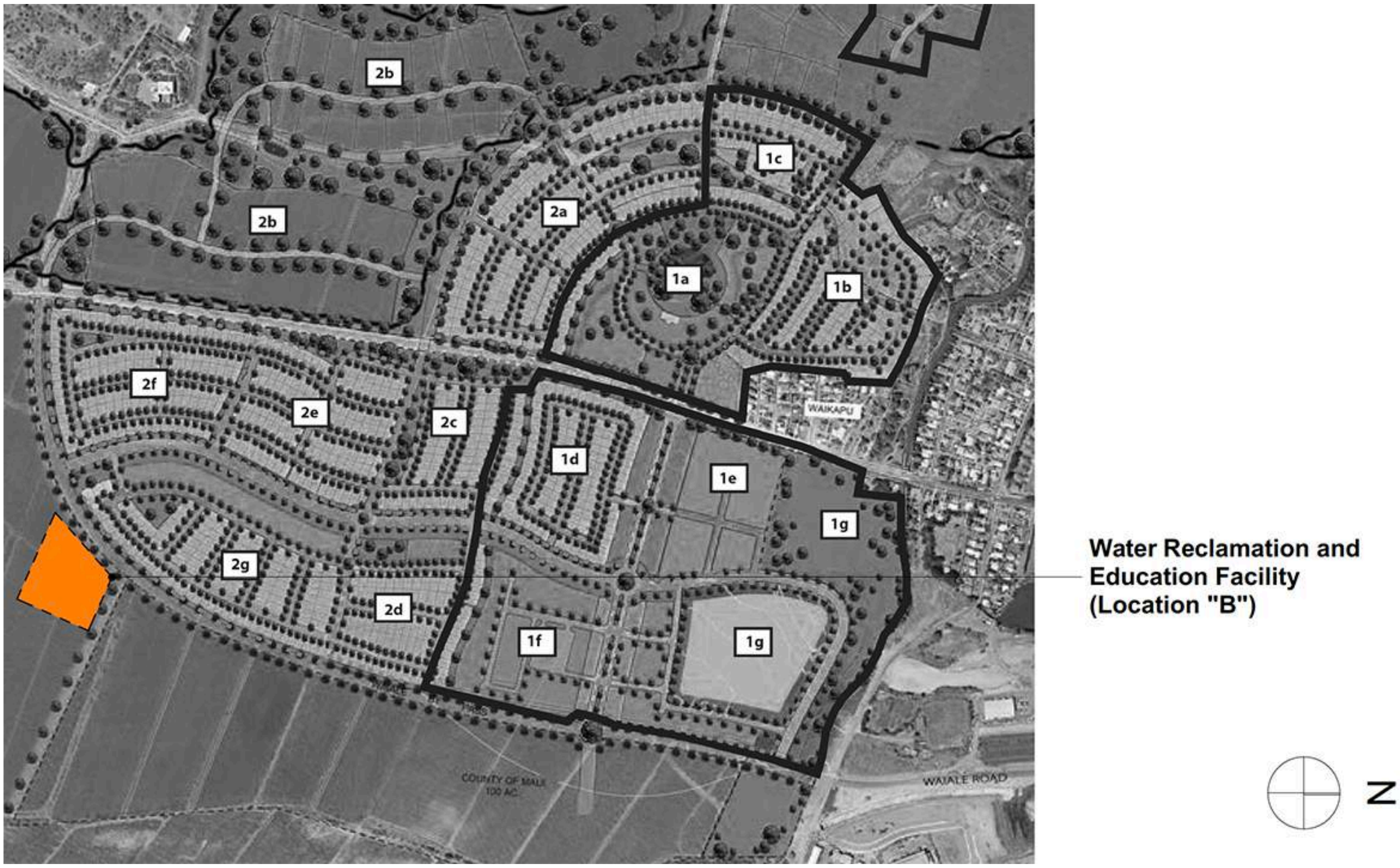


Image 9: Mana Water Site Location B

5. Education Center

5.1. Public Education

A key component of any successful wastewater treatment system and water reuse program is proactive public education. The proposed education center will be utilized by the WCT community and the general public to learn how wastewater is treated and how recycled water is beneficially reused. The Recycled Water Supervisor, as part of his/her work responsibilities will manage the public education program and utilize a variety of tools within the education center including videos, slide presentations, poster boards, and microbiology demonstrations to educate schools, community groups, environmental organizations etc. about wastewater treatment and reuse. Tours of the wastewater reclamation facility and water reuse sites will be provided in conjunction with the presentations provided at the education center.

Image 10: Mana Water Education Facility Rendering

5.2. Operator Training

Furthermore, the WCT Water Reclamation and Education Facility (WREF) will serve as a training room for the project's wastewater, water and recycled water distribution system operators. Both professions require State of Hawaii DOH certification thus the education center will provide an excellent location for operations personnel to prepare for their respective certification examinations as well at train entry level operations personnel on the basics of wastewater treatment and water distribution. The inclusion of an education center will greatly contribute to the success of the wastewater treatment and recycled water component of this project and be a source of community pride for years to come.

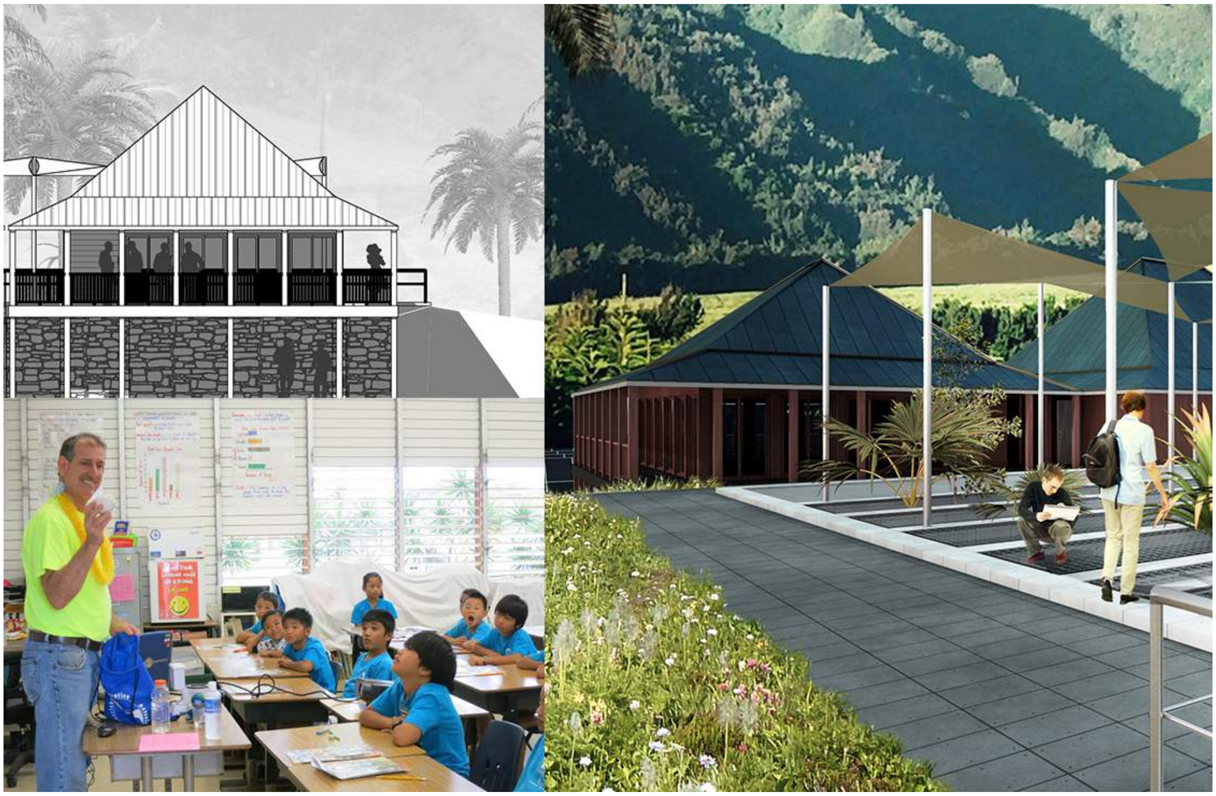


Image 11: Mana Water Member Steve Parabicoli in Action, Doing Water Reuse Outreach Education at Lihikai Elementary School (May 21, 2013 Maui) and renderings

6. Wastewater Treatment Facility Operation

6.1. Introduction

Organica solutions utilize a Food Chain Reactor (FCR) configuration, consisting of biological treatment in successive reactor zones utilizing fixed biomass on a combination of natural plant roots and Organica's engineered biofiber media, along with a limited amount of suspended biomass.

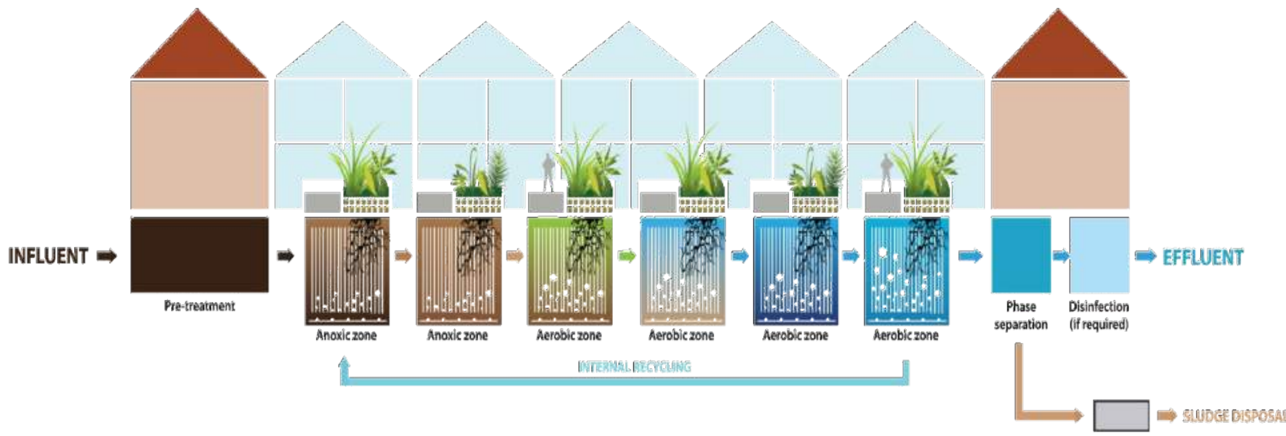


Image 12: Organica Process Diagram of Food Chain Reactors (FCR)

6.2. Organica FCR Operation

Organica FCR facilities are highly automated with minimum operator intervention required. Equipment and basic principles of operation are similar to conventional wastewater treatment. In selecting the technology Mana Water carefully examined the operator sophistication required to operate this type of facility to ensure that the level of sophistication, at minimum, does not exceed that required at conventional WWRFs on Maui. Generally, the level of sophistication required is significantly lower than a membrane bioreactor (MBR) and comparable to a conventional activated sludge (CAS) plant. It is anticipated that operation of the WREF will require:

- 1 superintendent/Supervisor
- 2 operators
- 1 part time mechanical maintenance personnel[1]
- 1 part time electrical maintenance personnel[2]

[1] can be outsourced
[2] can be outsourced

An operator that currently operates any of the Maui facilities will be competent in operating an Organica FCR facility. Mana Water in collaboration with Organica will provide operator training at the time of commissioning. Maintenance of plants (vegetation) can be done by the same personnel that manage the facility. Plant (vegetation) maintenance is similar to a home garden or other landscaping.

6.3. General Introduction to Organica FCR

Organica FCR solutions consist of a series of biological treatment zones simultaneously utilizing both fixed biofilm and suspended biomass in the reactors. Biodegradation of influent contaminants is accomplished by the combination of fixed and suspended biological cultures. Biomass in the Organica FCR is primarily fixed-film, utilizing natural plant roots along with additional engineered (biofiber) media as biofilm carriers. As influent travels through the FCR zones, the available organics and nutrients (various carbon, nitrogen, and phosphorus fractions) are consumed and/or transformed. As a result, the composition of the ecosystem fixed in the biofilm changes from zone to zone, gradually adapting to localized conditions as the organic and nutrient concentrations vary, as well as dissolved oxygen content. The end result is a specially-adapted ecosystem in each zone, acclimatized to the specific conditions to maximize treatment efficiency.

6.4. Advantages of the FCR Solution

A significant fraction of microorganisms responsible for biodegradation is in fixed-film form (attached growth). Benefits of fixed-film solutions include:

- Mixed liquor suspended solids (MLSS) concentrations significantly lower than conventional activated sludge systems
- Improved aeration & mixing efficiency (reducing energy requirements)
- Flexible phase-separation alternatives, including option of direct filtration (without clarifiers) to conserve space
- Increased concentration of active biomass in the treatment zones
- Eliminated requirement for sludge recirculation (RAS)
- Longer effective SRT (sludge age); resulting in more complex organisms with longer lifecycles (unicellular cilia, larvae, arthropods) establishing themselves on the biofilm
- Eliminated potential for biomass "washout"
- Significant reduction in biological reactor space requirements

6.5. Plant Roots Are Ideal Biofilm Carriers

Plant root specific surface area is an order of magnitude higher than most artificial carrier media, resulting in higher concentrations of active biomass.

- Plant roots are not susceptible to clogging, thus reducing operational risk.
- Plants excrete small amounts of organic acids from their root surfaces which act as a food source for the biofilm. This is of high importance when the influent organic load is low. This symbiotic relationship helps bacteria survive starvation periods, resulting in a larger and more diverse population of bacteria in the system when the wastewater load is re-established. As a result, FCR facilities have far greater flexibility compared to conventional activated sludge systems.
- Utilization of marsh plants (reeds, sedges, bulrushes, etc.) transport oxygen to their roots and increase biofilm activity.
- Plant roots provide a better habitat for slow-growing species, such as nitrifiers and eukaryotic organisms, resulting in improved nutrient removal performance over conventional processes.

Image 13: Organica FCR Facility

6.6. The Main Unit Processes

The main unit processes of the proposed facility include

1. Pretreatment
2. Biological Treatment
   - FCR multi-zone reactor with 6 zones in each reactor train
3. Secondary Phase Separation
   - Coagulation
   - Flocculation
   - Secondary clarifier or filtration
4. Tertiary Treatment
   - Tertiary filtration
   - UV disinfection
5. Solids Management
   - Sludge storage tank
   - Sludge thickening and dewatering
6. Reuse and Disposal
   - R-1 storage
   - R-1 pump station
   - SAT basin

6.7. Odor and Noise Control

Odor release from a WREF is a critical concern of the neighboring residents and businesses and must be addressed during the design phase of the WREF. The WREF will locate odor producing processes in buildings to contain and treat the potential foul odors prior to discharging the treated air to the atmosphere. Based on the size of the proposed collection system at WCT the collected wastewater is expected to reach the WREF in a relatively short period of time, thus minimizing the possibility of anaerobic conditions to develop within the collection system. This is based on a recommended design minimum flow rate of 2 feet per second in the collection system. During the early stages of build-out it is possible that the wastewater flow will be lower than design capacity, resulting in longer detention time of raw sewage in the collection system. A preventative maintenance program is recommended to prevent solids deposition in the collection system by means of regular flushing and the addition of caustic soda (as required) in order to reduce H2S formation. The WREF is committed to reducing the H2S concentration at the fence line to at or below 5 ppb to eliminate off-site odors. This concentration is well below the State air requirement for instantaneous concentration of hydrogen sulfide of 25 ppb or less. The sewage intake and headwords equipment is to be housed in a contained pre-treatment building equipped with air filters. Proven and reliable technologies will be incorporated into the planned odor mitigation. Noise control is mitigated by machinery (blowers, scrubbers) being confined to the enclosed pre-treatment area. Minimal noise associated with off haul and/or pumping of sludge is to be limited to 1-2 times per week and scheduled during normal business hours.

7. WREF Site Plan and Location

Mana Water, in conjunction with Kennedy/Jenks and Waikapu Country Town, has worked to develop a Water Reclamation and Education Facility that can serve as a model facility for the state of Hawaii. The following goals were set during the design process:

- Meet and/or exceed water treatment and reuse standards as set for the by the State Department of Health
- Reuse up to 100% of reclaimed water when feasible
- Use an innovative approach while staying within the bounds of industry accepted biological treatment standards
- Minimize the amount of land acreage allocated for structures
- Provide public outreach and education through dedicated facility
- Minimize any noise or odor impacts on neighboring community
- Design facility with best practice sustainable development standards
- Design facility to be both visually and aesthetically appealing
- Use natural processes where possible
- Integrate native Hawaiian plants for the landscaping and in Organica FCR plant racks
- Use renewable energy to offset as much power as possible

With odor causing processes contained in the pre-treatment area, the biological treatment process allows for a botanical garden style treatment area that is pleasant and accessible. In stark contrast with traditional wastewater treatment systems, with their exposed concrete reactors, large footprint and foul odors, the Organica facilities allow for an aesthetically pleasing approach to wastewater treatment embraced by communities around the world with over 80 facilities globally.

Image 14: Architectural Rendering of WCT WREF

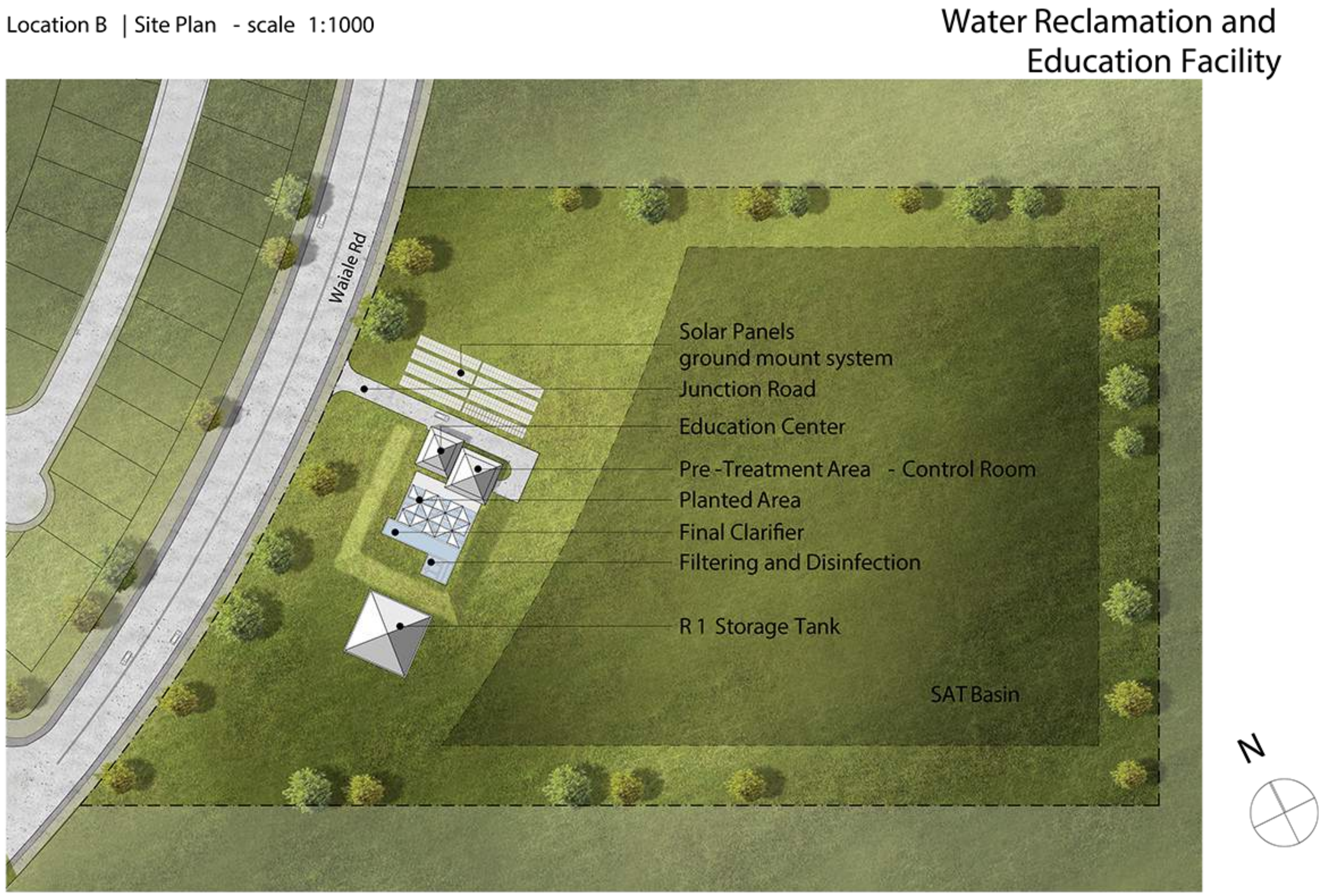


Image 15: Preliminary WCT WREF Site Plan. Total Area 12 acres, SAT basin 5.6 acres

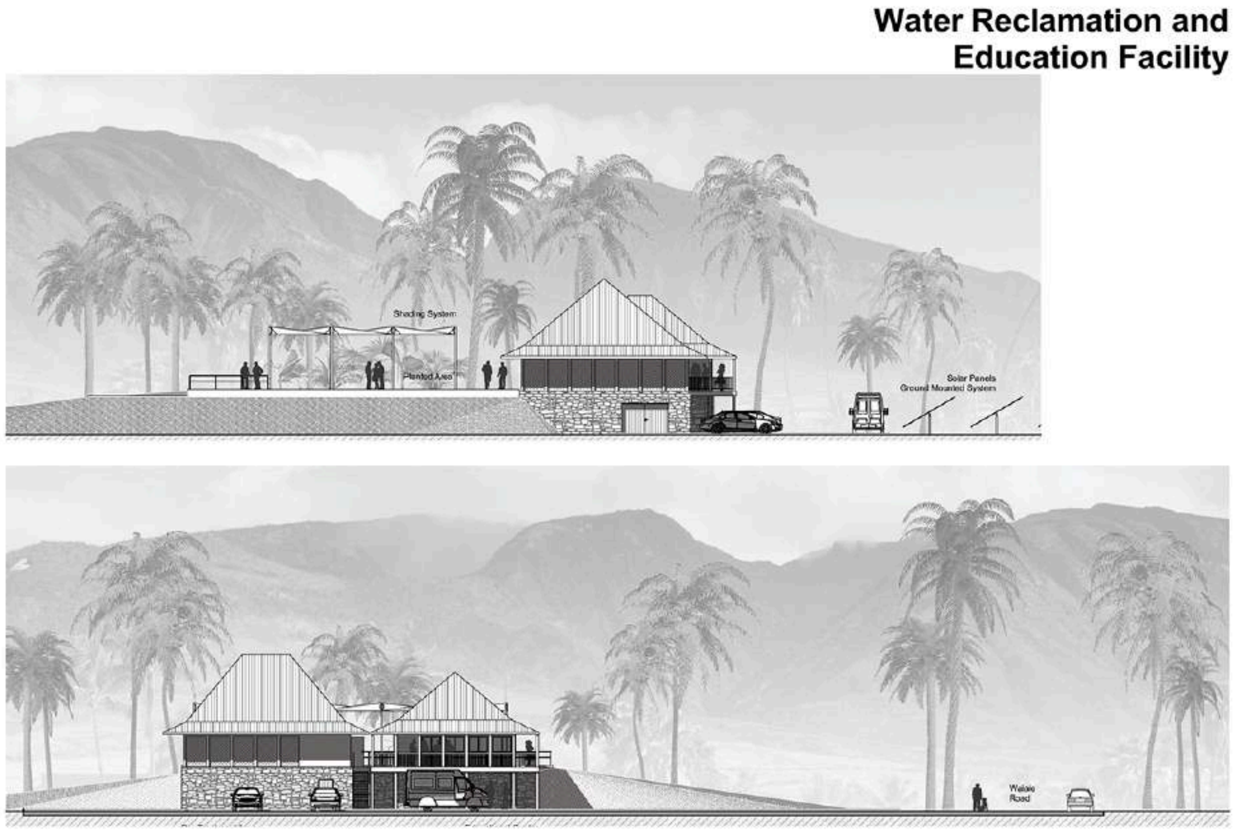


Image 16: Preliminary Rendering of WCT WREF Elevations

8. Cost implications and Phasing

8.1. Total Cost Estimates and Phasing

In order to most economically construct and commission the WREF, it is possible to synchronize certain aspects of the treatment process with the build out of WCT. While it is necessary to maintain the full treatment and redundancy requirements, not all phases of the treatment process need to be completed to 100% of expected final capacity. For this reason, the preliminary WREF design is a two train reactor system in order to allow for commissioning of each train in sync with the two phase build-out of WCT. By phasing WREF construction in tandem with WCT build-out, significant upfront capital cost savings can be realized in equipment such as headworks, limited secondary treatment commissioning, tertiary filtration, UV disinfection channel, aeration diffusers etc.

Scope	Phase1 ($M)	Phase 2 ($M)	Total ($M)
Engineering	$1.78	$0.20	**$1.98**
Civil Works	$1.61	$0.37	**$1.98**
Mechanical & Electrical	$3.10	$1.03	**$4.13**
Primary Treatment Process	$1.82	$0.93	**$2.75**
Secondary Treatment Process	$4.73	$3.15	**$7.88**
Tertiary Treatment Process	$1.69	$1.13	**$2.81**
Reuse and disposal system	$2.69	$1.13	**$3.82**
Solar PV Electric	$0.25	$0.25	**$0.50**
Total	**$17.66**	**$8.19**	**$25.84**

8.2. Cost Reduction Strategies

From technical and ecological perspectives, a private water reclamation facility is an enabling factor for sustainable development allowing for treatment and reuse to happen on site, while reducing reliance on county owned and operated municipal infrastructure. However, from an economic perspective, building and operating such a facility can burden the total cost structure of the overall development to a point where it may not be economically viable. To ensure a successful project both economically and environmentally the following cost reduction methods are encouraged:

- Following final approvals and master development plan, revisit the CoM Flow rates. As explained in this report, the CoM Flow rates are conservative and experience has shown that new developments indeed contribute significantly less wastewater than older existing dwellings. The case would have to be made with the appropriate agencies to justify such claims; however, the data is available and viable.
- Work with the CoM to offer capacity to surrounding neighborhoods (e.g. Wailuku Heights) using municipal infrastructure, to relieve the Kahului WRRF. It is known that the County facilities are under pressure from the EPA to stop using injection wells. One approach, specific to Kahului, is to incrementally decrease the influent flow to the facility by either setting up scalping plants along the sewage collection network or send wastewater to private facilities. The CoM "Capital Improvement Projects Report" has $46 million listed for a Central Maui Regional WWRF (Waikapu) [3]. Another issue surrounding the Kahului WRRF is its location within the federally designated tsunami zone and it would benefit all of Maui if that facility was relocated.

[3] County of Maui "Capital Improvement Projects Report" March 31, 2016

- Coordinate with neighboring developments (e.g. A&B Waiale, Pacific Rim and Land Waiko base yard, CoM Parks and Recreation) to invest in this facility and arrange a capital cost structure whereby they are charged a $/Gal fee to interconnect to the WCT WREF.
- Federal, State, USDA, and Rural Development funds exist for projects of this scope; including bonds, low interest loans etc. The securing of these funds are subject to application and the fulfilment of a variety of requirements. The availability of such funding mechanisms will need to be researched and a roadmap prepared in order to begin the application processes.

9. Company References and Background

9.1. Mana Water

2010 Honoapiilani Hwy., C-1
Lahaina, Hawaii 96761
www.mana-water.com
Project Manager: Zoltan Milaskey
Treatment and Reuse Manager: Steve Parabicoli

Mana Water is a management company created to usher in the next generation of wastewater treatment and reuse, striving to set a benchmark for the twenty-first century wastewater treatment infrastructure in Hawaii. Mana Water is aware of the current and foreseeable issues surrounding Hawaii's water resources. Not only is water scarce, but outdated wastewater treatment infrastructure and the limited reuse of effluent, all within a very prestigious and sensitive ecosystem, are further endangering our supply of clean water. Mana Water has partnered with the best in the industry locally and globally to provide solutions to Hawaii's wastewater challenges.

9.2. Organica Water

61 Princeton-Hightstown Road
Princeton, NJ 08550
www.organicawater.com
Project Coordinator: Peter Varga

Organica Water is a global provider of innovative solutions for the treatment and recycling of wastewater with operating references in North America, Europe and Asia. With nearly two decades of experience and more than 50 operating references that utilize root structures as a biofilm carrier, Organica offers proven, economic, and sustainable solutions for today's wastewater management challenges.

9.3. Kennedy/Jenks Consultants

220 Imi Kala Street, Suite 205
Wailuku, Hawaii 96793
www.kennedyjenks.com
Senior Engineer: Eassie Miller

Kennedy/Jenks provides engineering and scientific solutions for water, environmental, energy, and innovative projects to government agencies and private utilities, industry and business, federal programs, and transportation clients. Kennedy/Jenks is employee-owned, with offices throughout the United States.

9.4. SYM Engineers LLC

390B Haleloa Place
Honolulu, Hawaii 9681
Structural Engineer: Shawn Matsumoto

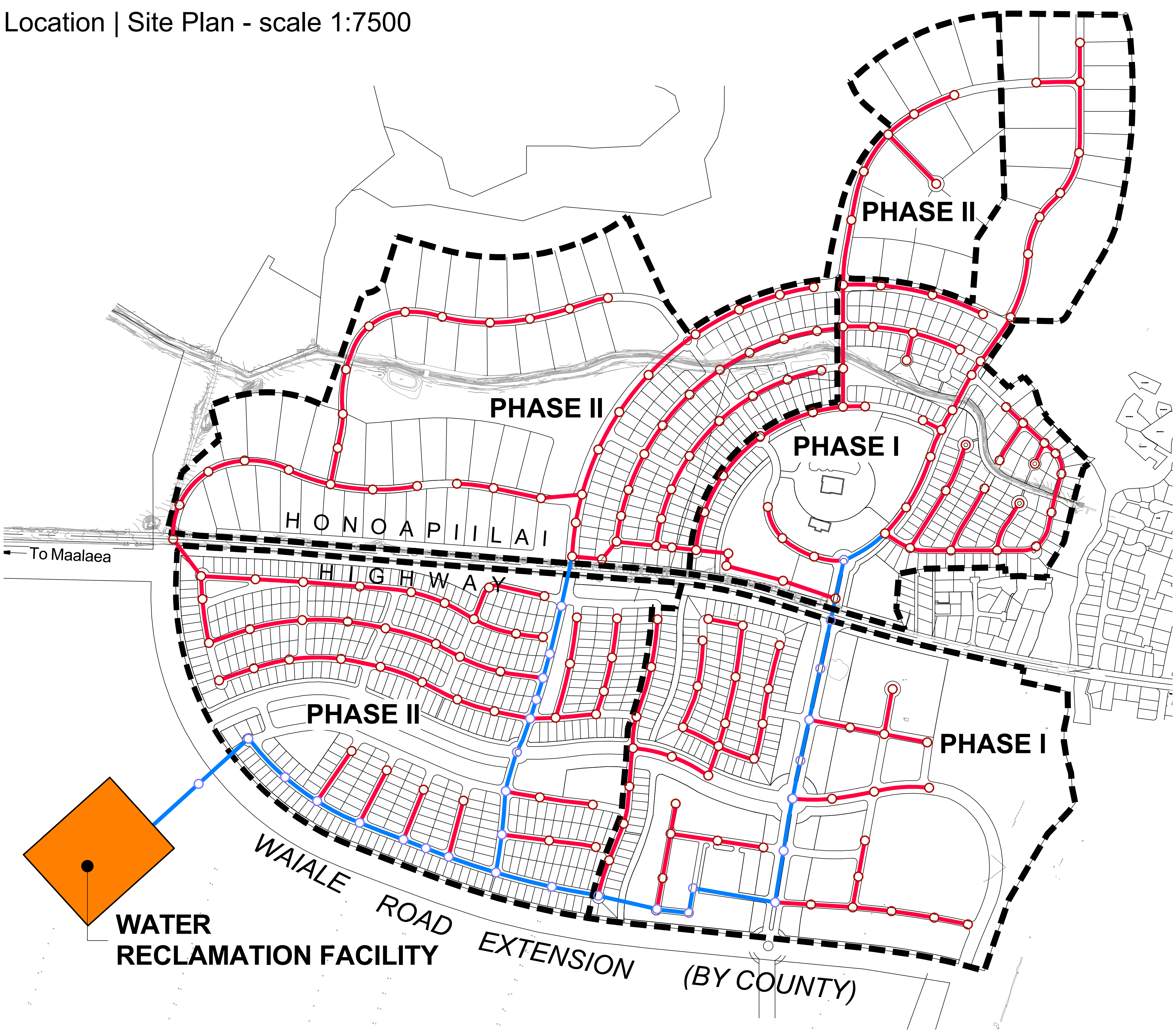
SYM Engineers LLC of Honolulu is a structural engineering firm licensed in the state of Hawaii. Engineering services include structural designs for new construction, repairs and renovations of various types of buildings and structural components. With over two decades of experience, SYM Engineers LLC has formulated structural framing schemes for a large variety of project types for both private and public sector clients. Design specialty includes a wide variety of structural systems using a large array of materials such as but not limited to, poured-in-place concrete, precast/prestressed concrete, post-tensioned concrete; structural and light-gage steel; concrete masonry; and timber.

10. Appendix 1 - Preliminary Architectural Renderings

10. Appendix 1 - Preliminary Architectural Renderings

Location | Site Plan - scale 1:7500

Water Reclamation Facility



Location A | Site Plan - scale 1:7500

Water Reclamation Facility

Water Reclamation Facility (Location "A")

N

Location B | Site Plan - scale 1:7500

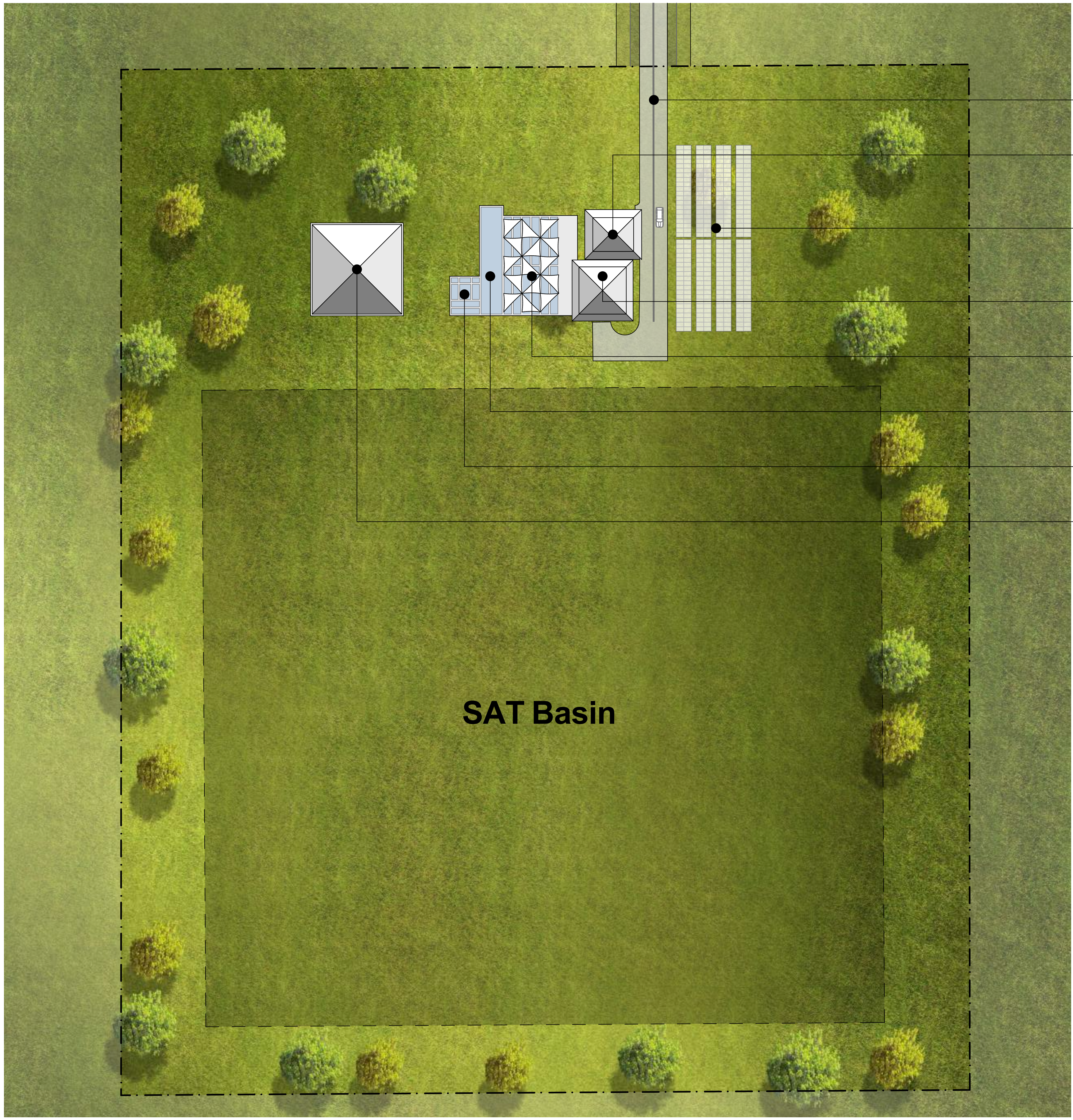
Water Reclamation Facility

Water Reclamation Facility (Location "B")

N

Location | Site Plan - scale 1:1000

Water Reclamation Facility



Junction Road

Education Center

Solar Panels
ground mount system

Pre-Treatment Area - Control Room

Planted Area

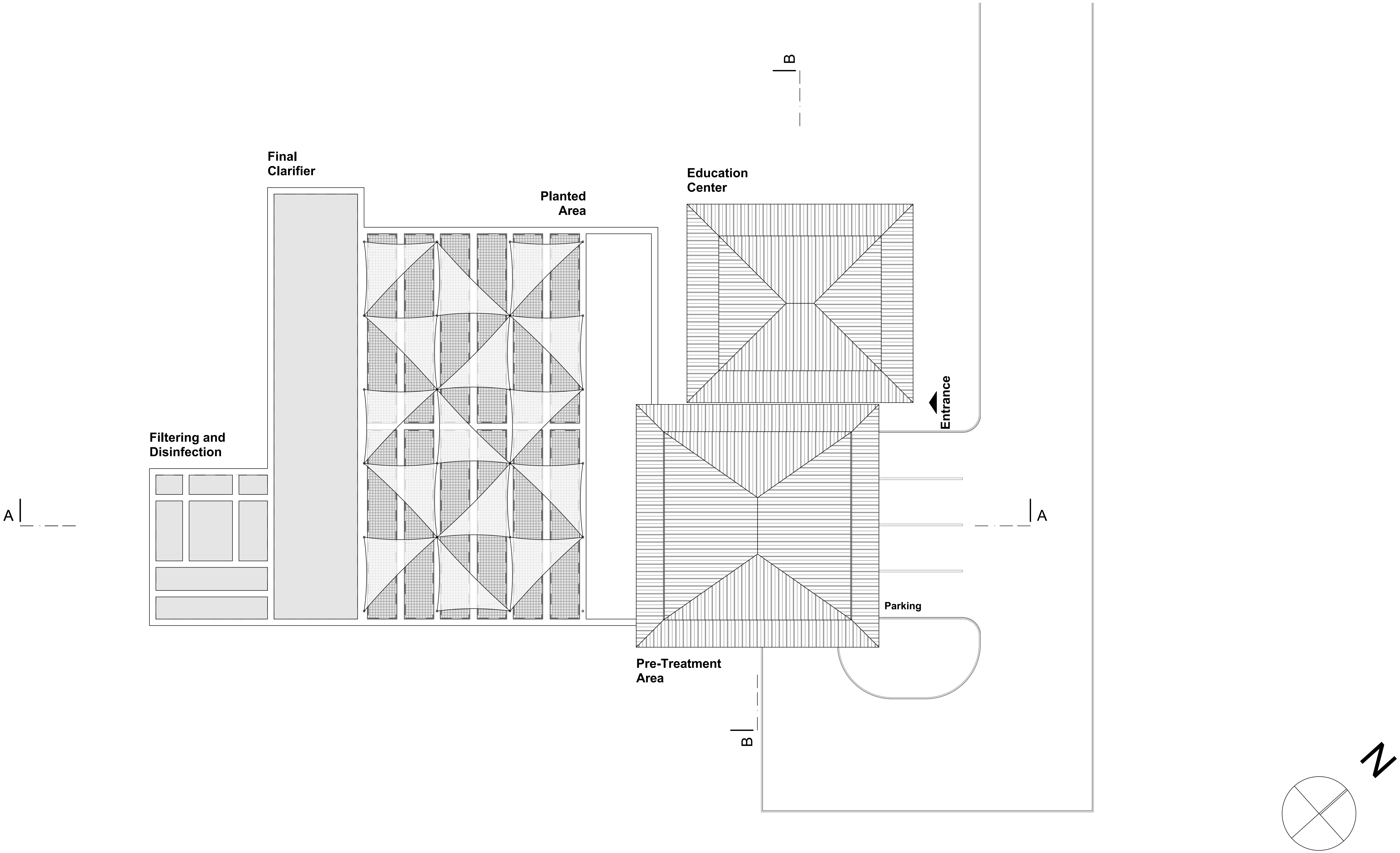
Final Clarifier

Filtering and Disinfection

R1 Storage Tank

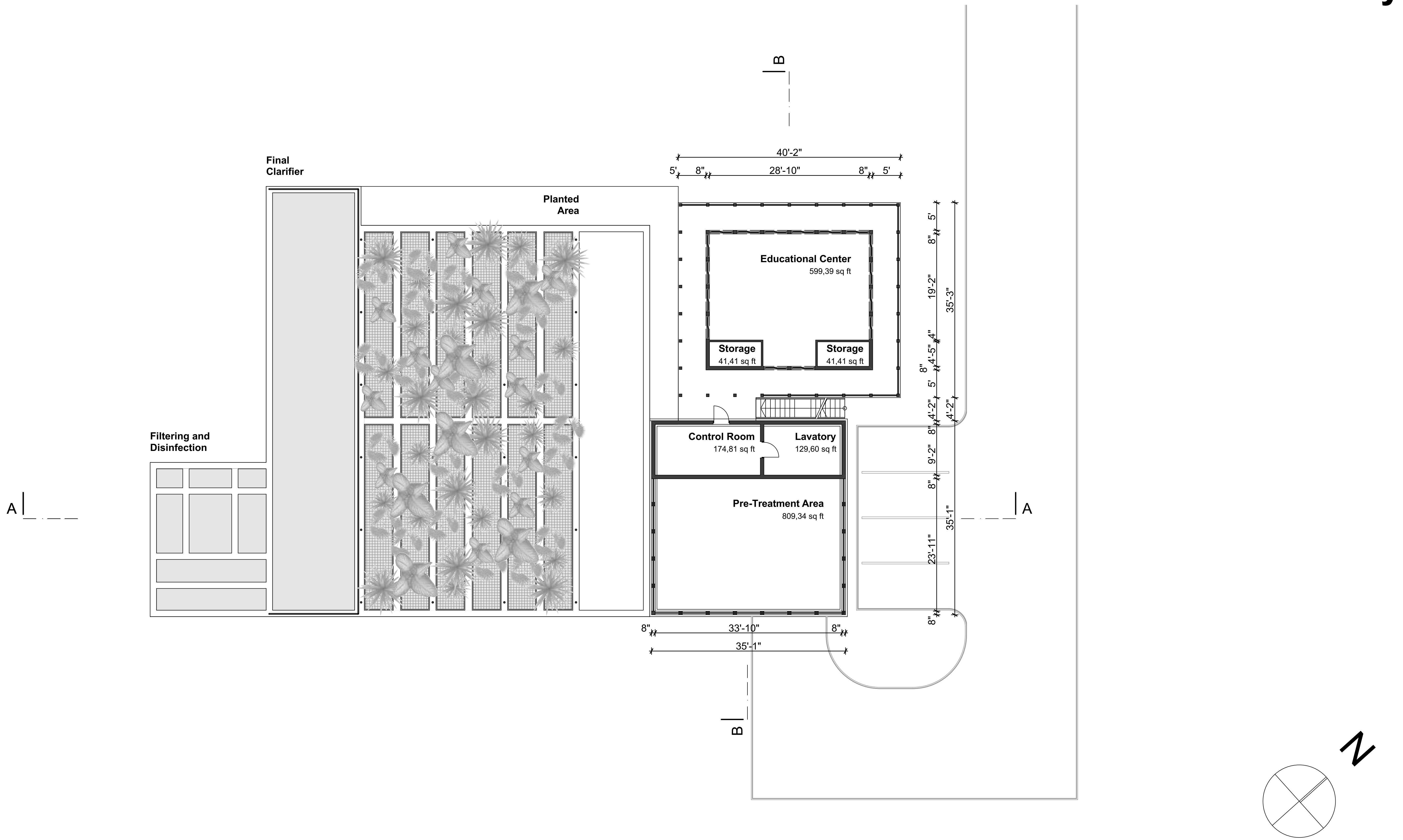
Overview - scale 1:200

Water Reclamation Facility



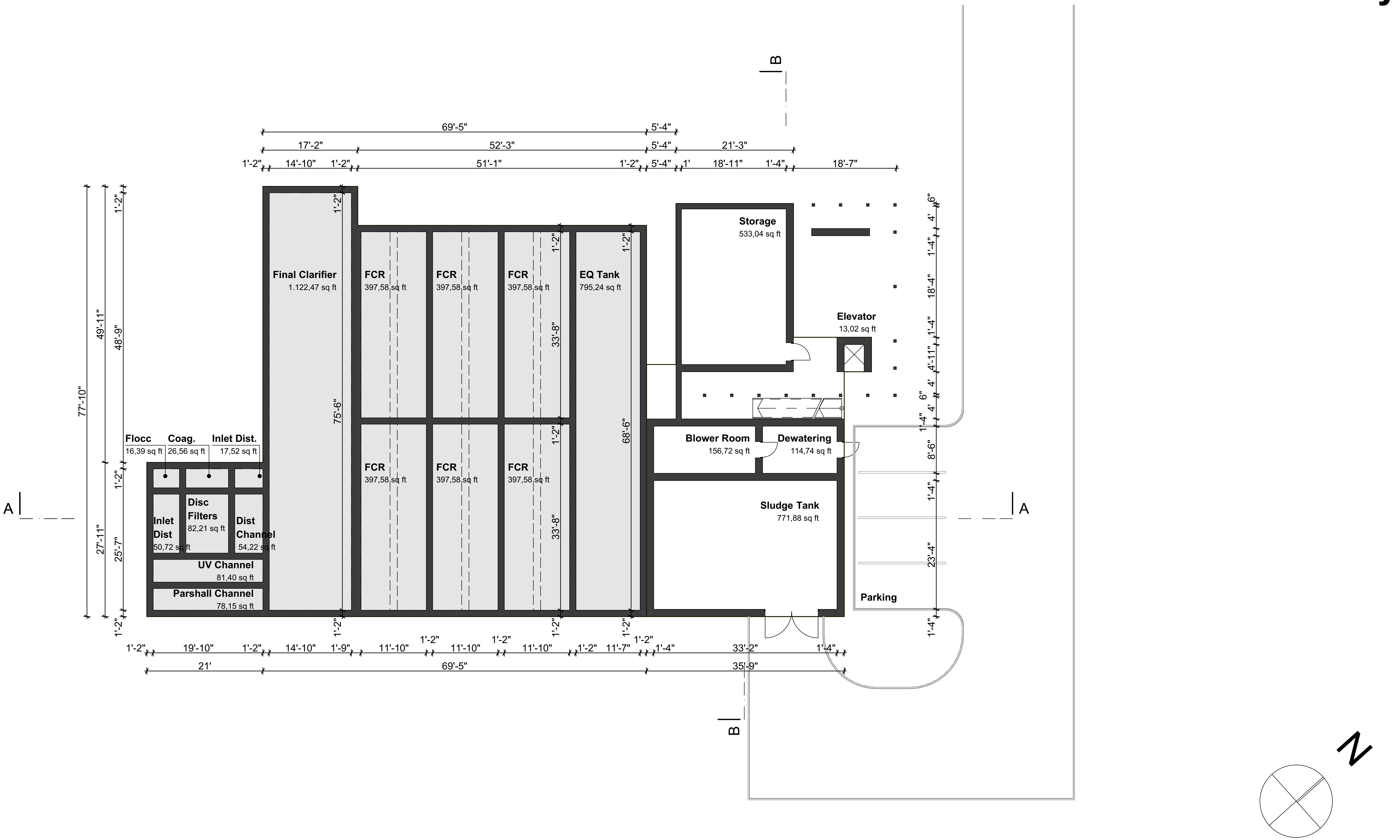
Ground Floor Plan - scale 1:200

Water Reclamation Facility



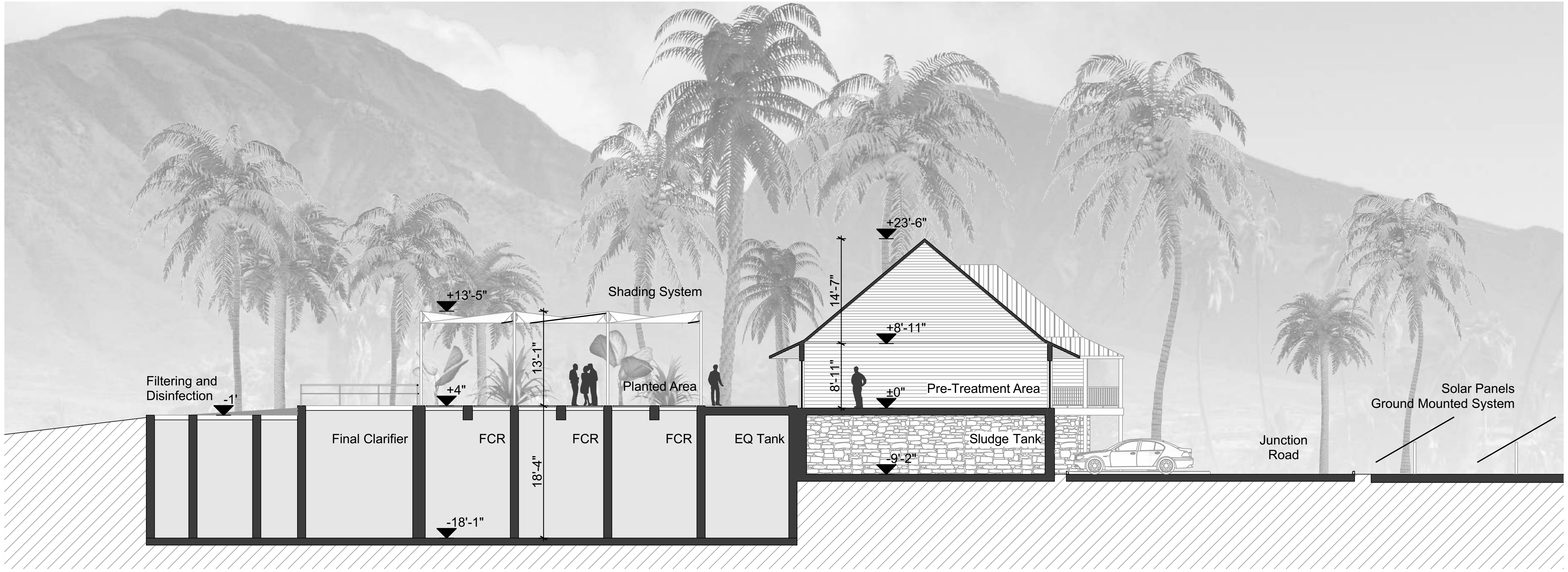
Ground Floor Plan - scale 1:200

Water Reclamation Facility



Sections - scale 1:200

Water Reclamation Facility

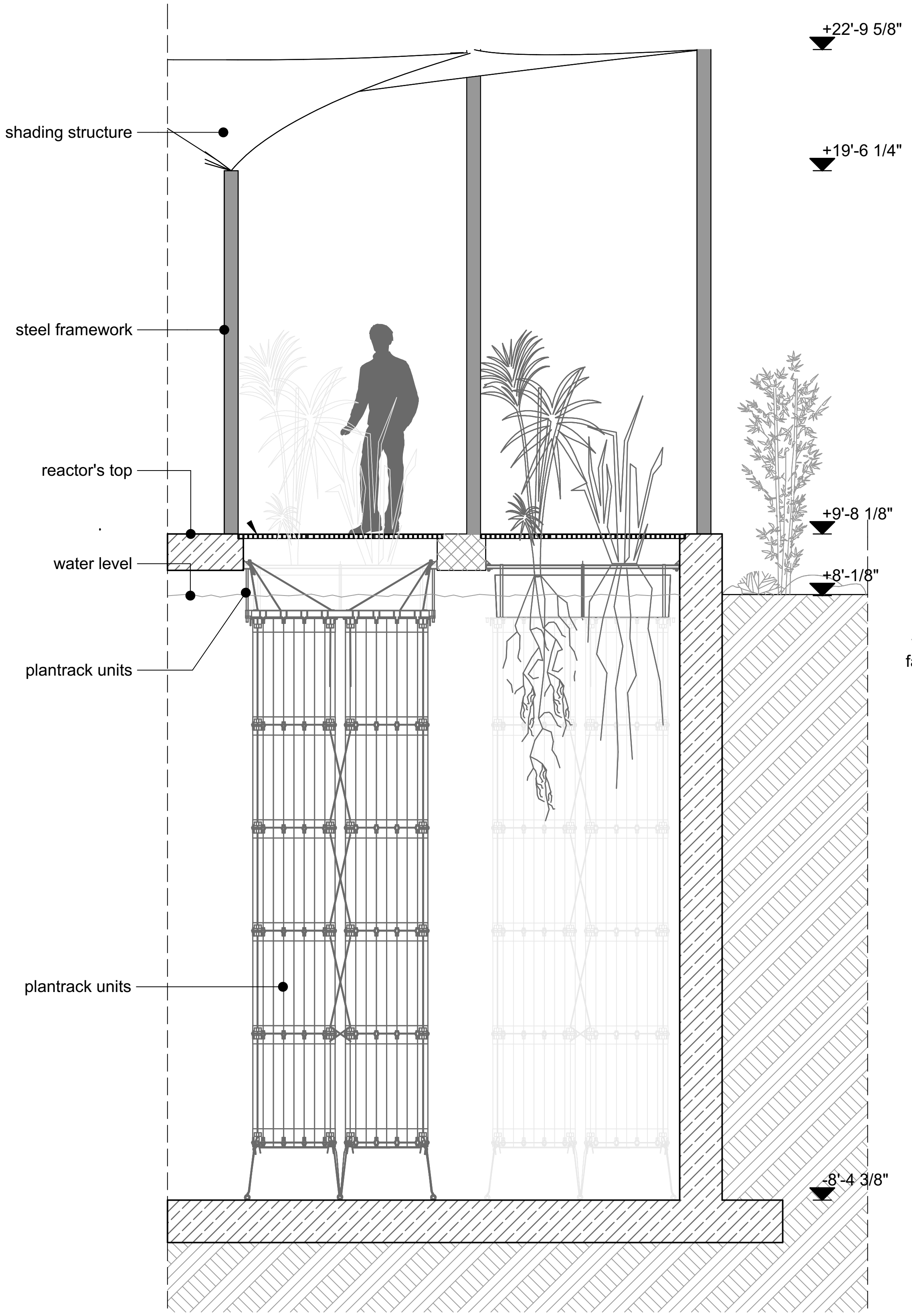


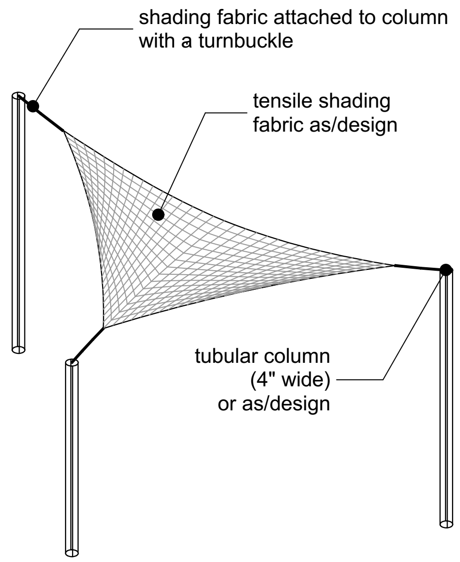
Elevations - scale 1:200

Water Reclamation Facility

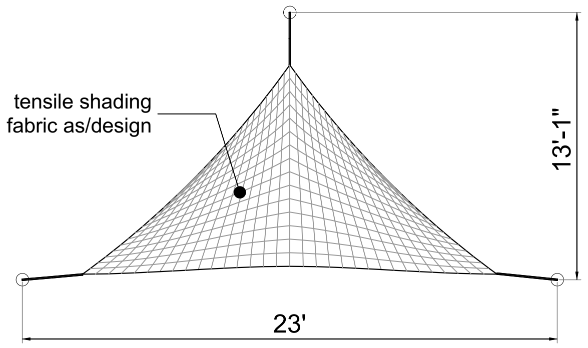
Detailed Reactor Section - scale 1:50

Water Reclamation Facility

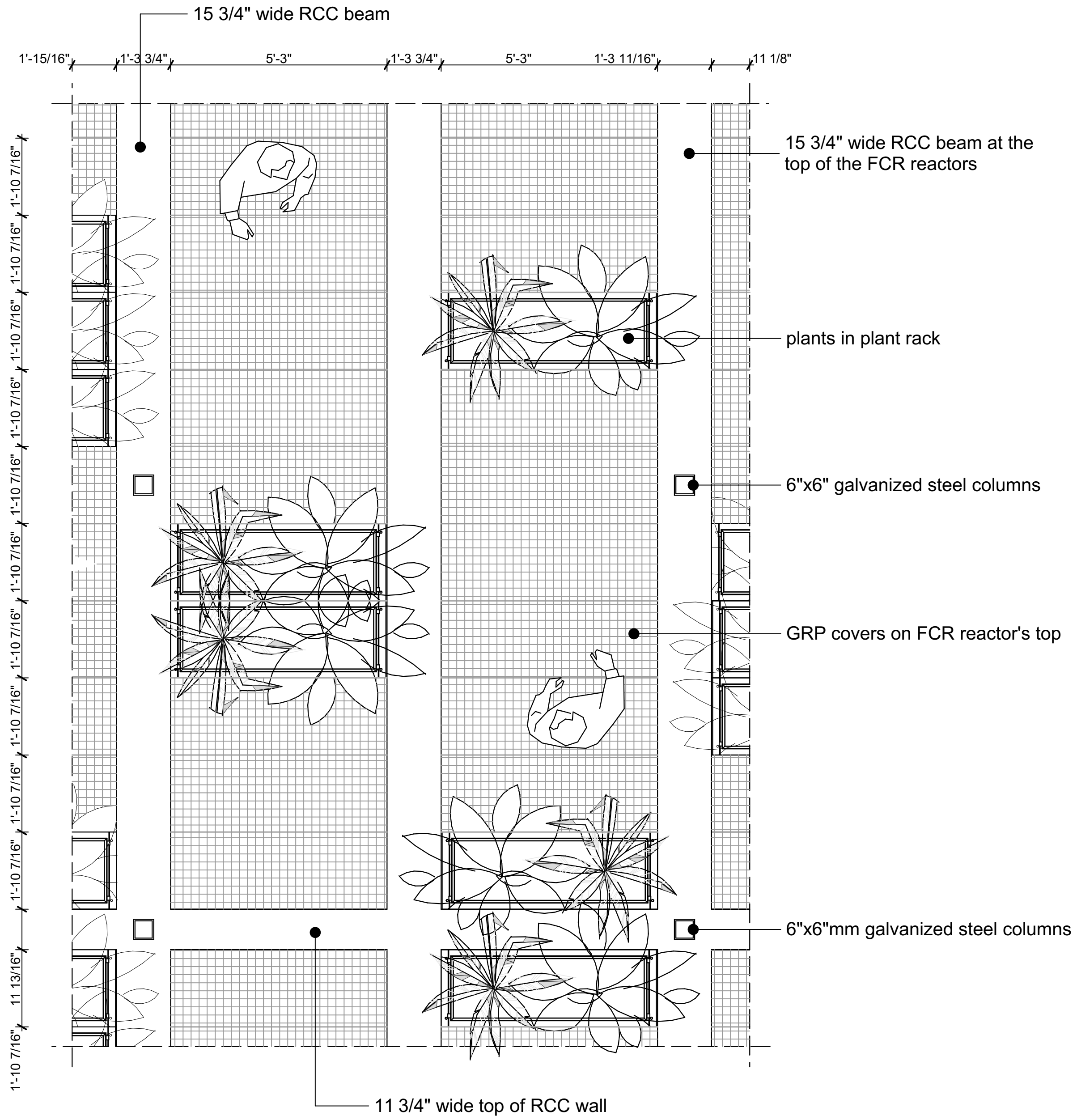




shading structure
(typical module concepttual 3D view)



shading structure
(typical module plan)



Detailed Building Section - scale 1:50

Water Reclamation Facility