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Technical Memorandum

Prepared for: City of Sunnyvale, CA

Project Title: Water Pollution Control Plant Strategic Infrastructure Plan

Project No: 135083

Technical Memorandum

Subject: Plant Replacement Alternatives Summary

Date: November 17, 2009

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1. EXECUTIVE SUMMARY

Needed improvements at the City of Sunnyvale Water Pollution Control Plant are being evaluated with a Strategic Infrastructure Plan (SIP). The SIP will evaluate overall strategic alternatives for renewal of aged facilities and will recommend a specific plan for executing the selected alternative. The overarching approach of the SIP is to compare the broad alternative of renovating and optimizing the existing plant facilities (the Plant Rehabilitation Alternative) against the broad alternative of generally replacing the existing facility with new treatment processes (the Plant Replacement Alternative). This technical memorandum provides a comprehensive description and evaluation of the Plant Replacement Alternative. Table 1-1 provides the main conceptual differences between the two broad alternatives.

Table 1-1. Unique Features of the Plant Replacement Alternative

Form of Treatment	Plant Rehabilitation Processes	Plant Replacement Processes
Secondary (biological) treatment	Oxidation Ponds	Conventional activated sludge (aeration basins + secondary clarifiers) or membrane bioreactor
Disinfection Facilities	Hypochlorite disinfection	Hypochlorite disinfection or UV disinfection
Recycled Water Production	AFT, dual-media filtration and hypochlorite disinfection	Cloth media filtration followed by hypochlorite disinfection or UV disinfection only
Sludge Thickening	Primary sludge gravity thickening	Co-thickening of primary sludge and waste activated sludge (WAS) in rotary drum thickeners
Sludge Digestion	Mesophilic anaerobic digestion	Temperature-Phased Anaerobic Digestion (TPAD)
Sludge Dewatering	Centrifuges	Screw Presses

Two "sub-alternatives" of the Plant Replacement Alternative are considered in this evaluation: Alternative A, which includes conventional activated sludge for secondary treatment and Alternative B, which includes a membrane bioreactor (MBR) for secondary treatment. Alternative B was formulated because it has a more compact footprint, to be considered should the City decide that there are significant issues associated with footprint for the (much more land-intensive) Alternative A. Alternative B also considers UV disinfection as an alternative to sodium hypochlorite disinfection (which is provided in Alternative A). Both Plant Replacement Alternatives include installation of temperature phased anaerobic digestion (TPAD), which is projected to produce Class A biosolids, co-thickening of primary and secondary sludge streams, and a new mechanical dewatering facility.

The total projected capital cost of Alternative B is significantly higher than that projected for Alternative A ($355 million versus $288 million). The projected operating cost for Alternative B is also significantly higher than that projected for Alternative A ($4.2 million versus $3.2 million), primarily due to the higher energy costs associated with operating the MBR facility.

2. INTRODUCTION

2.1 Background

Needed improvements at the City of Sunnyvale (City) Water Pollution Control Plant (WPCP) are being evaluated with a Strategic Infrastructure Plan (SIP). The SIP will evaluate overall strategic alternatives for renewal of aged facilities and will recommend a specific plan for executing the selected alternative. The overarching approach of the SIP is to compare the broad alternative of renovating and optimizing the existing plant facilities (the Plant Rehabilitation Alternative) against the broad alternative of generally replacing the existing facility with new treatment processes (the Plant Replacement Alternative). This Technical Memorandum (TM) provides a comprehensive description and evaluation of the Plant Replacement Alternative.

2.1.1 Initial TMs

Initial efforts detailed in TMs contributed to setting a foundation for definition and evaluation of the overall strategic alternatives being evaluated in the SIP. Three key efforts described in this section were the following:

- Decision-Making Framework
- Level of Service References
- Condition Assessment and Unit Process Performance Review

2.1.1.1 Decision-Making Framework

A TM entitled "Business Case Evaluation (BCE) Based Decision Making Methodology" describes a structured framework for decision-making to guide an Expert Panel consisting of City staff, managers, and consultants. This framework was assembled to aid in developing appropriate decision criteria, developing decision alternatives that address the criteria, and selecting which alternative best meets the criteria. The framework was developed to create an alternative selection process that can be rationally justified to "customers" with interests in the consequences of executing the alternative.

A related TM entitled "Levels of Service (LOS) Measures" presents the results of several Expert Panel workshops that were conducted to define the structured decision-making criteria. The LOS represent a collection of measures intended to align the decisions related to capital projects with the values and expectations of the "customers" the projects intend to serve. Customers can include rate-payers, regulators, any project partners, and the community at-large. The LOS were first organized under regulatory categories and then pertaining to three broad non-regulatory interest categories that comprise the elements of the "Triple Bottom Line" analysis: "Financial", "Environmental", and "Social". Development of alternatives descriptions as summarized in this Plant Replacement Alternatives Summary TM are based on LOS guidance.

2.1.1.2 Level of Service References

Several TMs were developed to provide reference and background information for development of the LOS and serve as foundation information for the development of the overall strategic alternatives to be included in the SIP. This included the following TMs:

- A TM entitled "Influent Flows and Loads Technical Memorandum": This TM established current and projected plant influent flow rates and influent pollutant loading rates. These flows and loads are fundamental to the physical sizing of key unit processes for wastewater treatment, including the processes discussed in this Plant Replacement Alternatives Summary TM.
- A TM entitled "Solid Flows Technical Memorandum": This TM established current and projected residual biosolids production rates, which are fundamental to sizing of solids thickening processes, solids

stabilization processes, solids dewatering processes, and off-site biosolids reuse and recycling programs, including the processes discussed in this Plant Replacement Alternatives Summary TM.

- A TM entitled "Regulatory Framework": This TM provided a summary of the overriding and detailed laws, agencies, and regulations that establish the ultimate legal treatment performance requirements for the WPCP. Background information was provided contributing to insights on potential future changes in regulatory requirements that may influence decision-making in major treatment process modifications or improvements. An example of this is the potential modifications to ammonia-nitrogen discharge limits, which could support implementation of the Plant Replacement Alternative.
- A TM entitled "Seismic Performance Goals": This TM provided a presentation and establishment of post-earthquake performance goals for the WPCP.
- A TM entitled "Electrical Power System Level of Service": This TM provided a discussion of reliability goals for provision of electric power for wastewater treatment processes at the WPCP. Goals for redundant power circuit designs and for reliable emergency on-site power generation were established. The role of continuous on-site power generation from biofuels was also discussed.

2.1.1.3 Condition Assessment and Unit Process Performance Review

Prior condition evaluation assessments by other consultants formed the basis of the condition assessment for the SIP and the salient conclusions of those assessments were summarized by treatment process area in a TM. Also included in this TM were conclusions about existing unit process performance drawn from data review and interviews of plant staff about specific performance and operational issues and their interests in process improvements. This review forms the much of the basis for a list of recommended improvement projects for the existing treatment processes (such as the anaerobic digesters, dual media filters, and chlorine contact tanks), which are included in the Plant Replacement Alternative. Further basis for improvement project recommendations was drawn from Unit Process Improvement Studies.

2.1.2 Unit Process Improvement Studies

In addition to the unit process performance review referred to in Section 2.1.1.3, further basis for WPCP existing facility improvement project recommendations was drawn from five Unit Process Improvement Studies, which were presented in separate TMs:

- Evaluation of Dewatering Alternatives
- Upgrade Alternatives for Air Flotation Tanks (AFTs)
- Nitrification Process Improvements
- Anaerobic Digestion of Algae
- Recycled Water Treatment Alternatives

These TMs addressed specific unit processes where evaluations for significant process optimizations or improvements were of operator and City interest. Of the five studies listed above, the Evaluation of Dewatering Alternatives and Recycled Water Treatment Alternatives studies are applicable to the development of the Plant Replacement Alternative.

2.1.2.1 Evaluation of Dewatering Alternatives

Recognizing the current gravity drainage bed method of dewatering digested sludge as overly consumptive of valuable plant site area and operationally inefficient, the TM entitled "Evaluation of Dewatering Alternatives" looked at alternative technological approaches for replacing the beds with a mechanical dewatering system. The mechanical dewatering system would consume much less site area and could dewater biosolids with less manual labor operational requirements. In the study, screw presses and centrifuges were deemed favorable over belt filter press systems. Both screw presses and centrifuges have desirable qualities with respect to

potential installation at the WPCP. Centrifuges are recognized as more favorable in the event of increasing costs for off-site sludge reuse (drier cake equates to lower hauling costs) and if there is a desire by the City to avoid 24 x 7 operation of the dewatering equipment (i.e. a day-shift only operation). Alternatively, the screw press technology has lower operational cost with respect to power requirements (significantly lower horsepower motor is required for similar sludge through-put). Screw presses were carried forth into the Plant Replacement Alternative, acknowledging that the centrifuge technology is also viable.

2.1.2.2 Recycled Water Treatment Alternatives

Recognizing that the current practice of producing recycled water for City use by regularly and frequently reconfiguring the entire tertiary treatment process to meet the differing requirements for San Francisco Bay discharge and for recycled water production was (1) operationally inefficient and (2) tended to create performance risks for both modes of discharge, this study assessed alternative technology approaches for recycled water production. The study proposed a recycled water production process scheme that would operate in parallel with and generally independent of the process treating most of the secondary effluent that ultimately is discharged to San Francisco Bay.

The results of this study and TM entitled "Recycled Water Treatment Alternatives" were directly incorporated into the Plant Replacement Alternative. The recommended alternative configuration includes cloth media filtration and hypochlorite disinfection of conventional activated sludge treatment process effluent. Alternatively, ultraviolet (UV) disinfection can be incorporated into the treatment scheme instead of hypochlorite disinfection and the need for cloth media filtration would be eliminated if the effluent were previously treated in a membrane bioreactor (MBR) instead of by conventional activated sludge.

2.1.3 Initial Process Technology Screening TM

A TM entitled "Plant Replacement Alternatives Goals, Objectives, and Technology Screening Review" was written to screen a range of process technologies that may be candidates for inclusion in the Plant Replacement Alternative. Goals and objectives in this TM were consistent with those formed in the initial TMs (Section 2.1.1). Furthermore, the TM made recommendations for new treatment processes based on comparison of proven technologies using the following criteria:

- Projected life cycle cost
- Projected footprint requirements
- Projected resource consumption

For each of these criteria, a rating of "low", "medium", or "high" was provided for each technology being evaluated, based on experience with the technology in similar applications. Recommendations for liquid-phase processes and solid-phase processes were made and have been carried forward into this TM. Process schematics for both liquid- and solid-phase flows were also produced in the Technology Screening Review TM and have also been incorporated into this TM.

2.1.4 Early Execution Projects TM

This TM presented an evaluation of very critical, higher risk improvement needs that could be candidate projects to execute in advance of final completion of the SIP. Process facilities meeting the following criteria were candidates for early execution:

- Process facilities known to be significantly deteriorated and at higher risk of unanticipated failures.
- Processes that would be included in either implementation of the Plant Rehabilitation Alternative or Plant Replacement Alternative.

- Processes that could be constructed in the same location within the WPCP property, regardless of whether the Plant Rehabilitation Alternative or Plant Replacement Alternative is selected following completion of the SIP.

The processes that were recommended for early execution in the TM were as follows (the TM also included a preliminary layout for each of these processes):

- Raw sewage screening and screenings processing
- Raw sewage pumping
- Grit removal and grit processing
- Primary sedimentation and primary sludge pumping
- Primary effluent pipeline
- Main plant electric switchgear center and diesel stand-by power facility
- Primary sludge thickening

2.2 Purpose and Objectives

The purpose of this TM is to describe the entire alternative plan associated with the Plant Replacement Alternative, which is based on new secondary and new or rehabilitated tertiary treatment plant processes. The following objectives are addressed in the TM:

- Describe what facilities are planned to be replaced and/or rehabilitated
- Describe the schematic arrangement of the processes
- Describe design and sizing criteria for the processes
- Describe the proposed layout on the plant site for the processes
- Describe the sequence of construction and recommended construction packages
- Present estimates of probable construction cost
- Present estimates of the major operational costs
- Describe the sustainability-related characteristics of the alternative.

3. DESCRIPTION OF PLANT REPLACEMENT ALTERNATIVES

3.1 Defining Characteristics of the Plant Replacement Alternative

While the Plant Rehabilitation Alternative consists primarily of renovating and optimizing the existing plant facilities, the Plant Replacement Alternative discussed in this TM consists of generally replacing the existing facility with new treatment processes. However, the alternatives are identical for raw sewage pumping and preliminary treatment (headworks facilities), and also for primary treatment (though the Plant Replacement Alternative includes primary sludge gravity thickening whereas the Plant Rehabilitation Alternative does not).

Table 3-1 presents a summary of major process areas where the Plant Replacement Alternative is different from the Plant Rehabilitation Alternative. In addition to these process areas, the Plant Replacement Alternative also includes some unique supporting facilities, such as additional electrical power area substations, chemical storage, and maintenance facilities, all of which are discussed in this TM.

Table 3-1. Unique Features of the Plant Replacement Alternative		
Form of Treatment	Plant Rehabilitation Processes	Plant Replacement Processes
Secondary (biological) treatment	Oxidation Ponds	Conventional activated sludge (aeration basins + secondary clarifiers) or membrane bioreactor
Disinfection Facilities	Hypochlorite disinfection	Hypochlorite disinfection or UV disinfection
Recycled Water Production	AFT, dual-media filtration and hypochlorite disinfection	Cloth media filtration followed by hypochlorite disinfection or UV disinfection only
Sludge Thickening	Primary sludge gravity thickening	Co-thickening of primary sludge and waste activated sludge (WAS) in rotary drum thickeners
Sludge Digestion	Mesophilic anaerobic digestion	Temperature-Phased Anaerobic Digestion (TPAD)
Sludge Dewatering	Centrifuges	Screw Presses

Note that for secondary treatment, disinfection, and recycled water, Table 3-1 indicates two distinct processes for the Plant Replacement Alternative (for example, for disinfection facilities both hypochlorite disinfection and UV disinfection are included). This is because two unique plant replacement "sub-alternatives" have been formulated, both of which are being considered for the broad alternative of generally replacing the existing facility with new treatment processes. These include a conventional activated sludge alternative (Alternative A) and a compact footprint alternative (Alternative B). These are described further in Section 3.2.

3.2 Treatment Process Schematic Descriptions

Two groups of liquid-phase treatment processes are considered in this TM. The first is described in a process flow diagram depicted in Figure 3-1. This diagram presents a typical treatment flow scheme using conventional activated sludge for secondary treatment. This process train is reflected in Alternative A. New screens, grit basins, and primary sedimentation basins would be constructed, along with new aeration basins and secondary clarifiers. The existing tertiary filters and chlorine contact basins would be retained, but would be upgraded; the media and some mechanical components in the tertiary filters would be replaced and disinfection would be accomplished using sodium hypochlorite instead of chlorine gas.

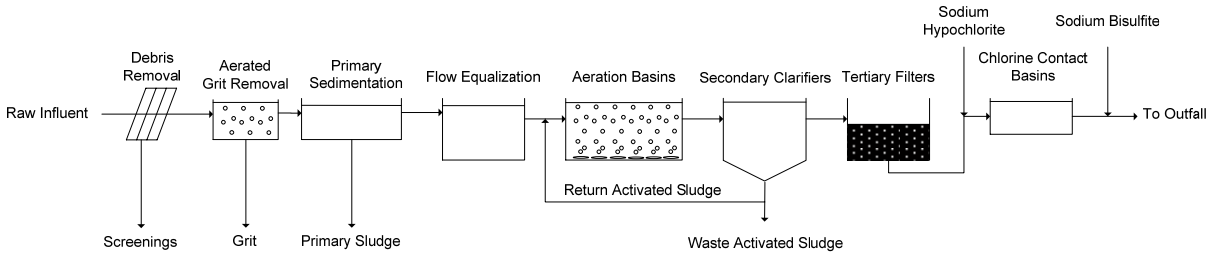


Figure 3-1. Plant Replacement Alternative A (conventional treatment) liquid-phase process flow diagram.

A second alternative and corresponding liquid-phase treatment process flow diagram was produced to address concerns that the existing plant site might not provide sufficient space for an efficient layout of the new processes. The Alternative B process train provides a more compact footprint, using a membrane bioreactor (MBR) instead of activated sludge and UV disinfection instead of hypochlorite disinfection. The flow scheme for Alternative B is shown in Figure 3-2. For this alternative, the existing filters would not be necessary since the MBR produces tertiary treated effluent water.

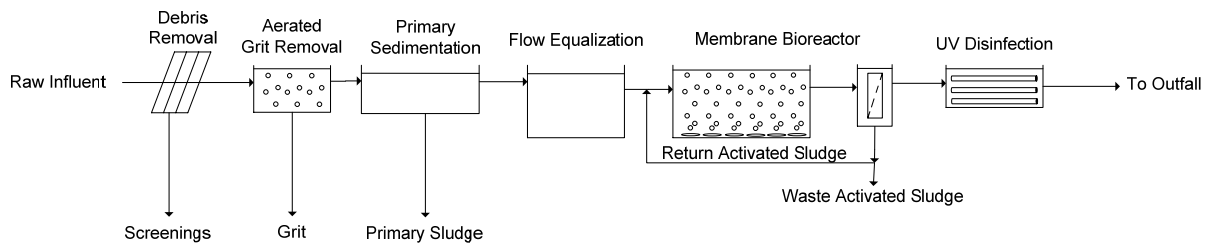


Figure 3-2. Plant Replacement Alternative B (compact footprint) liquid-phase process flow diagram.

Both liquid-phase treatment alternatives would use the same solids stream treatment processes, all of which would be new. A process flow diagram of the solids stream treatment flow scheme is shown in Figure 3-3. Primary and secondary sludge streams would be co-thickened in rotary drum thickeners (RDTs) and the existing digesters would be upgraded to be capable of temperature-phased anaerobic digestion (TPAD) with a series of thermophilic digestion, pasteurization, and mesophilic digestion tanks. Dewatering is accomplished using rotary screw presses. The final biosolids cake is assumed to be Class A material.

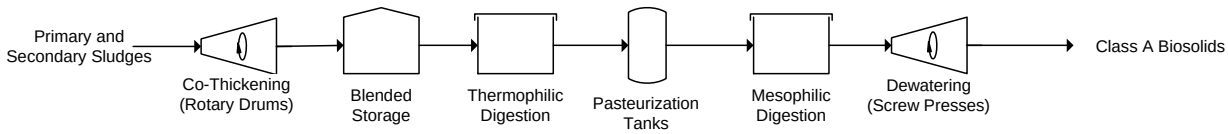


Figure 3-3. Plant Replacement Alternative solids stream process flow diagram.

More detail of the key processes shown in the two liquid-phase process flow diagrams and the solids stream process flow diagram is provided in Section 3.3, along with detail on supporting systems for these processes. The selection of the individual processes shown in the figures in this section resulted from the analysis detailed in the previously submitted Plant Replacement Alternatives Goals, Objectives, and Technology Screening Review TM and in Unit Process Improvement Studies TMs.

3.3 Unit Process Sizing and Design Criteria

This section provides an overview of the key processes associated with the Plant Replacement Alternative, including elements of the conventional treatment Alternative A and compact footprint Alternative B. As a complement to this overview, Attachment A provides a tabular breakdown for each major process, with each process broken down into sub-processes and then further into assets. Assets are defined as one of the following: pumps/blowers, pipeline, miscellaneous mechanical equipment, buildings, and electrical/controls. The tabular data provide design criteria used in conceptually developing the processes for the Plant Replacement Alternative, including quantity, dimensions, and capacity of specified assets.

3.3.1 Headworks

Preliminary treatment will consist of the following processes (listed in upstream to downstream order):

- **Screening:** Currently the WPCP has grinders which grind influent debris, but do not actually remove it from the liquid stream, therefore nuisance materials are conveyed downstream. The new screening and debris removal system will consist of mechanically cleaned screens located in deep channels which will remove large debris completely from the process and convey it to a washer and compactor system. The washer and compactor removes organic matter, reduces odors, and prepares the screenings to be hauled away (processed screenings are stored in a bin for two to three days).

- **Raw sewage pumping station:** A trench-style, self-cleaning wet well collects the screened wastewater and lifts it to the pre-aeration grit removal tanks. The pumping station includes variable speed vertical turbine solids handling pumps that have the capacity to handle peak hour influent flows projected for 2035 in the Influent Flow and Loads TM. Footprint for additional pump bays will be provided for potential expansion that would include the projected ultimate influent flow.
- **Grit removal:** The existing grit removal tanks are outdated and not optimally configured for grit separation. New aerated grit basins (two constructed for redundancy) will be shaped to promote separation and collection of grit material, and a vortex grit washer and dewatering vessel will process the grit for disposal. Aeration will be applied to the grit removal tanks; approximately 750 cubic feet per minute (cfm) will be required. Aerated grit basins are preferred over vortex grit basins because they are better suited for peak flow conditions.

The new headworks will be connected to the existing collection system via a junction structure that connects the two existing 48-in diameter influent sewers with one new 54-in diameter sewer. The new influent sewer is reinforced concrete pipe and runs for approximately 200 linear feet (LF) to the new headworks.

3.3.2 Primary Sedimentation

New primary sedimentation tanks will be constructed in the eastern portion of the plant and will not be directly connected to the grit removal tanks, as is currently the case. Prior to construction of the new process, the City will need to demolish the existing sludge dewatering beds and sludge pumping station. The new process will consist of 5 rectangular sedimentation tanks which are designed to settle out particulate material and produce an effluent containing mainly dissolved organic matter. Within each tank, overflow launders and chain-and-flight sludge collectors accommodate liquid-solids separation and transport of settled primary sludge. In the Plant Replacement Alternative, primary sludge will not be thickened in the primaries, but instead the sludge will be pumped to a separate process for co-thickening with waste activated sludge (WAS).

In the initial phase of construction, a 60-in diameter primary effluent pipeline will be constructed and connected to the existing primary effluent pipeline, which conveys effluent to the pond system for secondary treatment. This connection to the ponds will need to be maintained after the new primary sedimentation tanks are placed on line while the new aeration basins are constructed.

This alternative assumes that no chemicals will be used in the process to increase total suspended solids (TSS) and biochemical oxygen demand (BOD) removal, a system typically referred to as chemically enhanced primary treatment (CEPT). Because of this, the only energy requirement in the process is for the sludge scraper mechanisms and sludge pumping, which results in relatively low energy costs.

3.3.3 Flow Equalization and Pond Restoration

The Plant Replacement Alternative provides equalization of primary effluent using an area within the existing facultative pond system. Two equalization areas will be constructed:

- A 30-acre stormwater equalization area will be constructed within the southern part of the existing larger oxidation pond. This area was sized to contain projected 2035 peak month flows. Levees will be constructed to separate this area from the remainder of the pond. The earthen berm levees are assumed to be trapezoidal shaped with 3:1 side slopes and 12-ft height. Approximately 51,000 cubic yards of fill is needed for the levee construction. Prior to bringing this equalization area on line, the City may need to dredge the residual biosolids from the pond, a process projected to extend for approximately 10 years. Following completion of the dredging, the equalization area will be lined with an impermeable material. Note the primary effluent pipeline referred to above will also be used for this equalization purpose.
- A 2-acre diurnal equalization area will be constructed within the stormwater equalization area. This area was sized to contain 1/3 of the projected 2035 average dry weather flow, a typical quantity for a diurnal

equalization area. Concrete walls will be constructed to segment off this area, and the base of the area is to be concrete lined. Plant effluent water will be used to wash down collected solids on a daily basis.

The remainder of the existing oxidation ponds (approximately 410 acres) would no longer be needed as a WPCP treatment process area in the Plant Replacement Alternative. Therefore, following construction of the equalization basins this area would be converted to a beneficial ecological use. The following regional planning projects were considered in the evaluation of potential future habitat uses of the Sunnyvale pond:

- Baylands Habitat Goals Report (Goals Project, 1999)
- South Bay Salt Pond Restoration Project (U.S. Fish and Wildlife Service/California Department of Fish and Game, 2007)
- Shoreline Study (California Coastal Conservancy, 2006).

Based on the documents reviewed, three possible ecological habitat types were identified in Baylands habitat mosaic that are potential future uses of the Sunnyvale Pond:

- Tidal wetlands
- Managed ponds with island ponds
- Open water habitat

Conversion of the existing facultative ponds to tidal wetlands is less desirable because resulting San Francisco Bay sediment accretion in the ponds could deprive other more high-value tidal restoration projects of sediment in the South Bay. The southern portion of San Francisco Bay is known to be sediment-limited with respect to tidal wetland restoration projects, so other tidal wetland restoration projects in the region may be considered higher priority.

If the Sunnyvale ponds were converted to either managed ponds with island ponds or an open water habitat, a key design element would be provision of adequate flushing to avoid stagnation and low dissolved oxygen levels. This would be accomplished by circulating either San Francisco Bay water, fresh water, or recycled water through the restored habitat. Regardless of source of circulated water, design elements for cost estimating purposes would be similar. All designs and cost estimates involve gates, pipes, pumps, and berms. All designs and cost estimates would also need to consider biosolids management options and costs.

Assuming that either managed ponds with island ponds or an open water habitat will be constructed, two sets of water control structures will be needed to move tertiary treated WPCP effluent into the restored area and to move tidal water from San Francisco Bay in and out of the restored area. Each water control structure includes five 48-in diameter culverts, a headwall, fish screens, and gates/valves that are used to regulate water flow. The water control structures would be designed to allow flow in either direction, but the predominant direction would be away from the WPCP.

3.3.4 Secondary Treatment

The Plant Replacement Alternative is sub-divided into two secondary treatment process trains: Alternative A, which incorporates conventional activated sludge and secondary clarification, and Alternative B, which incorporates an MBR facility and UV disinfection to provide a compact footprint treatment system.

3.3.4.1 Activated Sludge (Alternative A)

The Technology Screening Review TM considered activated sludge, the MBR, integrated fixed film activated sludge (IFAS), and the biological aerated filter (BAF) as potential secondary treatment technologies. Though the activated sludge process has the largest footprint requirements, it also had the lowest projected life cycle cost and lowest projected resource consumption. Therefore, activated sludge was selected for the Plant

Replacement Alternative (Alternative A). The MBR was selected for the compact footprint alternative (Alternative B) in the case that the footprint issues associated with Alternative A drive an alternate direction.

The conventional activated sludge process (schematically shown in Figure 3-4) consists of aerated basins followed by secondary clarifiers. Concentrated biomass (activated sludge) grows under aerobic conditions in the aeration basins as a result of wastewater degradation and then is sent to the secondary clarifiers. In the clarifiers, sludge settles to the tank bottom and is recycled back to the aeration basins as return activated sludge (RAS), to maintain the biomass concentration. Secondary clarifier effluent flows over weirs and to the next liquid-phase treatment process. The continuous repetition of aeration and clarification results in the natural selection of an activated sludge that will tend to flocculate in the aeration basins and settle in the secondary clarifiers.

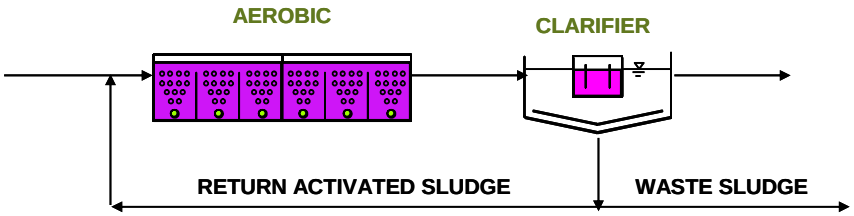


Figure 3-4. Process flow diagram of the activated sludge process.

The following process assumptions were made for conceptual design of the activated sludge system:

- The sludge yield is 0.79 lb TSS / lb BOD for complete nitrification in additional to carbonaceous BOD removal. Complete nitrification is desired to assure compliance with potential future plant effluent limits for ammonia as detailed in the Nitrification Process Improvements Unit Process Improvements Study. The yield identified was calculated using historical TSS and BOD removal rates through the existing primary clarifiers and completing a BioWin model of the proposed activated sludge system.
- A 10-day solids retention time (SRT) is assumed. The SRT is the amount of time the activated sludge remains in the system before it is removed as waste sludge. The SRT will determine the concentration of the activated sludge. For this activated sludge system, a 10-day SRT make nitrification possible by retaining nitrifying bacteria in the aeration basins.
- Included in the SRT is time for detention in an anoxic zone, which serves as a selector for alkalinity recovery and improved sludge settleability.
- The activated sludge concentration in the aeration basin, or mixed liquor suspended solids (MLSS) concentration, is assumed to be 2,500 mg/L.
- Because of the limited footprint available, deep (30-ft) aeration basins are assumed instead of the typical 15-ft sidewater depth.
- The aeration basin effluent channel will have a detention time of at least 10 minutes to sufficiently degasify nitrogen from the effluent flow.
- Secondary clarifiers (3 total) are sized at 110-ft diameter and designed to accommodate the projected 2035 peak month flow at a surface overflow rate of 1,000 gallon per day per square ft (gpd/ft^2).

3.3.4.2 Membrane Bioreactor (Alternative B)

The MBR process (schematically shown in Figure 3-5) is an activated sludge process that uses membranes for solids separation instead of secondary clarifiers. In modern designs, the membranes are placed inside the aeration tanks. An applied vacuum pressure filters the biomass so that solids are retained in the reactor and a membrane-filtered, effluent is produced. Coarse bubble aeration of the membrane is typically used to prevent

solids from accumulating at the surface, and routine backwashing (or membrane relaxing where applied vacuum pressure is stopped) is used to prevent solids accumulation. Because membranes are used for separation, the MBR effluent represents a tertiary effluent, so dual media filters would no longer be needed.

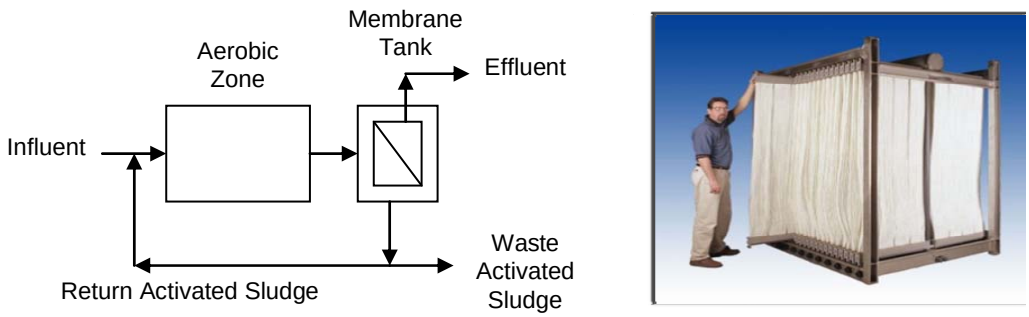


Figure 3-5. Process flow diagram of the MBR process (left) and picture of a membrane (right, Zenon membrane shown).

The following process assumptions were made for conceptual design of the MBR system:

- The same sludge yield of 0.79 lb TSS/lb BOD is assumed for the MBR system as was calculated for the conventional activated sludge system.
- The MBR process is typically operated at a high SRT to promote nitrification and minimize biological fouling of the membranes. The SRT for the MBR system is 10 days, identical to the SRT assumed for the conventional activated sludge system.
- Membranes allow operation at higher MLSS concentrations than conventional activated sludge, which results in smaller footprint requirements. The MLSS concentration for the MBR process is assumed to be 10,000 mg/L.
- Air flow requirements include those for biological treatment and membrane agitation air. Air requirements are significantly higher for an MBR versus conventional activated sludge.

Although the MBR represents a more compact footprint than conventional activated sludge, the high energy requirement associated with membrane operation and chemical requirements means the MBR process will require higher resource consumption.

3.3.5 Filtration

Dual media filters are currently used by the City to produce tertiary effluent. Plant Replacement Alternative A would keep the filters, but they would be modified with the following upgrades to aid performance:

- Both layers of media would be replaced.
- New backwash pumps and air blowers would be installed; existing equipment is nearing the end of their useful life, as indicated in the Condition Assessment and Unit Process Performance Review.
- New valving and piping will be installed.

Under Alternative B, the dual media filters would no longer be needed due to the presence of the MBR upstream. Therefore, if Alternative B were constructed, the filters would be demolished.

3.3.6 Disinfection

Disinfection is currently provided using chlorine gas. Filter effluent passes through two chlorine contact basins which provide sufficient contact time to meet disinfection requirements. City LOS requirements call

for abandoning the practice of using the hazardous chlorine gas at the WPCP, with disinfection in the future provided by injection of sodium hypochlorite (Alternative A) or treatment by UV light (Alternative B).

3.3.6.1 Sodium Hypochlorite Disinfection (Alternative A)

Sodium hypochlorite, a liquid solution at atmospheric conditions, will be delivered by truck and stored in tanks adjacent to the existing chlorine contact chamber. A dose appropriate for disinfection will be metered into the dual media filter effluent, upstream of the chlorine contact chamber. Dechlorination of the disinfection system effluent would still be necessary before discharge, though the existing sodium dioxide system will be replaced with a sodium bisulfite system (currently being designed).

In addition to the modification of type of disinfectant used, the following improvements will be made to the existing disinfection process:

- Increase chemical mixing and distribution efficiency by modifying the flow distribution channel
- Replace the effluent flow meter
- Rehabilitate the concrete tanks
- Construct a new sodium hypochlorite storage area, spill containment structure, and feed pump station

The capacity of the chlorine contact chamber will not be modified and the upgraded process will occupy essentially the same footprint as the existing process.

3.3.6.2 Ultraviolet Disinfection (Alternative B)

The UV disinfection process uses electromagnetic radiation emitted by specialized lamps to inactivate pathogens. This alternative form of disinfection complies with the LOS objective to reduce the use of harmful chemicals on site (minimal chemical use would be needed to perform routine cleaning of the quartz sleeves which enclose the UV bulbs). A wavelength of 254 nanometers (nm) has been shown to be the most effective at inactivating microorganisms, and thus is known as the germicidal wavelength.

Three major UV disinfection technologies are available on the market today:

- Low pressure, low-intensity (LPLI) systems: These systems represent the oldest technology, and have reliably used in the U.S. for the past 40 years. They have the lowest lamp input power requirement of the three technologies (typically 70 to 100 watts per lamp) and operate at 35 to 40 percent efficiency (defined as 254 nm output light divided by input power). Approximately 85 to 88 percent of the lamp output is at the germicidal wavelength. They do not have an automatic quartz sleeves cleaning system.
- Medium pressure, high-intensity (MPHI) systems: These systems have been used in the U.S. since the mid-1990's. They have the highest lamp input power requirement (2,000 to 5,000 watts per lamp) and produce output energy over a broad range of wavelengths. The output also includes a much lower concentration at the germicidal wavelength, thus they have the lowest efficiency of the three technologies (10 to 12 percent). Approximately 7 to 15 percent of the lamp output is at the germicidal wavelength. They at much higher temperatures than other systems, making lamp and ballast life significantly shorter. They do have an automatic cleaning system.
- Low pressure, high-intensity (LPHI) systems: These systems have been used as reliable disinfection systems in the U.S. since the late 1990's and in Europe for more than 30 years. The technology is similar to LPLI lamps, with the exception that a mercury-indium amalgam is used in place of mercury to generate the UV-C region wavelengths. Their lamp input power requirements range from 150 to 1,200 watts (depending on the manufacturer), and have a similar efficiency to the LPLI systems. These systems are available in horizontal (Figure 3-6) or vertical (Figure 3-7) lamp configurations. Proven, reliable horizontal lamp systems are provided by Trojan or Wedeco, and proven, reliable vertical systems are provided by either Ozonia or Siemens. All types include an automatic cleaning system.

An LPHI system was identified as the most appropriate for the Sunnyvale application and was used as a design basis for this TM.

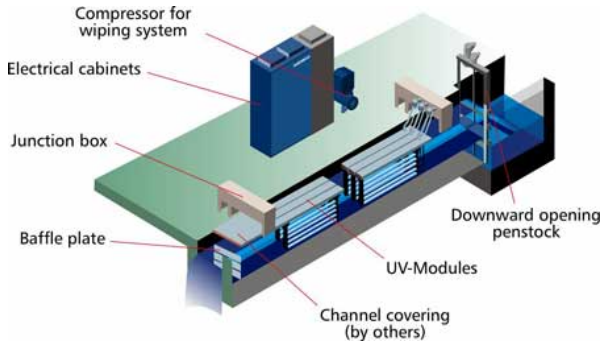


Figure 3-6. Schematic of a horizontal lamp UV disinfection system (Wedeco system shown).

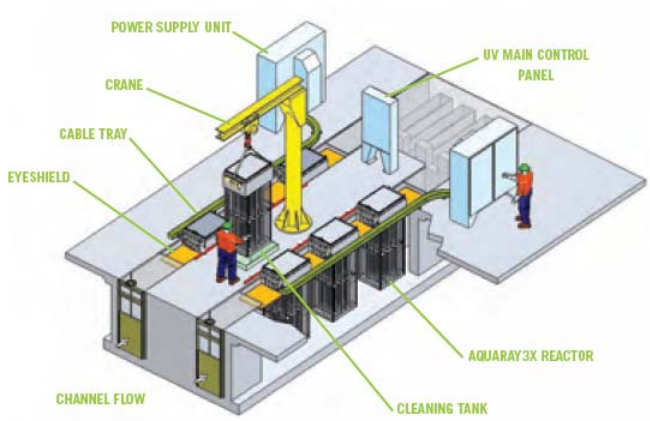


Figure 3-7. Schematic of a vertical lamp UV disinfection system (Ozonia system shown).

Figures 3-6 and 3-7 depict open-channel UV systems. Another design option would be to use a closed-channel ("in-pipe") system. Closed channel systems are sometimes used downstream of MBRs, since this type of system is easily installed downstream of permeate pumps. Previous experience indicates that there is not a significant cost difference between closed channel and open channel installations.

Effectiveness of UV disinfection is directly related to dose, which provides an indication of the amount of energy absorbed by the microorganisms. Dose is defined as the product of UV intensity, in milliwatts (mW) per square centimeter (cm^2), and contact time, which is usually 5 to 10 seconds (sufficient to inactivate most microorganisms). The required dose for meeting the National Pollutant Discharge Elimination System (NPDES) permit limit of 35 enterococcus bacteria colonies per 100 mL in secondary effluent is typically 30 to 60 millijoules (mJ) per cm^2. It should be noted that membrane filtration through an MBR is a physical disinfection method that by itself will probably meet the NPDES permit limit most of the time. However the California Water Quality Control Board requires a final disinfection step, such as UV, downstream of the MBR. A low UV dose is projected to be sufficient to meet effluent permit limits: 30 mJ/cm^2 was assumed.

The dose requirement depends in part on the UV transmittance (UVT) of the secondary effluent. UVT is defined as the percentage of 254 nm UV light that passes through 1 cm of water, with a value of 100 percent attributed to deionized water. UVT values have a pronounced effect on the system size and cost. Typical UVT values for MBR effluent range from 56 to 86 percent, however lower UVT values are possible with higher concentrations of dyes, dissolved iron, or other colored substances in the water. Prior to design, UVT, which could be measured using grab samples of the plant effluent, would need to be determined.

The following process assumptions were made for conceptual design of the UV disinfection system:

- A flow rate of 22.4 mgd is assumed. This is the projected 2035 peak month flow, which should be the maximum flow seen by the UV disinfection system downstream of primary effluent equalization.
- The Trojan UV 3000 Plus system is used as the basis for the conceptual development. This model contains horizontally configured UV lamps.
- The assumed dose requirement is 30 mJ/cm^2 and the UVT is 65 percent (a conservative assumption within the typical 56 to 86 percent range – lower values result in larger systems).
- The system includes two channels, each with a capacity of 16 mgd. Two channels allows for firm capacity in the system, whereby the projected 2035 average dry weather flow (ADWF) could be treated in the system with one channel out of service.
- Two UV banks are included per channel, for a total of four banks. Each bank contains 36 UV lamps, and each lamp would require 150 watts (W) of electrical input power.
- The total input power requirement for this system is approximately 22 kilowatts (kW).

The total footprint of the facility described above would be approximately 20 ft x 40 ft. This includes allowances for a crane (for removal of modules), instrumentation, power supply, and shed cover.

Note the existing plant utility water system consists of plant effluent, which has a chlorine residual that reduces biofilm growth within the utility water piping, hose bibs and spray nozzles. Because UV disinfection does not provide a chlorine residual, a small sodium hypochlorite system could be installed to assure the plant utility water system stays in good working order.

3.3.7 Recycled Water

Recycled water regulations in California are dictated by Title 22 California Code of Regulations. Recycled water for surface irrigation requires disinfected tertiary (filtered) recycled water, which has been biologically oxidized and meets the following criteria:

- Has been coagulated and passed through natural undisturbed solids or a bed of filter media or has been passed through a micro, nano, or reverse osmosis membrane.
- Has passed through a chlorine disinfection process that provides a CT of 450 mg-minutes/L with a modal contact time of not less than 90 minutes, or has passed through a disinfection process that, when combined with filtration, has been demonstrated to achieve 5-log inactivation of virus.

The Plant Replacement Alternative includes a separate 4-mgd process train that is available to produce recycled water. Recycled water would be produced using different processes for Alternative A (conventional activated sludge secondary treatment upstream) and Alternative B (MBR secondary treatment upstream).

3.3.7.1 Alternative A Recycled Water Production

The Alternative A recycled water system requires two processes in series to achieve sufficient treatment: cloth media filtration and sodium hypochlorite disinfection. Cloth media filtration is a low energy process in which the media is submerged in a process tank through which the wastewater passes, removing solids from the stream. The media is routinely cleaned using vacuum headers that remove attached solids. Aqua Aerobic

Systems, Inc. (Rockford, IL), one of six Title 22-approved cloth media suppliers, provides submerged fixed cloth media filters that are Title 22 approved for a flux of 6 gallons per minute per square foot (gpm/ft^2). Figure 3-8 presents a schematic of their AquaDisk system.

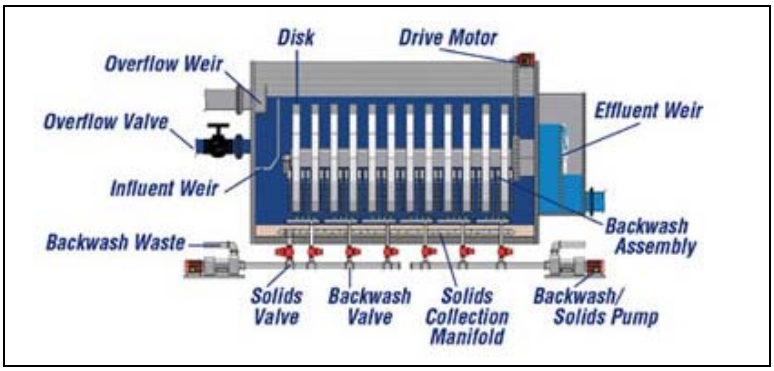


Figure 3-8. Cloth media filter (AquaDisk) manufactured by Aqua Aerobic Systems, Inc.

Water flows through the media by gravity, and over time the solids accumulate on the outside of the cloth while water flows to the inside. Solids will settle out in the tank, and can be routinely removed through a sludge valve. As solids accumulate, the tank level rises and, once a set level is reached, the backwash cycle initiates. During backwash, a vacuum pump removes solids from the surface of the cloth media as the disks are slowly rotated. Cloth media needs to be replaced approximately every 5 to 10 years (7 years is assumed for calculation of approximate yearly costs – see Section 4.1.2).

Assumed design criteria for the cloth filters are as follows (the AquaDisk Cloth Media Filtration System was used as the basis for the conceptual development):

- 2 units (for redundancy) with 8 disk filters per unit
- Footprint of each unit: 18 ft x 10 ft
- Height of each unit: 12 ft

Following filtration through the cloth media, the wastewater is passed through a separate chlorine contact chamber that uses sodium hypochlorite. Concentration and time requirements for recycled water treatment are provided at the beginning of this section, and are based on the projected peak day flows. Assumed design criteria for the hypochlorite disinfection process are as follows:

- Two units (for redundancy) with three passes per unit
- Each pass is 12 ft x 126 ft
- Depth of each pass is 13 ft

3.3.7.2 Alternative B Recycled Water Production

Following secondary treatment with an MBR, recycled water production requires disinfection that meets effluent limits of 2.2 total coliform per 100 mL and 5-log virus removal. The required UV dose is significantly higher than the required dose for Bay discharge. Guidance for recycled water production using UV is provided in the "Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse" document published by the National Water Research Institute (NWRI), which indicates that the design UV dose shall be at least 80 mJ/cm^2 under maximum daily flow. This high dose is required to achieve 5-log virus removal and will require a UV system several times larger than the system described in Section 3.3.6.2, which applies to secondary disinfection and Bay discharge.

Because the use of the effluent will be recycled water, the design requirements for this 4-mgd process train are also more stringent than the requirements for secondary disinfection and Bay discharge. In addition to the minimum 80 mJ/cm² dose requirement, the following other elements must be considered:

- The effluent turbidity shall be equal to or less than 0.2 nephelometric turbidity units (NTU) 95 percent of the time, and shall not exceed 0.5 NTU at any time (per NWRI guidelines).
- The MBR effluent UVT shall be 65 percent or greater at 254 nm (the germicidal wavelength)
- Greater redundancy must be incorporated into the design, in that the required UV dose must be capable of being applied following failure of a reactor or if a reactor is taken off line. Included in this redundancy shall be one stand-by reactor per reactor train and one stand-by reactor train (per NWRI guidelines). An exception for this can be applied for by demonstrating that adequate storage exists upstream of the UV system (such as the primary effluent equalization basin).
- A greater amount of instrumentation is required than for secondary disinfection only. The following parameters must be continuously monitored: flow rate, UV intensity, UV transmittance, turbidity, and operational UV dose. A number of alarms associated with these parameters must be provided, as detailed in the NWRI guidelines.

Note that if either the effluent turbidity or UVT requirement cannot be met, it may be possible to negotiate with the Department of Health Services, who maintains jurisdiction over the disinfection system and the recycled water it produces, for an acceptable modified UV dose (higher than 80 mJ/cm²)

Given the additional requirements for UV dose, redundancy, and instrumentation, system sizing should be estimated during the preliminary design phase and be based on MBR effluent sampling and testing. The following assumptions were made for conceptual design of the system for this evaluation:

- A flow rate of 4 mgd is assumed. This is the projected maximum flow for the recycled water train.
- The Trojan UV 3000 Plus system is used as the basis for the conceptual development. This model contains horizontally configured UV lamps which require 150 W of electrical input power per lamp.
- The system size is based on an assumed dose of 80 mJ/cm² and a UVT of 65 percent.
- Cloth media filter effluent will pass through a system of four parallel channels, which includes one redundant channel. The channels will contain between 400 to 450 lamps. Note that this is nearly four times the number of lamps projected for the 22.4 mgd UV system for secondary effluent and Bay discharge (Section 3.3.6.2).
- Total input power requirement for this system is approximately 65 kW.

The total footprint of the facility would be approximately 50 ft x 50 ft, which includes allowances for a crane (for removal of modules), instrumentation, power supply, and a shed cover.

3.3.8 Co-Thickening and Storage

In the Plant Replacement Alternative, thickening of primary sludge is no longer accomplished in the primary clarifiers. Instead, primary sludge and WAS are co-thickened in a single process. In the preliminary screening, the rotary drum thickener (RDT) process was selected over a gravity belt thickener or rotary screw thickener, because of its low life cycle cost and low resource consumption. Therefore, the RDT process is the basis for the thickening process conceptual development in this TM.

The RDT process uses a rotating cylindrical screen that retains sludge and allows excess water to drain out. Prior to the drum, polymer is added to the dilute sludge and the combination is mixed to promote floc formation. The RDT process is a relatively low energy process; electrical requirements are from polymer addition, sludge mixing, and the rotation of the drum. The RDT process can be operated continuously with

minimal operator attention. Three 200-gallon per minute (gpm) capacity RDTs are assumed to be needed, including one stand-by unit to provide firm capacity during shut-down of one unit.

Storage will be provided for the un-thickened sludge (where the primary sludge and WAS will be blended) as well as for the thickened sludge. Following are the assumed sizes of these storage systems:

- One 20,000-gallon capacity tank provides storage for un-thickened sludge
- Two 30,000-gallon capacity tanks provide storage for thickened sludge

Pump mixing systems are assumed to be installed for all three storage tanks.

3.3.9 Anaerobic Digestion

Stabilization and sludge solids destruction in the WPCP anaerobic digesters results in reduced biosolids hauling costs, and currently produces Class B biosolids, as defined by the US Environmental Protection Agency (USEPA). The WPCP currently uses mesophilic digestion as its stabilization process, which is defined as operation at temperatures between 30 to 38 degrees Celsius (C) and in the absence of molecular oxygen. The digester temperature determines the rate of solids destruction.

The digester hydraulic retention time (HRT) determines the amount of solids destruction, with higher solids destruction occurring at higher HRT values. The WPCP mesophilic digestion process is typically operated at HRT value of 15 days or greater. Biogas produced in the digesters contains methane, which is converted to electricity in the power generation facility.

The Plant Replacement Alternative includes two sets of improvements to the WPCP digester system: upgrades to the four existing mesophilic digesters (which is also included in the Plant Rehabilitation Alternative) and conversion to temperature-phased anaerobic digestion (TPAD), which has the goal of producing Class A biosolids. Conversion to TPAD is included in the Plant Replacement Alternative only.

3.3.9.1 Improvements to Existing Digesters

The first stage of improvements to the digesters involves installing modifications that will improve digester operation and efficiency. Following are the assumed improvements:

- Completion of the conversion from floating covers to fixed covers for all four digesters (this upgrade is underway with one digester currently converted to the new cover type).
- Upgrade digester heating and heat recovery for all four digesters
- Conversion from the current gas mixing system to a pumped mixing system.
- Installation of an automated sludge conveyance system throughout the digestion process, resulting in continuous sludge feed, mixing, and withdrawal. This includes installation of new sludge feed pumps and recirculation pumps.

3.3.9.2 Conversion to TPAD

The TPAD process is a solids stabilization process where in general two digesters of different temperatures are operated in series. The version of TPAD assumed for the Plant Replacement Alternative involves operating one digester at thermophilic temperatures (50 to 57 degrees C) and subsequent digesters at mesophilic temperature. The Plant Replacement Alternative assumes that all four existing digesters would be upgraded to incorporate the capacity for operation at thermophilic temperatures, though typically one or two digesters would be operated at the elevated temperature at any given time.

Operation at elevated temperatures in the first stage of digestion increases biological activity so that the digester can be operated at a lower HRT (5 to 8 days). The mesophilic digestion stage downstream is then also operated at a reduced HRT of approximately 10 days. The TPAD process will produce higher overall

volatile solids destruction than mesophilic digestion alone, however, the thermophilic digesters will require additional energy to heat the process to thermophilic temperatures.

To reduce the potential for short circuiting through the thermophilic digester, a batch pasteurization step is placed before mesophilic digestion. Three 30-ft diameter pasteurization tanks are assumed for this process, each with a 125,000-gallon capacity and cone-shaped bottom. Each tank will have its own heating system and a pump mixing system.

The Plant Replacement Alternative also includes improvements to digester gas management and cogeneration of power along with installation of TPAD. Following are the assumed improvements:

- Construction of two 45-ft diameter, 50,000-gallon capacity gas storage tanks
- Construction of a gas moisture separator, gas conditioning heat exchanger, and two digester gas chillers
- Construction of an iron sponge hydrogen sulfide (H_2S) reduction system and an activated carbon adsorption system for reduction of siloxanes
- Construction of new gas compressors, gas booster blowers, boilers, and flares

3.3.10 Dewatering

The Plant Replacement Alternative includes demolition of the existing sludge dewatering beds in the eastern part of the WPCP property and construction of a new mechanical dewatering facility enclosed within a building. The Technology Screening Review TM indicated that screw presses were preferred over centrifuges for mechanical dewatering due to their lower energy requirements. Centrifuges, alternatively, are desirable in the event of increasing costs for off-site sludge reuse (drier cake equates to lower hauling costs) and if there is a desire by the City for day-shift only dewatering. Screw presses were carried forth into the Plant Replacement Alternative, acknowledging that the centrifuge technology is also viable and could be constructed instead of the screw presses with no impacts to the other processes in the Plant Replacement Alternative.

The screw press process (depicted schematically in Figure 3-9) produces liquid-solids separation over a rotating screw, which is accomplished by gravity at the inlet end of the screw and then by reducing the volume as the as the sludge is conveyed to the discharge end of the screw. The separated liquid, or filtrate, is recycled to the head of the plant. Five screw presses are required, including one redundant screw press for establishing firm capacity. The maximum capacity of each screw press is 8.1 dry tons/day. Polymer is assumed to be added to the process, with a storage tank and blending unit included in the building. A dose of 12 lb polymer per dry ton solids is used for the conceptual development of the dewatering facilities.

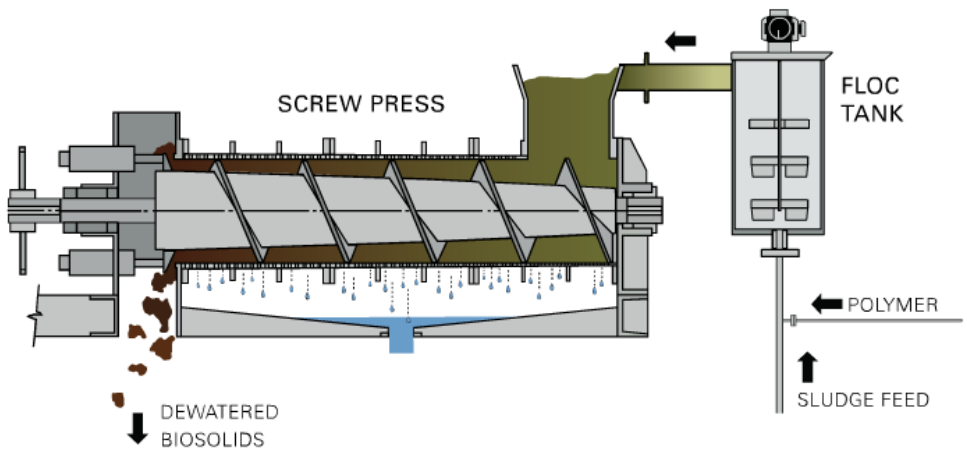


Figure 3-9. Screw press schematic (FKC design shown).

3.4 Supplemental Plant Amenities

The following sections present basic conceptual information on other areas of the new plant that provide support to the processes described in Section 3.3.

3.4.1 Power Generation

The following electrical elements are assumed for the Plant Replacement Alternative:

- The main power distribution center, which includes two main switchgears and sets of transformers that convert electricity supplied by Pacific Gas and Electric (PG&E) to 12-kilivolt (kV) power. Each switchgear includes new switching, conductors, conduits, and transformers to provide a fully redundant feed system. The electrical components of the main power distribution center are contained within the new power distribution center building.
- Stand-by power with a capacity of 2,000 kW is provided by an emergency generator which is powered by diesel fuel. The stand-by power facility, including a diesel storage tank, is also located within the new power distribution center building.
- Four area substations transfer power to the following process areas: (1) Headworks and primary clarifiers, (2) Aeration basins (Alternative A) or MBR (Alternative B), (3) Tertiary, UV disinfection, and/or recycled water processes, and (4) Solids handling processes. Each of these substations receives 12.47 kV from the main power distribution center, and each has a capacity of 480 volts (V).

Additionally, the Plant Replacement Alternative assumes that there will be improvements to the existing biogas power generation facility, whereby the system will be optimized to operate using biogas only. For this system, the engines will be replaced with more modern engines that include the advanced reciprocating engine systems (ARES) technology – a combined heat and power system – which would reduce operational and maintenance costs and are more likely to meet future emissions standards, in particular for nitrogen oxides. The inlet gas treatment systems will also be upgraded (see Section 3.3.9.2).

3.4.2 Relocated Utilities Building

Plant utilities are currently housed within the primary control building. This building will be demolished in the Plant Replacement Alternative, thus the existing utilities will have to be relocated (and new utilities would be housed in the new location). One of the main systems to be relocated is the plant hot water looping pumping

system, which is used to convey hot water throughout the plant. Equipment such as steam separators, blowers, and heat exchanger components will need to be moved into the new building. In cases where the equipment is nearing the end of its useful life, the equipment would need to be replaced.

Adjacent to the existing primary control building is the existing maintenance shed, which would also need to be relocated prior to demolition of the building. All maintenance tools and equipment are to be kept together inside a new shed as part of this alternative. The maintenance shed associated with the Plant Replacement Alternative is assumed to be approximately 50 percent larger than the shed associated with the Plant Rehabilitation Alternative, due to the increased amount of equipment associated with the new processes.

3.4.3 Landfill Gas Booster and Flare System

Because of necessary demolition and new construction in the southern part of the plant, the existing landfill gas booster and flare system needs to be moved to the northern portion of the main plant. In cases where the equipment is nearing the end of its useful life, the equipment would be replaced.

3.4.4 Community and Environmental Enhancements

The following community and environmental enhancements are assumed upon construction of the Plant Replacement Alternative:

- Construction of a new access road for site service.
- Construction of kiosks at the entrance to the oxidation ponds.
- Construction of new openings for trail parking access

3.4.5 New Administration Building

Because of necessary new construction in the southern part of the plant, the existing administration building will be demolished and a new building will be constructed that is larger than the existing building. A concrete masonry unit (CMU) building is assumed, with the building including laboratory facilities and occupying a larger footprint than the existing building.

3.5 Treatment Process Layout Descriptions

Attachment B depicts the proposed final layout of all elements of the Plant Replacement Alternative, with Drawing B-1 showing the final layout of Alternative A (conventional activated sludge secondary treatment) and Drawing B-6 showing the final layout of Alternative B (compact footprint alternative with an MBR facility and UV disinfection).

Note that the headworks, primary clarifiers, aeration basins, and TPAD facilities are all located within the "green field" area to the east of the existing plant, along with some support facilities and smaller processes. Early execution designated facilities (listed in Section 2.1.4), which are mainly located at the head of the liquid-phase process train, are to be constructed in this green field area so that treatment of wastewater can continue while these new facilities are being built.

3.6 Project Sequencing Descriptions

To keep critical plant processes in operation during construction of replacement plant processes, a phased approach is needed. Layout drawings indicating construction sequencing packages accomplishing this phased approach are presented in Attachment B. The following drawings correspond for sequencing for Plant Replacement Alternative A (conventional activated sludge):

- Drawing B-1 provides the final layout of the alternative within the WPCP property.

- Drawing B-2 (Construction Package 1) includes early execution projects (headworks, raw sewage pumping, primary clarifiers, etc). Demolition of the sludge dewatering beds and sludge pump station is necessary prior to construction.
- Drawing B-3 corresponds to Phase 1 of Construction Package 2 (Secondary Treatment) and mainly includes construction of the new aeration basins. Biological treatment is still provided in the ponds until the entire construction package is completed.
- Drawing B-4 corresponds to Phase 2 of Construction Package 2 (Secondary Treatment) and mainly includes construction of the new secondary clarifiers.
- Drawing B-5 (Construction Package 3, Advanced Treatment) includes construction of tertiary facilities, upgrades to existing facilities not being replaced (filters, chlorine contact tanks, digesters), installation of TPAD facilities, construction of the parallel recycled water process, and modifications to the pond system for primary effluent equalization and pond restoration.

The following sets of construction sequencing packages are presented in Attachment B for Plant Replacement Alternative B (compact footprint):

- Drawing B-6 provides the final layout of the alternative within the WPCP property.
- Drawing B-7 (Construction Package 1) includes early execution projects (headworks, raw sewage pumping, primary clarifiers, etc). Demolition of the sludge dewatering beds and sludge pump station is necessary prior to construction.
- Drawing B-8 corresponds to Construction Package 2 (Secondary Treatment) and mainly includes construction of the MBR facility.
- Drawing B-9 (Construction Package 3, Advanced Treatment) includes construction of tertiary facilities, upgrades to the digesters, installation of TPAD facilities, construction of the parallel recycled water process, and modifications to the pond system for primary effluent equalization and pond restoration.

4. EVALUATION OF PLANT REPLACEMENT ALTERNATIVES

4.1 Cost Evaluation Summary

This section includes a breakdown of capital and operational costs projected for the Plant Replacement Alternative, including Alternatives A and B. Costs opinions have been prepared for individual processes and are based on assumptions listed in this section. The costs opinions are assumed to be planning level.

4.1.1 Capital Cost Summary

Estimates of capital costs for elements of Plant Replacement Alternative A (conventional activated sludge) and Alternative B (compact footprint) are shown in Table 4-1. Details of the capital cost estimates are provided by process area and are included in Attachment C. Note that the costs vary in some instances between Alternative A and Alternative B because of differences in length of time assumed for completion of construction packages, as estimates are made at the mid-point of construction, which is impacted by projected annual inflation.

Table 4-1. Plant Replacement Alternatives Capital Cost Summary (in Millions of Dollars)			
Process Area	Sub-Process	Capital Cost Estimates	
		Alternative A	Alternative B
Main Process Areas			
Headworks	Screening – Debris Removal	3.7	3.6
Headworks	Raw Sewage Pumping	5.9	5.9
Headworks	Grit Removal	4.3	4.3
Primary Sedimentation	Primary Sedimentation Tanks	15.4	15.4
Primary Sedimentation	Primary Effluent Pipeline	2.6	2.6
Primary Effluent Equalization	Stormwater Equalization	18.7	20.9
Primary Effluent Equalization	Diurnal Equalization	7.3	8.0
Pond Restoration	Pond Restoration	13.9	15.1
Pond Effluent Pump Station	Pond Effluent Pump Station	3.4	3.6
Secondary Treatment	Aeration Basins	27.6	
Secondary Treatment	Secondary Clarifiers	15.7	
Secondary Treatment	Membrane Bioreactor		94.3
Existing Facility Improvements	Dual Media Filters	4.5	
Existing Facility Improvements	Disinfection Facilities	3.5	
UV Disinfection	UV Disinfection System		3.3
Recycled Water	Cloth Media Filters + Hypochlorite	4.8	
Recycled Water	UV Disinfection		4.9
Co-Thickening	RDTs and Sludge Storage	12.1	11.6
Existing Facility Improvements	Anaerobic Digestion System	22.8	24.9
Anaerobic Digestion (New Facilities)	Conversion to TPAD	30.3	33.2
Anaerobic Digestion (New Facilities)	Digester Gas Management	11.7	13.1
Dewatering	Screw Presses	19.2	18.5
Supporting Facilities and Miscellaneous Improvements			
Relocated Facilities	Utilities Building	1.5	1.5
Relocated Facilities	Landfill Gas Booster and Flare System	0.8	0.8
Relocated Facilities	Maintenance Facility	1.3	1.4
Relocated Facilities	New Administration Building	3.1	4.5
Electrical Power	Main Power Distribution Center (with Stand-By Power)	2.7	2.7

Table 4-1. Plant Replacement Alternatives Capital Cost Summary (in Millions of Dollars)			
Process Area	Sub-Process	Capital Cost Estimates	
		Alternative A	Alternative B
Electrical Power	Area Substations	15.1	16.0
Electrical Power	Biogas Power Generation	12.3	13.8
Demolition	Demolition of Existing Facilities	21.3	28.2
Civil / Site Work	Activities in Existing Plant Area	2.4	2.9
Community Improvements	Community Improvements	0.4	0.4
	Total Capital Cost Estimate	288.4	355.6

Capital costs have also been broken down into the construction packages presented in layout form in Sections 3.5 and 3.6. The cost estimates for Plant Replacement Alternative A are as follows:

- Construction Package 1 (Early Execution): $52.9 million
- Construction Package 2, Phase 1 (Aeration Basins) $45.4 million
- Construction Package 2, Phase 2 (Secondary Clarifiers): $51.4 million
- Construction Package 3 (Advanced Treatment): $138.7 million

The cost estimates for Plant Replacement Alternative B are as follows:

- Construction Package 1 (Early Execution): $52.9 million
- Construction Package 2 (MBR) $139.7 million
- Construction Package 3 (Advanced Treatment): $163.0 million

These estimates have been incorporated into a projected construction schedule in Figure 4-1.

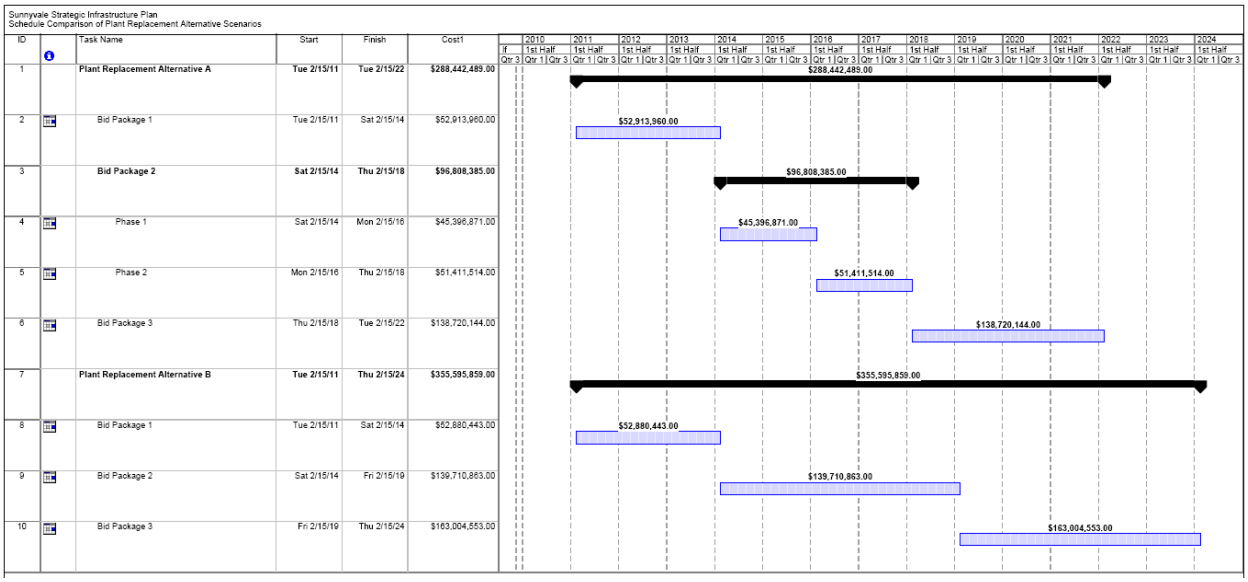


Figure 4-1. Construction schedule and total cost estimates.

4.1.2 Operational Cost Summary

The Plant Replacement Alternatives' projected yearly operational costs are presented in Table 4-2. The costs are based on projected 2035 flows and loads and are reflective of all main processes discussed in this TM. A breakdown of operational costs by process area is provided in Attachment D.

The following assumptions are made in the cost estimates:

- Power consumption is presented in total kilowatt-hours per year (kW-hr/yr) and power costs are calculated by assuming an electricity cost of $0.20/kW-hr.
- Cost of sodium hypochlorite is $0.71/lb chlorine
- Cost of sodium bisulfite is $803/ton
- Cost of citric acid is $5.70/gallon
- Cost of polymer is $5.30/active pound for co-thickening
- Cost of polymer is $1.25/active pound for dewatering
- Cost of biosolids hauling is $44.69/ton wet solids
- Sand media replacement cost is $20/ft^3
- Anthracite media replacement cost is $30/ft^3
- Cloth filter media replacement cost is $220/unit and is replaced every 7 years (sales tax, shipping, and installation costs also included)
- UV bulb replacement cost is $175/bulb

Table 4-2. Plant Replacement Alternatives Operational Cost Summary

Consumable Item	Alternative A		Alternative B	
	Quantity	Cost	Quantity	Cost
Power Consumption (kW-hr/yr)	8,618,000	$1,724,000	17,262,000	$3,452,000
Sodium Hypochlorite (gal/yr)	43,800	$398,000	13,500	$10,000
Sodium Bisulfite (gal/yr)	40,100	$176,000	-	-
Citric Acid (gal/yr)	-	-	370	$2,000
Co-Thickener Polymer (gal/yr)	4,100	$183,000	4,100	$183,000
Screw Press Polymer (gal/yr)	3,100	$33,000	3,100	$33,000
Biosolids Hauling (wet tons/yr)	10,409	$465,000	10,409	$465,000
Sand Media Replacement (ft^3)	2,300	$46,000	-	-
Anthracite Media Replacement (ft^3)	5,600	$168,000	-	-
Cloth Filter Replacement (units)	144	$3,000	-	-
UV Bulb Replacement (no. bulbs)	-	-	107	$19,000
Total	-	$3,195,000	-	$4,164,000

The power consumption cost for the compact footprint Alternative B is significantly higher than the cost for conventional activated sludge Alternative A, mainly due to much higher energy requirement associated with the membrane operation in the MBR. Conventional activated sludge is generally considered to have low resource consumption compared to other secondary processes, with process aeration and oxygen transfer efficiency being the main contributors.

Chemical costs are higher for Alternative A due to the presence of hypochlorite disinfection and sodium bisulfite disinfection versus UV disinfection in Alternative B. The MBR facility does have some chemical requirements (sodium hypochlorite and citric acid) for filter cleaning, though these costs are low in comparison to the chemical costs for hypochlorite disinfection. There are also media replacement costs in Alternative A that are not present in Alternative B. Polymer use and costs are identical for both alternatives.

The TPAD process produces increased energy costs for both Plant Replacement Alternatives as compared to the mesophilic digestion associated with the Plant Rehabilitation Alternative. However, associated with the Plant Rehabilitation Alternative there is polymer use and additional pumping (to additional processes that are not part of the Plant Replacement Alternatives).

5. CONCLUSIONS

The over-arching strategy of the Plant Replacement Alternative is replacing most of the Sunnyvale WPCP main treatment processes with new processes. Two sub-alternatives are considered: Alternative A, which includes conventional activated sludge for secondary treatment and Alternative B, which includes a membrane bioreactor for secondary treatment. Alternative B was formulated because it has a more compact footprint, to be considered should the City decide that there are significant issues associated with footprint for the (much more land-intensive) Alternative A. Alternative B also considers UV disinfection as an alternative to sodium hypochlorite disinfection (which is provided in Alternative A). Both Plant Replacement Alternatives include installation of TPAD, which is projected to produce Class A biosolids, co-thickening of primary and secondary sludge streams, and a new mechanical dewatering facility.

The total projected capital cost of Alternative B is significantly higher than that projected for Alternative A ($355 million versus $288 million). The projected operating cost for Alternative B is also significantly higher than that projected for Alternative A ($4.2 million versus $3.2 million), primarily due to the energy costs associated with operating the MBR facility.

ATTACHMENT A: PROCESS PARAMETERS AND DESIGN CRITERIA DATABASE

Recommended Improvemens for Plant Replacement Scenarios

Headworks / Screening — *Removes large debris from influent raw wastewater*

Improvement	*Description*
Screenings Storage	**Structure for short-term storage and load out of washed screenings**

	No of stories	Length	Width	Height	Construction Material		Notes
Canopy		12 ft	12 ft	10 ft	Fabric		Canopy to cover storage bin for rain protection
Concrete Pad		12 ft	12 ft	1 ft	Concrete		For structural support of screenings bin
	Quantity	Length	tank width	Depth	Diameter	Construction Material	Notes
Storage Bin	1	6 ft	3.5 ft	4.2 ft		Metal	3 cu yd of storage Assume bins on site for 3 days

Screenings Washer / Compactor — **Equipment that collects removed screenings, washes away organic matter, and dewaters cleaned debris**

	Type	Description	Notes
Washer/Compactor	Screenings washer/compactor	4 cu ft/hr capacity	2 units 1 duty / 1 stand-by unit Assume 1.4 cubic ft screenings per million gallons wastewater influent

Screens — **Deep channels and mechanically cleaned screening equipment**

	Type	Description	Notes
Influent Screens	Mechanical Screen	3 screens	3 screens at 17 mgd capacity for each screen 3 screens with 3/8 inch openings Design criteria: 0.9-1.0 mgd/sq ft screen

	Quantity	Length	tank width	Depth	Diameter	Construction Material	Notes
Influent channels	3	30 ft	6 ft	22 ft		Concrete	Deep channels for influent screening Design criteria: channel velocity = 3 ft/s

Headworks / Raw Sewage Pumping — *Lifts raw wastewater to grit removal facilities*

Improvement	*Description*
Influent Flow Measurement	**New open channel flow meter down stream of influent pumping station**

	Type	Description	Notes
Influent Flow Meter	Open channel flow meter	100 mgd capacity	

Influent Pump Station — **Self cleaning, trench-style wet well**

Recommended Improvemens for Plant Replacement Scenarios

Headworks / Raw Sewage Pumping — *Lifts raw wastewater to grit removal facilities*

Improvement		*Description*					
	Quantity	Length	tank width	Depth	Diameter	Construction Material	Notes
Pump Station Structure	1	25 ft	87 ft	30 ft		Concrete	Footprint based on 5 pumps, 2 future Below ground structure, no building
Influent Sewer		**New influent sewer to convey raw wastewater to screening facilities**					
	Length	Diameter	Material				Notes
Influent Sewer	190 ft	4 ft	Reinforced Concrete Pipe				22 ft invert depth below grade, 0.001 slope
Junction Structures		48-in and 54-in pipelines	Concrete				Needed for connection to existing influent sewers 2 junction structures, each 21 ft below grade
Raw Sewage Pumps		**Vertical turbine solids handling influent pumps**					
	Type	Quantity	Horse power	Capacity	Capacity Units		Notes
Pump 1 - 4	VTSH	4	100	10000	gpm		Includes VFD electric motors Pump efficiency = 80%
Pump 5	VTSH	1	50	5000	gpm		Install smaller pump for lower flows Includes VFD electric motor Pump efficiency = 80%

Headworks / Grit Removal — *Facilities to remove inert, abrasive, sand-like particles from incomiong sewage*

Improvement		*Description*					
Aerated Grit Removal Tanks		**New baffled aerated tanks that are shaped to promote separation and collection of grit materials**					
	Quantity	Length	tank width	Depth	Diameter	Construction Material	Notes
Grit Tanks	2	24 ft	45 ft	17 to 30 ft		Concrete	2 tanks with 3 hoppers each Design criteria: 5 min detention time at peak hour flow
Aeration Equipment		**Piping and diffusers to supply coarse bubble air to aerated grit tanks**					
	Type	Quantity	Horse power	Capacity	Capacity Units		Notes
Aerated Grit Blowers	Multi-Stage Centrifugal	3	50	750	scfm		10 psig, blowers to be located in gallery structure Design criteria: 12.4 scfm per ft tank length
Gallery Structure		**New below grade structure to house grit removal pumps**					

Recommended Improvemens for Plant Replacement Scenarios

Headworks / Grit Removal ***Facilities to remove inert, abrasive, sand-like particles from incomiong sewage***

Improvement *Description*

	No of stories	Length	Width	Height	Construction Material	Notes
Gallery	1	100 ft	28 ft	20 ft	Concrete	Adjacent to grit removal tanks and below grade

Grit Removal Pumps **Pumps that withdraw grit slurry from deep hoppers in bottom of grit removal tank**

	Type	Quantity	Horse power	Capacity	Capacity Units	Notes
Grit pumps	Recessed impellar (severe duty)	3	20	125	gpm	Approx 51 ft of head 65% mechanical efficiency 95% motor efficiency

Grit Storage Bin and Loadout **Facilities to temporarily store washed grit and accommodate loading for off-site transportation to disposal**

	No of stories	Length	Width	Height	Construction Material	Notes
Canopy	1	13 ft	12 ft	10 ft	Fabric	
Concrete Pad	1	12 ft	13ft	1 ft	Concrete	Foundation for grit storage bin (structural support)

	Quantity	Length	tank width	Depth	Diameter	Construction Material	Notes
Storage Bin	1	6 ft	5.3 ft	4.7 ft		Metal	Cover to prevent rain entry 5.5 cu yd storage Assumes bins on site for 3 days

Vortex Chamber Grit Washers **Equipment to accept, wash, and dewater grit slurry that is pumped from aerated grit basins**

	Type	Description	Notes
Grit Washers	Huber Coanda Grit Washer RoSF4	2 grit washers	8 ft diameter vortex chamber 375 gpm capacity each 1 duty / 1 stand-by Assume 2.6 cubic ft grit collected per million gallons wastewater influent

Recommended Improvemens for Plant Replacement Scenarios

Primary Sedimentation / Primary Sedimentation Tanks ***Tanks that separate settled solids from incoming sewage***

Improvement	*Description*
Gallery Structure	**Below grade structure adjacent to all primary sedimentation tanks to house pumping equipment for primary sludge, primary scum, and thickened primary sludge**

	Quantity	Length	tank width	Depth	Diameter	Construction Material	Notes
Gallery Structure	1	105 ft	100 ft	20 ft		Concrete	New below-grade gallery structure to house pumping eqipment

New Inlet Distribution Channel — **Channel that distributes incoming wastewater between multiple tanks and keeps organic solids in suspension**

	Quantity	Length	tank width	Depth	Diameter	Construction Material	Notes
Inlet Channel	1	100 ft	10 ft	10 ft		Concrete	

New Primary Effluent Collection Channel — **Downstream channel structure to aggregate primary effluent flows from multiple operating tanks**

	Quantity	Length	tank width	Depth	Diameter	Construction Material	Notes
Primary Effluent Channel	1	100 ft	10 ft	10 ft		Concrete	

New Primary Sedimentation Tank Equipment — **Overflow launders and sludge collectors that accommodate overflow liquid solids separation and intra-tank transport of settled primary sludge**

	Type	Description	Notes
Sludge Collectors	Chain and flights	5 units	5 sets of chain and flight sludge collectors
Scum collectors	Scum collection equipment	5 units	
Sluice gates	Sluice gates	10 gates	Upstream and downstream end of each tank

New Sedimentation Tanks — **Concrete tanks**

	Quantity	Length	tank width	Depth	Diameter	Construction Material	Notes
Primary Sedimentation Tanks	5	105 ft	20 ft	10 ft		Concrete	Design criteria: At ADWF, SOR = 2000 gpd/sq ft At Peak Day flow, SOR = 4000 gpd/sq ft

Primary Scum Pumps — **Pumping equipment for pumping primary scum from primary sedimentation tanks to anaerobic digesters**

	Type	Quantity	Horse power	Capacity	Capacity Units	Notes
Primary Scum Pumps	Submersible screw centrifugal	8	4	150	gpm	5 duty, 3 standby

Primary Sludge Pumps — **Pumping equipment for pumping primary sludge from primary sedimentation tanks to primary sludge thickeners**

Recommended Improvemens for Plant Replacement Scenarios

Primary Sedimentation / Primary Sedimentation Tanks — *Tanks that separate settled solids from incoming sewage*

Improvement	*Description*					
	Type	Quantity	Horse power	Capacity	Capacity Units	Notes
Primary Sludge Pumps	Positive displacement rotary lobe	8	15	150	gpm	5 duty pumps and 3 stand-by Projected 2035 primary sludge load to digesters = 13,200 lb/day

Primary Sedimentation / Primary Effluent Pipeline — *Pipeline from new primary effluent channel to oxidation ponds*

Improvement	*Description*			
New Primary Effluent Pipeline	**Pipe to transport primary effluent from primary sedimentation area to recirculation channel in oxidation ponds system**			
	Length	Diameter	Material	Notes
Primary Effluent Pipeline	1000 ft	60 in	RCP	For use before new secondary treatment process is constructed

Biological Treatment (Activated Sludge or MBR) / Aeration Basins (Alternative A) — *Tanks for BOD removal and complete nitrification of all flow*

Improvement	*Description*					
Aeration Basin Blower Building	**Houses all blowers**					
	No of stories	Length	Width	Height	Construction Material	Notes
Blower Building	1	50 ft	20 ft	15 ft	Concrete	Houses current and future blowers; include HVAC system for bldg
Aeration Basin Blowers	**Provide aeration air for all tanks**					
	Type	Quantity	Horse power	Capacity	Capacity Units	Notes
Aeration Basin Blowers	Single-stage	2	525	5500	scfm	Conventional aeration basin blowers VSS to TSS ratio = 75% f (ratio of ultimate BOD to BOD5) = 0.75 Assume effluent BOD is non-detect FED = 0.325 65% mechanical blower efficiency 95% motor blower efficiency
Aeration Basin Effluent Channel	**Channel for denitrification**					

Recommended Improvemens for Plant Replacement Scenarios

Biological Treatment (Activated Sludge or MBR) / Aeration Basins (Alternative A) — ***Tanks for BOD removal and complete nitrification of all flow***

Improvement	*Description*						
	Quantity	Length	tank_width	Depth	Diameter	Construction Material	Notes
Aeration Basin Effluent Channel	1	310 ft	7 ft	15 ft		Concrete	Dimensions include side walls Design criteria: detention time at least 10 minutes for degassification
Aeration Basin Influent Channel	**Conveys flow into anaeraobic selector**						
	Quantity	Length	tank_width	Depth	Diameter	Construction Material	Notes
Aeration Basin Influent Channel	1	310 ft	7 ft	15 ft		Concrete	Dimensions include side walls
Aeration Basin Tanks	**Tanks for complete nitrification**						
	Quantity	Length	tank_width	Depth	Diameter	Construction Material	Notes
Aeration Basins	7	194 ft	46 ft	30 ft		Concrete	Dimensions include side walls Yield = 0.79 lb TSS / lb BOD SRT = 10 days MLSS = 2,500 mg/L Assume BOD removal in primary sed tanks is 22%

Biological Treatment (Activated Sludge or MBR) / Secondary Clarifiers (Alternative A) — ***Provides clarification of aeration tanks effluent, includes RAS pumps and return pipeline***

Improvement	*Description*						
RAS Pipeline	**Returns RAS to aeration basins**						
	Length	Diameter	Material				Notes
RAS Pipeline	100 LF	54 in	RCP				Construct two parallel 54-in pipes for redundancy
RAS Pumps	**Conveys RAS to aeration basins**						
	Type	Quantity	Horse power	Capacity	Capacity Units		Notes
RAS Pumps	Horizontal solids handling	5	50	7000	gpm		3 duty, 2 stand-by
RAS Storage Tank	**Holds RAS prior to pumping**						
	Quantity	Length	tank_width	Depth	Diameter	Construction Material	Notes
RAS Storage Tank	1	20 ft	10 ft	10 ft		Concrete	

Recommended Improvemens for Plant Replacement Scenarios

Biological Treatment (Activated Sludge or MBR) / Secondary Clarifiers (Alternative A) — ***Provides clarification of aeration tanks effluent, includes RAS pumps and return pipeline***

Improvement	*Description*
Secondary Clarifier Tanks	**Three 110-ft diameter circular clarifiers**

	Quantity	Length	tank width	Depth	Diameter	Construction Material	Notes
Secondary Clariifer Tanks	3			20 ft	110 ft	Concrete	Add 1 ft for tank wall thickness Design criteria: Peak month 2035 flow and SOR = 1,100 gpd/sq ft

Biological Treatment (Activated Sludge or MBR) / Membrane Bioreactor (Alternative B) — ***MBR Tanks for BOD removal and complete nitrification of all flow***

Improvement	*Description*
MBR Aeration Tanks	**Tanks for nitrification and BOD removal**

	Quantity	Length	tank width	Depth	Diameter	Construction Material	Notes
MBR Tanks	5	182 ft	32 ft	15 ft		Concrete	Dimensions include side walls Yield = 0.79 lb TSS / lb BOD SRT = 10 days MLSS = 10,000 mg/L

MBR Blower Building — **Houses MBR blowers**

	No of stories	Length	Width	Height	Construction Material	Notes
MBR Blower Building	1	100 ft	20 ft	15 ft	Concrete	Houses current and future blowers; include HVAC system

MBR Blowers — **Blowers for aeration air for MBR process**

	Type	Quantity	Horse power	Capacity	Capacity Units	Notes
MBR Blowers	Multi-stage centrifugal blowers	5	850	15000	scfm	75% VSS to TSS ratio f (ratio of ultimate BOD to BOD5) = 0.75 Effluent BOD is non-detect FED = 0.325 1,171 scfm/mgd for membrane agitation flow rate 65% blower mechanical efficiency 95% blower motor efficiency

MBR Effluent Channel — **MBR process effluent**

	Quantity	Length	tank width	Depth	Diameter	Construction Material	Notes
MBR Effluent Channel	1	180 ft	7 ft	15 ft		Concrete	Dimensions include side walls

Recommended Improvemens for Plant Replacement Scenarios

Biological Treatment (Activated Sludge or MBR) / Membrane Bioreactor (Alternative B) ***MBR Tanks for BOD removal and complete nitrification of all flow***

Improvement	*Description*
MBR Influent Channel	**MBR process influent**

	Quantity	Length	tank_width	Depth	Diameter	Construction Material	Notes
MBR Influent Channel	1	180 ft	7 ft	15 ft		Concrete	Dimensions include side walls

UV Disinfection / UV Disinfection System ***Concrete channels with banks of UV lamps for secondary effluent disinfection***

Improvement	*Description*
Concrete Channels	

	Quantity	Length	tank_width	Depth	Diameter	Construction Material	Notes
UV Channels	2	40 ft	10 ft	5 ft		Concrete	Includes second channel for firm capacity

UV Disinfection Equipment **Horizontal lamps within banks of UV lamps in channels**

	Type	Description	Notes
UV Equipment	UV Disinfection Equipment	Sufficient to produce 35 mJ/cm2 UV dose	Projected dose requirement for secondary effluent disinfection and Bay discharge 144 lamps projected for sufficient dose

Recycled Water / Recycled Water Production ***4-mgd facility dedicated only to recycled water (Alternative A)***

Improvement	*Description*
Chlorine Contact Tanks	**Additional chlorine contact tanks**

	Quantity	Length	tank_width	Depth	Diameter	Construction Material	Notes
Chlorine Contact Tanks	6	126 ft	12 ft	13 ft		Concrete	Dimensions are for each pass (3 passes per unit, 2 units)

Cloth Media Filters **Above-ground filters on a concrete pad (based on Aqua-Disk Cloth Media Filtration System by Aqua Aerobic Systems Inc)**

	Type	Description	Notes
Cloth Media Filters	Filters	2 units, 8 disk filters per unit	18-ft x 10-ft x 12-ft height for each unit

Recommended Improvemens for Plant Replacement Scenarios

Recycled Water / Recycled Water Production — *4-mgd facility dedicated only to recycled water (Alternative B)*

Improvement	*Description*
UV Disinfection Channels	**Provide sufficient contact time for disinfection**

	Quantity	Length	tank_width	Depth	Diameter	Construction Material	Notes
UV Channels	4	50 ft	10 ft	5 ft		Concrete	Includes 1 redundant channel for firm capacity

UV Disinfection Equipment — **80 mJ/cm2 dose needed for Title 22 water**

	Type	Description	Notes
UV Equipment	UV System	UV lamp banks	450 lamps required Total energy use is 65 kW

Flow Equalization / Stormwater Equalization — *Primary effluent equalization for wet weather flows*

Improvement	*Description*
Equalization Area Lining	**Install impermeable liner at base of pond**

	Type	Description	Notes
Lining	Lining		1.2 million sq ft

Levee Construction — **New levee to separate equalization area from rest of the larger oxidation pond**

	No of stories	Length	Width	Height	Construction Material	Notes
Levee Construction		1850 ft	20-104 ft	12 ft	Earthen berm	

	Type	Description	Notes
Fill Quantity	Levee Fill		51,000 cubic yards

Flow Equalization / Diurnal Equalization — *Primary effluent equalization for daily flows*

Improvement	*Description*
Concrete Lining	**Line base of new basin**

	Type	Description	Notes
Lining	Concrete Lining	475 ft x 200 ft	1-ft thickness

Concrete Walls — **Basin consists of 4 concrete walls to contain daily flows**

	No of stories	Length	Width	Height	Construction Material	Notes
Walls		475 ft	200 ft	10 ft	Concrete	

Recommended Improvemens for Plant Replacement Scenarios

Flow Equalization / Diurnal Equalization — *Primary effluent equalization for daily flows*

Improvement	*Description*
Washdown Equipment	**Install equipment to wash down solids daily**

	Type	Description	Notes
Washdown Equipment	Washdown Equipment		Hoses to cover 475-ft x 200-ft

Pond Restoration / Pond Water Control Structures — *Install two new water control structures with 5 culverts each*

Improvement	*Description*
Anti-Seep Collars	**Install on each culvert end**

	Type	Description	Notes
Ant-Seep Collars	Bentonite Clay	Thickness = 12 in	2 for each culvert

Catwalks — **For access**

	No of stories	Length	Width	Height	Construction Material	Notes
Catwalks		50 ft	4 ft		Wood	2 total (one for each water control structure)

Culvert Pipes — **5 pipes per water control structure**

	Length	Diameter	Material	Notes
Culverts	114 ft	48 in	HDPE, DR 26	10 total

Fish Screens — **Furnished and installed by manufacturer**

	Type	Description	Notes
Fish Screens	12-ft cone diameter	On primary intake structure	5 screens total

Fresno Valves and Casting — **For 20 openings**

	Type	Description	Notes
Fresno Valves and Casting	48-in diameter		20 total

Headwall — **Wood headwall on slough side**

	No of stories	Length	Width	Height	Construction Material	Notes
Headwall		56 ft	6 in	8 ft	Wood (6-in thickness)	For slough side only (one headwall total)

Manholes — **5 manholes for each set of culverts**

Recommended Improvemens for Plant Replacement Scenarios

Pond Restoration / Pond Water Control Structures ***Install two new water control structures with 5 culverts each***

Improvement		*Description*		
	Length	Diameter	Material	Notes
Manholes	12 ft	2 ft	Concrete	10 total (1 per culvert)
Side/Flap Combination Gates		**For 10 openings**		
	Type	Description		Notes
Side/Flap Combo Gates	Cast Iron	On 10 openings		Epoxy coated cast iron with 316 SS stem
Slide Gates		**For 10 openings**		
	Type	Description		Notes
Slide Gates	Cast Iron	for 10 openings		Epoxy coated cast iron w/ 316 SS stem

Pond Restoration / Water Control Structure Earthwork ***Earthwork for cutting into levees and installing new structures***

Improvement		*Description*		
Base Rock		**Placed around culverts**		
	Type	Description		Notes
Base Rock	6" thick layer	1" rock		13.3 cubic yards total
Channel		**Trapezoidal channel to connect to slough**		
	Length	Diameter	Material	Notes
Channel	100 ft		Cut into exist earth	500 cubic yards cut volume
Culvert Cuts		**Cut 2-ft below grade for culvert installation, 950 cu yd total**		
Dewatering		**Required for each levee cut**		
	Type	Description		Notes
Dewatering	Dewatering	At 2 cuts		Earthen berm or sheep pile wall on each side, each location
Levee Cuts		**Cut levees in 2 locations for water control structures, 3600 cu yd total**		
Rip Rap		**Placed around culverts**		

Recommended Improvemens for Plant Replacement Scenarios

Pond Restoration / Water Control Structure Earthwork — *Earthwork for cutting into levees and installing new structures*

Improvement	*Description*		
	Type	Description	Notes
Rip Rap	12" thick layer	8" rock	26.7 cubic yards total

Pond Restoration / Pond Dredging — *Dredging of biosolids over 10-year period*

Improvement	*Description*					
Dredging System	**Dredge and associated piping and equipment for removal of solids from the ponds**					
	Type	Description				Notes
Gangway and Crank	Gangway and hand crank	Used for maintenance activities				
Dredge Cable and Harness	Cable and Harness	Ancillary dredge equipment				
Dredge	Sludge Dredge	1000 gpm				VMI Tier 3 diesel dredge
	Length	Diameter	Material			Notes
Dredge off-shore floating piping	6000 ft	8 inch	PVC piping on floats			
Dredge off-shore piping	150 ft	6 inch	Flexible piping			
Dredgings Transport Pipeline	**Pipeline from dredgings transport pump station to dewatering facilities at treatment plant site**					
	Length	Diameter	Material			Notes
Dredging Transport Pipeline	3600 ft	8 inch	DI			Buried pipe along pond levee to treatment plant
Dredgings Transport Pump Station	**Station at ponds to receive dredged biosolids and pump them to dewatering facilities at the main treatment plant site**					
	No of stories	Length	Width	Height	Construction Material	Notes
Pump Station Structure	1	25 ft	15 ft		Concrete	Concrete pad with pumps, no cover needed
	Type	Quantity	Horse power	Capacity	Capacity Units	Notes
Dredging Booster Pumps	Screw centrifugal	2	5	500	gpm	40 ft of head, WEMCO or Hayward Gordon recommended

Recommended Improvemens for Plant Replacement Scenarios

Pond Restoration / Pond Effluent Pump Station — *Pump station and pipeline to convey pond effluent back to tertiary treatment site*

Improvement	*Description*
Replace Electric Power Supply	**Replace conduits, wiring, and switching for power supply to pump station**

	Type	Description	Notes
Pond Effluent Pumping Electrical	Pond Effluent Pumping Electrical		

Replace Pond Effluent Pipeline — **Replace pipeline from pond effluent pump station to tertiary facilities area on main treatment site**

	Length	Diameter	Material	Notes
Pond Effluent Pipeline	1000 ft	34"	Concrete	

Replace Pump Station Structure — **Replace wooden pump structure with new structure serving same function**

	No of stories	Length	Width	Height	Construction Material	Notes
Pond Effluent Pier					Wood pier	Replace pier with identical structure

Replace Pumping Equipment — **Replace pumps and motors**

	Type	Quantity	Horse power	Capacity	Capacity Units	Notes
Pond Effluent Pumps	Vertical	4	0	8	mgd	

Co-Thickening and Sludge Storage / Un-Thickened Sludge Storage — *Detention of primary sludge and WAS prior to thickening*

Improvement	*Description*
Sludge Blend Tank System	**Blend tank**

	Type	Description	Notes
Tank Mixing System	Pump mix		20,000 gal tank will be mixed using pumps

	Quantity	Length	tank width	Depth	Diameter	Construction Material	Notes
Sludge Blend Tank	1					Concrete	20,000 gal storage tank

Co-Thickening and Sludge Storage / Rotary Drum Thickeners — *Thickening of primary sludge and WAS*

Improvement	*Description*
Rotary Drum Thickeners	**Equipment to thicken primary sludge and WAS**

	Type	Description	Notes
Rotary Drum Thickener	Drum Thickener		Capcity of 200 gpm each

Recommended Improvemens for Plant Replacement Scenarios

Co-Thickening and Sludge Storage / Rotary Drum Thickeners — *Thickening of primary sludge and WAS*

Improvement	*Description*
Thickened Primary Sludge Pipeline	**Pipeline to convey thickened sludge to anaerobic digesters**

	Length	Diameter	Material	Notes
Thickened PS Pipeline	300 ft	12 in	HDPE	Pipeline to convey thickened sludge to digesters

Thickened Primary Sludge Pumps — **Equipment for pumping thickened sludge from drum thickeners to anaerobic digesters**

	Type	Quantity	Horse power	Capacity	Capacity Units	Notes
Thickened PS Pumps	Recessed impellar centrifugal	4	15	75	gpm	Variable speed pumps 2 duty / 2 stand-by

Co-Thickening and Sludge Storage / Thickened Sludge Storage — *Storage of thickened sludge prior to digestion*

Improvement	*Description*
Thickened Sludge Storage	**Detention of thickened sludge prior to digestion**

	Type	Description	Notes
Mixing System	Pump mix		Contents of thickened sludge storage tank will be mixed with pumps

	Quantity	Length	tank width	Depth	Diameter	Construction Material	Notes
Thickened Sludge Tank	2					Concrete	30,000 gal capacity each

Anaerobic Digestion Improvements / Digester Improvements — *Upgrades to existing anaerobic digestion tanks and feed system*

Improvement	*Description*
Digester cover conversions	**Conversion of floating covers to fixed covers**

	Type	Description	Notes
Cover Conversion	Digester Fixed Cover	Replacement of floating covers on three digesters	Continuation of cover conversions already in process

Digester mixing equipment upgrades — **Convert from gas mixing to pumped mixing systems**

Recommended Improvemens for Plant Replacement Scenarios

Anaerobic Digestion Improvements / Digester Improvements — *Upgrades to existing anaerobic digestion tanks and feed system*

Improvement	*Description*					
	Type	Description				Notes
Mixing Upgrades	Digester Mixing Upgrades	Mixing upgrades on the remaining digesters				Continuation of work already in progress
Pumping and piping system upgrades	**Upgrades to improve automated continuous feed, mixing, and withdrawal from digesters and to support Class A process configuration**					
	Type	Description				Notes
Stand Pipe	Stand pipe for digester withdrawl	Typical BC design, digesters have side water depth of 33 ft				Needed in all 4 digesters
	Length	Diameter	Material			Notes
Feed loop piping	350 ft	4 in	Glass lined steel			Piping in feed loop system that allows for continuous feed to the digesters
Withdrawal piping	~450 ft	4 in	Steel			Piping allocation for withdrawal system
	Type	Quantity	Horse power	Capacity	Capacity Units	Notes
Digester 4 Feed Pumps	Positive displacement rotary lobe pump	1		45	gpm	Feed pump for Digester 4
Loop feed pump	Positive displacement rotary lobe	2		100	gpm	Pumps will operate at 100 gpm to maintain velocities in feed loop piping
Digesters 1-3 Feed Pumps	Positive displacement rotary lobe pump	3		30	gpm	Pumps for digesters 1 - 3

Anaerobic Digestion Improvements / Pasteurization Tanks and Class A Heating Equipment — *Pasteurization tanks*

Improvement	*Description*		
Class A Heating Equipment Additions	**Heating equipment used in Temperature Phased Digestion process**		
	Type	Description	Notes
Heating Exchangers	Spiral type, Plate and Frame	Water/sludge heat exchangers	5 spiral type, 5 plate and frame

Recommended Improvemens for Plant Replacement Scenarios

Anaerobic Digestion Improvements / Pasteurization Tanks and Class A Heating Equipment — *Pasteurization tanks*

Improvement	*Description*						
	Type	Quantity	Horse power	Capacity	Capacity Units		Notes
Transfer pumps	Transfer pumps	4					Pumps for transferring between digestion phases
Heating System Pumps	Hot water and cooling	14					Digester heat and cooling pumps
Mixing Equipment	**Mixing equipment for Pasteurization Tanks**						
	Type	Description					Notes
Mixing System	Pump Mixing						Contents of pasteurization tanks will be mixed using pumps
Pasteurization Tanks	**Tanks used in Temperature Phased Digestion process**						
	Quantity	Length	tank_width	Depth	Diameter	Construction Material	Notes
Pasteurization Tank	3			25 ft	30 ft	Concrete	125,000 gal capacity, cone shaped bottom

Anaerobic Digestion Improvements / Digested Sludge Storage — *Storage of digested sludge prior to dewatering*

Improvement	*Description*						
Digested Sludge Storage Tank	**Construct following conversion to fixed cover digesters**						
	Quantity	Length	tank_width	Depth	Diameter	Construction Material	Notes
Digested Sludge Storage	1			25 ft	30 ft	HDPE	Construct adjacent to pasteurization tanks
Sludge Storage Tank Heating System							
	Type	Description					Notes
Heating System	Spiral hot water/sludge heat exchanger						Same as Pasteurization tanks
Sludge Storage Tank Mixing System							
	Type	Description					Notes
Mixing System	Pump mix						Same as Pasteurization tanks

Recommended Improvemens for Plant Replacement Scenarios

Digester Gas Management / Gas Storage — *Gas storage for equalization within cogen system*

Improvement — *Description*

Gas Storage Tank

	Quantity	Length	tank_width	Depth	Diameter	Construction Material	Notes
Gas Storage Tank	2			45 ft	45 ft	Stainless Steel	50,000 gal each

Digester Gas Management / Gas Moisture Reduction — *Removal of water from digester gas*

Improvement — *Description*

Gas Moisture Reduction

	Type	Description	Notes
Moisture Separator	Equipment	1 unit	Gas moisture separator
Heat Exchanger	Gas Conditioning HEX	1 unit	
Gas Chiller	Digester Gas Chiller	2 units	

Digester Gas Management / Gas Purification — *Removes slioxane and H2S from digester gas*

Improvement — *Description*

H2S Removal

	Type	Description	Notes
Iron Sponge Unit	Iron Oxide Vessel	4 units	4 ft diameter and 4 ft of bed depth Iron Sponge or SulfaTreat

Siloxane Removal

	Type	Description	Notes
Activated Carbon Filter	Activated Carbon Filter	2 units	4 ft diameter and 4 ft bed depth

Recommended Improvemens for Plant Replacement Scenarios

Digester Gas Management / Gas Compressors — *Boost pressure of digester gas for cogen engines*

Improvement	*Description*
Gas Booster Blowers	

	Type	Quantity	Horse power	Capacity	Capacity Units	Notes
Gas Booster Blowers	Centrifugal	2		225	cfm	4 psig assumed pressure

Digester Gas Management / Boilers — *Back up heat source*

Improvement	*Description*
Boilers	

	Type	Description	Notes
Boilers	Gas/Oil Boiler		Gas/oil combination, gross output 9,800 MBH, 286 BHP Includes burners, controls, insulated jacket

Digester Gas Management / Flares — *Excess digester gas wasting*

Improvement	*Description*
Flares	

	Type	Description	Notes
Waste Gas Burner	Burner		Includes flame check, inlet control prv, and maual drip trap
Flares	New Flare System	2 units	6" flares and associated equipment

Dewatering Facilities / Dewatering Facilities — *New scew press dewatering with polymer addition*

Improvement	*Description*
Cake Storage and Loadout	

	Type	Description	Notes
Cake Hoppers	Cake Hoppers	Stainless steel hoppers	4 hoppers with diamond gate bottoms. 70 cu yd each
Cake Loadout Area	Truck Bay	Under 4 hoppers	No need for foul air treatment

New Dewatering System

Recommended Improvemens for Plant Replacement Scenarios

Dewatering Facilities / Dewatering Facilities — *New scew press dewatering with polymer addition*

Improvement	*Description*						
	No of stories	Length	Width	Height	Construction Material		Notes
Dewatering Building	1	70 ft	220 ft	12 ft	Concrete		
	Type	Description					Notes
Screw Press	FKC Screw Press						5 units at max capacity of 8.1 dry tons/day
Polymer Blending Units	Polymer Blending Unit	3 uints at 22 gal/hr each					Mannich polymer dose is 12 lb/dry ton
	Type	Quantity	Horse power	Capacity	Capacity Units		Notes
Cake Pumps	Progressive cavity	8	3	15	gpm		
	Quantity	Length	tank width	Depth	Diameter	Construction Material	Notes
Polymer Storage Tank	1			10ft	7.5 ft	HDPE	Assume Mannich Polymer

Relocated Facilities / Administration Building — *New CMU building replacing existing building*

Improvement	*Description*
Administration Building	**New building will include offices, meeting space and laboratory functions**

Relocated Facilities / Landfill Gas Booster and Flare System — *Relocate existing system*

Improvement	*Description*
Relocate Booster and Flare Station	**Move to north part of plant**

Relocated Facilities / Utilities Building — *Relocate existing plant utilities to a new building in northern part of site*

Improvement	*Description*
New Building	**New utilities building ~2500 sq ft**
Relocate Hot Water Loop Pumping	**System for conveying hot water throughout the plant**

Recommended Improvemens for Plant Replacement Scenarios

Relocated Facilities / Utilities Building — ***Relocate existing plant utilities to a new building in northern part of site***

Improvement	*Description*
Relocate Plant Service Air Blowers	**Blowers for service air throughout the plant**

Relocated Facilities / Maintenance Building — ***Relocate and expand maintenance building***

Improvement	*Description*
Maintenance Building	**New building that will serve all maintenace and garage functions**

Community and Environmental Enhancements / On-Site Features — ***Improvement to enhance site***

Improvement	*Description*
New Route	**Alternate access road for site service**

Community and Environmental Enhancements / Off-Site Features — ***Improvements to bay trail area***

Improvement	*Description*
Parking Improvements	**Additional parking at head of bay trail**
Trail Improvements	**Education kiosks and oxidation pond trail features**

Recommended Improvemens for Plant Replacement Scenarios

Electrical Power / Electrical Power Distribution — *Main Distribution Center, includes stand-by power*

Improvement	*Description*
Diesel Fuel Tank	**For stand-by power**

	Quantity	Length	tank_width	Depth	Diameter	Construction Material	Notes
Diesel Fuel Tank	1			6 ft	5 ft	HDPE	5,000-gallon tank, includes piping and control panel

Power Distribution Center Building — **Houses main switchgears and stand-by power**

	No of stories	Length	Width	Height	Construction Material	Notes
Power Dist Center Building	1	50	15	15	CMU	

Stand-By Power (Engine Generator) — **Located within Power Distribution Center building; operates off diesel fuel**

	Type	Description	Notes
Stand-By Power	Stand-By Power	Diesel Fueled Stand-by Generators	2,000-kW capacity total

Switchgear 1 — **New switching, conductors, conduits and transformers to provide redundant feed system**

	Type	Description	Notes
Switchgear 1	12 kV Switchgear	8-ft x 15-ft x 6-ft height	All breakers rated 600 A @ 12.47 kV (15 kV), 500 MVA Interrupt (23 KA)

Switchgear 2 — **New switching, conductors, conduits and transformers to provide redundant feed system**

	Type	Description	Notes
Switchgear 2	12 kV Switchgear	8-ft x 18-ft x 6-ft height	All breakers rated 600 A @ 12.47 kV (15 kV), 500 MVA Interrupt (23 KA)

Electrical Power / Headworks/Primaries Substation — *Main switchgears transfer power to area substation*

Improvement	*Description*
Headworks and Primaries Substation	**Transfers power to influent pumping station, headworks, and primaries (receives 12.47 kV)**

	No of stories	Length	Width	Height	Construction Material	Notes
HW/Prim Area Substation	1	10 ft	7 ft	12 ft	Concrete	Capacity = 480 V

Recommended Improvemens for Plant Replacement Scenarios

Electrical Power / Biological Area Substation — *Main switchgears transfer power to area substation*

Improvement	*Description*
Aeration Basins or MBR Substation	**Transfers power to aeration basins or MBR facilities (receives 12.47 kV)**

	No of stories	Length	Width	Height	Construction Material	Notes
Bio Area Substation	1	10 ft	7 ft	12 ft	Concrete	Capacity = 480 V

Electrical Power / Tertiary Area Substation — *Main switchgears transfer power to area substation*

Improvement	*Description*
Tertiary Area Substation	**Transfers power to filters or UV disinfection facilities (receives 12.47 kV)**

	No of stories	Length	Width	Height	Construction Material	Notes
Tertiary Area Substation	1	10 ft	7 ft	12 ft	Concrete	Capacity = 480 V

Electrical Power / Solids Handling Area Substation — *Main switchgears transfer power to area substation*

Improvement	*Description*
Solids Handling Area Substation	**Transfers power to solids handling facilities (receives 12.47 kV)**

	No of stories	Length	Width	Height	Construction Material	Notes
Solids Area Substation	1	10 ft	7 ft	12 ft	Concrete	Capacity = 480 V

Electrical Power / Biogas Power Generation — *Optimization of existing biogas power generation system*

Improvement	*Description*
Replace engines with ARES technology	

	Type	Quantity	Horse power	Capacity	Capacity Units	Notes
Cogen Unit	Engine-Driven Cogen Unit	3	225	1200	RPM	Assume Waukesha

Civil/Site Work / Activities in Existing Plant Area — *Paving, grading, and other activities within existing plant area*

Improvement	*Description*
Civil/Site Work	**Final paving and grading throughout plant site**

Recommended Improvemens for Plant Replacement Scenarios

Demolition of Existing Facilities / Demo Auxiliary Pump Station ***Demolish auxiliary pump station***

Improvement	*Description*
Demolish existing pump station	**Abandon / demolish existing structure**

Demolition of Existing Facilities / Demo Primary Sedimentation Tanks 1 - 5 ***Demo existing tanks and equipment***

Improvement	*Description*
Demolish Existing Primary Sedimentation Tanks 1-5	**Demolish tanks, associated equipment and underground galleries**

Demolition of Existing Facilities / Demo Primary Sedimentation Tanks 6 - 10 ***Demo existing tanks and equipment***

Improvement	*Description*
Demolish Existing Primary Sedimentation Tanks 6-10	**Demolish tanks, associated equipment and underground galleries**

Demolition of Existing Facilities / Demo 66-inch Pipe ***Demo existing pipe***

Improvement	*Description*
Demolish Existing 66-inch pipe	**Pipeline on south and west sides of primary sedimentation tanks**

Demolition of Existing Facilities / Demo 24-inch and 30-inch Pipes ***Demo existing pipes***

Improvement	*Description*
Demolish existing 24-inch and 30-inch pipes	**Remove three 24-inch and two 30-inch pipelines from Control Building and Auxillary PS to the Primary Clarifiers**

Recommended Improvemens for Plant Replacement Scenarios

Demolition of Existing Facilities / Demo Primary Control Building ***Demolish existing headworks and existing primary control building***

Improvement	*Description*
Demolish Primary Control Building	**Function of this structure will be replaced with new facilities**

Demolition of Existing Facilities / Demo Sludge Dewatering Bins ***Demo existing structure***

Improvement	*Description*
Demolish Existing Sludge Dewatering Area	**Restore sludge berm, digested sludge routed to oxidation ponds for extended stabilization**

Demolition of Existing Facilities / Demo DAFT Area ***Demo all tanks and equipment***

Improvement	*Description*
Demolish Existing DAFT Area	**Circular DAF tanks and all structures and equipment associated with the tanks will be demolished**

Demolition of Existing Facilities / Demo Float Pumping Station ***Demo building and equipment***

Improvement	*Description*
Demolish Float Pumping Station	**Function replaced by new struction, demo of structure and equipment**

Demolition of Existing Facilities / Demo Fixed Growth Reactor Pump Station ***Demo building and equipment***

Improvement	*Description*
Demolish FGR Influent Pump Station	**Function replaced by new struction, demo of structure and equipment**

Recommended Improvemens for Plant Replacement Scenarios

Demolition of Existing Facilities / Demo Chlorination Building ***Demo building and equipment***

Improvement	*Description*
Demolish Chlorination Building	**With switch to sodium hypochlorite this structure is no longer needed**

Demolition of Existing Facilities / Demo Dechlorination Building ***Demo building and equipment***

Improvement	*Description*
Demolish Dechlorination Building	**With switch to sodium hypochlorite this structure is no longer needed**

Demolition of Existing Facilities / Demo Chemical Storage Area ***Demo equipment, including chlorine scrubbers***

Improvement	*Description*
Demolish Chemical Storage Area	**With switch to sodium hypochlorite this structure is no longer needed**

Demolition of Existing Facilities / Demo Fixed Growth Reactors ***Demo 3 fixed growth reactors and supplemental equipment***

Improvement	*Description*
Demolish existing FGRs	**With new secondary/tertiary process technologies the FGRs will no longer be needed**

Demolition of Existing Facilities / Demo Tertiary Facilities ***Demo dual media filtration system and chlorine contact channels (Alternative B)***

Improvement	*Description*
Demolish filters and chlorine contact channels	**In Alternative B dual media filtration and chlorine contact tanks are replaced with MBR and UV technologies**

Recommended Improvemens for Plant Replacement Scenarios

Demolition of Existing Facilities / Demo Administration Building — ***Abandon/demolish existing structure***

Improvement	*Description*
Demolish Existing Adminstration Building	**Function to be replaced by new structure**

Demolition of Existing Facilities / Demo Maintenance Building and Garage — ***Demo existing maintenance shed and move equipment to new facility***

Improvement	*Description*
Demolish Existing Maintenance Building	**Function to be replaced by new structure**

Dual Media Filtration Improvements / Filter System Improvements — ***Upgrades to aged equipment (Alternative A)***

Improvement	*Description*
Repace Control Valves	**Filter control valves and rate measuring equipment**

	Type	Description	Notes
Control Valves	Control Valves	Replace valves on all four filters	

Replace Controls	**Automation equipment controlling filter run sequences and filter backwash sequences**

	Type	Description	Notes
New PLC	PLC	Replace existing controls with a PLC for controlling feed and backwash operation for four filters	

Replace Filter Media	**Anthracite and sand media**

	Type	Description	Notes
Anthracite Media	Anthracite Media	3840 cu ft of media per filter	Replace media in all four filters
Sand Media	Sand Media	1440 cu ft of media per filter	Replace media in all four filters

Recommended Improvemens for Plant Replacement Scenarios

Dual Media Filtration Improvements / Filter System Improvements — *Upgrades to aged equipment (Alternative A)*

Improvement	*Description*
Replace Filter Underdrains	**Replace nozzles and nozzle support structures**

	Type	Description	Notes
Filter underdrains	Valves and nozzles	Replace valves and nozzles for each of four filters	

Replace Mechanical Equipment — **Replace backwash pumps and backwash air blowers**

	Type	Quantity	Horse power	Capacity	Capacity Units	Notes
Backwash Pumps		4	0	8400	gpm	20 ft TDH
Backwash Blowers		4	0	3840	cfm	5 psig

Disinfection Improvements / Contact Reactors — *Upgrades and rehabilitation of chlorine contact tanks (Alternative A)*

Improvement	*Description*
Improve Flow Distribution Channel	**Upgrade will improve mixing upstream of contact tanks**

	Type	Description	Notes
Rapid Mixer	Rapid Mixer	Mixer used for sodium hypochlorite addition for final effluent disinfection	10 -12 hp

	Quantity	Length	tank_width	Depth	Diameter	Construction Material	Notes
Channel Modifications	0	10.3 ft	10.3 ft	7 ft		Concrete	Modifications to analysis room to create a vault for mixing with sodium hypochlorite addition. Concrete allowance for this.

New Effluent Flow Measurement — **Reliable effluent flow measurement**

	Type	Description	Notes
Effluent Flow Meter	In pipe mag meter with vault		Range of flows to be measured is 0-100 mgd

Rehabiltate Concrete Tanks — **Rehabilitation of aged structure**

Recommended Improvemens for Plant Replacement Scenarios

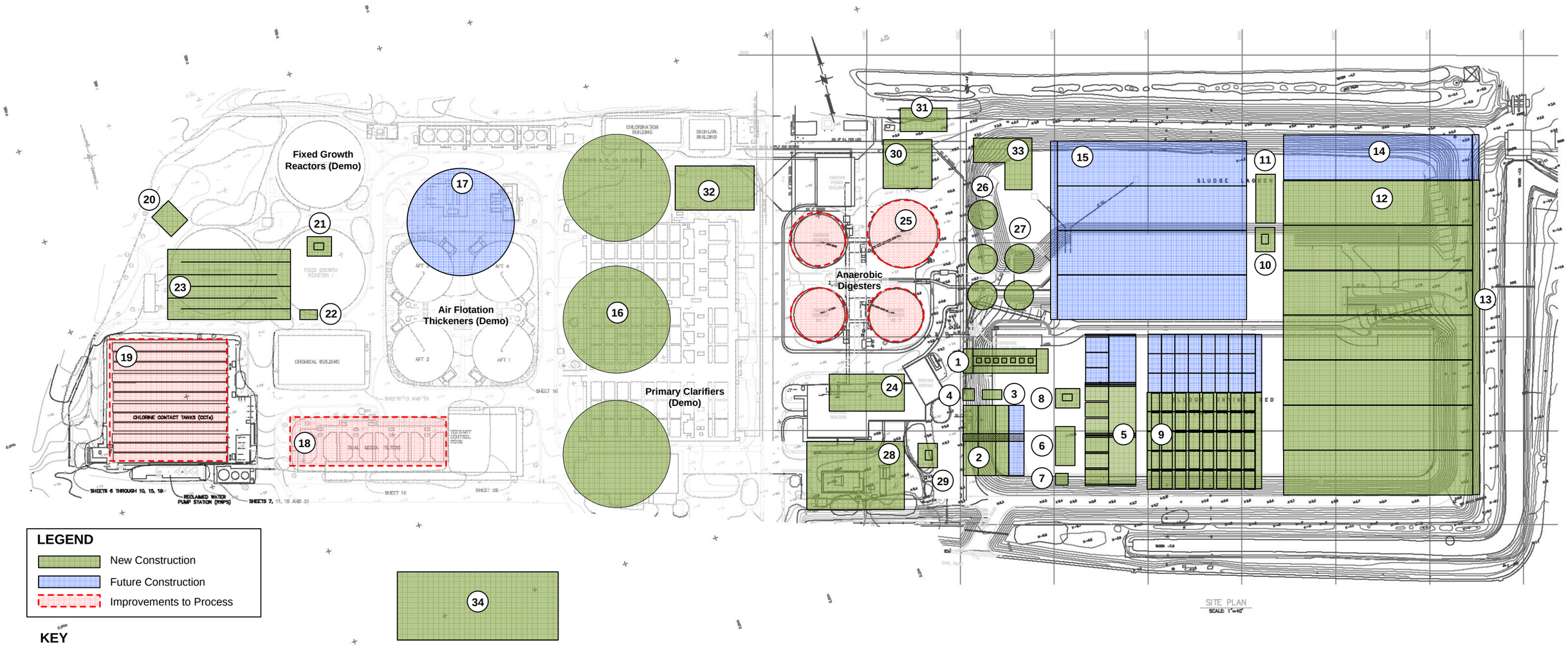
Disinfection Improvements / Contact Reactors ***Upgrades and rehabilitation of chlorine contact tanks (Alternative A)***

Improvement	*Description*						
	Quantity	Length	tank_width	Depth	Diameter	Construction Material	Notes
Replace concrete	4	372	10 ft	12 ft		Concrete	Assume an allocation for replacement of concrete over 50% of each unit's surface area for a total of 25,000 square ft

Disinfection Improvements / Disinfectant Management ***Replace existing liquid / gaseous chlorine system for risk mitigation concerns (Alternative A)***

Improvement	*Description*						
Sodium Hypochlorite Feed Pump Station	**Feed pumps for new sodium hypochlorite system**						
	Type	Quantity	Horse power	Capacity	Capacity Units		Notes
Chemical Feed Pumps	Chemical Feed Pumps	2	0	2	gpm		
Sodium Hypochlorite Storage	**Storage tanks and spill containment structure**						
	Quantity	Length	tank_width	Depth	Diameter	Construction Material	Notes
Sodium Hypochlorite Storage	1			30	12	Polyethelene	25,000 gal capacity to store approximately 1 weeks worth of sodium hypo

ATTACHMENT B: PLANT REPLACEMENT ALTERNATIVE LAYOUT DRAWINGS



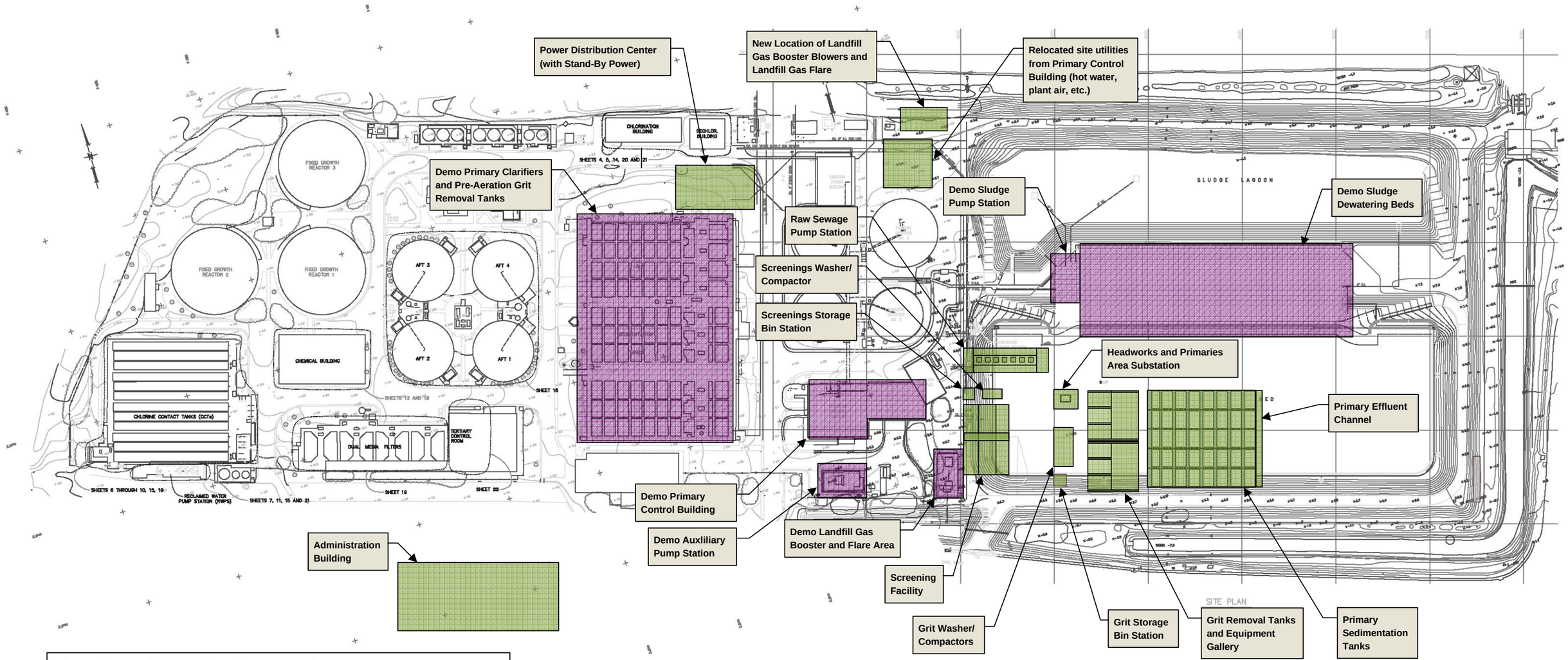
LEGEND

- New Construction
- Future Construction
- Improvements to Process

KEY

1. Raw Sewage Pump Station
2. Screening Facility
3. Screenings Washer/Compactor
4. Screenings Storage Bin Station
5. Grit Removal Tanks and Equipment Gallery
6. Grit Washer/Compactors
7. Grit Bin Station
8. Headworks and Primaries Area Substation
9. Primary Sedimentation Tanks
10. Aeration Basin Area Substation
11. Blower Building
12. Aeration Basins 1-7
13. Aeration Basin Effluent Channel
14. Future Aeration Basin 8
15. Future Aeration Basins 9-12
16. Secondary Clarifiers (3)
17. Future Secondary Clarifier
18. Dual Media Filter Improvements
19. Chlorine Contact Tanks Improvements
20. Hypochlorite Storage
21. Tertiary Treatment Area Substation
22. Cloth Media Filters
23. Recycled Water Disinfection Channels
24. Co-Thickening
25. Anaerobic Digesters Improvements
26. Digested Sludge Storage
27. Pasteurization Tanks (4)
28. Solids Dewatering
29. Solids Handling Area Substation
30. Relocated Ste Utilities from Primary Control Building (hot water, plant air, etc.)
31. New Location of Landfill Gas Booster Blowers and Landfill Gas Flare
32. Power Distribution Center (w/Stand-By Power)
33. New Maintenance Facility
34. Administration Building

SITE	Sunnyvale Strategic Implementation Plan: Plant Replacement Alternative A
TITLE	Final Layout (Including Ultimate Influent Flow Allocation)
BROWN AND CALDWELL	DATE: October 2009
	PROJECT: 135083-005-001
	Figure B-1



Plant Operation During Construction:

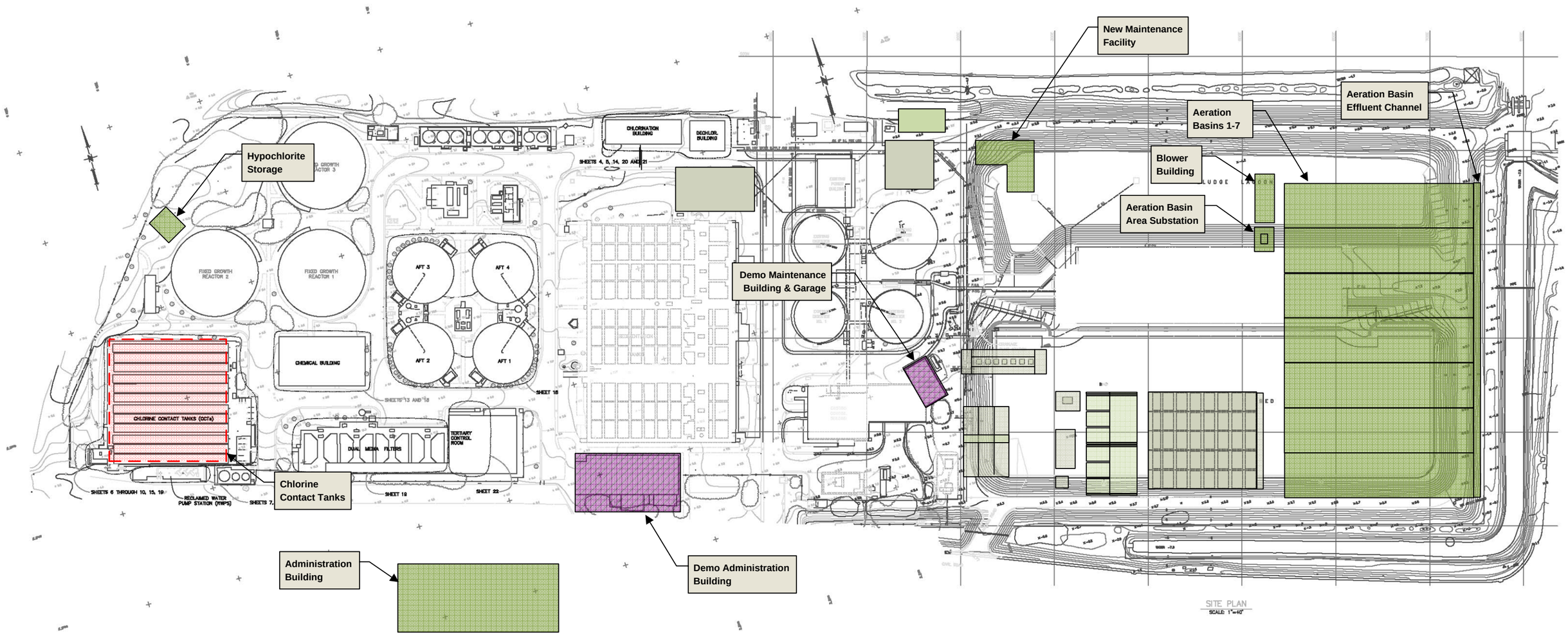
- Current normal operation of all liquid-phase treatment processes
- Digested sludge sent directly to ponds (no dewatering)

LEGEND

Demolition

New Construction

SITE	**Sunnyvale Strategic Implementation Plan: Plant Replacement Alternative A**	
TITLE	**Construction Package 1 Phase 1 (Early Execution Projects)**	
BROWN AND CALDWELL	DATE October 2009	**Figure B-2**
	PROJECT 135083-005-001	



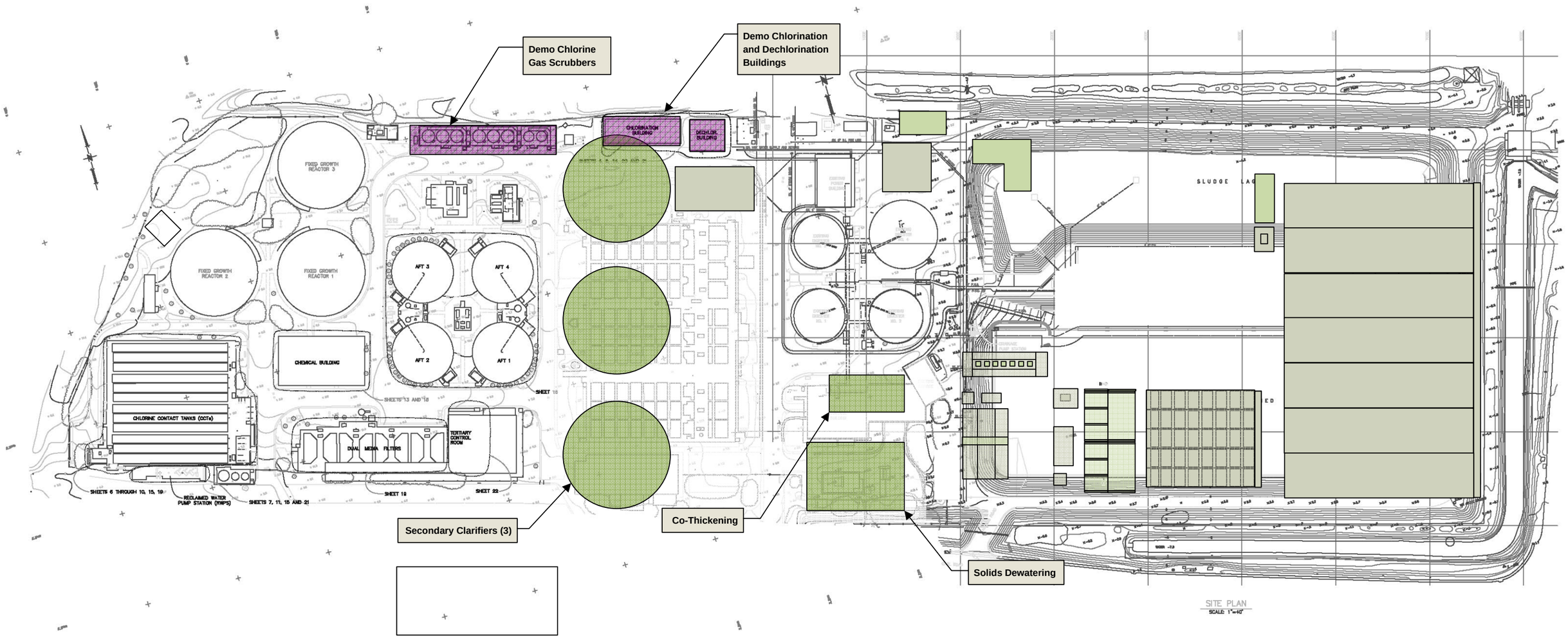
Plant Operation during Construction:

- New raw sewage pump station, headworks, and primary clarifiers online
- Primary effluent sent to ponds for biological treatment through new pipeline
- Digested sludge sent directly to ponds (no dewatering)

LEGEND

- Demolition
- New Construction
- Improvement to Process

SITE	**Sunnyvale Strategic Implementation Plan: Plant Replacement Alternative A**	
TITLE	**Construction Package 2 (Secondary Treatment Facilities): Phase 1**	
BROWN AND CALDWELL	DATE October 2009 PROJECT 135083-005-001	**Figure B-3**



Plant Operation during Construction:

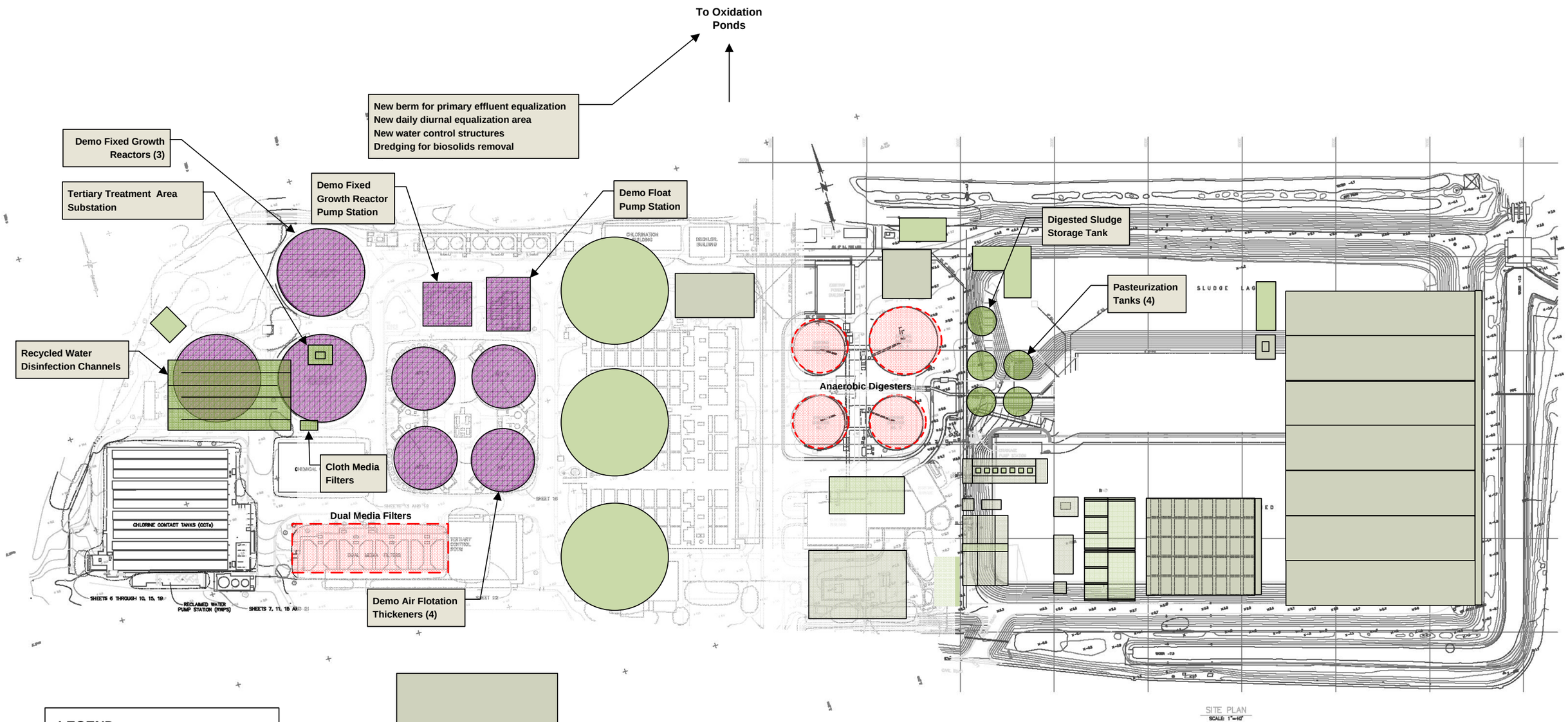
- New raw sewage pump station, headworks, and primary clarifiers online
- Primary effluent sent to ponds for biological treatment (aeration basins not on line)
- New hypochlorite disinfection system on line with upgrades to chlorine contact tanks
- Digested sludge sent directly to ponds (no dewatering)

LEGEND

Demolition

New Construction

SITE	**Sunnyvale Strategic Implementation Plan: Plant Replacement Alternative A**	
TITLE	**Construction Package 2 (Secondary Treatment Facilities): Phase 2**	
BROWN AND CALDWELL	DATE October 2009 PROJECT 135083-005-001	**Figure B-4**



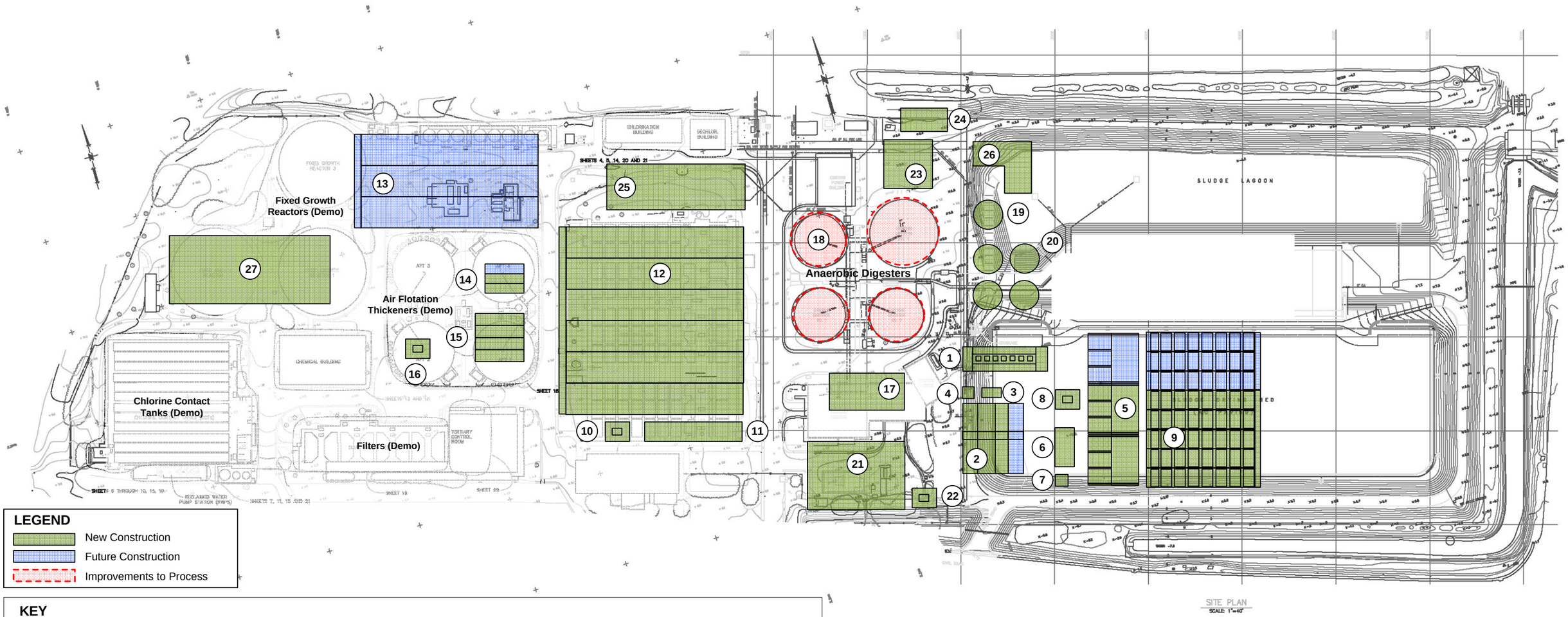
LEGEND

- Demolition
- New Construction
- Improvement to Process

Plant Operation during Construction:

- New preliminary, primary, and secondary treatment processes all on line
- New hypochlorite disinfection system on line
- Discontinue use of ponds for regular treatment; use ponds only for storm water equalization
- Full solids processing train completed (through dewatering)

SITE	**Sunnyvale Strategic Implementation Plan: Plant Replacement Alternative A**	
TITLE	**Construction Package 3 (Advanced Treatment Facilities)**	
BROWN AND CALDWELL	DATE October 2009 PROJECT 135083-005-001	**Figure B-5**



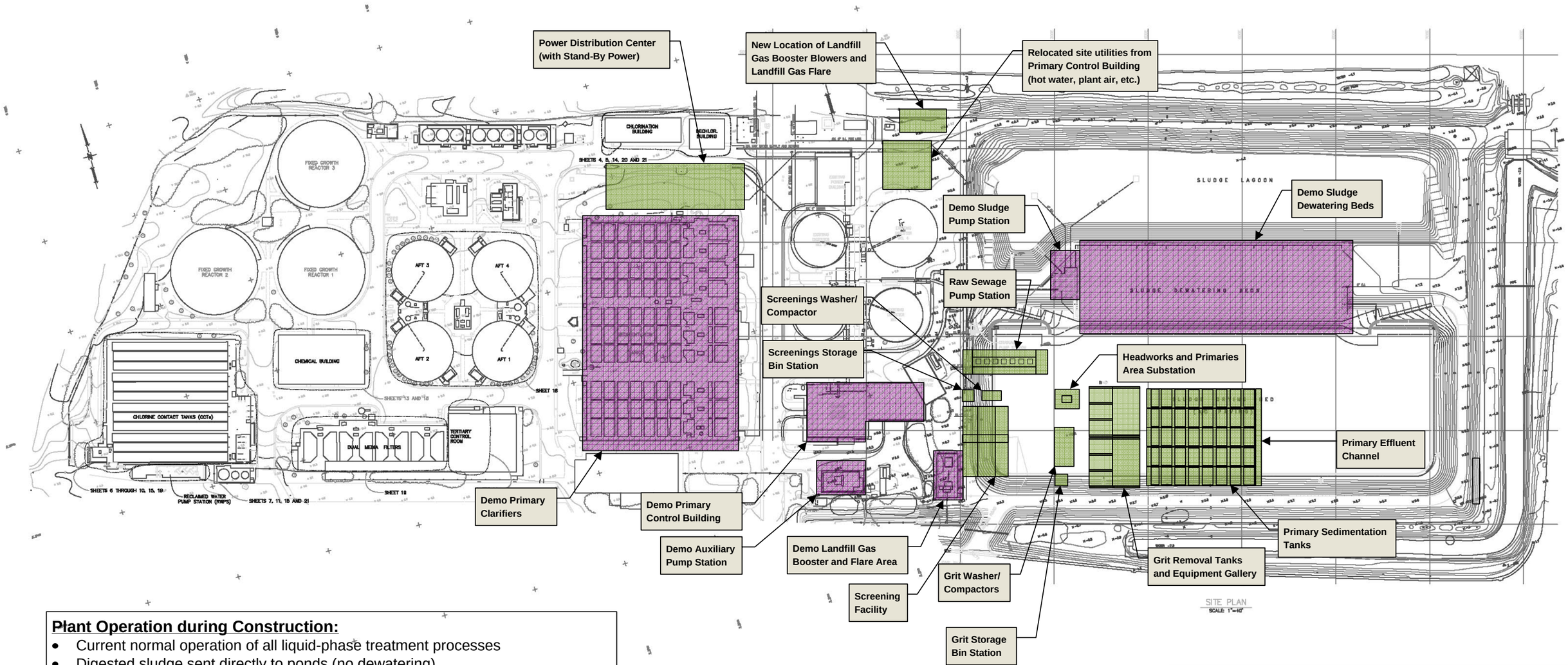
LEGEND

- New Construction
- Future Construction
- Improvements to Process

KEY

1. Raw Sewage Pump Station
2. Screening Facility
3. Screenings Washer/Compactor
4. Screenings Storage Bin Station
5. Grit Removal Tanks and Equipment Gallery
6. Grit Washer/ Compactors
7. Grit Bin Station
8. Headworks and Primaries Area Substation
9. Primary Sedimentation Tanks
10. MBR Area Substation
11. Blower Building
12. MBR Tanks 1-6
13. Future MBR Tanks
14. UV Disinfection Channels
15. UV Disinfection for Recycled Water
16. UV Disinfection Area Substation
17. Co-Thickening
18. Anaerobic Digesters Improvements
19. Digested Sludge Storage
20. Pasteurization Tanks (4)
21. Solids Dewatering
22. Solids Handling Area Substation
23. Relocated Site Utilities from Primary Control Building (hot water, plant air, etc.)
24. New Location of Landfill Gas Booster Blowers and Landfill Gas Flare
25. Power Distribution Center (with Stand-By Power)
26. New Maintenance Facility
27. Administration Building

SITE	**Sunnyvale Strategic Implementation Plan: Plant Replacement Alternative B**
TITLE	**Final Layout (Including Ultimate Influent Flow Allocation)**
BROWN AND CALDWELL	DATE: October 2009
	PROJECT: 135083-005-001
	Figure B-6



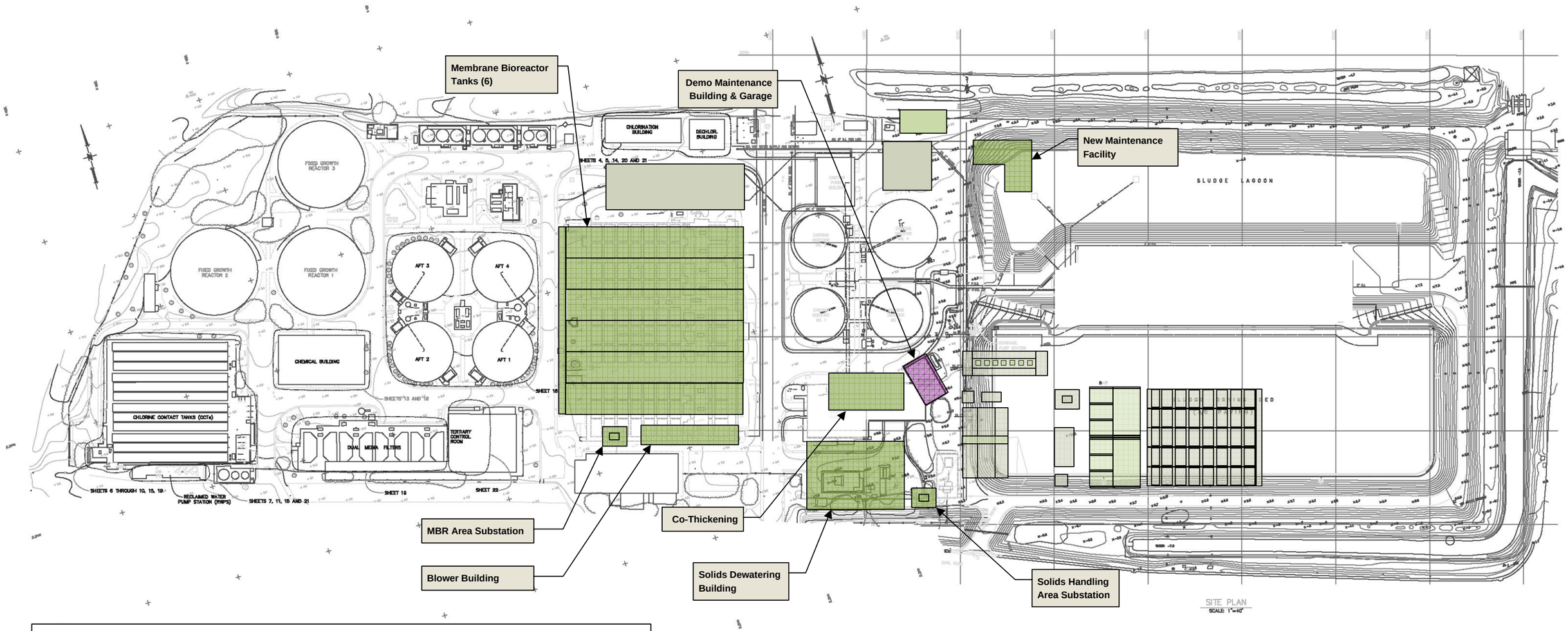
Plant Operation during Construction:

- Current normal operation of all liquid-phase treatment processes
- Digested sludge sent directly to ponds (no dewatering)

LEGEND

- Demolition
- New Construction

SITE: **Sunnyvale Strategic Implementation Plan: Plant Replacement Alternative B**		
TITLE: **Construction Package 1 (Early Execution Projects)**		
BROWN AND CALDWELL	DATE: October 2009 PROJECT: 135083-005-001	**Figure B-7**



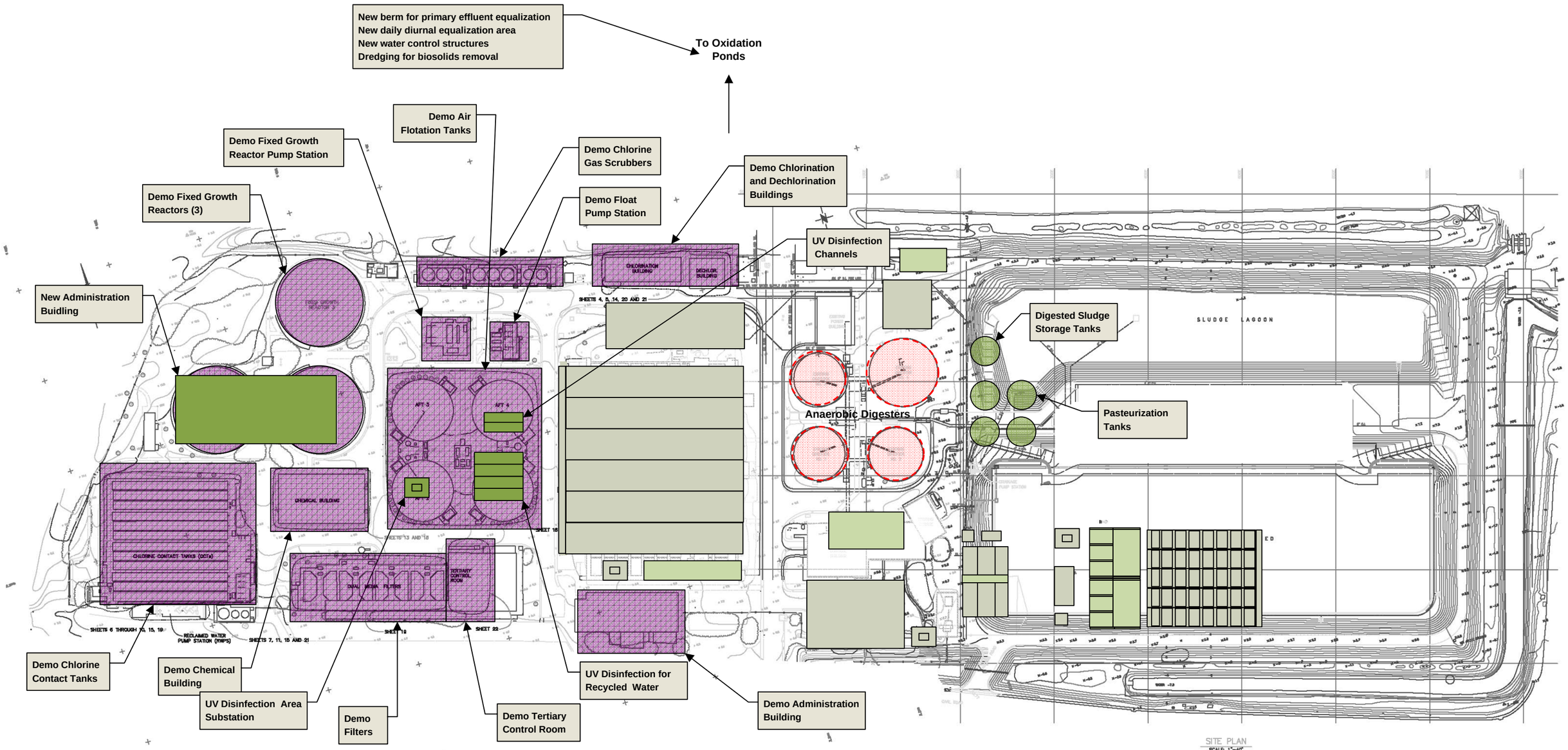
Plant Operation during Construction:

- New raw sewage pump station, headworks, and primary clarifiers online
- Primary effluent sent to ponds for biological treatment through new pipeline
- Existing disinfection system on line
- Digested sludge sent directly to ponds (no dewatering)

LEGEND

- Demolition
- New Construction

SITE	**Sunnyvale Strategic Implementation Plan: Plant Replacement Alternative B**
TITLE	**Construction Package 2 (Secondary Treatment Facilities)**
BROWN AND CALDWELL	DATE: October 2009
	PROJECT: 135083-005-001
	Figure B-8



Plant Operation during Construction:

- New preliminary, primary, and MBR processes all on line
- Convey MBR effluent to chlorine contact tanks for disinfection
- Discontinue use of ponds for regular treatment; use ponds only for primary effluent equalization
- Biosolids dewatered on main plant site

LEGEND

- Demolition
- New Construction

SITE	**Sunnyvale Strategic Implementation Plan: Plant Replacement Alternative B**
TITLE	**Construction Package 3 (Advanced Treatment Facilities)**
BROWN AND CALDWELL	DATE: October 2009
	PROJECT: 135083-005-001
	Figure B-9

ATTACHMENT C: CAPITAL COST ESTIMATE (ALTERNATIVES A AND B)

Summary of Project Costs for Plant Replacement Alternatives

Process Location Number	Revised Name	Plant Replacement Alternative A				Plant Replacement Alternative B		
		Bid Pkg 1	Bid Pkg 2 - Ph 1	Bid Pkg 2 - Ph 2	Bid Pkg 3	Bid Pkg 1	Bid Pkg 2	Bid Pkg 3
		2/15/11 - 2/15/14	2/15/14 - 2/15/16	2/15/16 - 2/15/18	2/15/18 - 2/15/22	2/15/11 - 2/15/14	2/15/14 - 2/15/19	2/15/19 - 2/15/24
1100	Civil/Site Work Existing Plant Area		2,400,749				2,907,666	
1101	Raw Sewage Pumping Station	5,923,861				5,906,960		
1102	Screening	3,652,447				3,647,811		
1103	Grit Removal	4,328,267				4,326,582		
1105	Landfill Gas Booster and Flare System	842,495				841,983		
1106	Primary Sedimentation Tanks	15,431,188				15,427,159		
1107	New Administration Building		3,060,977					4,527,814
1108	Area Substation - Headworks/Primaries	4,005,055				4,005,055		
1109	Demolition - Auxilliary Pump Station	3,371,008				3,371,008		
1110	Demo - Sludge Dewatering Bins	3,935,186				3,935,149		
1111	Demo - Primary Sedimentation Tanks 1-5	1,406,093				1,406,093		
1112	Demo - Primary Sedimentation Tanks 6-10	1,230,819				1,230,819		
1113	Primary Effluent Pipeline	2,619,003				2,619,003		
1114	Demo - 66" RCP	47,521				47,519		
1115	Demo - 24" and 30" Pipe	143,956				143,945		
1116	Demo - Primary control Building	1,736,672				1,736,257		
1117	Relocated Utilities Building	1,527,349				1,522,060		
1118	Area Substation - Tertiary				4,379,335			4,891,543
1120	Community Improvements - On-Site Features				274,048			306,056
1121	Community Improvements - Off-Site Features				99,238			110,266
1128	Area Substation - Biological		3,651,599				4,066,581	
1129	Maintenance Building		1,282,090				1,405,657	
1130	Demo - DAFT Area				1,656,704			1,762,978
1131	Demo - Chlorination Building			544,628				672,633
1132	Demo - Dechlorination Building			195,763				241,442
1133	Demo - Chemical Storage Area			577,078				711,469
1134	Demo - Float Pumping Station				1,129,948			1,222,940
1135	Demo - FGR Pump Station				1,313,793			1,419,220
1136	Demo - Existing Administration Building		272,262					366,606
1137	Demo - Maintenance Building and Garage		291,469				311,039	
1138	Demo - Fixed Growth Reactors				3,478,513			3,713,838
1139	Demo - Tertiary Facility							5,858,035
2103	Pond Effluent Pump Station		3,357,248				3,636,683	
2109	Dual Media Filtration				4,533,112			
2110	Chlorine Contact Reactors		904,860					
2111	Disinfectant Management		2,620,901					
2118	Main Power Distribution Center	2,713,040				2,713,040		
2119	Biogas Power Generation				12,361,532			13,812,682
3001	Stormwater Equalization				18,753,766			20,881,075
3002	Diurnal Equalization				7,265,674			7,991,344
3003	Pond Water Control Structures				4,098,907			4,521,515
3004	Pond Earthwork				647,456			693,648
3005	Pond Dredging				9,123,250			9,924,301
3102	Rotary Drum Thickeners			4,493,045			4,324,657	
3103	Thickened Sludge Storage			7,158,306			6,880,317	
3104	Anaerobic Digesters				22,776,694			24,858,765
3105	Pasteurization Tanks				25,669,771			28,133,506
3106	Un-Thickened Sludge Storage			429,359			414,353	
3107	Gas Storage				5,102,535			5,740,268
3108	Gas Moisture Reduction				1,456,965			1,621,468
3109	Gas Purification				1,163,276			1,301,440
3110	Gas Compressors				482,658			535,704
3111	Boilers				645,676			714,764
3112	Digester Gas Flares				2,870,229			3,189,175
3114	Screw Press			19,209,519			18,494,410	
3118	Area Substation - Solids Handling			3,113,199			3,002,138	
3119	Digested Sludge Storage				4,636,694			5,057,464
4101	Aeration Basins		27,554,716					
4102	Secondary Clarifiers			15,690,617				
4103	Recycled Water (Cloth Filters, Cl2)				4,800,370			
4105	Recycled Water (UV only)							4,891,020
5101	Membrane Bioreactor						94,267,362	
5102	UV Disinfection							3,331,574
Subtotal		52,913,960	45,396,871	51,411,514	138,720,144	52,880,443	139,710,863	163,004,553
Total		**288,442,489**				**355,595,859**		

ATTACHMENT D: SUMMARY TABLE OF OPERATIONAL COSTS (ALTERNATIVES A AND B)

Estimated Quantities of Plant Consumables

	Task 5a				Task 5b			
	Electrical (kW-hr/yr)	Chemicals (gal/yr)	Labor (qualitative)	Hauling (wet ton/yr)	Electrical (kW-hr/yr)	Chemicals (gal/yr)	Labor (qualitative)	Hauling (wet ton/yr)
Preliminary Treatment								
Raw Sewage Pumping	743,684				743,684			
Grit Removal								
Grit Pumping	261,293				261,293			
Aeration Blowers	391,340				391,340			
Primary Treatment								
Primary Sedimentation Tanks								
Sludge Pumping	9,944				9,944			
Scum Pumping	45,072				45,072			
Secondary Treatment								
Oxidation Ponds								
Effluent Pumping	122,766				122,766			
Aeration Basins								
Blowers	4,192,910							
Secondary Clarifiers								
RAS Pumping	163,704							
WAS Pumping	20,477							
Membrane Bioreactor								
Blowers					13,042,460			
RAS Pumping					129,370			
WAS Pumping					9,132			
Permeate Pumps					468,224			
Sodium Hypochlorite						13,500		
Citric Acid						370		
Tertiary Treatment								
Dual Media Filtration								
Backwash Pumping	146,577							
Backwash Blowers	432,032							
Sodium Hypochlorite Disinfection								
Booster Pumping	391,636							
Mixer	87,100							
Sodium Hypochlorite		34,353						
Sodium Bisulfite		40,122						
UV Disinfection								
UV Lamps					141,912			
Solids Handling								
Anaerobic Digestion								
Feed Pumping	10,611				10,611			
Circulation Pumping	94,400				94,400			
Digester Mixing Pumping	888,602				888,602			
Digested Sludge Transfer Pumping	10,060				10,060			
Pasteurization Feed and Mixing	68,422				68,422			
Digested Sludge Tank Pumping	47,200				47,200			
Rotary Drum Thickeners								
Thickener Operation	143,711				143,711			
Feed Pumping	171,474				171,474			
Thickened Sludge Pumping	53,347				53,347			
Polymer		4,107				4,107		
Screw Press								
Screw Press Operation	43,743				43,743			
Feed Pumping	23,330				23,330			
Cake Pumping	46,660				46,660			
Polymer		3,131				3,131		
Biosolids Hauling				10,409				10,409
Recycled Water								
Recycled Water (Cloth Filters, Cl2)								
Cloth Filter Power	8,000							
Sodium Hypochlorite		9,460						
Recycled Water (UV only)								
UV Lamp Power					295,650			