KOLOA-POIPU REGIONAL WASTEWATER RECLAMATION FACILITY BASIS OF DESIGN

Koloa, Kauai, Hawaii

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APPENDICES

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KOLOA-POIPU REGIONAL WASTEWATER RECLAMATION FACILITY BASIS OF DESIGN

Koloa, Kauai, Hawaii

1. EXECUTIVE SUMMARY

A new Koloa-Poipu Regional Wastewater Reclamation Facility (Regional WRF) is part of an overall plan to provide wastewater collection, treatment and reuse in the Koloa and Poipu region of Kauai, Hawaii. The need for a regional wastewater system is driven by the existing and planned economic growth in the region. In addition, existing businesses in Koloa Town are required to comply with the Environmental Protection Agency's mandate to close all existing large capacity cesspools.

The objective of the Regional WRF development program is to construct the WRF in phases based on the demand for treatment capacity. The scheduled completion of the first phase of the facility and associated projects is slated for June 2010.

Development projections and existing service connections of the Koloa and Poipu area to the Regional WRF had been prepared in the development of the Basis of Design Report *"Koloa Regional Wastewater Transmission System-December 2007"* and were used as the basis for the preliminary design of the facility. The first phase of the facility is designed for a flow of 0.6 MGD average daily flow (ADF). With the completion of Kukui'ula Increment 2 and the Villages at Poipu Phase 3 in the year 2015, marks the second increment (first expansion) of the facility to 1.1 MGD ADF. Beyond the year 2020, demand for new wastewater treatment capacity will be dependent upon the connection of existing packaged wastewater treatment units in Poipu, east of Weliweli Tract. In the event of a project to consolidate the individual package plants and to pump

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the wastewater to the Regional WRF, the facility will then be again expanded to a capacity of 1.7 MGD ADF. Koloa Town will also pump their wastewater to the regional facility. The flows are minimal, approximately 65,000 gallons per day, ADF.

Selection of the appropriate wastewater treatment process train alternatives were determined based on meeting three objectives.

- Produce the highest quality of recycled water (R-1) in Hawaii as defined by the State of Hawaii Department of Health and Guidelines for the Treatment and Use of Recycled Water.
- Comply with the requirements of DOH's Underground Injection Control (UIC) rules
- Construct a WRF that will reduce the effluent total nitrogen concentration to less than 10 mg/l.

The proposed Regional WRF will be located on property owned by Grove Farm Company adjacent to the existing Koloa Mill that has not been in operation for about 10 years. Development plans for the Mill have not been determined. Plans range from using the area as a historic site, commercial or tourist area. Therefore the facility design must complement future development of the Mill and surrounding areas. Also, with the facility being located on Kauai, some inherent characteristics such as cost and stability of power, size and capability of labor pool, delivery of equipment, parts availability, etc. needs to be taken into account. Points considered while evaluating the alternatives for the proposed Regional WRF were:

- The WRF should consider controls to minimize noise, odors and vehicle traffic.
- The WRF should incorporate aesthetic design features that will make it blend in with the existing Koloa Mill, thereby minimizing the WRF's visual impact.
- The WRF should be simple to operate and not require complex procedures or intensive on-site monitoring.

- The WRF will be manned only 8 hours per day and should be capable of running unattended.
- The WRF should reliably achieve discharge permit requirements over all anticipated flow and loading ranges, as well as achieve nitrogen removal.
- The WRF should be equipped with a Supervisory Control and Data Acquisition (SCADA) system which will allow remote monitoring of the entire facility.

Five wastewater secondary treatment alternatives were identified as possible systems that would be suitable for implementation at the Regional WRF. These alternatives were:

- Conventional activated sludge-Extended aeration (CAS)
- Sequencing batch reactor (SBR)
- Membrane bioreactor (MBR)
- Moving bed bioreactor/Integrated fixed-film activated sludge (MBBR/IFAS)
- Advanced Ecological Engineering Systems (AEES)

Each secondary alternative and related ancillary processes were reviewed. The secondary process drives the treatment required up- and downstream. An Analytic Hierarchy Process (AHP) Pairwise Comparison exercise was employed for the selection of the secondary process for the Regional WRF. The five secondary processes listed above were evaluated against three sets of categorized criteria - cost, operations and social impact.

The AHP Pairwise Comparison resulted in MBBR/IFAS and MBR being ranked a very close top two. Opinions of probable capital cost were prepared for the MBBR/IFAS and MBR alternatives to provide a comparative order of magnitude for the construction of a new regional wastewater facility at a capacity of 0.6 MGD, ADF with a peak flow through the facility of 1.1 MGD.

At this preliminary design stage, the opinion of probable costs is approximately $21.1 million for the MBBR/IFAS process and $19.5 million for the MBR process. These estimates include a 25% contingency.

The prorated costs for a 0.6 MGD facility were determined to be approximately $12,740,000 for the MBBR/IFAS process and $12,940,000 for the MBR process. These are the portions of the total costs that the owner of the Regional WRF would likely be allowed to charge the users for this initial phase of the Regional WRF. The balance would be charged to users in subsequent phases, as expansion of the Regional WRF becomes necessary to accommodate these additional users.

Land areas based on the preliminary layouts are 3.1 acres and 3.9 acres for MBR and MBBR/IFAS alternatives, respectively. The principal advantage of these processes over CAS is the ability to meet or exceed treatment capability with a smaller overall footprint.

Both MBBR/IFAS and MBR will be able to produce R-1 disinfected-tertiary recycled water and reduce nitrogen. Capital costs and area required for a MBBR/IFAS system are somewhat higher than for an MBR system, and also requires more processes to meet the R-1 criteria than an MBR system. However, a major factor to consider is that the Regional WRF will be located on Kauai, where resources to operate and maintain the facility are limited. At a power cost of more than $0.30/KWH, the MBR process would be more costly to operate than an MBBR/IFAS process, due to the number of pumps and blowers required to operate the facility. The MBBR/IFAS process will allow the operator to manually manipulate the flows to achieve a better effluent, whereas the MBR system requires intensive instrumentation trouble shooting by uniquely skilled operators. Another factor that contributes to the selection of the MBBR/IFAS process is that the team who will be operating this facility is currently operating a MBBR/IFAS wastewater facility on Poipu, Kauai and they are already familiar with the processes, equipment and biology of MBBR/IFAS option. Therefore, given the limitations and challenges of operating a sophisticated, power-intensive MBR process on Kauai, and considering the current experience of the operators that will be attending to the Regional WRF, the MBBR/IFAS process has been selected as being most suitable for this facility.

2. BASIS OF DESIGN

2.1 Introduction

Based on previous planning studies, an upgrade of the existing Poipu Water Reclamation Facility (WRF) and the construction of a new Koloa-Poipu Regional WRF are critical to meet the wastewater treatment requirements for the region. The proposed Regional WRF is to be constructed on a site within the Koloa Mill property owned by Grove Farm Company. The new facility will treat excess wastewater (beyond 1 MGD), including waste activated sludge from the existing Poipu WRF, and wastewater from other residential and commercial developments within Koloa and Poipu.

As part of the upgrade to the Poipu WRF, a new integrated influent pump station will be constructed which will distribute the flow between the existing Poipu WRF and the proposed Regional WRF. Flows that are directed to the proposed Regional WRF will be conveyed via two proposed intermediate pump stations. The first pump station in this series will be located below the entry road to the Kiahuna Golf Course (Golf Course Pump Station) and the second, which collects and transports the flow to the proposed Regional WRF, will be located near an existing water tank (Water Tank Pump Station). Other flows that will be treated at the Regional WRF will originate from a few existing, new and planned developments in Koloa Town. The flow from this area will be pumped directly to the Regional WRF. The anticipated flow from Koloa town is minimal, approximately 65,000 gpd ADF flow. Technical Memorandum *"Koloa Regional Wastewater Transmission System-December 2007"* can be referenced to further investigate derivation of the present and projected future flows within the tributary area and the basis of design of the Golf Course Pump Station and the Water Tank Pump Station.

2.2 Design Flows and Loadings

To summarize this report, flows to the Regional WRF will increase as developments within the tributary areas are completed and occupied. The planned Water Tank Pump Station will have the greatest impact to the facility.

From the aforementioned report, the projected wastewater flows from the Water Tank Pump Station to the Regional WRF are presented in **Table 2-1**.

The proposed Water Tank Pump Station will be designed with 3 installed, constant speed, equally sized, submersible pumps to accommodate the flows between the present and year 2020. Two of the three pumps will handle the peak flows entering the station with the third on standby. Beyond the year 2020, or when existing developments east of Weliweli Tract discharge into the Water Tank Pump Station, a fourth pump of equal capacity will be added. At this time, three pumps will operate to handle the ultimate peak with the fourth pump on standby.

Table 2-1 Design Wastewater Flows to Proposed Regional WRF

PHASE	FLOW	WATER TANK PUMP STATION	KOLOA TOWN PUMP STATION	TOTAL
Existing to 2010	Design Average (MGD)	0.56	.065	**0.63**
	Design Maximum (MGD)	3.15	.15	3.30
	Design Peak (MGD)	5.08	.23	5.31
Between 2010 to 2020	Design Average (MGD)	1.10	.065	**1.17**
	Design Maximum (MGD)	4.34	.15	4.49
	Design Peak (MGD)	6.27	.23	6.50
2020 and Beyond	Design Average (MGD)	1.69	.065	**1.76**
	Design Maximum (MGD)	5.55	.15	5.70
	Design Peak (MGD)	7.69	.23	7.92

Table 2-2 presents the flow rates from the Water Tank Pump Station to the Regional WRF gathered from the Technical Memorandum.

Table 2-2 Water Tank Pump Station Pumping Rates

1 PUMP		2 PUMPS		3 PUMPS	
FLOW (GPM)	FLOW (MGD)	FLOW (GPM)	FLOW (MGD)	FLOW (GPM)	FLOW (MGD)
2,850	4.10	5,150	7,42	6,850	9.86

The loadings used for design of the proposed Regional WRF are summarized in **Table 2-3**.

Table 2-3 Influent Design Criteria

Parameter	0.6 MGD	1.1 MGD	1.7 MGD
INFLUENT BOD_5			
Average Day, mg/l	250	250	250
Maximum Month, mg/l	300	300	300
Maximum Month, lb/day	1500	2750	4250
INFLUENT TSS			
Average Day, mg/l	250	250	250
Maximum Month, mg/l	300	300	300
Maximum Month, lb/day	1500	2750	4250
Ammonia			
Average Day, mg/l	17	17	17
Maximum Month, mg/l	20	20	20
Maximum Month, lb/day	100	185	285

The wastewater treatment process selection is also largely determined by the planned use of the effluent generated from the facility. Two factors govern the consideration of the treatment process alternatives to be used at the Regional WRF. First, reuse of the effluent for irrigation purposes will require filtration and disinfection as part of the process train to meet the R-1 requirements as stated in the State of Hawaii, Department of Health's (DOH's), Chapter 62 of Title 11, Hawaii Administrative Rules. The second factor is that the excess R-1 water, as well as effluent that does not conform to R-1 water requirements, will be discharged into injection wells situated below the underground injection control (UIC) line, provided that it conforms with the UIC permitted discharge limits.

Table 2-4 summarizes the effluent discharge permit limits for R-1 use and injection well discharge.

Table 2-4. Koloa-Poipu Regional WRF Permit Limits

Parameter	UIC Criteria	DOH, R-1 Criteria
BOD_5, mg/l	30	< 5*
Total Suspended Solids, mg/l	30	<5*
Turbidity, NTU		2
Fecal Coliform		<2.2/100 milliliters

Abbreviations:
BOD – 5-day Biochemical Oxygen Demand
UIC – Underground Injection Control
mg/l – milligrams/liter
NTU – Nephelometric Turbidity Units

*Not regulatory criteria, but rather reasonable limit to achieve 2 NTU turbidity.

Typically, reclaimed water contains nutrients such as nitrogen and phosphorus. The treated effluent from the WRF will be discharged into the basaltic substrata near Poipu, where it will eventually percolate up through the formations and diffuse into the near shore waters. In the past, the EPA had limited the quantity of effluent to be discharged to some injection wells, because it believed that nitrogen in the effluent was one of the reasons attributing to the recurring algal blooms in the coastal waters of Hawaii. Thus, although nitrogen levels are not specifically indicated for the UIC or DOH, R-1 water limits, it should be considered. In addition, it is also possible that in the near future, the discharge permits may include nitrogen within its criteria to follow suit with some counties on the United States.

Although the UIC limits the TSS to 30 mg/l, a much lower TSS level, on the order of 5 mg/l or less, should be attained to prevent the injection wells from plugging. Given these criteria, only secondary processes that are able to provide nitrification and de-nitrification followed by tertiary filtration will be considered for further investigation.

2.3 Facility Design

The Regional WRF will be located adjacent to the existing Koloa Mill that has not been in operation for about 10 years. Future development plans for the Mill have not been determined, although possible plans may include using the area as a historic site, commercial or tourist area. Therefore, the proposed Regional WRF design will encumber future development of the Mill and surrounding areas as well. Also, with the facility being located on Kauai, there are inherent considerations such as cost and stability of power, size and capability of labor pool, delivery of equipment, parts availability, etc. Characteristics considered while evaluating the alternative processes and equipment for the Regional WRF were:

- The WRF should consider controls to minimize noise, odors and vehicle traffic.
- The WRF should incorporate aesthetic design features that will make it blend in with the existing Koloa Mill, thereby minimizing the WRF's visual impact.
- The WRF should be simple to operate and not require complex procedures or intensive on-site monitoring.
- The WRF will be manned only 8 hours per day and should be capable of running unattended.
- The WRF should reliably achieve discharge permit requirements over all anticipated flow and loading ranges, as well as achieve nitrogen removal.
- The WRF should be equipped with a Supervisory Control and Data Acquisition (SCADA) system which will allow remote monitoring of the entire facility.

Due to the size of the facility an aerobic secondary process and aerobic sludge stabilization has been selected. This process will minimize the odors, reduce operational complexity and reduce the overall footprint of the Regional WRF. Primary clarifiers will also not be incorporated in the design which will eliminate the handling of the raw primary sludge which is difficult to stabilize and increase the odor potential. Dewatering the aerobically digested stabilized sludge will be done through mechanical means as opposed to a less costly and potential odor producing operation such as on site sand drying beds.

2.4 Required Treatment Processes

The required treatment processes and equipment for the proposed Regional WRF, consistent with the overall facility design are listed below:

- Influent and effluent flow monitoring
- Headworks with screening and grit removal, and equipment for screenings and grit washing, dewatering and compaction
- Aerobic secondary treatment
- Effluent filters, or equal
- Effluent pump station and on-site R-1 water storage tank
- Wastewater disinfection using ultraviolet light technology
- Aerobic sludge digestion and mechanical dewatering
- Renovation of existing Koloa Mill Bagasse building to house offices, laboratory and maintenance area.
- Support facilities such as a plant water system, roads and utilities
- Odor control for odor potential areas

The Headworks for the Regional WRF will receive the majority of the flow from the two proposed pump stations currently under design. Process options for the Headworks facility are described in Section 3. After screening and grit removal, the plant flow will be conveyed to secondary treatment. Evaluations of the secondary treatment alternatives are included in Section 4. Sludge processing facilities and other support facilities are described in Section 5. Section 6 displays the facility layout for each alternative and processes required. Section 7 summarizes the selection process using an Analytic Hierarchy Process (AHP) Pairwise analysis used at the WRF. The top two alternatives are discussed and an opinion of costs for these two alternatives is generated.

Section 8 summarizes the final alternative to be used and associated processes required.

3. PRELIMINARY TREATMENT

The Preliminary Treatment facilities, or Headworks, consist of the following processes:

- Flow monitoring
- Fine screenings
- Grit removal
- Screenings washing, compacting and dewatering
- Grit washing and dewatering

3.1 Influent Flow Monitoring

Raw wastewater will be pumped to the new Regional WRF via two separate proposed pump stations, one located near the existing water tank and the other located in Koloa Town. The current long-term plan includes no gravity sewer flow to the facility. There are two popular methods of monitoring incoming raw wastewater to a treatment facility. One is through the use of a flume, such as a Parshall flume coupled with a level measuring device. The other is an in-line, pipe-mounted flow meter which can be either a magnetic flow meter or a Doppler meter installed in a section of pipe that is always flowing full.

A Parshall flume is typically installed within a concrete channel. A straight run of channel before and after the flume is required to stabilize water profile to achieve accurate measurements. Due to the extensive length of concrete channel required, the flume and level indicator will cost considerably more to construct than installing an in-line meter. It would also provide a potential pathway for the release of odorous gases.

Either an in-line magnetic or a Doppler meter is suggested for this project. The final selection will be made during design.

3.2 Fine Screenings

Installation of a mechanical fine screen (1/4 in openings) in the Headworks is provided for the purpose of removing rags, stringy material, and other non-biodegradable material from the influent stream that might hinder the downstream processes. Additionally, the installation of a fine screen will remove a considerable amount of the floatables and other solids in the wastewater and will reduce wear, deterioration, and plugging in downstream process equipment, allowing them to function more efficiently.

If a Membrane Bioreactor is selected as the secondary process, a coarse screen followed by grit removal then a fine screen is recommended. Very fine screens must be used, with openings from 1-3 mm, depending on the membrane manufacturer to prevent damage to the membrane or entanglement by hair and stringy material.

Mechanical screens are discussed further in Appendix A and are available in several designs:

- In-channel grinder with auger
- Belt/Band screen
- Center-flow screen
- Step-style screen
- Rotary arc fine screen
- Vertical bar screen

The key criteria considered when evaluating the different screening technologies include the following:

- Headloss through the screen

- Amount of screenings removal, or screenings capture ratio (SCR)
- Screen dimensions and arrangement
- Screen and washer compactor capital cost

The operations and maintenance requirements for the screens and screening washer compactors evaluated in this report are estimated to be approximately the same for each system, except for the Auger Monster. The Auger Monster will require the grinder motor to run continuously, as its main function is to grind anything in the waste stream and retain as much organic material as possible. The grinding action upstream of the grit removal system also necessitates replacement of the cutter cartridges every six to eight years. All other screen manufacturers indicate that all routine maintenance requirements are performed above and outside of the channel. The motors for all of the evaluated screens and washer compactors are of minimal horsepower and run intermittently. Therefore, power requirements are approximately the same for the alternatives, and a very minor portion of the overall treatment process power requirements. The Auger Monster is the only unit that requires continuous motor operation for the grinders. Most units have similar moving parts and have similar recommended maintenance requirements.

Collected screenings will be deposited into a screenings washer/compactor, of which several designs are available. Dewatered screening will be discharged to a roll off container for disposal offsite. To minimize odors, it is recommended that a bagging system be incorporated on the screenings dewatering device.

3.3 Grit Removal

Grit, which consists of smaller and heavier non-degradable particles, primarily sand, that are washed into the sewer system. This material must be removed so it does not damage process pumps and other equipment, and it does not accumulate in the tanks which eventually reduce capacity. Grit is normally handled as solid waste, like the screenings. The grit removal equipment includes a material washer to separate the grit from the treatable organics, and a dewatering screw to drain away the water and make the grit dry enough to be handled by the solid waste utility.

Several grit removal designs have been used historically. The two designs that are best suited for the Regional WRF are:

- Vortex grit removal
- Aerated grit chamber

The two types of Vortex grit removal systems are discussed further in Appendix A.

The design that is best suited for the Regional WRF is classified under a Vortex grit removal and is further subcategorized into two types: free vortex and forced vortex. Free vortex grit chambers use centrifugal force to push the grit particles against the side walls of the grit basin, and the particles travel down and out the bottom of the chamber whereas a forced vortex uses an external drive and a paddle to create the vortex. The recommended selection of the vortex grit removal to be used is in Section 8.

3.4 Flow Equalization

Flow to the Regional WRF will be primarily from the Water Tank Pump Station, thus the Regional WRF will receive slugs of wastewater at a rate excessive of the designed average dry weather and peak flow as shown in **Table 2-2**. Reducing the raw sewage flow rate before it enters the secondary processes by diverting it into an equalization basin is recommended for some processes. Equalization is achieved through the use of a wide spot in the line or an additional basin to provide storage volume and subsequent steady release of the flows to the downstream processes. Advantages to the Regional WRF include achieving consistent flows through the damping of peak and wet-weather flows and loads. Other benefits, in addition to the downsizing of secondary and tertiary processes include enhanced biological treatment through consistent loading.

Disadvantages of flow equalization include odor concerns and needs for odor mitigation due to the storage of raw or preliminary treated wastewater; additional operations and maintenance requirements; and additional land requirements in which to construct the basin.

Equalization tanks are best placed downstream of preliminary process areas, including screening and grit removal facilities. This reduces the need for mixing, grit accumulation in the equalization tank and mitigates the majority of concerns associated with flotables and scum accumulation.

3.5 Odor Control

The principal odor control techniques available for use on the Headworks and other odor potential process areas include:

- Three-stage chemical scrubbers
- Carbon filters
- Biological scrubbers
- Biofilters

All of the odor control techniques can be designed to achieve the desired removal levels of odorous compounds. Chemical scrubbing would require storage and feeding of caustic soda, liquid sodium hypochlorite, and possibly sulfuric acid. However, the large air volume from the total headworks and other areas may be too great to make this approach practical. Biological scrubbers involve the use of re-circulated biomass to create bacterial growth on the scrubber packing that absorbs odorous compounds. Carbon scrubbers would also be very effective, although the operation and maintenance costs would be greater due to the need to periodically regenerate and replace the carbon.

4. SECONDARY TREATMENT OPTIONS

As mentioned in Section 2, the process selected will be largely determined by the effluent quality generated from the facility and its ability to meet the State of Hawaii R-1 water requirements for water reuse and to meet the UIC discharge permit requirements. Although the removal of nitrogen is not a requirement under the R-1 water reuse and UIC discharge permit, the alternative selected shall be able to provide nitrification/denitrification to reduce the levels of nitrogen in the effluent.

4.1 Identification/Screening of Process Alternatives

Secondary treatment processes exist in a variety of configurations, most of which are variants of the conventional activated sludge process. Some of the processes that are able to meet the criteria for the Regional WRF include:

- Conventional activated sludge-Extended aeration (CAS)
- Sequencing batch reactor (SBR)
- Membrane bioreactor (MBR)
- Moving bed bioreactor/Integrated fixed-film activated sludge (MBBR/IFAS)
- Advanced Ecological Engineering Systems (AEES)

These five secondary treatment alternatives are described in detail below. Ancillary processes such as sludge stabilization and disinfection are discussed in Section 5.

4.2 Activated Sludge Process-Extended Aeration

Conventional activated sludge (CAS) generally consists of a long and narrow aerated basin followed by clarification. Aeration systems are used in the activated sludge process to provide oxygen for the biochemical oxidation of carbonaceous and nitrogenous matter and to maintain the biochemical solids in suspension.

The extended aeration process is a modification of the CAS process that provides a longer retention time of the wastewater in the tank, a better organic removal, less biosolids generation and nitrification. These characteristics make it suitable for small facilities for its ease in operation, low solid yields and generally good settlebility. Aeration tank retention times are generally between 20-30 hours, or over twice that of a CAS process. Typically in a small facility such as the proposed Regional WRF, a primary clarifier is not used, thus reducing the capital and operational costs.

This process also has the potential for upgrading and providing a flexible alternative for future needs. The process is flexible and robust, but like most suspended growth systems it has occasional settling problems, as well as foaming and bulking sludge.

The reduction of nitrates is desired for the Regional WRF if injection wells are to be used as a means of discharging the effluent. Denitrification can be accomplished with the incorporation of a separate basin upstream of the aeration basin that can support an anoxic environment where denitrifying microorganisms can synthesize the soluble nitrate into nitrogen gas. Alternatively, the aeration basin can be designed to use flexible headers connected to diffusers that span the basins, perpendicular to the direction of flow. Denitrification can then be achieved simultaneously in the same tank by alternating the flow of air to the headers to provide traveling aerated and anoxic zones within the single aeration tank.

CAS systems can be designed to incorporate simple bioselectors that can be operated in either an anoxic, anaerobic, or aerobic mode, as a step-feed process. **Figure 4-1** is a step feed CAS where raw wastewater is introduced to several points along the length of the activated sludge reactor. With this process, the reactor basin is more evenly loaded compared to having all organic load introduced at the front end. This results in an increase in treatment efficiency and a smaller tank. Additionally, flow peaks can be routed to the last one or two passes to prevent biomass washout during storms.

To maximize the flexibility inherent in a step feed process, the ability to regulate flows between the various passes is required. This is done through a series of flow meters and modulating valves. A static flow distribution box could also be provided although flow regulation capability would be more limited.

The flow from the aeration tanks will flow to a final clarifier to allow for solids separation. The clarified wastewater will go on to additional treatment to meet the effluent requirements. Settled solids in the final clarifier will be concentrated, stabilized, dewatered and hauled to a biosolids disposing site.

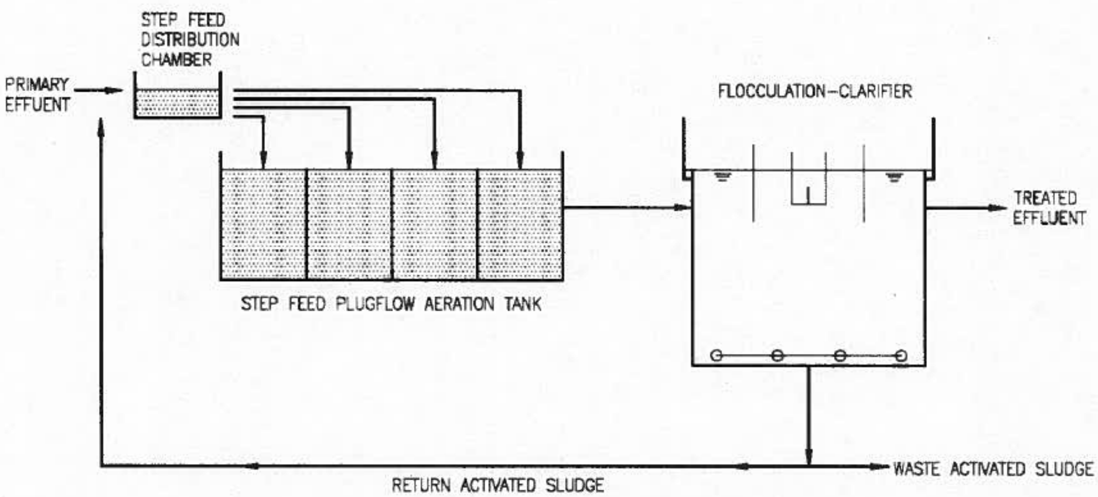


Figure 4-1. Typical CAS Process

4.3 Sequencing Batch Reactors

The sequencing batch reactor (SBR) is one of the oldest forms of wastewater treatment. As its name indicates, the operation is a "batch process". Before the advent of programmable logic controllers, this process was impractical. However, the recent coupling of this batch process with programmable logic controls created a growing recognition of the benefits of the batch mode activated sludge system.

The SBR is a mixed culture, suspended growth activated sludge treatment system that is operated on a fill-and-draw basis. It uses a single tank for waste stabilization and solids separation, thereby eliminating the need for secondary clarifiers. The semi-continuous operation of the SBR consists of four distinct phases (fill, react, settle, and decant). The first step is the fill mode, where wastewater is introduced at 25%-100% of the design volume. When the set point volume is reached, the flow to the tank is stopped. Alternate phases of aeration and mixing (without aeration) follows as the second step. The aeration phase promotes soluble BOD removal and nitrification. The mixing or anoxic phase promotes denitrificaion. Once completed, the process switches to settling mode, which provides solids separation. When the solids have settled, the clarified portion is decanted to further treatment to meet the effluent standards. The biomass remains in the reactor during all cycles, thereby eliminating the need for separate secondary sedimentation tanks. The biomass is sequentially subjected to alternating anaerobic, anoxic, and aerobic condition in the biological reactor. This characteristic makes SBRs suitable for the selection and enhancement of desired microbial populations, which can alter the discharge levels of organic carbon, nitrogen and phosphorus. SBRs can also be used to control bulking sludge, a common problem in continuous flow wastewater treatment systems.

The SBR uses an overall smaller process footprint than the activated sludge process due to the deletion of the secondary clarifiers. An advantage of the SBR is its good settling conditions, although the controls for the process are more complex than most activated sludge processes.

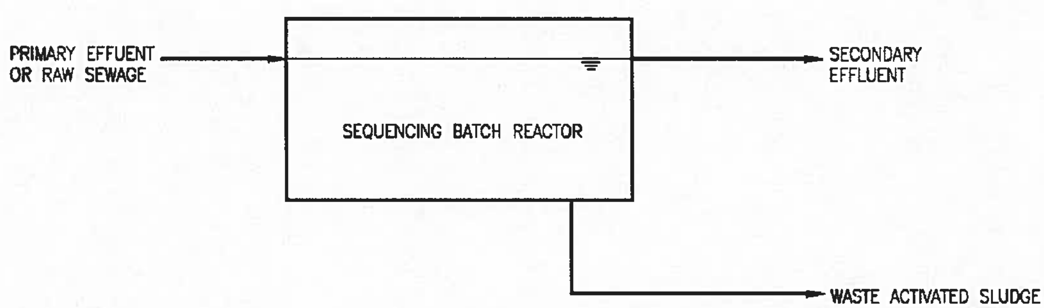


Figure 4-2. Typical Sequencing Batch Reactor (SBR) Process Configuration

4.4 Membrane Bioreactors (MBR)

MBR is arguably the most innovative wastewater treatment process since the invention of the activated sludge process. By using membranes to provide the separation of the final effluent from the mixed liquor, the biggest problem with the activated sludge process, poor settling sludge is eliminated. The operator no longer has to closely monitor the biology of the mixed liquor for indications of nuisance bacteria that inhibit settling. The other very significant advantage of using membrane clarification is the process can be operated at very high mixed liquor suspended solids (MLSS) concentrations, thereby reducing the activated sludge reactor volume by more than half.

Figure 4-3. Membrane Cassettes being Installed

The earliest MBRs used the only available membranes at the time, pressure membranes, to filter the mixed liquor and these systems failed due to rapid fouling and plugging of the membranes. Pressure membranes never completely fell out of the MBR market, but found limited use because of the very high recycle rates required. It is interesting to note that Parkson, teamed with

Many different types of media are currently marketed, including plastic carrier elements, foam cubes, and several configurations of fixed media. These materials are placed in the bioreactors, and a fixed biofilm develops on their surfaces. The process capacity of the reactors increases due to the biomass that grows on the fixed-film material. A higher level of biomass can be maintained, at lower MLSS concentrations, than with conventional activated sludge. The fixed film media is held in the reactor, so loading to the downstream clarifiers is decreased. In a related process, Integrated Fixed-Film Activated Sludge (IFAS) utilizes the same media types as the MBBR system but also utilizes return activated sludge pumping, and accordingly, is closely related to the activated sludge processes.

Applications

MBBR and IFAS systems can be applied in virtually any application where conventional activated sludge systems are viable. MBBR and IFAS have begun to find its industry niche in existing plant upgrade programs, especially where there is minimal available site area for expansion. Upgrading an existing non-nitrifying plant to full nitrification, or increasing the capacity of an existing nitrifying facility, are common IFAS applications. IFAS systems are also suitable for nitrogen removal (BNR) applications. Upgrading an existing facility to BNR usually requires increased biological mass, specifically the need that IFAS systems fill.

Media

The heart of any MBBR or IFAS system is the media, **Figure 4-5**, that is located within the bioreactor volume. Media can generally be classified as one of two types: suspended and fixed. It appears that in the recent past the suspended media type has become a more preferred option. The various media vendors go to great lengths to differentiate their media from their competitors', and it can be challenging to compare "apples to apples" when evaluating the different media for a specific application. The relatively high concentration of maintained biomass allows a higher organic loading rate, which offers reductions in aeration tank volumes. Other reported advantages include lower net biomass

Norit, is now marketing a pressure membrane system and they are referring to as the "Next Generation MBR."

MBR technology did not become well established until Zenon introduced the "Zeeweed" suction membrane. By pulling the clean water into the membrane under a low vacuum, leaving the mixed liquor outside the membrane, membrane fouling was greatly reduced. However, it is still the membrane fouling issue that is the single biggest challenge of the technology, because of the large amount of air and chemicals required to control the fouling.

While less attention can be paid to the biology, monitoring of the "flux rate" (the flow rate that the membranes are able to filter the mixed liquor) is still required, and decreasing flux rate can be caused by either chemical fouling or a change in the biology. Flux rate is determined by monitoring transmembrane pressure (TMP).

- ***Chemical fouling*** is a gradual process and results in a steady increase in the TMP over the life of the membranes in order to maintain the same flux. This is a gradual process because the net effect of usage and cleaning cycles is an irreversible degradation of capacity.

- ***Biological fouling***, or "sludging" is the physical deposition of biological material on the surface of the membranes that is caused by inadequate scouring and and/or chemical cleaning. The rate of solids deposition is directly proportional to the flux rate, while the rate of solids removal depends on the effectiveness of the scour systems. For a given, system, the "critical flux rate" is defined as the flux rate at which the rate of deposition is equal to the rate at which the scour system can remove the solids. A change in the biology can result in solids that are harder to slough off the membranes, therefore a whole new set of considerations related to the

- ***Filterability*** of the solids comes into play. Though filamentous bulking may no longer be of concern, many of the same conditions that lead to bulking and foaming can also result in conditions that affect filterability, particularly growth of slime resulting in an excess of extracellular polysaccharides that can cause blinding of the membranes.

Challenges of MBR technology are high equipment cost, the need for fine screening of influent to prevent damage to the membranes, and high power costs associated with decreased oxygen transfer in the high MLSS, scouring systems (air and jets for membrane cleaning), and permeate pumping. Another limitation is the requirement of high sludge return (RAS) rates. Early versions of MBRs had the membranes directly placed in the aeration tank, resulting in the elimination of RAS pumping. The first significant municipal system was the Arapahoe, Co., CO. The early systems required the operator to regularly remove the membranes for cleaning. The biggest lesson learned from the Arapahoe plant was that the membranes are better maintained in a separate tank to allow in situ cleaning. In order to prevent an excessive buildup of solids in this separate tank, a high RAS rate (typically 400 to 500 percent of influent flow, compared to 25 to 100 percent for conventional RAS) must be used. If the influent BOD is low, this high RAS rate cannot be used for anoxic or anaerobic zone return streams in a nutrient removal plant because of the significant amount of dissolved oxygen in the RAS from the membrane tank.

There are two major types of immersed low-vacuum membrane systems currently in use; hollow fiber membranes floating freely in the mixed liquor and connected at one or both ends, and flat panel membranes that mounted directly to filtrate suction plenum frames. All systems require 1-2 mm prescreening. In the US flat panel manufacturers claim to be able to accept 3 mm screening, though this may be a marketing ploy because all of their systems in Europe have 2 mm screening. Flat panel systems require development of an organic layer of material on the membrane sheet to reduce deep pore fouling because their membranes have larger pore sizes than the hollow fiber systems. Flat panel membrane systems require larger membrane tank volumes than hollow fiber membranes, though this disadvantage was reduced recently by introducing a stacked plate configuration, where the plates are stacked horizontally on top of each other allowing the use of deeper tanks.

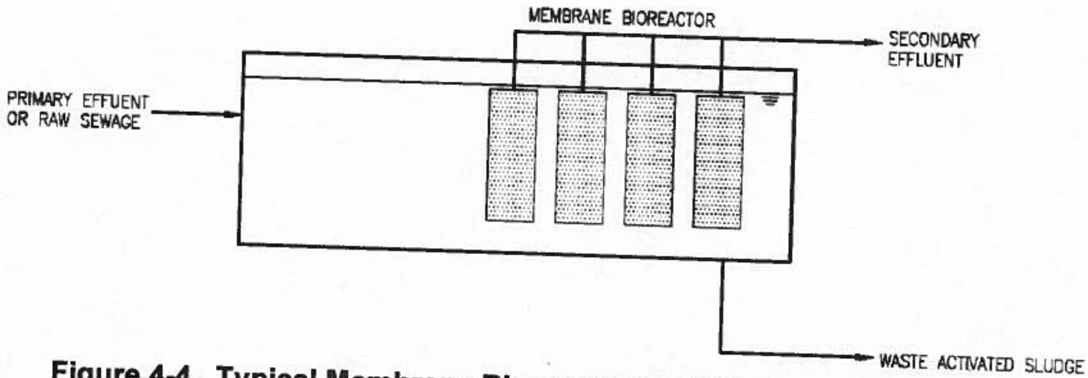


Figure 4-4. Typical Membrane Bioreactor (MBR) Process Configuration

4.5 Moving Bed Biofilm Reactors (MBBR) and Integrated Fixed-Film Activated Sludge (IFAS)

The Moving Bed Biofilm Reactor (MBBR) incorporates a fixed-film, attached-growth process, similar to a trickling filter process. However, the attached- growth in MBBR is accomplished through the use of small media with high surface/growth area that is suspended in the process tanks. This allows MBBR to occupy a smaller footprint than TF and mitigates much of the odor concerns.

Integrated Fixed-Film Activated Sludge (IFAS), as the name implies, utilizes both the CAS process, and the addition of the same fixed-film media employed with MBBR within the mixed liquor in the biological reactor tanks. As with MBBR, the attached growth population is developed over the surface of suspended plastic media within the aeration basin. The process consists of a completely mixed biological reactor containing attached-growth microorganisms, thereby providing the ability to carry higher levels of effective biomass. As a result, the aeration volume can be reduced proportionally while maintaining identical organic loading (F:M Ratio) and removal efficiency. For MBBR, excess growth from the plastic media is continuously sloughed off and separated from the wastewater with a downstream clarifier or dissolved air flotation (DAF) thickener. Since IFAS employs mixed liquor and return activated sludge (RAS), secondary clarifiers are used to achieve liquid solids separation downstream of the principal process train.

production, enhances nitrifying capabilities or fixed film growth, and process stability. In the United States, this process is relatively new and there have been some concerns with the screens that hold the media within the aeration chamber and/or media being susceptible to clogging. These concerns are being mitigated, however and this technology is finding more and more applications.

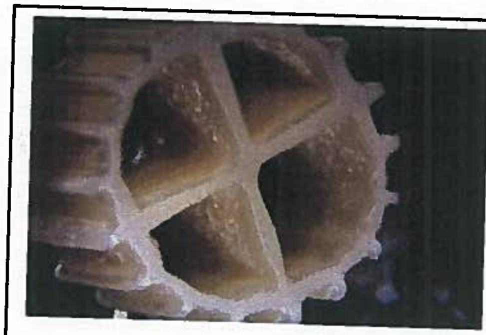


Figure 4-5. MBR media

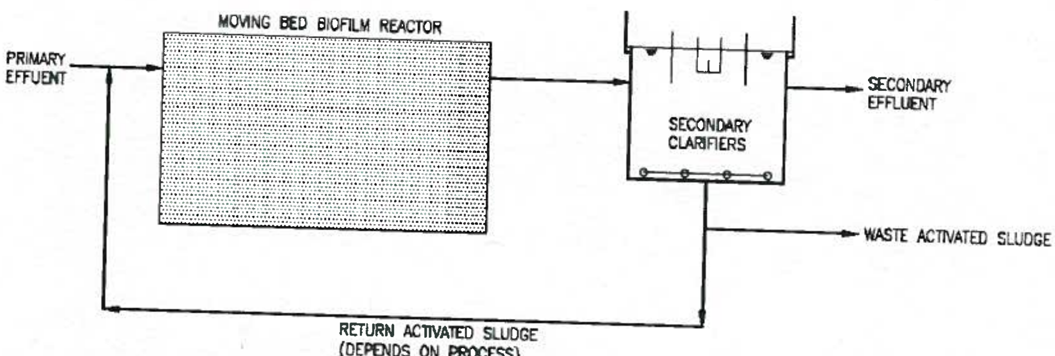


Figure 4-6. `Typical IFAS Process Configuration *(note, MBBR would not employ RAS and could use dissolved air flotation downstream of the process reactors)*

4.6 Advanced Ecological Engineering System

Advanced Ecological Engineering System (AEES) is a wastewater treatment process centered on a series of aerated tanks which contain microbes, insects, and invertebrates that digest wastewater as well as aquatic plants that cover the surface of the tanks. The idea behind the treatment process is that mesocosms, which mimic natural ecosystems, can be used to treat wastewater.

The goal is for the treatment system to contain sufficient biological diversity to allow it to adapt itself through natural selection. The systems can have a strong resiliency to shock loading due to the biodiversity and reliance on multiple microbial habitats.

While the plants do remove a small amount of the nutrients and toxins from the wastewater, their principle role is to allow for the colonization of microbes on their roots, which are submerged in the wastewater column. Therefore, the tanks must have a high surface area to depth ratio if the plants are to have an appreciable effect on water quality.

If the tank volume is large with respect to the available growing area on the surface, the roots will not penetrate sufficiently deep into the water column. As a result, the microbial populations on the plants' roots will be insignificant when compared to the overall microbial population in the tank.

At an AEES is Fredrick County, MD, the tanks were 9 feet deep and 10 feet in diameter. Because of this, when plants were completely removed from the process with no other alterations made, the quality of the effluent was not significantly affected, except in total nitrogen which was not as effectively reduced.

When appropriately designed and constructed, AEESs like the Living Machine provide benefits and characteristics similar to natural wetlands. They support similar vegetation and microbes to assimilate pollutants and are effective in the treatment of BOD, TSS, nitrogen, phosphorus, pathogens, metals, sulfates, organics, and other toxic substances. The limitations with respect to surface area versus depth ratio for plant root zone effectiveness are discussed above. For the Living Machine, aeration is provided to supplement oxygen transfer required for adequate treatment. The size of the overall system is a concern and is a limitation for the intended location of the Regional WRF. There are other limitations and concerns associated with an AEES approach for this facility.

To effectively treat and reclaim municipal wastewater, the system should be dependable and robust. The dependency on plant life and other organisms for treatment increases the risk that dependable, consistent treatment to regulatory limits will be achievable at all times, under all conditions. Green houses to cultivate and grow the plants would add to the space required of the system. The O&M required to manage, maintain, harvest and dispose of the plants are another consideration. Many communities that are faced with stringent effluent limits such as those imposed with nitrogen limits that have previously employed wetland systems have opted for other technologies such as MBRs to replace failing natural treatment systems. For the capacity potentially required at build-out, or 1.7 MGD, and the reliability required of the Regional WRF within a limited ground area to maintain R-1 quality effluent while meeting key criteria such as dependability, ease of operation and complexity, ability limited on-site operation, controlling odors and adverse impacts to the community on a land-locked location, an AEES is not recommended for the Regional WRF. Descriptions of marketed examples of Advanced Ecological Engineering System are in Appendix B.

5. OTHER PLANT PROCESSES

This section describes other treatment processes and support facilities required for the Regional WRF. These include:

- Secondary clarification
- Biosolids thickening
- Biosolids stabilization
- Biosolids dewatering
- Effluent filtration
- Disinfection
- Septage receiving stations

5.1 Secondary Clarification

All of the secondary process alternatives outlined herein may not require conventional secondary clarification. The membrane bioreactor (MBR) process incorporates membranes that serve as the means for solids/liquid separation. The SBR process has secondary clarification integrated into the reactor basin, thereby eliminating the need for a separate secondary clarifier tank. Conventional secondary clarification will be used with the CAS-extended aeration alternative and the MBBR/IFAS.

Secondary clarifier design is well established, and specific requirements vary by regulatory region. Common design parameters include solids loading rate, surface overflow rate, and detention time. Table 5.1 summarizes the operating criteria for the conventional activated sludge process in the "Design Standards of the Division of Wastewater Management, Volume 2" from the Department of Public Works, City and County of Honolulu, State of Hawaii.

Table 5-1. Clarifier Design Requirements

Parameter	Average Flow	Peak Flow
Maximum solids loading rate, lbs solids/day/SF-EA	20	30
Maximum surface overflow rate, gal/day/SF-EA	300	600
Maximum solids loading rate, lbs solids/day/SF-CAS	25	40
Maximum surface overflow rate, gal/day/SF-CAS	500	1000

EA-Extended Aeration
CAS-Conventional Activated Sludge

In addition to the above requirements, minimum side water depth (SWD) and various clarifier enhancements are also commonly considered. Common enhancements include flocculating centerwell, energy dissipating inlet (EDI), and effluent launder baffle systems.

Depending on size and client preferences, various hydraulic and mechanical configurations are available, including:

- Inboard or Outboard Launder Troughs
- Suction header, Scraper, Draft Tube sludge removal mechanisms
- Flat bottom or sloped bottom designs
- Various scum removal designs

5.2 Biosolids Thickening

The purpose of waste biosolids thickening is to remove excess water prior to downstream biosolids stabilization. Removal of the excess water reduces the treatment and pumping volumes required, and generally improves the efficiency and performance of biosolids digestion.

The most common application of thickening typically involves the processing of secondary waste biosolids with a solids concentration of less than

1% solids through the use of thickeners which are able to achieve 4% to 8% solids concentration. Biosolids thickening is generally accomplished using physical process such as gravity thickeners, flotation thickeners, centrifuges, belt thickeners or perforated rotary drum screens to decrease the water content of the liquid biosolids. These methods differ with respect to process configuration, degree of achievable solids concentration, and the requirement of chemicals, energy and labor.

The following are commercially available and established process options for waste biosolids thickening:

- Dissolved-air flotation (DAF)
- Centrifugation
- Gravity belt thickening
- Rotary drum screening

The sludge thickening process recommended for the Regional WRF is the dissolved-air flotation (DAF) thickener. This process was selected because of its ability to run unattended 24-hours per day, which facilitates uniform sludge wasting and aerobic digester feeding. Another attribute of a DAF unit is the operation and maintenance required will be less with the DAF as compared with the other three alternatives.

5.3 Biosolids Stabilization

For purposes of meeting the Class B sludge pathogen reduction requirements as discussed in Appendix C, the preferred approach is aerobic digestion. For smaller facilities, this approach is attractive due to ease of maintenance, low level of operational complexity, and small footprint. Comparatively low odor emissions are also an attractive feature associated with aerobic digestion. The biosolids are held in an aerobic environment for 40 days at a temperature equal to or greater than 20° C. Coarse bubble aeration is commonly used, and often fed from positive displacement blowers, to maintain the biosolids in an oxygenated state.

5.4 Biosolids Dewatering

For a dewatering method to be cost effective, its compatibility with the plant size, sludge treatment process and utilization or disposal routes available must be investigated. Consideration should be given to sludge/biosolids type and other site-specific variables including wastewater and sludge treatment processes. The effects of side streams (e.g., filtrate or centrate) on the wastewater treatment system should be considered. Suspended solids recovery efficiency of greater than 95% is an important design objective to prevent excessive recycle loads to the WPCC liquid train.

There are a number of benefits associated with dewatering, especially in the case of stabilized biosolids. The dewatered cake solids concentration achievable will influence the cost of downstream biosolids management operations. The costs of hauling dewatered biosolids to a final utilization or disposal site are substantially reduced and the handling of a dewatered product is generally easier. Following dewatering, the cake can have the properties of a solid.

The processes used to dewater bisolids can be divided into two categories, mechanical and air-drying. Mechanical dewatering is more capital intensive and applied mainly at medium to large sized wastewater treatment plants, while air drying is used at smaller plants that have available land. Benefits associated with mechanical dewatering include compactness, aesthetics, insensitivity to climate, and reduced hauling costs.

Mechanical methods include:

- Centrifugation
- Belt Press Filter
- Vacuum filtration

- Filter presses

Air-drying processes include:

- Drying beds
- Sludge Lagoons.

Air-drying will not be considered for the Regional WRF, due to the large land area requirements, odor potential of open beds and lagoons, and are susceptible to weather conditions if not enclosed.

Of the mechanical processes, a belt press filter or a centrifuge are recommended for the Regional WRF. Centrifuges, although more expensive, provide drier biosolids, which reduce hauling costs as compared to a belt press filter. Belt press filters, are less expensive than centrifuges, but generate more odors and greater recycle flow rates. Vacuum filtration has been popular for the past 60 years but it use in sludge dewatering has declined due to the development of alternative mechanical dewatering processes and the high operating costs and maintenance problems associated with vacuum filtration. Filter presses produce a very dry cake in the range of 35% or higher. These systems operate in a batch mode and operator attention is required during the sludge discharge phase to make sure that the cake is separating from the filter media.

5.5 Effluent Filtration

In order to allow all or portions of the wastewater flow to be used for unlimited irrigation, wash down, toilet flushing or other approved recycling uses, the entire waste stream must be treated to a tertiary level consistent with the requirements to meet the R-1 requirements as stated in the State of Hawaii, Department of Health's (DOH's), Chapter 62 of Title 11, Hawaii Administrative Rules. According to Chapter 62, R-1 water following secondary treatment, must be filtered and disinfected by an approved process. Of the four alternatives being considered for the Regional WRF, only the MBR alternative will not require filtration.

Tertiary filters also improve the efficiency of the ultraviolet (UV) light disinfection system by removing solids from the effluent. The UV system would be more effective with lower solids content in the effluent from the secondary process.

There are several different options for tertiary filtration, such as high rate sand filters, disc filters, and fuzzy filters. For this project, disk filters are recommended. Disc filters, **Figure 5-1,** provide several advantages, such as compact footprint, minimal mechanical equipment, and simple automated controls. Disc filters consist of several submerged, rotating discs with cloth medical filters. Water passes through the cloth media by gravity, and solids accumulate on the media. Filtered water passes through the discs and into a collection tube for discharge. As the headloss across the discs increases, a backwash cycle is automatically initiated to remove the accumulated solids.

This technology was approved by the Department of Health Services, California, for Title 22 reclaimed water, provided the hydraulic loading rate does not exceed 6 gpm/sf.

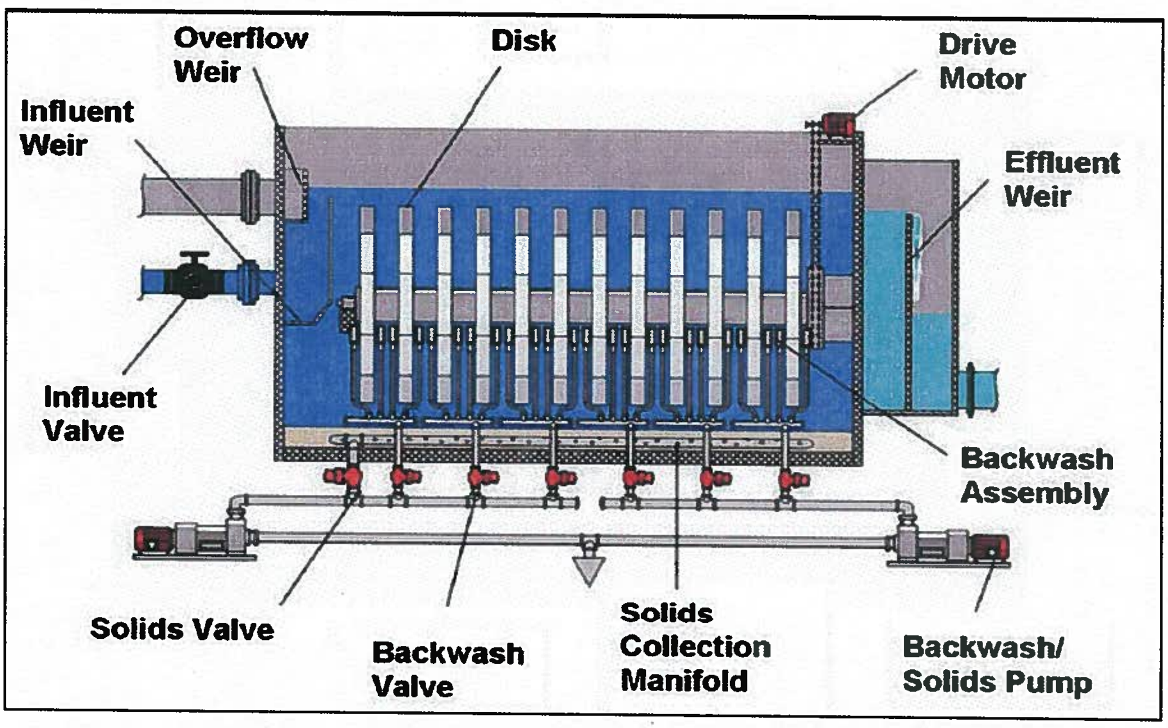


Figure 5-1. Aqua Aerobics Continuous Backwash Cloth Filter

Figure 5-2 shows a comparison of approved filtration technologies to comply with California's Title 22 reclaimed water requirements. From this graph, it appears that the cloth filter manufactured by Aqua Aerobics (AquaDISK) has performed consistently with increasing influent turbidity as compared to the other technologies.

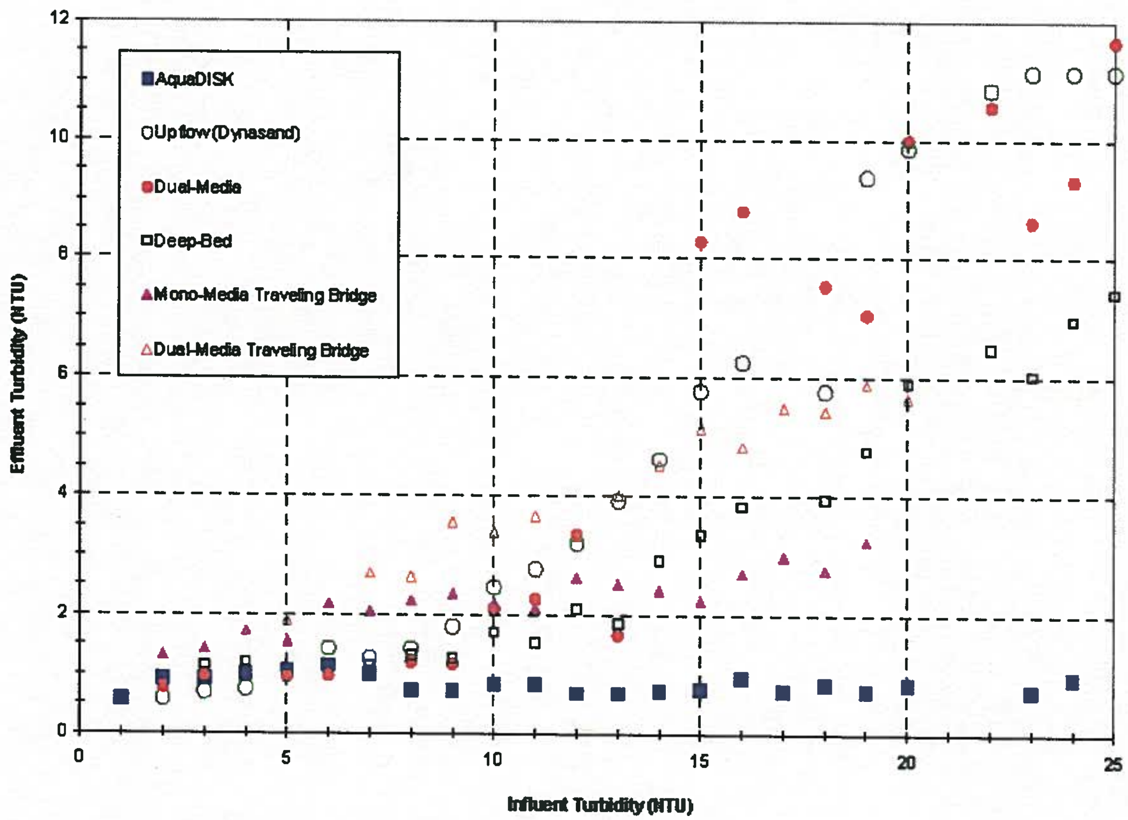


Figure 5-2. Comparison of Influent and Effluent Turbitities for the Various Title 22 Approved Filter Technologies, Riess, J., et. Al.

5.6 Disinfection

Disinfection of the effluent will be required to meet the anticipated discharge requirement of an average coliform count of less than 2.2 MPN/100 mL. It is anticipated that the effluent suspended solids will have to be reduced to 10 mg/L or less in order to allow effective and reliable disinfection. Two disinfection options were considered: liquid sodium hypochlorite, and ultra violet light (UV).

Sodium Hypochlorite

To avoid the problems associated with chlorine gas, a chlorination system could be designed using a sodium hypochlorite solution and a feed system. All chlorination equipment would be located in a new treatment building.

The chlorination system would require a storage area for the concentrated sodium hypochlorite, a 1000 gallon double containment storage tank with concrete pad and berm, piping, duplex chemical feed pumps with flow proportioning controls, flow meter and recorder.

Ultra Violet Light (UV) Disinfection

The use of UV for disinfection is an established practice in water and wastewater treatment and other applications. There are no chemicals involved in the process and no toxic residual in the treated water. Effective disinfection depends on obtaining adequate penetration of the light into the water to be treated, so that all microorganisms present are exposed. This requires a relatively short light path, sufficient light intensity and low turbidity water. Disinfection of wastewater with turbidity in excess of 5 NTU may not be effective at the disinfection level required of 2.2 MPN/100 ml due to shielding of the microorganism by the solids.

5.7 Septage Receiving Station

Compared to raw domestic wastewater from a conventional municipal sewer collection system, septage usually is quite high in organics, grease, hair, stringy material, scum, grit, solids and other extraneous debris. Also substantial quantities of phosphorus, ammonia nitrogen, bacterial growth inhibitors and cleaning materials may be present in septage, depending on the source. Table 2-4 from the U.S. EPA Handbook entitled “Septage Treatment and Disposal”, 1984 gives a comparison of some of the common parameters for septage and municipal wastewater.

The septage receiving station will be provided with the following elements.

- A truck unloading ramp sloped to drain to allow the cleaning of any spillage and washing of the haul truck, hoses, and fittings.

- A flexible hose fitted with cam lock couplings to provide direct connection from the haul truck outlet to minimize the spillage and help control odors.

- Washdown water with ample pressure, hose and spray nozzles for convenient cleaning of the septage receiving station and haul trucks. The water to be used will be R-1 water.

- A screening unit to remove any large debris and rocks before entering the off-line septage receiving tank.

6. FACILITY LAYOUTS

Four alternative wastewater treatment processes were considered for evaluation: (1) conventional activated sludge-extended aeration (CAS); (2) sequencing batch reactor (SBR); (3) immersed membrane bioreactors (MBR); and (4) moving bed bioreactor/integrated fixed-film activated sludge (MBBR/IFAS). These processes are capable of meeting the effluent limitations for both R-1 recycled water and underground injection. This section describes the wastewater treatment process evaluated and presents preliminary design information on each alternative. Each treatment alternative was selected and developed to achieve specific goals consistent with and appropriate to the specific discharge criteria and scenario conditions.

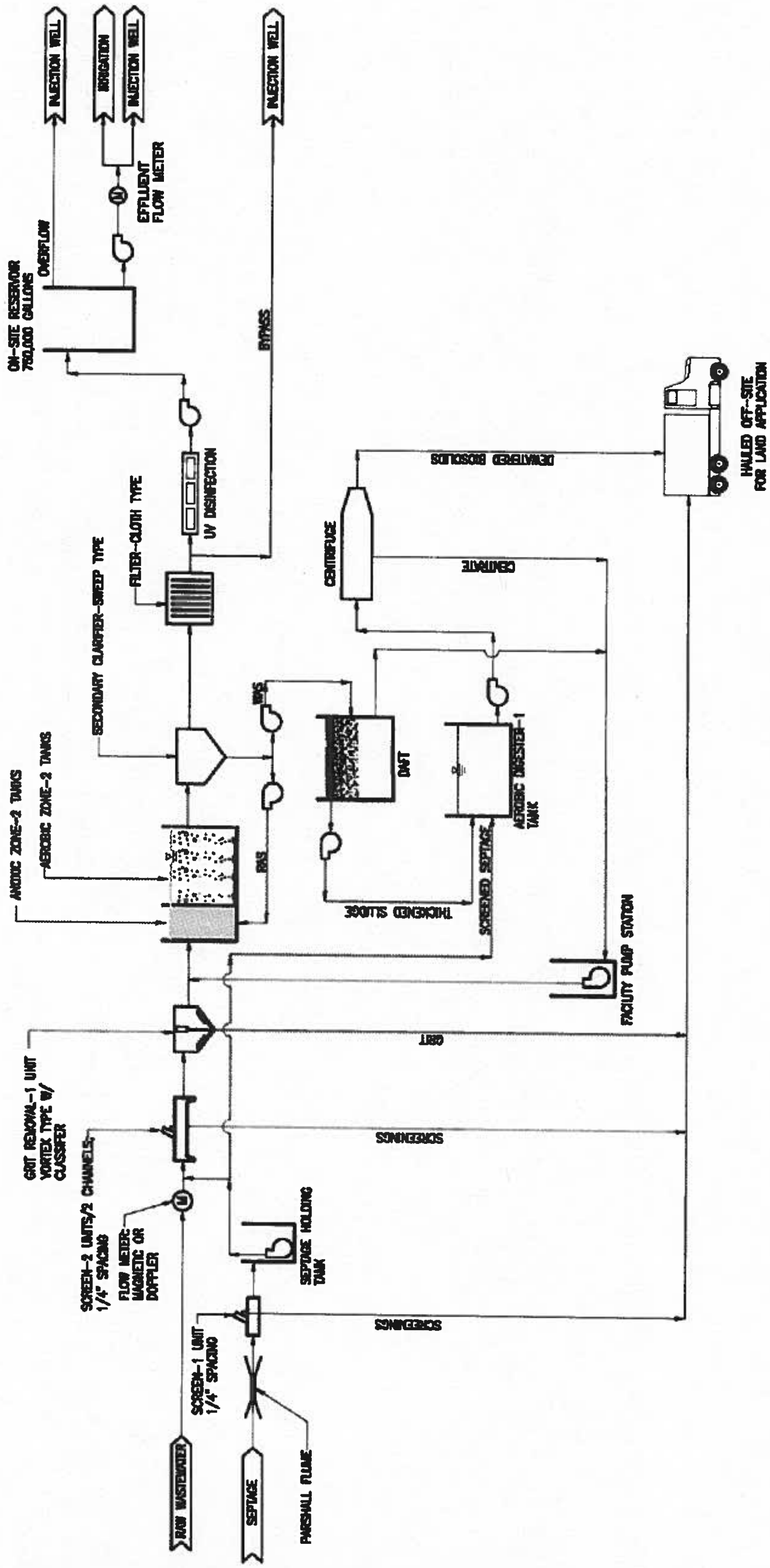
6.1 Process Alternative 1-Extended Aeration System

Conventional activated sludge extended aeration systems are biological treatment that provide BOD removal and nitrification through aerated tanks using fine bubble diffusers and secondary clarification for solids separation. A preliminary process flow diagram is shown in **Figure 6-1**, illustrating the various process components required to meet the DOH, Chapter 62 requirements for R-1 water. The key processes are described in the following paragraphs.

Preliminary Treatment

The headwork facility will consist of screening, grit removal, and equalization. The metered raw wastewater will flow into a concrete rectangular channel where the flow will split into two identical concrete channels. Each channel will have a rotary drum screen with a 0.25-inch slot width.

Following the primary screens, the flow will be combined into a single channel that directs it to a grit removal system. The settled grit would be pumped using recessed impeller pumps to a grit classifier to remove organics from the inert grit and to dewater the grit. The degritted wastewater from the classifier will be transferred back to the facility for further treatment, while the grit will be collected and hauled to a landfill.


RAW WASTEWATER
SEPTAGE
PARSHALL FLUME
SCREEN-1 UNIT 1/4" SPACING
SCREENINGS
SEPTAGE HOLDING TANK
FLOW METER: MAGNETIC OR DOPPLER
SCREEN-2 UNITS/2 CHANNELS 1/4" SPACING
GRIT REMOVAL-1 UNIT VORTEX TYPE W/ CLASSIFIER
SCREENINGS
GRIT
ANOXIC ZONE-2 TANKS
AEROBIC ZONE-2 TANKS
RAS
WAS
SECONDARY CLARIFIER-SWEEP TYPE
DAFT
THICKENED SLUDGE
SCREENED SEPTAGE
AEROBIC DIGESTER-1 TANK
FACILITY PUMP STATION
FILTER-CLOTH TYPE
CENTRIFUGE
CENTRATE
UV DISINFECTION
DEWATERED BIOSOLIDS
HAULED OFF-SITE FOR LAND APPLICATION
BYPASS
INJECTION WELL
ON-SITE RESERVOIR 750,000 GALLONS
OVERFLOW
EFFLUENT FLOW METER
IRRIGATION
INJECTION WELL
INJECTION WELL

The equalization tank will be constructed of concrete. The floor of the equalization basin will be sloped and lined with aeration headers and diffusers to prevent the stored raw wastewater from becoming septic. The entire basin will be covered with panels to contain foul odors. Two rail mounted variable speed, submersible pumps located within the equalization basin will be used to continually transfer the wastewater to a distribution channel. The distribution channel will evenly distribute the wastewater into the extended aeration system.

Extended Aeration System

The screened/degritted wastewater would be blended with a recycled stream of oxidized/nitrified effluent from the aeration zone and then introduced into the anoxic zone, where the anoxic bacteria will accomplish denitrification. From the anoxic zone, the effluent would flow by gravity to the aeration zone for BOD removal and nitrification.

The extended aeration system would consist of two rectangular concrete tanks with a series of floor mounted aeration headers with fine bubble diffuser assemblies. The two tanks would share a common wall to minimize land area and construction costs. Land area will be provided adjacent to the two tanks to meet future flow requirements.

From the two extended aeration tanks the flow will be evenly distributed to the secondary clarifiers by gravity.

Clarifiers

Two circular clarifiers will be used for secondary sedimentation. A flow-splitting structure upstream of the clarifiers would evenly distribute the flow between the two clarifiers and would enter the clarifier in the center. A surface skimmer would remove floating debris, while rakes at the bottom would collect the settled sludge and deposit it into a centrally located sludge pit. A pump will be used to transfer the settled sludge from the clarifiers back to the extended aeration system or to the sludge thickening/stabilization process. The clarified effluent would gravity flow to the filters to meet the DOH chapter 62, R-1 water requirements.

Filtration

Cloth Disk filtration would follow the clarifiers for effluent polishing and to meet DOH, Chapter 62, R-1 water requirements. The filter backwash water will be recycled to either the headworks or the anoxic zone of the secondary treatment process.

UV Disinfection

For effluent to be discharged to be used as R-1 water or groundwater recharge, UV disinfection will be used to eliminate the need for dechlorination. A maximum total coliform MPN of 2.2 per 100 mL is required.

6.2 Process Alternative 2-Sequencing Batch Reactor

Sequencing batch reactors are a batch loaded variation of the activated sludge process where BOD removal, nitrification/denitrification and solids liquid separation occurs in a single tank. A preliminary process flow diagram is shown in **Figure 6-2**, illustrating the various process components required to meet the DOH, Chapter 62 requirements for R-1 water. The key processes are described in the following paragraphs.

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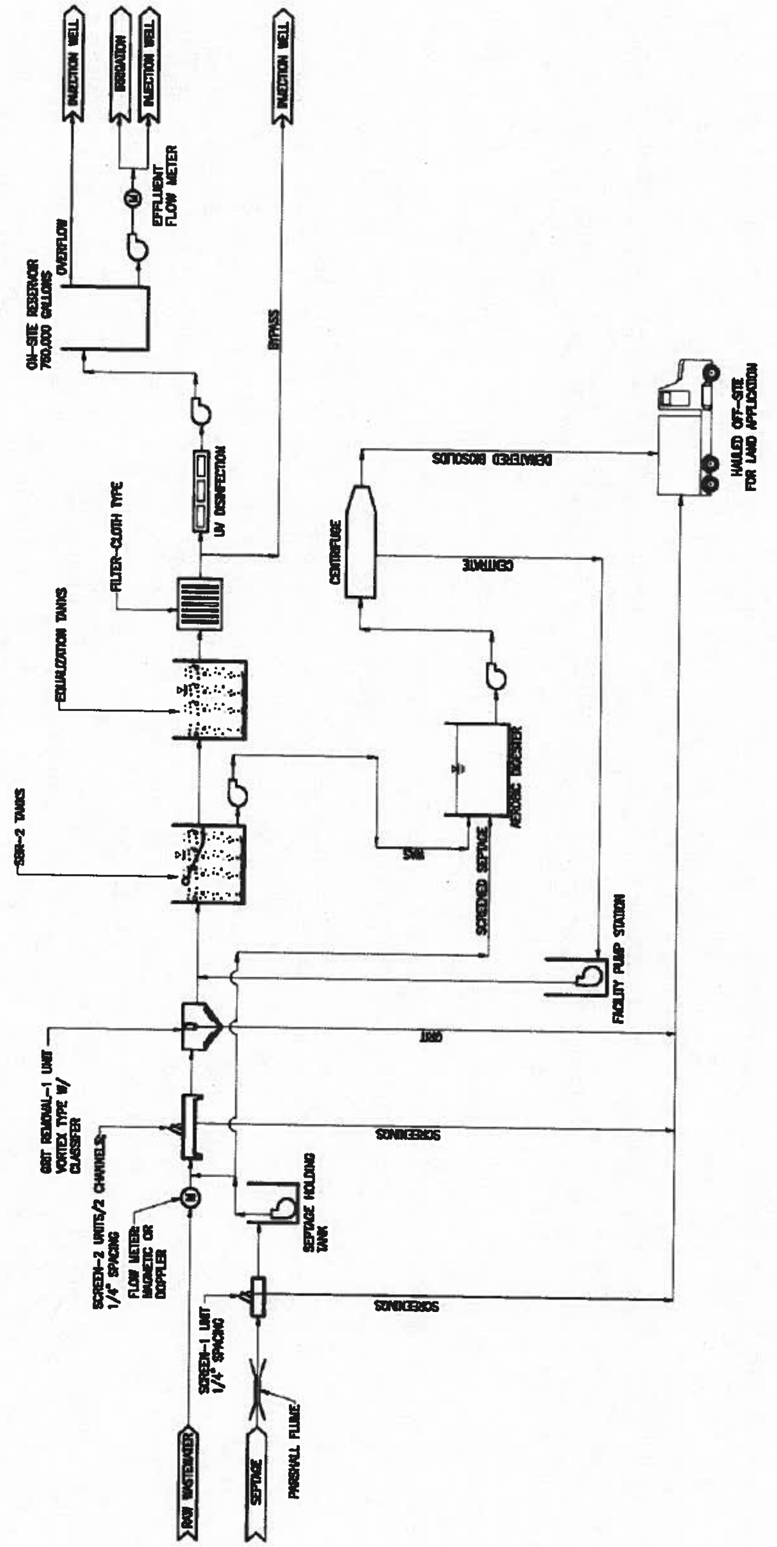


Preliminary Treatment

The headwork facility will consist of screening, grit removal, and equalization. The metered raw wastewater will flow into a concrete rectangular channel where the flow will split into two identical concrete channels. Each channel will have a rotary drum screen with a 0.25-inch slot width.

Following the primary screens, the flow will be combined into a single channel that directs it to a grit removal system. The settled grit would be pumped using recessed impeller pumps to a grit classifier to remove organics from the inert grit and to dewater the grit. The degritted wastewater from the classifier will be transferred back to the facility for further treatment, while the grit will be collected and hauled to a landfill.

Following grit removal the wastewater will be pumped to one of two SBR tanks for treatment.

Sequencing Batch Reactor

The SBR system would consist of two square concrete basins with a series of aeration headers and diffuser assemblies. Initially, two separate SBR basins would be provided for flexibility of the system over a wide range of flows. Space would be designated for additional SBR basins in the future to meet buildout flows.

Post-SBR Equalization Tank

Because the SBR process discharges in "batches" with flow rates several times higher than average flow rates, there will be an impact on downstream unit processes such as the filtration and disinfection units. The filters and UV units will not operate satisfactorily if there are batch flows such as in the case when using SBRs. A post-SBR flow equalization tank will be included as part of the facility requirements. Controlled flows from the post-SBR equalization tank will be will be first filtered, then through a UV channel for disinfection. The excess sludge would be wasted to the aerobic digester for stabilization.

Filtration

Cloth Disk filtration would follow the clarifiers for effluent polishing and to meet DOH, Chapter 62, R-1 water requirements. The filter backwash water will be recycled to either the headworks or the anoxic zone of the secondary treatment process.

UV Disinfection

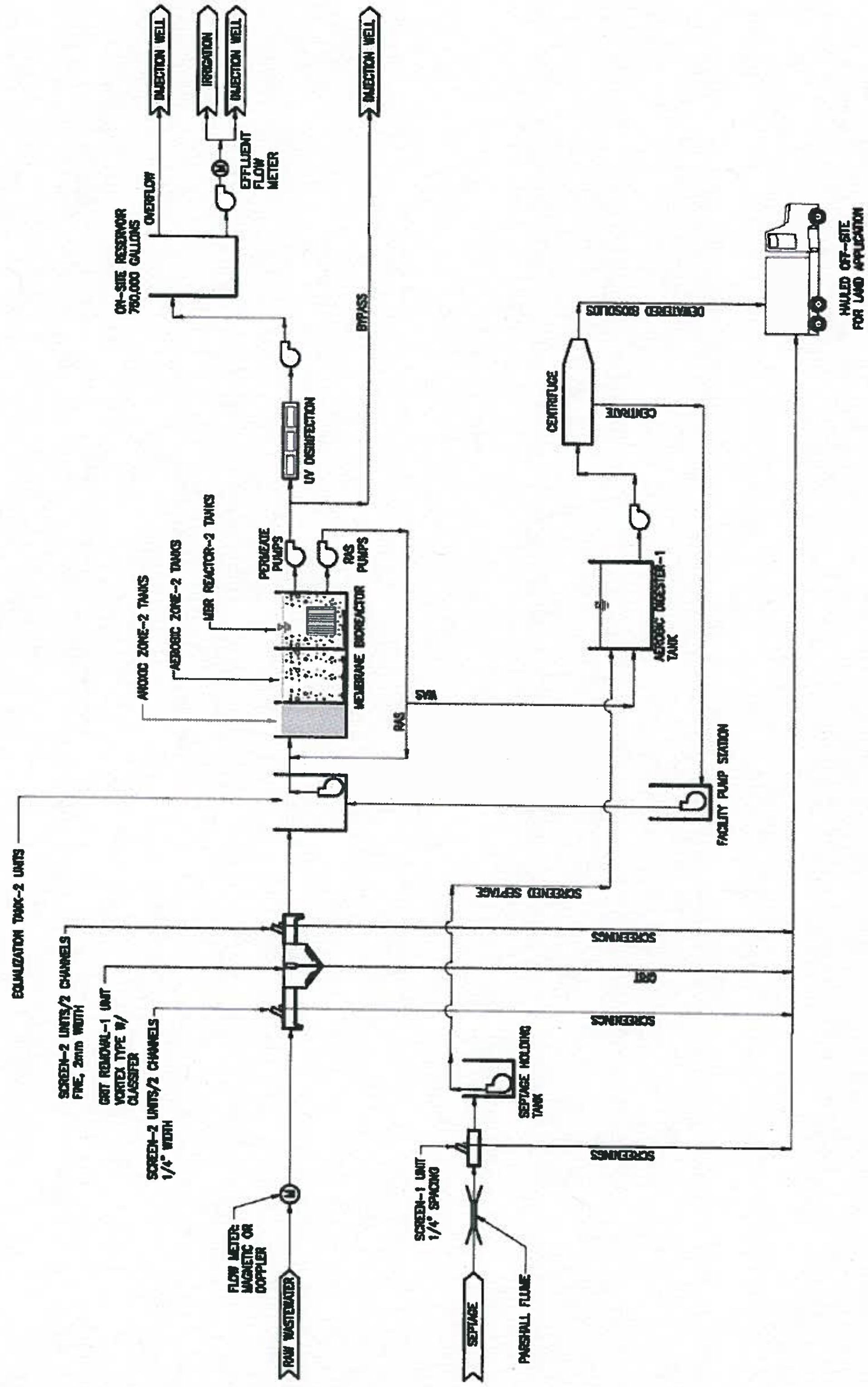
For effluent to be discharged to be used as R-1 water or groundwater recharge, UV disinfection will be used to eliminate the need for dechlorination and to eliminate the potential for chlorine residual discharge violations when discharging to the injection well. A maximum total coliform MPN of 2.2 per 100 mL is required.

6.3 Process Alternative 3-Membrane Bioreactor

The MBR system combines a suspended growth biological reactor with membrane filtration. Each MBR process train will consist of an anoxic zone for denitrification, an aeration zone for soluble BOD reduction and nitrification, and a membrane filtration zone for solids removal. A preliminary process flow diagram is shown in **Figure 6-3**, illustrating the various process components required to meet the DOH, Chapter 62 requirements for R-1 water. The key processes are described in the following paragraphs.

Preliminary Treatment

The headwork facility consists of screening, grit removal and equalization. The metered raw wastewater will flow into a concrete rectangular channel where the flow will split into two identical concrete channels. Unlike the other three alternatives, a finer screen is required to prevent large debris from damaging the membranes. Each channel will have a primary self-cleaning screen with a 0.25-inch slot width.


INJECTION WELL
IRRIGATION
INJECTION WELL
INJECTION WELL
OVERFLOW
EFFLUENT FLOW METER
ON-SITE RESERVOIR 750,000 GALLONS
BYPASS
UV DISINFECTION
PERMEATE PUMPS
RAS PUMPS
MBR REACTOR-2 TANKS
AEROBIC ZONE-2 TANKS
ANOXIC ZONE-2 TANKS
MEMBRANE BIOREACTOR
WAS
RAS
EQUALIZATION TANK-2 UNITS
SCREEN-2 UNITS/2 CHANNELS FINE, 2mm WIDTH
GRIT REMOVAL-1 UNIT VORTEX TYPE W/ CLASSIFIER
SCREEN-2 UNITS/2 CHANNELS 1/4" WIDTH
FLOW METER: MAGNETIC OR DOPPLER
RAW WASTEWATER
SEPTAGE
PARSHALL FLUME
SCREEN-1 UNIT 1/4" SPACING
SEPTAGE HOLDING TANK
SCREENINGS
GRIT
SCREENINGS
SCREENINGS
SCREENED SEPTAGE
FACILITY PUMP STATION
AEROBIC DIGESTER-1 TANK
CENTRIFUGE
CENTRATE
DEWATERED BIOSOLIDS
HAULED OFF-SITE FOR LAND APPLICATION

Following the primary screens, the flow will be combined into a single channel that directs it to a grit removal system. The grit would be pumped using recessed impeller pumps to a grit classifier to remove organics from the inert grit and to dewater the grit. The degritted wastewater from the classifier will be transferred back to the facility for further treatment, while the grit will be collected and hauled to a landfill. After the wastewater leaves the grit removal system, the flow will be again channeled into two identical concrete channels to the secondary screens. These screens are similar in design as the primary screens except the size of perforations will be 2 mm. After the secondary screens the flow will enter the equalization tank.

The equalization basin will be constructed of concrete. The floor of the equalization basin will be sloped and lined with aeration headers and diffusers to prevent the stored raw wastewater from becoming septic. The entire basin will be covered panels to contain foul odors.

Two rail mounted variable speed, submersible pumps located within the equalization basin will be used to continually transfer the wastewater to a distribution channel. The distribution channel will evenly distribute the wastewater into the MBR system.

MBR

The MBR system combines a suspended growth biological reactor with membrane filtration. Each MBR process train will consist of an anoxic zone for denitrification, an aeration zone for soluble BOD reduction and nitrification, and a membrane filtration zone for solids removal.

Anoxic Zone: The first stage of an MBR is the anoxic zone. The screened wastewater is pumped from the equalization basin to a distribution channel prior to the anoxic zones. The anoxic zones are equipped with submerged mechanical mixers. From the anoxic zones, the wastewater flows to the aeration tanks.

Aeration Zone: The aeration tanks are equipped with fine bubble diffusers for mixing and oxygen transfer.

Membranes: The membranes are located in a separate membrane basin adjoining the aeration tanks. Three membrane tanks are proposed for the initial facility. Membrane cassettes are immersed in each basin; each cassette contains numerous membrane elements. A membrane element consists of a bundle of hollow micro filtration or ultra filtration fibers or sheets, with a typical nominal pore size of approximately 0.1 to 0.4 microns.

UV Disinfection

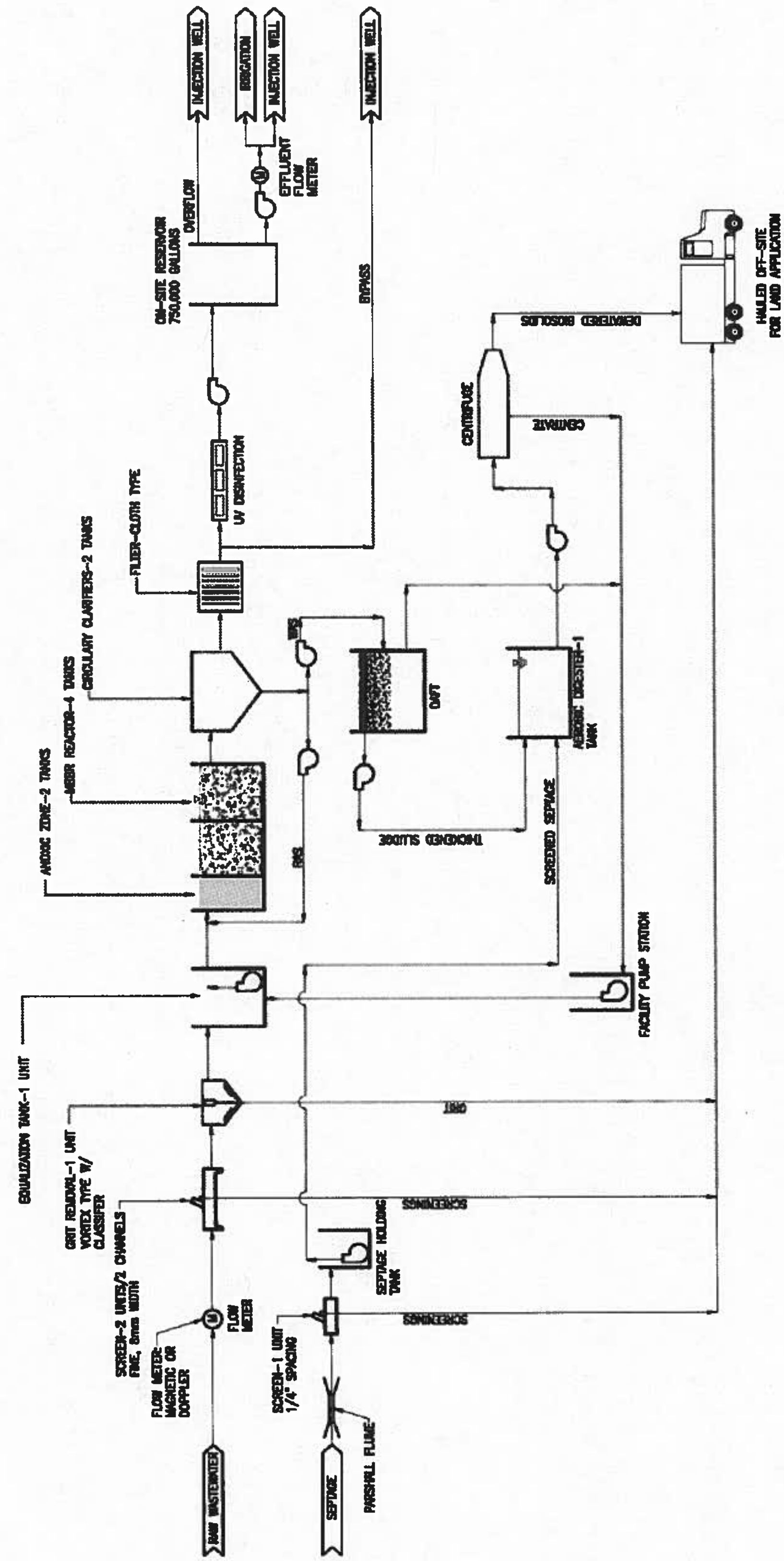
From the membranes the effluent before it can be discharged to be used as R-1 water or groundwater recharge disinfection is required. UV disinfection will be used to eliminate the need for dechlorination and to eliminate the potential for chlorine residual discharge violations when discharging to the injection well.

6.4 Process Alternative 4-Moving Bed Biofilm Reactor/Integrated Fixed Film Activated Sludge

An MBBR/IFAS is very similar to an activated sludge system where it combines fixed-film and suspended solids in an aerated reactor. Adding an inert media to the aeration tank makes it possible to decrease the tank volume while providing nitrification. A preliminary process flow diagram is shown in **Figure 6-4**, illustrating the various process components required to meet the DOH, Chapter 62 requirements for R-1 water. The key processes are described in the following paragraphs.

Preliminary Treatment

The headwork facility will consist of screening, grit removal, and equalization. The metered raw wastewater will flow into a concrete rectangular channel where the flow will split into two identical concrete channels. Each channel will have a rotary drum screen with a 0.25-inch slot width.


INJECTION WELL
IRRIGATION
INJECTION WELL
INJECTION WELL
EFFLUENT FLOW METER
OVERFLOW
ON-SITE RESERVOIR 750,000 GALLONS
BYPASS
DEWATERED BIOSOLIDS
HAULED OFF-SITE FOR LAND APPLICATION
CENTRIFUGE
CENTRATE
UV DISINFECTION
FILTER-CLOTH TYPE
CIRCULARY CLARIFIERS-2 TANKS
WAS
DAFT
AEROBIC DIGESTER-1 TANK
ANOXIC ZONE-2 TANKS
MBBR REACTOR-4 TANKS
RAS
THICKENED SLUDGE
SCREENED SEPTAGE
FACILITY PUMP STATION
EQUALIZATION TANK-1 UNIT
GRIT
GRIT REMOVAL-1 UNIT VORTEX TYPE W/ CLASSIFIER
SCREENINGS
SCREEN-2 UNITS/2 CHANNELS FINE, 6mm WIDTH
FLOW METER
FLOW METER: MAGNETIC OR DOPPLER
SEPTAGE HOLDING TANK
SCREENINGS
SCREEN-1 UNIT 1/4" SPACING
RAW WASTEWATER
SEPTAGE
PARSHALL FLUME

Following the primary screens, the flow will be combined into a single channel that directs it to a grit removal system. The settled grit would be pumped using recessed impeller pumps to a grit classifier to remove organics from the inert grit and to dewater the grit. The degritted wastewater from the classifier will be transferred back to the facility for further treatment, while the grit will be collected and hauled to a landfill.

The equalization tank will be constructed of concrete. The floor of the equalization basin will be sloped and lined with aeration headers and diffusers to prevent the stored raw wastewater from becoming septic. The entire basin will be covered with panels to contain foul odors. Two rail mounted variable speed, submersible pumps located within the equalization basin will be used to continually transfer the wastewater to a distribution channel. The distribution channel will evenly distribute the wastewater into the MBBR system.

Moving Bed Biofilm Reactor

The MBBR system combines a suspended growth biological reactor and suspended synthetic media with attached biofilm. Each MBBR process train will consist of an anoxic zone for denitrification, and two aeration zones for soluble BOD reduction and nitrification.

Anoxic Zone: The first stage of an MBR is the anoxic zone. The screened wastewater is pumped from the equalization basin to a distribution channel prior to the anoxic zones. The anoxic zones are equipped with submerged mechanical mixers. From the anoxic zones, the wastewater flows to the aeration tanks.

Aeration Zone: Two aeration tanks are in series and filled with inert media for biofilm attachment. The aeration tanks are equipped with coarse bubble diffusers for mixing and oxygen transfer. Screens are provided between the two aeration tanks and the final tank to retain the inert media and allow the MLSS to flow through.

Clarifiers

Two circular clarifiers will be used for secondary sedimentation. A flow-splitting structure upstream of the clarifiers would evenly distribute the flow between the two clarifiers and would enter the clarifier in the center. A surface skimmer would remove floating debris, while rakes at the bottom would collect the settled sludge and deposit it into a centrally located sludge pit. A pump will be used to transfer the settled sludge from the clarifiers back to the extended aeration system or to the sludge thickening/stabilization process. The clarified effluent would gravity flow to the filters.

Filtration

Media filtration would follow the DAF for effluent polishing and to meet DOH, Chapter 62, R-1 water requirements. The filter backwash water will be recycled to either the headworks or the anoxic zone of the secondary treatment process. The final discharge location will be determined during the design phase.

UV Disinfection

For effluent to be discharged to be used as R-1 water or groundwater recharge, UV disinfection will be used to eliminate the need for dechlorination and to eliminate the potential for chlorine residual discharge violations when discharging to the injection well. A maximum total coliform MPN of 2.2 per 100 mL is required. A concrete channel with an interior width of 3 ft. by 50 ft. long will house 3 banks of UV units.

6.5 Summary

Table 6-1 is a tabulated summary of the major processes required for each alternative and preliminary design tank sizes.

Table 6-1. Summary of Process Elements Required for each Alternative at a flow of 0.6 MGD ADF

PROCESS	ALTERNATIVE			
	CAS	SBR	MBR	MBBR/IFAS
PRELIMINARY TREATMENT				
Screens	1/4" screens	1/4" screens	1/4" screens and 2 mm screens required	1/4" screens
Vortex grit system	9' dia vortex type	9' dia vortex type	9' dia vortex type	9' dia vortex type
Grit Classifier	Required	Required	Required	Required
Equalization tank	46 ft x 50 ft x 17.5 ft SWD	Not required	46 ft x 50 ft x 17.5 ft SWD	46 ft x 50 ft x 17.5 ft SWD
SECONDARY TREATMENT				
Anoxic tank	2 tanks, each 30 ft x 10 ft x 21 ft SWD	Not required	2 tanks, each 25 ft x 10 ft x 21 ft SWD	2 tanks, each 25 ft x 10 ft x 21 ft SWD
Aeration tanks	2 tanks, each 30 ft x 92 ft x 18 ft SWD	2 tanks, each 75 ft x 75 ft x 20 ft SWD	2 tanks, each 25 ft x 35 ft x 16 SWD	4 tanks, each 25 ft x 22 ft x 19.5 SWD
Secondary clarifiers	2 tanks, each 45 ft dia x 16 ft SWD	Not required	Not required	2 tanks, each 45 ft dia x 16 ft SWD
Post equalization tank	Not required	41 ft x 51 ft x 12 ft SWD	Not required*	Not required
TERTIARY TREATMENT				
Equalization tank	1 tank 41 ft x 51ft x 12.5 ft SWD	Not required	Not required	Not required
Filters	2 units	2 units	Not required	2 units
Ultraviolet disinfection	3 banks	3 banks	3 banks	3 banks
BIOSOLIDS STABILIZATION				
DAF thickener	Required	Required	Not required**	Required
Aerobic Digester	Required	Required	Required	Required
Centrifuge	Required	Required	Required	Required

* A permeate tank is required for back flushing of the membranes

** Not required if a tank equipped with membranes is provided to thicken the waste activated sludge prior to aerobic digestion

7. FACILITY SELECTION

7.1 Approach

Definition of the effluent quality requirements established the process treatment train alternatives for consideration. A two step process was used to select a recommended process train to meet the effluent quality objectives. First, the consultant and developer team used the Analytic Hierarch Process Pairwise Comparison Model to rank the process treatment train alternatives. Following this action the top two process trains were evaluated based on capital and O&M costs to reach a recommended process treatment train. The details of the selection process are presented below.

7.2 Overview of the Analytic Hierarch Process Pairwise Comparison Model

Each of the secondary process alternatives outlined in the previous section were evaluated through an innovative and systematic approach that is a multi-criteria evaluation method which results in a scientific and reasonable outcome. The Analytic Hierarchy Process (AHP) Pairwise Comparison model is a structured approach to using sets of pairwise comparisons to rate options in terms of each criterion, in which many competing alternatives exist. The alternatives are ranked using several quantitative and/or qualitative criteria, depending on how they contribute in achieving an overall goal. AHP incorporates the knowledge, experience and the intuition of each individual member of the selection committee. Appendix C describes the worksheet used in the AHP Pairwise exercise.

7.3 Description of Criteria Used for Evaluation

For this Basis of Design, the AHP Pairwise exercise was employed for the selection of the Koloa-Poipu Regional WRF secondary process. This was achieved by weighing the five alternatives namely Conventional Activated Sludge-Extended Aeration (CAS), Sequencing Batch Reactor (SBR), Membrane Bioreactor (MBR), Moving Bed Biofilm Reactor/Integrated Fixed Film Activated Sludge (MBBR/IFAS) and the Advanced Ecological Engineering Systems

(AEES). These five processes were evaluated with the use of three sets of categorized criterion:

Cost Criterion

This category consisted of the following:

- Low capital costs: Alternatives were judged on the capital required to construct the entire facility at an average flow of 0.6 MGD.

- Low operation and maintenance costs: Alternatives were judged on the perceived yearly costs are going to be.

- Low power requirements: Alternatives were judged on the yearly perceived power consumption.

- Cost impact to rate payers: Alternatives were judged on the monthly fees to be assessed to the users, which includes capital costs, operation and maintenance costs.

Operations Criterion

This category consisted of the following:

- Modular design/expansion capabilities to meet future demands: Alternatives were rated based on their ability to provide greater flexibility to add components to meet needs for the increase in future capacity.

- Operational expertise requirements: Consideration was given to operational complexity, operator attention requirements, and operator familiarity.

- Reliability/robustness for duty: Alternatives were rated based on their ability to continuously process and dispose of wastewater and sludge to meet present regulations. Consideration was given to external factors such as materials availability, weather conditions, and market availability.

- Ability to meet potentially more stringent future effluent criteria: Alternatives were rated based on the ability to new or changing regulatory requirements by chemical additions or add-on processes.

- Facility's ability to meet current effluent requirements: Alternatives were rated based on the entire facility to meet the current effluent requirements for R-1 water and UIC permit.

- Chemical requirements: Alternatives were ranked on the amount, frequency of use and availability of chemicals to be used with the alternative.

- Sludge/biosolids management-volume of biosolids generated for stabilization: Alternatives were ranked on the volume of sludge produced, equipment required for thickening, odor generation and ease of stabilization.

- Secondary process to be taken off-line: Alternatives were ranked on the stability of the system if one train were taken off-line for repairs or maintenance.

- Short term impacts of facility construction: Alternatives were judged in the disruptive nature of construction due to special requirements to construct the alternative.

- Local representation and support: Alternatives were ranked on history of representatives in the islands for the particular equipment and their past performance record.

- Regulatory acceptance: Alternatives were judged on the potential of the governing agencies being familiar with the process, thus providing less resistance in the review and permitting process.

- Short term impacts of facility construction: Alternatives were judged in the disruptive nature of construction due to special requirements to construct the alternative.

Social Impact Criterion

Treatment plants are viewed as undesirable facilities to be located in a neighborhood and often give rise to neighborhood oppositions. This category consisted of the following:

- Compatibility factors with neighbors: Alternatives were judged if impacts resulting from noise, odors, aesthetics, traffic would require additional mitigation efforts. Also considered were buffer zones requirements and ease in satisfying public opinions.

- Noise impacts: Alternatives were judged on the potential of noise emanating from the facility.

- Odor potential: Alternatives were judged on the potential of odor being generated from any of the required support processes.

- Visual impacts: Alternatives were judged on the ability to visually mask the processes from the public line of sight, ability to match environment.

7.4 Results of the AHP Pairwise Comparison

The ranking of the alternatives based on the results of the AHP Pairwise exercise is shown in **Table 7-1**. The results can be interpreted as the MBBR/IFAS and MBR alternatives are equal with only a 2% difference in the ranking points. To achieve a recommended alternative the MBBR/IFAS and MBR processes were compared based on an opinion of probable costs.

Table 7-1. Summation of Pairwise Results

Position	Process	Points
1	Moving Bed Biofilm Reactor	159147
2	Membrane Bioreactor	156721
3	Sequencing Batch Reactor	144893
4	Living Machines	143411
5	CAS-Extended Aeration	142581

7.5 Opinion of Probable Costs

Capital cost opinions were prepared for the MBBR/IFAS and MBR alternatives to provide a comparative order of magnitude costs for the construction of a new regional wastewater facility. Quantities were based on the previous preliminary facility layouts at a capacity of 0.6 MGD ADF.

The cost opinions shown have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule and other variable factors. As a result, the final project costs will vary from estimates presented here. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure project evaluation and adequate funding. **Table 7-2** summarizes these cost opinions of the various processes for both the MBBR/IFAS and MBR alternatives.

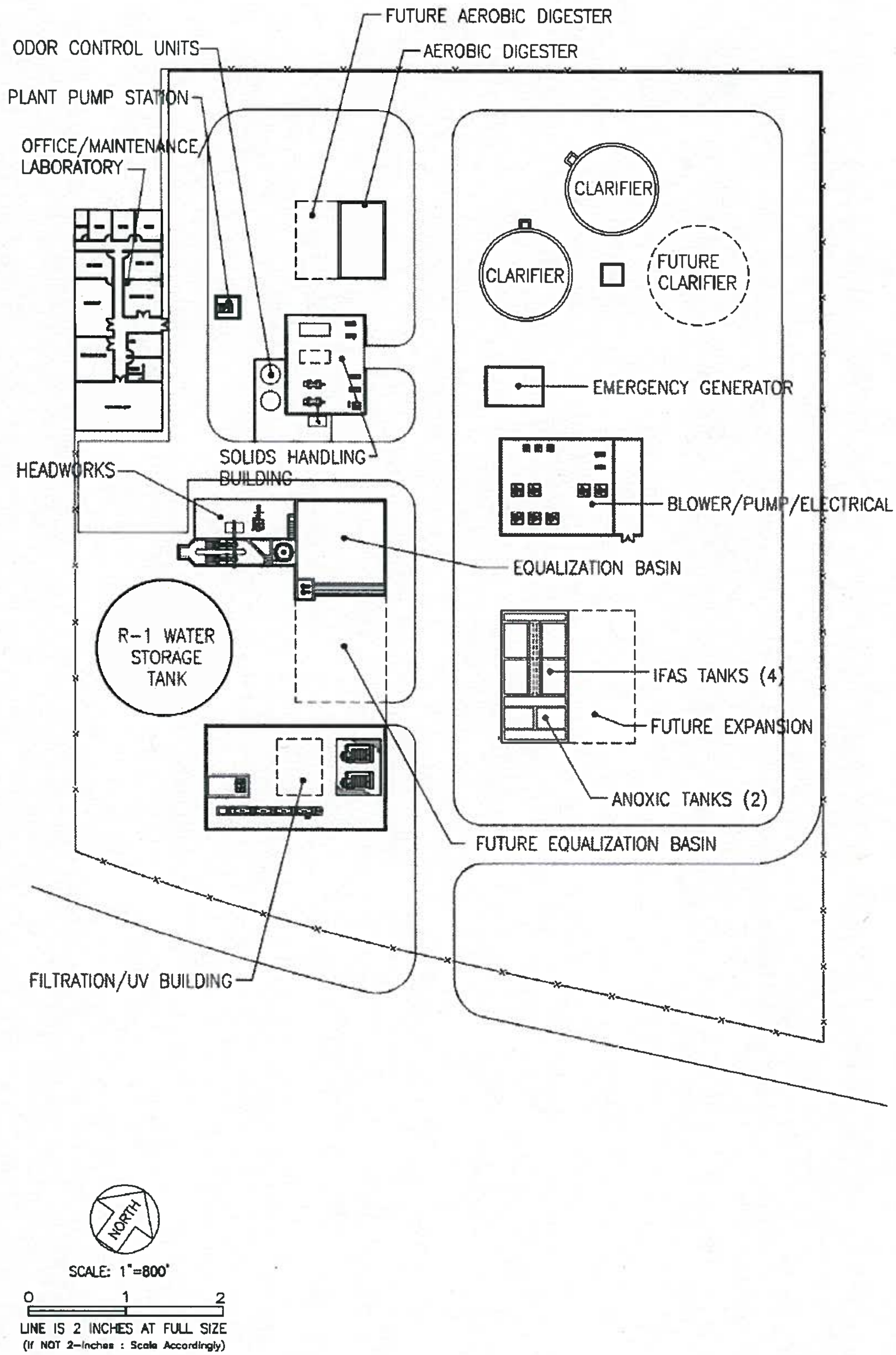
Also included in this table is a column titled *"PRORATED COST FOR 0.6 MGD FACILITY"*. This column represents an opinion of what the facility would cost if it was designed and constructed for a flow to **only treat** 0.6 MGD. During design, there are occasions where it makes good engineering sense to design for the future. An example of this is designing a structure to house the blowers. Rather than to size the building for only the required number of blowers at an initial flow of 0.6 MGD, the building is sized to house blowers for the ultimate flow of 1.7 MGD. As flows approach the ultimate of 1.7 MGD, it will be easier and less costly to purchase and install the required blower, then connect it to an existing connection point that has been already provided. As opposed to having to demolish a wall and roofline, extend the building, install new piping, and then install the blower.

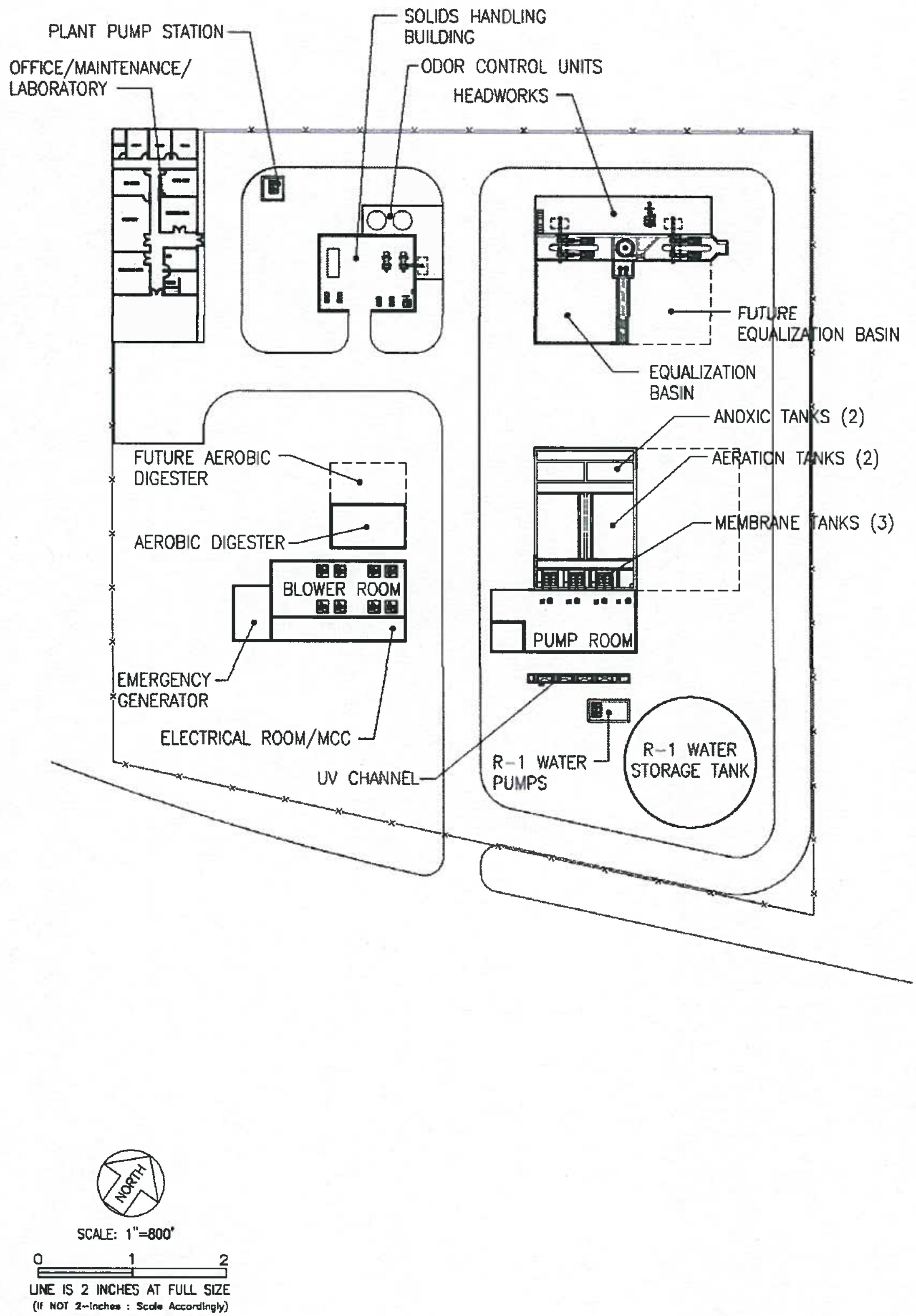
The importance of prorating these opinions of costs is when the utility agency has to charge the end users. It would be unfair to the users who would have to pay for the entire upfront costs of constructing the facility. Later as more users tie into the sewage system, the amount that these late users pay is a fraction of the actual costs.

A detailed spreadsheet is in Appendix D. **Figure 7-1** and **Figure 7-2** are the preliminary layouts of the MBBR/IFAS and MBR alternatives, respectively.

Table 7-2. Probable and Prorated Opinion of Cost Comparison

PROCESS AREA		MBBR/IFAS		MBR	
	Unit Process Capacity-MGD	OPINION OF PROBALE COST	PRORATED COST FOR 0.6 MGD FACILITY	OPINION OF PROBALE COST	PRORATED COST FOR 0.6 MGD FACILITY
Headworks	2	1,025,000	307,500	1,566,000	307,500
Equalization tank	1.1	1,178,000	642,500	1,178,000	642,500
Secondary units	0.6	2,868,000	2,868,000	5,073,000	5,073,000
Solids/liquid separation	1.1	2,755,000	1,502,700	N/A	0
Filtration	1.1	772,500	421,400	N/A	0
Filtration building	1.1	947,700	516,900	N/A	0
Disinfection	1.1	857,000	467,500	857,000	467,500
Centrifuge	2	330,000	99,000	330,000	99,000
DAF	1.1	300,000	163,600	300,000	163,600
Aerobic digester	1.1	769,700	419,800	769,700	419,800
Biosolids building	2	325,900	97,800	325,900	97,800
Facility building	2	1,076,000	322,800	1,076,000	322,800
Support facilities	2	1,901,000	570,300	1,929,000	570,300
Electrical	0.6	1,100,000	1,100,000	1,500,000	1,500,000
Facility Subtotal		**16,205,800**	**9,499,800**	**14,904,600**	**9,663,800**
Mobilization/demobilization		80,000	80,000	80,000	80,000
Demolition/site clearing		180,000	180,000	180,000	180,000
Cons. management		430,000	430,000	430,000	430,000
Subtotal		**16,895,800**	**10,189,800**	**15,594,600**	**10,353,800**
Contingency @ 25%		4,224,000	2,547,500	3,898,700	2,588,500
Total		**21,119,800**	**12,737,300**	**19,493,300**	**12,942,300**


FUTURE AEROBIC DIGESTER
ODOR CONTROL UNITS
AEROBIC DIGESTER
PLANT PUMP STATION
OFFICE/MAINTENANCE/
LABORATORY
CLARIFIER
CLARIFIER
FUTURE CLARIFIER
EMERGENCY GENERATOR
SOLIDS HANDLING BUILDING
HEADWORKS
BLOWER/PUMP/ELECTRICAL
EQUALIZATION BASIN
R-1 WATER STORAGE TANK
IFAS TANKS (4)
FUTURE EXPANSION
ANOXIC TANKS (2)
FUTURE EQUALIZATION BASIN
FILTRATION/UV BUILDING
NORTH
SCALE: 1"=800'
0
1
2
LINE IS 2 INCHES AT FULL SIZE
(If NOT 2-Inches : Scale Accordingly)


PLANT PUMP STATION
OFFICE/MAINTENANCE/ LABORATORY
SOLIDS HANDLING BUILDING
ODOR CONTROL UNITS
HEADWORKS
FUTURE EQUALIZATION BASIN
EQUALIZATION BASIN
ANOXIC TANKS (2)
AERATION TANKS (2)
MEMBRANE TANKS (3)
FUTURE AEROBIC DIGESTER
AEROBIC DIGESTER
BLOWER ROOM
PUMP ROOM
EMERGENCY GENERATOR
ELECTRICAL ROOM/MCC
UV CHANNEL
R-1 WATER PUMPS
R-1 WATER STORAGE TANK
NORTH
SCALE: 1"=800'
0
1
2
LINE IS 2 INCHES AT FULL SIZE
(If NOT 2-Inches : Scale Accordingly)

7.6 Recommended Treatment Design

The results of the AHP Pairwise Comparison ranked the MBBR/IFAS and MBR alternatives as the top two. Opinions of probable capital cost were prepared for the MBBR/IFAS and MBR alternatives to provide a comparative order of magnitude cost for the construction of the first phase of the proposed Regional WRF at a capacity of 0.6 MGD ADF with a peak flow of 1.1 MGD. At this preliminary design stage, the opinion of probable costs is approximately $21,120,000 for the MBBR/IFAS process and $19,490,000 for the MBR process which includes a 25% contingency for each alternative.

The prorated costs for a 0.6 MGD Regional WRF were determined to be approximately $12,740,000 for the MBBR/IFAS process and $12,940,000 for the MBR process. These are the portions of the total costs that the owner of the Regional WRF would likely be allowed to charge the users for this initial phase of the Regional WRF. The balance would be charged to users in subsequent phases, as expansion of the facility becomes necessary to accommodate these additional users.

Based on the preliminary layouts land area requirements for the MBR and MBBR/IFAS alternatives are 3.1 acres and 3.9 acres respectively. Although an energy audit was not performed for both of these alternatives, typically the MBR process consumes 20% higher energy than a CAS system. As a comparison between a CAS system and a MBBR/IFAS system, the primary difference is the media that is used in the aeration tanks which results in a smaller footprint for the aeration units. All other auxiliary processes are the same.

In conclusion both the MBBR/IFAS and MBR are proven process trains to produce R-1 disinfected-tertiary recycled water and reduce nitrogen before discharge. Capital costs and area required for an MBBR/IFAS system are somewhat higher than for an MBR system, and also requires more processes to meet the R-1 criteria than an MBR system. However, a major factor to consider is that the Regional WRF will be located on Kauai, where resources to operate and maintain the facility is very limited. At a power cost of more than $0.30/KWH, the MBR process will also be very expensive to operate than the

MBBR/IFAS process, due to the numerous pumps and blowers required to operate the facility. The MBBR/IFAS process will allow the operator to manually manipulate the flows to achieve a better effluent, whereas the MBR system requires intensive instrumentation trouble shooting by uniquely skilled operators. It involves understanding the PLC programming, testing sensors and automated valves plus the multitude of interlocks that makes the facility operate. Another factor that contributes to the selection of the MBBR/IFAS process is that the team who will be operating this facility is currently operating an MBBR/IFAS wastewater facility on Poipu, Kauai, and therefore, they are already familiar with the process, equipment and biology of an MBBR/IFAS system. Thus, for an area such as Kauai, and considering the firm who will be operating the Regional WRF, the MBBR/IFAS process has been selected as the process to be used for the Regional WRF.

8. RECOMMENDED ALTERNATIVE

8.1 General

This Section summarizes the recommendations for the design of the Koloa-Poipu Regional Wastewater Reclamation Facility (Regional WRF). It has been generally organized into the following subsections:

- Pretreatment
- MBBR/IFAS process
- Tertiary process
- Biosolids stabilization
- Facility pump stations
- Odor contol
- Buildings
- Electrical and control systems

The raw wastewater will be pumped from the proposed Water Tank Pump Station through a flow meter before entering the Headworks of the proposed Regional WRF. The concrete Headworks will be equipped with a mechanical fine screen, a vortex grit chamber and an equalization tank. Submersible pumps will transfer the flow to a distribution channel, then to two anoxic tanks equipped with mechanical mixers. From the anoxic tank, another distribution channel will evenly split the flow to a series of two aeration tanks filled with inert media mixed liquor. The screened mixed liquor from the aeration tanks will be flow by gravity to a splitter box to distribute the flow to two circular clarifiers. The clarified effluent will flow by gravity to the disk filters.

The filtered effluent will flow by gravity to the ultraviolet (UV) disinfection channel for inactivation of microorganisms to meet the Chapter 62 requirements for R-1 water. After disinfection, the effluent will be pumped to an on-site 0.75 million gallon storage reservoir for off-site use or disposed to an injection well.

The biosolids generated from the MBBR/IFAS process will be stabilized using an aerobic digester, with a biosolids retention time of 20 days, to meet the Department of Health, Class B biosolids requirement for land disposal. The stabilized biosolids will be dewatered using a centrifuge. The dewatered sludge will be hauled offsite for disposal.

8.2 Pretreatment

The headworks will be a long, narrow concrete structure. The force main from the Water Tank Pump Station and Koloa Town Pump Station will each have a separate in-line magnetic flow meter and discharge into the headworks. No present or future wastewater flows by gravity is expected to enter the facility. The headwork provides preliminary treatment of the raw wastewater, which includes screening, grit removal and equalization. **Table 8-1** summarizes the headworks design criteria

Table 8-1. Headworks Design Criteria

HEADWORKS	
INFLUENT FLOW MEASUREMENT	
Type	Magnetic flow meter
Quantity	2
Size, (Water Tank P.S./Koloa Town P.S.)	16" /4"
Range, (Water Tank P.S./Koloa Town P.S.)	0-30 MGD/0-2 MGD
FINE SCREENS	
Type	Rotating Drum Screens
Opening Size	1/4 in
Quantity	2
Flow capacity	10 MGD each
Drum diameter	54 in
Drive power	3 Hp each
Spray washwater required	5-30 gpm @ 80 psig, intermittent, R-1
Screenings Transport	Screw conveyor
Quantity	1
Conveyor diameter	14 in
Screening conveying capacity	140 cubic feet per hour
Number of inlet hopper	2
Drive power	2 Hp

Table 8-1. Headworks Design Criteria (cont'd)

GRIT SYSTEM	
Type	Vortex
Capacity, max	10.0 MGD
Quantity	1
Diameter	9 ft
Grit pump	
Type	Recessed impeller
Quantity	2 (1 duty, 1 shelved spare)
Flow	210 gpm, continuous
Power	2.5 Hp
Grit dewaterer	
Type	Inclined belt w/ slurry cup
Capacity	1 cu yd/hr
Water Requirement	36 gpm @ 50 psig, continuous R-1
	50 gpm @50 psig, intermittent
Drive	1/3 Hp
EQUALIZATION TANK	
Type	Concrete
Quantity	1
Dimensions	45 ft x 45 ft x 17.5 ft SWD
Volume	260,000 gal
Operating water level	Variable
Mixing/aeration	Coarse bubble, full floor coverage
Mixing requirements	2 scfm/1000 cu ft
Blowers	
Type	Positive displacement
Flow	520 scfm
Motor	40 Hp
Pumps	
Type	Submersible, variable speed
Quantity	2 (1 duty, 1 standby)
Flow	820 gpm
Hp	15 Hp

Screening

The raw wastewater will enter the headworks where it will be directed to either of two concrete channels, each containing a rotary drum screen. Each channel is equipped with slide gates for redirecting the flow for maintenance or isolation. The drum screens will be sized with ¼" spacing either wedge wire or a perforated stainless steel drum.

The headworks will be receiving pumped waste water primarily from the proposed Water Tank Pump Station. Three similar sized, constant speed submersible pumps will be installed, each with a capacity of 2,850 gpm (4.1 MGD). In the unlikely event all three pumps were to be engaged, the flow to the headwoks will be 6,850 gpm (9.8 MGD). Although the initial design of the Regional WRF is 0.6 MGD, the headworks will have to be designed to accept the worst case scenario which is 3 pumps online, at a flow rate of 9.8 MGD.

Each screen will be sized for a flow of 10.0 MGD. In the unlikely event that one screen is down for maintenance and 3 pumps are engaged at the Water Tank Pump Station, the facility will still be able to process the flow without overflowing the headworks channel. Also, as a precautionary measure an overflow at the headworks channel will be included to bypass the raw wastewater directly to the equalization basin. The wastewater will flow through the rotary drum screens and be collected in a common channel to direct it to the vortex grit removal system.

Solids larger than the perforations will be retained on the screen. When the wastewater rises to a certain level, the drum will rotate which lifts the screened material out of the liquid stream. The screened material will be then be flushed with water to remove any organics. An internal screw will convey/compact the screenings to a discharge chute. A common screw conveyor will collect the screened materials from both rotary drum screen and deposit it in a collection bin for removal to a landfill.

The headworks channels will be covered with removable fiberglass panels as a means to control the odors. The headspace within the channels will be continually evacuated to a centrally located odor control units.

Grit Removal

After screening the screened wastewater will flow to the vortex grit chamber, which will remove fine, inorganic, inert, sand-like materials from the wastewater. Wastewater will enter the grit chamber where a flow distribution header will distribute the influent over stacked, multiple conical trays. No mechanical devices are required with this unit, which makes it a virtually maintenance free process.

The settled grit slurry from the vortex grit chamber is continuously pumped by a recessed impeller pump to a grit washing unit, which will consist of a cyclone grit concentrator and an inclined belt grit classifier.

The grit washing unit will act as a high-rate, vortex/settling device for separation of residual organic materials and retention of the grit as small as 270 mesh (50 microns). Organic material will be washed out and returned to the process via a drain system. The inclined belt will then transport the grit to the discharge chute and enable free water to run back into the classifier while the dewatered grit will be discharged into a dumpster.

The water from the grit washing unit and grit classifier will be drained to the plant pump station, where it will be collected with other flows and pumped back to the headworks ahead of the drum screens.

Equalization Tank

From the vortex grit system, the wastewater will flow into an adjacent concrete equalization tank. Two equalization tanks are recommended at the ultimate design flow of 1.7 MGD. Equalization tanks are typically sized based upon the diurnal flow patterns of a 24 hour period. The size of the equalization tank will generally vary from approximately 20 to 40 percent of the 24 hour flow for a small facility and 10 to 20 percent of the average daily dry weather flow for large plants. The Regional WRF is considered a small facility and without any data regarding the flows being treated by the facility, 30 percent of the ultimate flow of 1.7 MGD will be used.

A single concrete tank with a storage capacity of approximately 260,000 gallons is recommended for this phase. At year 2015, the flow is expected to increase to 1.1 MGD. A new equalization tank will be constructed adjacent to the existing equalization tank. To maintain aerobic conditions and provide mixing, aeration headers and coarse bubble diffusers will line the floor. A positive displacement blower located in the blower room will provide air to these diffusers.

Two variable speed (1duty, 1 standby), submersible pumps will be used to transfer the wastewater from the equalization basin for further downstream treatment. Flows will vary between 480 gpm to 850 gpm initially. The pumps are sized to accommodate the flows of 0.6 MGD at year 2010 to 1.1 MGD for year 2015. At year 2020 the pumps will be changed with an increase in flow to 1.7 MGD.

The entire equalization basin will be covered with removable fiberglass panels as a means to control the odors. The headspace within the equalization basin will be continually evacuated by centrally located odor control units.

Control Panels

The rotary drum screens, screenings conveyor and grit dewatering units will be supplied with its own PLC based control panel from the manufacturer and connected to the Regional WRF's SCADA system. The power for the screen motor, grit classifier motor, solenoid valves and level sensors will be fed from the control panels provided by the individual manufactures. Each, control panel will include a "hand-off-auto" selector switch. A separate local disconnect will be installed adjacent to the control panel. All panels will be rated NEMA 4X with 316 stainless steel enclosures and rack mounted.

8.3 MBBR/IFAS Process

The recommended secondary process for the Regional WRF is an MBBR/IFAS. The MBBR/IFAS will provide high quality water for water reuse and an operations friendly process. The MBBR/IFAS combines an attached growth media in a suspended growth biological reactor. The media and mixed liquor are contained within concrete tanks. The media is retained within the tanks by screens allowing the mixed liquor suspended solids to be distributed to the secondary clarifiers. **Table 8-2** is the design criteria for the MBBR/IFAS system.

Table 8-2. MBBR/IFAS Design Criteria

MBBR/IFAS PROCESS	
Anoxic Basins	
Quantity	2
Dimensions	15 ft x 10.6 ft x 21.0 ft SWD
Volume	24,980 gal
Mixed Liquor Suspended Solids	1,800 mg/l
HRT	2.0 hours @ 0.6 MGD
Mixer	
Type	Submersible
Quantity	1-per anoxic tank (2 total)
Capacity	6 Hp/mixer
MBBR/IFAS Tank	
Quantity	2 per train, 4 total
Dimensions	15 ft x 18 ft x 19 SWD
Volume	76,750 gal per basin (153,500 gal per train)
Mixed liquor suspended solids	1,800 mg/l (suspended solids)
HRT	6.1 hours @ 0.6 MGD
SRT	4 days
Recycle rate	1 x flow rate
Aerator type	Coarse bubble
Process air flow required	1,100 scfm per tank (4,400 total)
Process Air Blowers	
Type	Positive Displacement
Quantity	3 total (2 duty, 1 standby)
Control	Continuous, constant speed
Capacity	2,200 scfm each
Discharge pressure	11.6 psi
Motor power	160 hp each

Table 8-2. MBBR/IFAS Design Criteria, cont'd.

Secondary Clarifiers	
Type	Circular,
Quantity	2
Dimensions	45 ft diameter x 16 ft SWD
Motor	To be determined
Overflow	
Minimum	190 gpd/sq ft (2 clarifiers @ 0.6 MGD)
Design	370 gpd/sq ft (3 clarifiers in operation @ 1.76 MGD future flow)
Maximum	691 gpd/sq ft (1 clarifier in operation @ 1.1 MGD future flow)
Solids loading	
Minimum	5.6 lb/sq ft/day (2 clarifiers @ 0.6 MGD)
Design	11.1 lb/sq ft/day (3 clarifiers in operation @ 1.76 MGD future flow)
Maximum	20.8 lb/sq ft/day (1 clarifier in operation @ 1.1 MGD future flow)
Recycle Pumps	
Type	Centrifugal, variable speed
Quantity	3 (2 duty, 1 standby)
Flow	400 gpm
Power	5 Hp

Influent Distribution

Screened and degritted wastewater will be pumped from the equalization basins to the MBBR/IFAS influent distribution channel that is used to distribute the wastewater to the anoxic tanks. This structure will be covered with fiberglass plates for odor control.

The flow will be evenly distributed to each process train by providing a downward acting weir gate. The weir gates are manually adjusted to provide a proper flow split to each train. The process trains can be isolated by raising or closing the weir gate.

Anoxic Zone

The next treatment stage of the MBBR/IFAS process is the anoxic zone, which is operated as a completely mixed basin without any aeration. The dissolved oxygen in the anoxic basin will be purposely kept low, typically in the 0.1-0.2 mg/L range, to promote the oxidation of dissolved nitrates into nitrogen gas which is removed to the atmosphere, a process called denitrification. Mixing of the anoxic basins will be accomplished with submersible mixers.

Recycled mixed liquor from the MBBR/IFAS, which is rich in nitrates, will be mixed with the influent wastewater in the anoxic zone, thereby providing a carbon source for the denitrifying bacteria. This mixture of influent and recirculated mixed liquor along with the low dissolved oxygen level promotes the growth of the denitrifying bacteria. This denitrification process is capable of reducing the nitrate level to <5mg/L nitrates (as N).

The anoxic zone will be divided into two tanks to reduce short-circuiting and provide redundancy. The anoxic basin has a HRT of 3.1 hours at 0.6 MGD with two anoxic tanks in operation.

Aeration Zone

Wastewater will flow by gravity from the anoxic basin to another distribution channel then to the aeration basins by gravity. The aeration zone will be equipped with coarse bubble diffusers for mixing and oxygen transfer. Synthetic media will be placed in this zone, promote fixed biomass which will assist to remove the organics from the waste stream. Either fixed or suspended media will be used and shall be determined during final design.

The aeration zone is typically operated with a dissolved oxygen level of 2-3 mg/L. The aeration zone establishes an environment to promote a suspended biological growth that breaks down the soluble BOD by converting it into cellular biomass. The aeration zone is also designed to promote growth of nitrifying bacteria, which oxidize ammonia into nitrates, a process called nitrification.

Two aeration trains are designed to provide the ability to continue processing wastewater with one train out of service. The aeration basins will be designed with a hydraulic retention time (HRT) of approximately 6.1 hours at the average daily flow rate of 0.6 MGD. In the event one of the aeration tanks are taken out of service the entire flow of 0.6 MGD will be able to flow through a single aeration train and meet the required effluent. The aeration zone will operate with a mixed liquor suspended solids (MLSS) concentration of approximately 1,800 mg/L. Coarse diffusers will be used and air will be provided by positive displacement blowers. These blowers will be centrally located in a blower building.

Two blowers will be provided for the biological process requirements. One additional blower will be provided as a standby blower.

Clarifiers

At the ultimate flow rate of 1.7 MGD, three 45 ft. diameter clarifiers will be required for solids/liquid separation after the MBBR/IFAS process. All three will be in operation at all times, however in the event that one clarifier is down for maintenance, the remaining two will be able to clarify the flow rate with out exceeding the Division of Wastewater Management, State of Hawaii operation criteria. For the interim flow rates of 0.6 MGD and 1.1 MGD two circular clarifiers constructed of concrete are recommended for secondary sedimentation. A flow-splitting structure upstream of the clarifiers would ensure even distribution of flow to the two clarifiers. Each clarifier would have a diameter of 45 ft. and a working depth of 16 feet. A surface skimmer would remove floating material, while spiral scrapers at the bottom would collect the settled biomass and return it to the MBBR/IFAS process or to the aerobic digester for stabilization.

As mentioned, two clarifiers will be constructed, both will be operate online. In the event one clarifier is down for maintenance, the entire flow can be will be rerouted through a single clarifier at the future flow rate of 1.1 MGD. As the daily average flows approach 1.5 MGD a third clarifier should be constructed. Space will be designated for the addition of a third future clarifier.

From the clarifiers, the clarified effluent will flow by gravity to the cloth disk filters.

8.4 Tertiary Process

After the secondary clarifiers a cloth disk filter and UV disinfection are recommended for the polishing and disinfection of the clarified effluent to meet the R-1 reclaimed water standards. The cloth disk filters are a complete packaged unit requiring a concrete foundation, electrical and piping connections. A concrete channel will be used for the UV unit. Both of these processes, the R-1 water pump station to the on-site reservoir, and the facility water pumps will be housed in a structure large enough to accommodate one more filter installation to meet the future flows. **Table 8-3** is displays the design criteria for the tertiary process

Cloth Disk Filters

The effluent filtration process will consist of two fabric media filters units. The housing for these filters will be manufactured from 316 stainless steel for longevity. These cloth disk filters follow the clarifiers for additional effluent polishing to meet the DOH R-1 recycled water requirements.

At the initial flow of 0.6 MGD a single unit employing 4 disk filters will filter a flow rate of 1.0 MGD at a surface loading of 3.25 gpm/ft^2. Keeping inline with the testing conducted by California's Department of Health Services, for Title 22 reclaimed water, hydraulic loading for disk filters shall not exceed 6 gpm/sf. Thus the maximum capacity for this recommended filter is 1.8 MGD. These two units are adequate to filter the present and the 2010 flow of 1.1 MGD including peaks that will occur if two of the pumps located at the equalization tanks come online together with one filter unit offline for maintenance. As flows approach 1.7 MGD, a third filter will be installed to handle the peak flows in the event one filter is down for maintenance.

Table 8-3. Tertiary Process Design Criteria

TERTIARY PROCESS	
Filter	
Filter type	Fabric disk filter
Quantity	2
Capacity, each	0.5 MGD to 1.8 MGD
Number of disks	4 each filter
Motor	1/2 Hp
Back wash pump	3 Hp
UV Disinfection	
Design flow	1.1 MGD
Average effluent TSS	< 10 mg/l
Disinfection standard	<2.2 fecal coliform/100 ml
UV transmittance	55%
Average Turbidity	2-5 NTU
Design Temperature	23°C
UV tube type	Low pressure, low intensity
Orientation	Horizontal
UV dose	100,000 watt-sec/cm^2

Influent and effluent from the filter will be monitored continuously with a locally mounted turbidimeter. A sample pump will pump filtered effluent to the turbidimeter where turbidity will be measured and recorded on a continuous basis to ensure compliance with the R-1 reclaimed water standards. An effluent turbidity reading in excess of 2 NTU, or if the UV system experiences alarm conditions (e.g., no power, low transmittance), will trigger an automated valve to open, discharging the water to the injection well. In normal conditions, filtered water will be piped to the UV channel for disinfection.

Disinfection

For effluent to be used as R-1 water, UV disinfection is proposed. This will eliminate the need for any type of chlorine to be used and the associated hazards of working with chlorine. The UV channel and equipment will be installed adjacent to the cloth disk filters in a concrete channel. The channel will be sized larger to accommodate future flows and the addition of future banks. In the interim, spacers will be used to decrease the width of the channel.

The UV system to be used is horizontal, low-pressure, low intensity system that is comprised of three banks of UV lamps. Two banks will be designed to provide this level of disinfection. One entire bank of UV lights will be installed for redundancy. UV units to be provided shall be Title 22 approved.

A finger weir at the outlet of the channel will control the level in the channel, ensuring that the minimum recommended water level be maintained in the UV channel during all flow conditions.

8.5 Biosolids Stabilization

The waste activated sludge (WAS) from the secondary clarifiers will be pumped to a dissolved air flotation (DAF) thickener to thicken the WAS before it is stabilized in an aerobic digester. The biosolids in the digester will have a solids retention time of 20 days to meet the federal requirement to produce a Class B sludge for land disposal. From the aerobic digester the stabilized biosolids will be pumped to a centrifuge for dewatering before being hauled off site. The DAF, centrifuge, polymer units and pumps will be located in a solids handling building, large enough to accommodate pumps and equipment to satisfy future buildout. The solids handling building will be equipped with a vent to remove any foul odors and direct it to a centrally located odor control units. **Table 8-4** is displays the design criteria for the biosolids stabilization process.

Table 8-4. Biosolids Stabilization Process Design Criteria

BIOSOLIDS STABILIZATION PROCESS	
Biosolids Thickener	
Thickener type	Dissolved air flotation thickener
Quantity	1
Flow @ 0.5% solids	25 gpm @ 0.9 MGD
Solids loading	1880 lbs/day
Rake motor	¼ Hp
Dissolved air pump	3 Hp
Subnatant flow	29,970 gpd/21 gpm
Water Requirement	5 gpm @ 60 psig, intermittent R-1
Compressed air	32 cfm @80 psi, intermittent

Table 8-4. Biosolids Stabilization Process Design Criteria, cont'd.

WAS Pump	
Type	Centrifugal, variable speed
Quantity	2 (1 duty, 1 standby)
Flow	15 gpm
Power	½ Hp
Thickened sludge pump	
Type	Rotary lobe pump, variable speed
Quantity	2 (1duty, 1 standby)
Flow	4.2 gpm
Power	½ Hp
Aerobic Digester	
Quantity	1
Flow	7,100 gpd
Total Solids Input @ 0.9 MGD	
Volatile suspended solids	1125 lbs/day
Inert Solids	375 lbs/day
TSS concentration from thickener	30,000 mg/l
Biosolids TSS from Digester	40,000 mg/l
Reduction of VSS at 24°C	45%
Solids retention time	20 days
Required Oxygen Concentration	2 mg/l
Type of tank	Rectangular, concrete
Dimensions	22 ft x 38 ft x 16 ft SWD
Tank volume	100,000 gallons
Freeboard	2 ft
Oxygen requirements	1265 lbs/day
Air requirements	800 scfm
Blowers	
Quantity	2 (1 duty, 1 standby)
Motor	65 Hp
Supernatant flow back to facility	3,060 gpd
Stabilized biosolids flow to centrifuge	2,940 gpd
Centrifuge	
Quantity	2 (1 duty, 1 standby)
Feed flow	10-22 gpm
Main motor	15 Hp
Hours of operation per day	4 hours @ 0.9 MGD
Stabilized biosolids flow to centrifuge	2940 gpd, 12.25 gpm @ 4 hours operation
Pumps	
Type	Rotary lobe, variable speed
Quantity	2 (1 duty, 1 standby)
Flow	10 – 22 gpm
Hp	1 Hp
Solids concentration	30%
Quantity solids	390 gpd or 53 cubic ft/day
Centrate flow	2550 gpd, 10.6 gpm @ 4 hours operation

Dissolved Air Flotation (DAF) Thickener

It is estimated that the MBBR process will generate approximately 1550 pounds dry weight of solids per day at the design flow of 0.9 MGD. This WAS is at a concentration of approximately 0.5 percent dry solids by weight from the secondary clarifiers, which equates to approximately 35,970 gallons per day of WAS. Pumping this quantity of sludge to the aerobic digester equipped with supernating equipment would require an aerobic digester tank of approximately 225,000 gallons at an SRT of 20 days. Pumping the WAS to a thickener, and concentrating the WAS from 0.5 percent to 3.0 percent dry solids by weight can reduce the aerobic digester volume to approximately 85,000 gallons. Because this facility will be manned 8 hours per day, it is recommended that the type of thickener to be used is a DAF thickener because it is designed to operate unattended. Rotary lobed pumps will transfer the thickened sludge from the DAF units to the aerobic digester.

Aerobic Digester

The aerobic digester provides solids stabilization and an overall reduction in the quantity of biosolids. The ultimate buildout of the WRF is expected to be 1.8 MGD. For this size of facility, aerobic digesters will be used to stabilize the sludge for ease of operation. Ultimately there will be two interconnected concrete aerobic digesters at the future design flow of 1.8 MGD. Although the required size for each of the aerobic digester is 85,000 gallons, it will be sized for 100,000 gallons in the event raw septage from outside sources is pumped to the aerobic digester for stabilization. Air will be provided using positive displacement blowers through coarse bubble diffusers lining the floor of the digester. The digestion tank will be equipped with a variable height decanting mechanism. Using this method, aerobically digested biosolids can be thickened to a typical concentration of 4% solids. The supernatant from the aerobic digester will flow by gravity to the plant pump station and be returned to the plant headworks upstream of the fine screens.

The stabilized biosolids will be pumped from the aerobic digester to a centrifuge unit to dewater the biosolids located within the solids handling building. The dewatered biosolids will then be hauled offsite for disposal.

Centrifuge

Centrifuges are recommended for the dewatering of the stabilized biosolids. Two centrifuges will be installed, one as duty and the other as standby. Each centrifuge will be sized to dewater the stabilized biosolids for the future flow of 1.8 MGD within an 8 hour day. Initially at a design flow of 0.9 MGD, the pumping rate to the duty centrifuge will vary between 10 and 22 gpm, depending on the hours per day the operators dewater the biosolids. By year 2020 as the flow approach 1.8 MGD, they can operate the centrifuge for 7 hours per day/7 days a week at 14 gpm through a single centrifuge.

Polymers will be added to the digested biosolids to condition it prior to centrifuging. The dewatered biosolids will be conveyed to a sludge bin to be hauled away to a landfill. The centrate will flow by gravity to the pump drain pump station and returned to the plant headworks.

8.6 Facility Pump Stations

Table 8-5 describes the design criteria for the pump stations required at the WRF.

Table 8-5. Facility Pump Stations Criteria

BIOSOLIDS STABILIZATION PROCESS	
Effluent Pump Station	
Purpose	Transfer R-1 water to reservoir
Type	Submersible
Quantity	2 (1 duty, 1 standby)
Flow	850 gpm
Motor	20 Hp
Control	Constant speed, level switch on/off
Plant Water Pump Station	
Purpose	Provide facility with R-1 water
Type	Vertical turbine
Quantity	2 (1 duty, 1 standby)
Flow	250 gpm

Table 8-5. Facility Pump Stations Criteria, Cont'd

Head	210 ft TDH each
Motor	20 Hp
Control	Variable speed
Plant Drain Pump Station	
Purpose	Collect/pump plant wide discharges
Type	Submersible
Quantity	2 (1 duty, 1 standby)
Flow	400 gpm
Motor	8 Hp
Control	Constant speed, level switch on/off

Effluent Pump Station

Effluent from the UV filters flows to the effluent pump station. The effluent will then be pumped to an onsite 0.75 MG above ground steel tank reservoir to be used as a source of irrigation water for future developments. Excess R-1 water and non-compliant R-1 water will be discharged to a back-up injection well. The final use of the R-1 water and discharge of non-compliant/excess R-1 water is still under discussion with Grove Farm Company and the DOH Safe Drinking Water Branch. The effluent pumps will be constant speed submersible pumps. The pump station will consist of one duty pump and one standby pump. The pumps will be sized to provide approximately 650 gpm each. The pump station will be provided with an overflow, an effluent flow meter and pipeline to convey flow to the offsite injection wells.

Plant Water Pump Station

R-1 water to be used at the facility will be withdrawn from the on-site reservoir. Variable speed, vertical, close coupled turbine pumps are selected to boost pressures between 60 to 80 psi required at some of the processes. Two pumps, one duty and one standby will be installed in a barrel booster type of installation. R-1 water from the tank will be piped to two vertically mounted stainless steel suction barrels. Each suction barrel is fitted with an inlet connection. The vertical turbine is fitted into the barrel providing the required flow and pressure.

Plant Drain Pump Station

A plant drain pump station will be provided to collect all in-plant building drains, process drains, building sanitary sewers, tank drains from the plant site. The plant drain pump station will pump this collected water to headworks upstream of the primary screen. This pump station will be a square concrete wetwell equipped with two submersible sewage pumps. The pumps will be sized for approximately 300 gpm each and will be controlled by discrete float switches or by floats in combination with an analog level device.

8.7 Buildings

Operations Center

A new operations building will be required to house the operations center, computer and SCADA areas, offices, laboratory, toilet and locker facilities, break room, storage and filing rooms, and maintenance areas. The facilities will be located in the existing Bagasse structure. Interior walls will be metal stud with drywall or masonry. Office space will have a suspended ceiling. Wet areas such as toilet areas, laboratory rooms, and maintenance rooms will have a drywall ceiling. Ventilation ducting will be installed in the overhead space. Air conditioning equipment will be mounted outside on a pad at ground level.

The lab will be equipped with a fume hood, emergency shower, lab casework and counter space, a separate microbiological testing room, and a storage room. Special consideration will be given to the HVAC requirements of the laboratory in order to maintain temperatures and other environment requirements.

Blower/Pump Building

The blower/pump building will house the aeration tank, equalization and aerobic digester blowers. A standby blower will be provided for each of the process areas. Sufficient space will be allotted for future blowers. The blowers will be positive displacement blowers housed in sound attenuating enclosures.

Acoustical louvers will be provided for air intakes and a roll-up door will provide access for blower and motor maintenance.

WAS pumps and the RAS pumps will also be housed in this building. A single RAS pump will be dedicated to each clarifier with an installed standby. The discharge manifold from the WAS pumps will be connected to the RAS intake manifold to regulate the amount of WAS that is wasted to the DAF prior to aerobic digestion.

The MCC/electrical room will be located adjacent to the Blower/Pump building and will house the MCC for all of the plant mechanical equipment with electrical motors and other electrical loads. The MCC sections will include pretreatment screens, grit removal equipment, blowers, plant drain pumps, plant water pumps, effluent pumps, aerators, operations building and other miscellaneous equipment.

The footprint of the entire building is 74 ft x 50 feet. The height of the building is proposed at 12 feet. A 12 feet wide by 10 feet roll up door will face the roadway to facilitate the installation and removal of equipment. One personnel door will be provided. MCC/electrical room will be housed separate from the rest of the building. AC units will be installed to maintain a constant temperature and humidity for the MCC panels. A 12 feet wide by 10 feet high roll up door will face the roadway to facilitate the installation and removal of equipment. For this preliminary design and opinion of costs, the solids handling building will be covered by coated corrugated metal sheets to match the Koloa Mill motif.

Solids Handling Building

The solids handling building will house the two centrifuges, thickened sludge pumps, DAF thickener and centrifuge feed pumps. Space will be provided for a secondary DAF for future increase in solids thickening. The preliminary footprint of the building is 40 feet x 50 feet. The height of the building will depend on the size of the DAF selected. Headroom above the DAF of 8' will be provided. A 12 feet wide by 12 feet high roll up door will face the roadway to facilitate the installation and removal of equipment. For this preliminary design and opinion of costs, the solids handling building will be covered by coated corrugated metal sheets to match the Koloa Mill motif.

The solids handling building will be connected with the odor control biofilter in the event odors become a problem.

Filtration/UV Building

The filtration/UV building will house the two cloth disk filters, UV channel, effluent pump station and the plant water pumps.

The Filtration/UV building has a preliminary footprint of 92 feet x 54 feet. Space within the building has been allotted for a future filtration unit. The height of the building will be 15 feet. A 12 feet wide by 12 feet high roll up door will face the roadway to facilitate the installation and removal of equipment. For this preliminary design and opinion of costs, the solids handling building will be covered by coated corrugated metal sheets to match the Koloa Mill motif.

8.8 Odor Control Biofilter

The headworks facility will be designed to be fully enclosed. All open channels shall be covered will removable non-slip fiberglass plates to help contain odors inside the, channels, grit chamber and equalization basin. Additionally, the grit washer and screenings washer/compactor areas, along with their associated dumpsters, may be enclosed in a building which will be determined during the final design. Foul air will be collected from the headspace of the headworks structure and from the solids thickening/dewatering building. A foul air blower will provide the necessary negative pressure to insure that the outside air is drawn into the pretreatment airspace and into solids thickening/dewatering building. Ultimately, the foul air will be conveyed to an odor control biofilter for treatment.

The odor control biofilter will consist of a packaged synthetic media biofilter. The foul air will be collected in ductwork from the various facilities. The odor control unit is complete with a humidification section, synthetic media, a moisture control system, discharge blower and controls. The foul air will then be distributed through the biofilter media. Bacteria that are naturally growing in the media will maintain the optimum content in the bed to promote good biological growth.

8.9 Septage Receiving Station

A septage receiving station will be included in the project. The septage station will be located in the vicinity of the headworks. The station will consist of a coarse screen and a concrete containment pad for washdown and dumping of non-hazardous, septic waste. The septage will be accumulated in a single holding tank with a volume of 14,000 gallons. The holding tank will be pumped either to the headworks or aerobic digester. The operator will have the selection of when and where to pump the septage.

8.10 Electrical and Control Systems

A standby power system will be provided to meet the full 100% backup power requirements associated will the initial 0.6 MGD. The size of this generator will be determined during the electrical evaluation during the design process. It is anticipated that the standby power system will consist of a single generator set housed in a sound attenuating enclosure that meets all requirements of the local air quality board.

The plant will include instrumentation and control systems to allow the plant operators the ability to monitor and control the operations associated with the plant processes, as well as provide for SCADA-based control and monitoring of portions of the wastewater facility as well as the proposed wastewater pump stations.