Appendix D
Overview of Treatment Plants and Processes

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CENTRAL CONTRA COSTA SANITARY DISTRICT

General and Plant Process Description

The wastewater treatment processes include screening, grit removal, primary sedimentation, activated sludge process, secondary clarification, and ultraviolet disinfection. Waste activated sludge, thickened by dissolved air flotation, is combined with primary sludge. After lime and polymer are added, waste activated sludge is dewatered in centrifuges and pumped into a multiple hearth furnace for incineration. Some of the disinfected secondary effluent receives further treatment through direct filtration, hypochlorination, and coagulant addition if necessary. This recycled water is used in the plant for seal water, cooling water, etc. Recycled water is also sold to customers for dust control and landscape and golf course irrigation. In addition to the various treatment processes, the District operates a gas turbine, which produces approximately 3 megawatts of power, nearly all of the Districts power requirement.

Headworks and Influent Pumping

CCCSD uses four mechanically cleaned IDF Climber bar screens. There is a ¾-inch opening between bars of each screen. Screened items are ground with four Muffin Monster grinders and are returned to influent flow. Each grinder has the capacity to grind 45 cu ft per hour.

There are five different Ingersoll-Dresser Worthington influent pumps ranging from 400 to 700 hp each. There are two pumps with a 49-mgd capacity, two pumps with a 77.8-mgd capacity, and one pump with an 85-mgd capacity. Pump speed is regulated by Variable Frequency Drives (VFDs) located in the pump station electrical rooms. The pumps discharge through 48-inch lines.

Preliminary Treatment

Grit is removed through aerated grit tanks, each measuring 30-foot wide, 61.5-foot long and 15-foot average water depth. Grit is pumped through six Wemco pumps to grit cyclones where water is removed and grit goes to a chop box for removal and disposal at landfill. CCCSD spends approximately $49,000 annually for disposal.

Primary Treatment

The primary treatment process allows for settling and flotation of solids and organic materials. Solids sink to the bottom of the rectangular tank while lighter organic float to the uncovered top. There are a total of four primary sedimentation tanks with widths of 38 feet and lengths of 254 feet. No chemicals are used in the process.

An Envirex loop chain with fiberglass flights is used to collect solids. Scum is collected through ejectors and piped to the furnace. There are four submerged launders per sedimentation tank, each with a 20-inch diameter.

Secondary Treatment

CCCSD uses a conventional activated sludge process during secondary treatment. Microorganisms, such as stalked ciliates, annelid worms, and rotifers, break down and consume the suspended waste particles. As these bugs consume waste particles, many sink to the bottom of the tanks and are removed through the clarification process.

An anaerobic selector is used upstream of the aeration basins in order to control the quality of the sludge within an acceptable range. The selector was previously part of the primary effluent channel until the District spent $1 million in rerouting piping and adding mechanical mixers. An estimated $100,000 is saved annually through eliminating chorine usage for sludge bulking control.

The aeration process consists of four tanks with two passes per tank. Secondary flow ranges from 36.8 to 87.4 mgd, but has an average value of 49.2 mgd. A porous plate/fine-bubble diffuser is used to aerate the flow. Each aeration tank pass is 35-foot wide and 270-foot long. The average water depth is approximately 15 feet. The hydraulic retention time is estimated at 1.04 hours. The solids retention time is approximately 1.9 days. The concentration of MLSS is 1,320 mg/L and RAS is 3,750 mg/L. There are eight secondary clarifiers with diameters of 115 feet each and depths of up to 16 feet. The overflow rate is 590 gal/ft^2/day. Overall, there is an operating temperature range of 18.5 to 27.5ºC for secondary treatment.

Sludge Thickening

Liquid sludge is thickened in any of three dissolved air flotation (DAF) tanks. Each tank measures 40 feet in diameter and has a sidewater depth of 8.25 feet. The waste activated sludge (WAS) loading rate averages 29.2 tons per day. The thickened WAS rate averages at 27.6 tons per day. Chemicals are not used currently, but cationic polymer is used at times. The thickened sludge is combined with primary sludge and sent to the dewatering process.

Digesters

CCCSD does not have digesters.

Dewatering

CCCSD processes about 186 wet tons per day of biosolids. This is equivalent to about 45 dry tons per day. Primary sludge and thickened waste activated sludge enter a 734,000-gallon sludge-blending tank. Carbide lime is injected into this tank at a rate of 3.7 dry tons per day. The purpose of the lime is to raise the fusion temperature of the ash, during incineration, as well as to precipitate various metals.

The blended sludge enters the Solids Conditioning Building (SCB) where polymer addition, dewatering, and incineration takes place. The sludge entering the SCB is mixed with a mannich type polymer. The polymer is added to two 3,300-gallon mixing tanks.

The dewatering system includes four Sharples horizontal solid bowl centrifuges. Each has a design capacity of 100 gpm. The removed solids, or cake, is pumped by four 30-hp Schwing hydraulically driven reciprocating piston pumps to the incinerator. The remaining centrate returns to either the headworks or secondary treatment.

There is a 4% solids content in the centrifuge feed and a 23% solids content in the cake. There is an average of 89% solids' capture in the dewatering process. The method in calculating this percentage involves a microwave, cook off, and mass balance.

Biosolids

The dewatered sludge is pumped into an 11 hearth multiple hearth furnaces where the sludge is incinerated. CCCSD alternates yearly between two Bartlett Snow Pacific incinerators. Each measures 22 ft 3 in. in diameter and approximately 50 ft in height. The ash removed from the furnace is loaded into trucks and hauled to landfill. Nearly 11.4 tons of ash is hauled each day.

An approximate cost of $1,500,000 is spent yearly on total operating costs associated with the biosolids reuse/disposal process. In terms of capital investments, the estimated cost of the incineration process is about 40% of the plant cost in 1977. This results in a $37 million value and an $18 million depreciation value.

Odor Control

In order to meet these requirements, various methods are incorporated to control odors. Hydrogen peroxide is injected into different areas of flow. Scrubbing towers clean foul air at the plant during primary treatment, sludge dewatering, and incineration. Vapor phase reactants are used to neutralize odors. Soil filters and other devices are also applied during odor control.

Upstream of the plant, hydrogen peroxide and sodium hydroxide are added. Addition occurs at various pump station in order to reduce hydrogen sulfide content and other odors.

The combined flow of foul air from the aerated grit tanks, grit boxes, and the primary effluent channel enters a single Calvert odor control scrubber system. This system, located in the primary sedimentation area, is a co-current spray scrubber. The Calvert incorporates a finely divided chemical mist solution of water, sodium hypochlorite, and sodium hydroxide. Foul air enters the bottom of the vertical scrubber vessel and is evenly mixed with the chemical mist. This mist absorbs and oxidizes odorous compounds during the upward flow. A mesh style mist eliminator removes water droplets prior to atmospheric discharge.

The combined flow of foul air from the wet wells and the influent structure enter two Quad scrubbers located at the headworks area. Both scrubbers, like the Calvert, use chemical mists. Each measures 10 feet in diameter and 34 feet in height.

The combined flow of foul air from the sludge blending tanks, centrifuges, scrubber water, and the cake pump area enters the scrubber area at the north side of the Solids Conditioning Building. There are two countercurrent packed bed foul air scrubbers, each with a diameter of 6 feet and a packing height of 8 feet. Hypochlorite solution is sprayed over the top of the media inside the scrubbers. As the solution trickles down through the media, hydrogen sulfide and other odor causing substances are oxidized.

In order to neutralize odors in the primary sedimentation and secondary aeration tanks, CCCSD applies NuTech vapor phase reactants. These reactants react with odorous molecules and remove them from the air stream. The reactive chemicals alter molecular characteristics of odors through polymerization and esterification. Approximately 3.1 gallons of concentrated NuTech is sprayed daily.

Hydrogen peroxide addition at the headworks and the solids handling system has effectively reduced sulfide concentrations in the flow. During late summer and the fall, 200 gpd of 50% peroxide is injected at the headworks. Year-round, 25 gpd of 50% peroxide is added to the centrate line. Sulfide levels in the centrate line have dropped from 5 to 8 ppm to less than 0.3 ppm with peroxide addition.

CCCSD controls odorous emissions from the three DAF tanks through a dual biofiltration system. This system incorporates DAF tank covers, exhaust ducting, and a 3,500-cfm exhaust air biofilter. Exhaust gas from the enclosed DAF tanks passes through an organic medium where absorption/adsorption and bio-oxidation occur. Microorganisms, existing on the media surface, aerobically degrade odorous compounds that are adsorbed on the media surface and absorbed in the water film.

The total cost to install the biofiltration odor control system was $525,000. The system has proven to be highly effective with a 98% odor removal.

Disinfection

CCCSD employs an ultraviolet (UV) facility for disinfecting wastewater. Our permit requires that for fecal coliform, the "30-day log mean cannot exceed 200 mpn/100 ml" and "10% of the samples cannot exceed 400 mpn/100 ml."

UV disinfection, a $13.3 million project instituted early in 1997, treats up to 90 mgd of wastewater. During the process, light radiating from the UV lamps breaks down reproductive segments of bacterial and viral DNA chains of microorganisms. A large-scale pilot study, conducted by CCCSD in 1992, showed that UV is more effective at disinfecting viruses than chlorine. In addition, there are no chemical residuals or byproducts produced by UV. There is, however, a sodium hypochlorite backup system in place for disinfection. (Sodium hypochlorite is also used for any reclaimed water.) UV is comparable in annual direct costs to chlorine. CCCSD expects to save up to $400,000 per year in personnel, training and safety costs by switching to UV.

There are two UV basins, which are each, divided into four channels (78.5" W x 102" D x 848" L). Motorized slide gates control the flow of secondary effluent into these eight channels. Currently, up to six channels are in operation, each containing three UV banks supplied by Elsag Bailey. Each UV banks holds up to 26 lamp racks. Each lamp rack holds 16 lamps for an overall total of 7,488 lamps.

Each of the 18 lamp banks receives power from one of 18 Power Distribution Centers (PDCs) mounted on a deck above the channels. The power consumption per bank is 29.1 kW. The minimum UV dosage provided at peak flow is 46,871 μW-s/cm^2. The minimum retention time required for a UV density of 3.35 W/L is 14.9 seconds.

Effluent Pumping/Outfall

Effluent flow ranges from 37.7 to 88.5 mgd, but has an average value of 48.93 mgd. There are three 75-mgd capacity pumps that divert effluent flow into the Suisun Bay, which flows to the San Francisco Bay. There is a head of 5 feet at 60 mgd. The land section of the outfall is 18,600 feet and the submarine section is 1,900 feet. The diameter of the outfall pipe is 72 inches. The outfall has eleven 24-inch-diameter diffusers. The depth of the outfall varies approximately 3 feet depending on tide. However, the average depth is 26 feet at mean sea level.

Utilities

CCCSD employs three different water systems designed for plant use. The '1 water' system is basically city water. The '2' water system is filtered secondary effluent. CCCSD's filter plant, which filters the secondary effluent, has the capability of treating 30 mgd. Finally, the '3' water system is unfiltered secondary effluent.

Natural gas is used for cogeneration and the auxiliary blowers. Landfill gas is used for the furnace. Acme supplies approximately 150,000 dTH of landfill gas yearly at a cost of $370,000. PG&E and Amoco supply a combined amount of almost 400,000 dTH of natural gas yearly at a cost of $1.07 million.

In addition to natural gas, PG&E provides 325 kW of electricity. There is a 115-kV transmission line to the plant, 12 kV in the plant and 480 V at the Motor Control Centers (MCCs).

The air system in the plant is a combination service air/instrument air system. The air, provided by two Atlas Copco compressors, is delivered at a rate of about 387 SCFM.

Automation

CCCSD's control philosophy is to maintain a dual, redundant, central control computer, which handles most of the control and alarm functions as well as historical storage and retrieval. The field instruments and equipment are wired to remote programmable logic controllers (PLCs) which do some interlock type logic, but mostly serve as multiplexors to the central system. Our plan is to use more of the PLCs' capabilities in the future. This will provide distributed-type backup to the central system.

From the six consoles located in three different control rooms, operators can monitor and control plant processes and equipment. The computer system provides all of the control, alarming, and historical trending. Alarms are generated by analog and discrete inputs as well as by the computerized control system. The four different alarm categories include operator notices, analog alarms, discrete events, and discrepancy conditions.

Information from the computerized control system is archived through a redundant pair of minicomputers. These minicomputers are programmed to request current values of process data at 1-minute intervals. The archived data is processed for computing average, total, and high and low values. Finally, the data is compressed and written to disk.

The computerized control system makes detailed current and historical information available for use in decision making. The information can be presented in various formats such as graphs, tabular reports, and individual value displays. Plant operation uses the system for controlling and monitoring plant processes as well as monitoring off-site pumping stations. The system delivers process information and reports alarms to the centralized control room. Equipment throughout the plant is controlled and process setpoints and control loop tuning parameters are adjusted from the control room.

Power/Energy

CCCSD generates most on-site power use, rated at 6.4 MW. Our cogeneration system and standby power generators have the potential of generating approximately 3.2 MW each. Pacific Gas and Electric (PG&E) provides a small import of power through a transmission line at 115 kV.

CCCSD spends approximately $1.8 million annually for outside electricity, landfill gas, and natural gas. There is an electricity and steam requirement of approximately 3,200 kW. The District's Cogeneration facility, operating since June of 1995, produces enough energy to satisfy nearly 90% of this demand. Currently, the $6.2 million project saves approximately $1 million annually.

Designed to use both landfill gas and natural gas, Cogeneration includes a 3.3-MW Solar Centaur Model 4700 gas turbine engine. Cogeneration also provides 40% of the steam requirement. The heat recovery is used in steam turbine driven blowers and the HVAC system.

In case of cogeneration failure, there are two 16-cylinder Detroit diesel turbo charged emergency generators. These generators, located in the Standby Power Building, can produce up to 1,600 kW each. In addition, a 230-kW Empire generator is currently being installed as a black start of the cogeneration turbine if both standby power units were unavailable.

CITY OF LOS ANGELES, BUREAU OF SANITATION

Hyperion Treatment Plant

General and Plant Process Description

The City owns and operates its own wastewater collection and treatment system. The City of Los Angles and the County of Los Angeles set up separate wastewater collection systems at the beginning of the 20^{th} Century. The geography of the area allowed the City and the County to design their separate collection systems to work almost entirely by gravity. A number of contracts were negotiated between the two entities. The contracts allowed flow from each agency that could not flow by gravity to the agency's disposal point (there were no treatment plants back then, just raw sewage dumped into the Pacific Ocean) to be allowed to flow by gravity to the other agency's system. The City system handles the wastewater from eight other cities in Los Angeles County, and wastewater from 21 other agencies as a result of these contracts. These so-called "contract agencies" pay a portion of the City's O&M and Capital costs, based on flow. The City and contract agencies are renegotiating the contracts to include wastewater strength as well.

There are two separate collection and treatment systems in the City. The bulk of the city is served in the Hyperion Service Area (HSA), which covers over 90 percent of the City and treats the flow from almost all of the contract agencies. The City's harbor area, which is geographically separate from the rest of the City, is served by the Terminal Island Treatment Plant.

The HSA collects the wastewater from about 4,000,000 population, covers a surface area of over 600 square miles, and uses three treatment plants to process the wastewater flow. The collection system for the HSA is 6,500 miles in length. The Hyperion Treatment Plant was built in 1950 to treat the wastewater from the HSA. The City's population quickly grew from the 1950's to the 1970's. The City chose to build two water reclamation plants in the San Fernando Valley that would treat the wastewater to tertiary standards, but send all of their solids generated in the treatment process to Hyperion for processing. This meant that the City did not have to build huge underground sewer lines from the San Fernando Valley to Hyperion, and did not need to build solids handing processes at these plants. This made for significant capital and O&M cost savings for the City without causing any environmental impacts. This strategy was first developed by the County of Los Angeles before it was used by the City.

These plants are the Donald C. Tillman Water Reclamation Plant, and the Los Angles Glendale Water Reclamation Plant. Each of these plants has a separate description in this report, along with the Terminal Island Collection System and Treatment Plant. The rest of this section deals with the Hyperion Treatment Plant.

Hyperion Treatment Plant sits on 144 acres of land, and is located on the Pacific Ocean in Santa Monica Bay adjacent to the Los Angeles International Airport. The plant has a dry weather capacity of 420 MGD for Primary Treatment, 200 MGD for Secondary treatment, and an 850 MGD wet weather capacity. Current flow is 355 MGD.

Hyperion is a partial secondary treatment plant. The City has entered into a Consent Decree with the State of California and the EPA to expand Hyperion to full secondary by December 31, 1998.
Interim limits have been approved in the Consent Decree to allow Hyperion to operate as a partial secondary plant until its expansion project is completed. The City began work on the the Hyperion Full Secondary (HFS) project in 1986, and is expected to cost $1.4 Billion. The City embarked on a Hyperion Interim Improvement Project to substantially improve the existing Hyperion while building the full secondary project. This project included going to chemical coagulation in primary treatment, and doubling the old air activated sludge system flow from 100 MGD to 200 MGD. Hyperion was able to meet all full secondary standards, except for BOD, by 1988.

The HFS project will completely rebuild and expand all unit processes at Hyperion. A new headworks has been built, and two older, obsolete ones were demolished. Primary treatment will be expanded by almost 60 percent. Secondary treatment will be more than doubled from 200 MGD to 450 MGD. Digestion will be expanded from 18 to 38 tanks. Each new tank will be a 2.5 MG modified egg-shaped digester. The dewatering system is being greatly expanded and modernized by adding nine new “high cake’ centrifuges.

The first phase of the Secondary expansion project was completed in 1995. A new 200 MGD pure oxygen activated sludge process was placed into service. This allowed the old 200 MGD air activated sludge system to be demolished and replaced with a 250 MGD pure oxygen system with room for another 100 MGD of treatment in the middle of the next century if necessary. Land constraints dictated the use of oxygen instead of air for the secondary system at Hyperion.
The HFS project is proceeding according to schedule and should be completed on schedule.

Collection System

Background

The City operates and maintains the second largest wastewater collection system in the country. The City provides wastewater collection, treatment, and disposal services for approximately 3.7 million people within a 533-square-mile service area. It also provides service to 29 contract agencies outside the City. The City-owned pipeline system consists of more than 6,500 miles of sewers, 145,000 maintenance holes, and 48 sewage-pumping plants. The system includes primary and secondary sewers.

Primary sewers are defined as sewers that are 16 inches and larger in diameter. These sewers are the backbone of the system and represent the trunk, interceptor, and outfall portion of the system. They convey wastewater received from the secondary sewers to the treatment plants. There are approximately 634 miles of primary sewers in the 6500-mile system. Secondary sewers include all of the public pipelines that are less than 16 inches in diameter. These sewers serve local neighborhoods. Secondary sewers make up about 90 percent of the City's wastewater collection system network.

The primary system consists mainly of clay and clay-tile lined or plastic-lined concrete pipes. The average age of the primary sewer system is close to 50 years old. The secondary sewers include the mains and laterals, generally 15 inches in diameter and under. More than 85 percent of the secondary system was constructed with clay pipe materials and about 12 percent with non-reinforced concrete (cement) pipe materials. The average age of the pipelines in the secondary system, excluding the cement sewers, is just over 50 years, while the average age of the cement sewers exceeds 70 years.

Condition Assessment and System Monitoring

The City of Los Angeles utilizes an established condition assessment program to identify and accelerate necessary capital improvement projects to increase sewer capacity and replace badly deteriorated sewers. The catalyst to condition assessment is the City's ability to visually inspect the collection system interior. The city has effectively used closed circuit televising (CCTV) and lamping of sewers. Guiding this effort is a comprehensively developed identification, prioritization and scheduling mechanism to place sewers in need of repair or replacement into a capital project implementation program.

The City uses other tools to keep pace with the condition, both structural and hydraulic, as well as the operational character of the sewer system at all times. The Sewer Information and Maintenance Management System or SIMMS is used to keep track of the components of a sewer system and to manage their day-to-day and emergency maintenance. SIMMS stores inventory and historical information, schedules maintenance, creates work orders and generates reports that provides summarized and detailed information about the sewer system. The Supervisory Control and Data Acquisition (SCADA) System has been put in place to enable continuous monitoring and control of the pumping plants. Geographic Information System (GIS) have been developed and continue to be upgraded to serve for comprehending and managing the collection system effectively. A permanent Flow Monitoring Program has been implemented to evaluate system performance and monitor the "pulse beat" of the system throughout all conditions of flow. Sewer dynamic flow modeling has been used for predictive modeling and for active collection system operation.

Operation and Maintenance

The operation and maintenance activities are operated by a staff of 208 maintenance employees with an annual budget of about $15,900,000. The major O&M activities revolve around preventive maintenance, corrective maintenance and emergency response activities. They include sewer and maintenance hole inspection, sewer cleaning, root control, easement cleaning, sewer repair and construction, pumping plant O&M, and emergency response. Specifically, 6000 miles of sewers are inspected annually; 1900 miles of sewers are cleaned annually; Root control is performed on 600 miles of sewers a year; all siphons and trap maintenance holes are cleaned and inspected annually; and 90 miles of sewers are CCTV'd every year, etc. The City's aggressive inspection and cleaning program has resulted the control of sanitary sewer overflows (SSO). In FY1996/97, 229 SSOs occurred, about 1 spill for every 28 miles of pipe in the system annually.

Odor and Corrosion Control

Hydrogen sulfide odor and corrosion has been an on-going and growing concern with the Los Angeles sewer system. With the promulgation of the of the federal pretreatment program, sulfides in the collections system has increased drastically resulting in continued odor complaints, accelerating corrosion and the premature failure of the sewer infrastructure. To address the odor issue, the City of Los Angeles implemented sodium hydroxide shock dosing to control odors at its' major odor hot spot. Shock dosing kills sulfate reducing bacteria resulting in reduced dissolved sulfides in the wastestream. Consequently, odor complaints have decreased by 70%. Corrosion control is performed by the annual application of magnesium hydroxide slurry to the crown of primary sewers susceptible to corrosion. The magnesium hydroxide neutralizes any sulfuric acid present on the pipe surface and raises the pH up to about 10. The high pH renders the environment useless for the re-colonization of the bacteria responsible for the acid generation, since they cannot tolerate high pH conditions. This program has reduced the rate of corrosion and deterioration in the sewers allowing for additional time until rehabilitation is needed.

Capital Expenditure

Out of the City's commitment to protecting the public health and safety, and preserving the environment, more than $700,000 have been expended on improving the collection system over the last 10 years. In addition, more than $1.3 billion is currently being budgeted over the next 10 years solely for upgrading and meeting the needs of the collection system.

Preliminary Treatment

Sewage gravity flows down five main sewers into the plant. The influent sewers range in size from 48 inches to 144 inches in diameter. Each influent sewer has its flow measured by a Venturi meter. The sewers are combined in a common channel upstream of the Headworks Facility. The pretreatment process involves the removal of large size solids and grit from the influent by eight mechanically raked bar screens and six aerated grit basins.

Four bar screens are required for normal operation while the other four serve as standby in dry weather. All eight barsrceens are needed to handle wet weather peak flow of 850 MGD. Each barscreen is equipped with isolation sluice gates for maintenance purposes, and a dedicated dewatering pump system has been provided to dewater each barscreen. The barscreens run their rakes continuously while in service.

There are six aerated grit basins downstream of the bar screens. They are rectangular in shape. A minimum of four is required but typically five or six are in service if available. About 7,500 lbs of grit and screenings are transported to a sanitary landfill daily. The pre-treated effluent is then distributed by hydraulic gates and metered to the four primary sedimentation batteries. Venturi meters are the flow measuring device.

Daily peak dry weather flow is 450 MGD. Low flow is about 150 MGD. The plant peak lasts for 12 hours. The peak is attenuated and stretched due to the large size of the collection system. Flow typically takes 0 to 48 hours to reach Hyperion.

Primary Treatment

The primary treatment system consists of 12 large and 12 small rectangular primary sedimentation tanks, organized into four batteries. Three of the batteries have four large tanks each, and one has the 12 small tanks (which are the equivalent of four large tanks). The large tanks are 56.5 feet wide, 15 feet deep and 300 feet long, and the small tanks are 20 feet wide and have the same depth and length as the large tanks. All of the tanks are covered.

Each tank is equipped with chain and flight mechanisms that transport settled sludge to a sump at the head of the tank and grease and other floatables to the opposite end. . There are three long collectors in each of the large tanks. The long collectors scrape the sludge to a cross collector, which moves the sludge to a withdrawal sump. The small tanks contain one long collector that's moves the material to two sumps. The chain and flight collectors are a mix of traditional iron and redwood and modern plastic

The raw sludge, grease, and other floatables are then removed from the tanks and conveyed to the anaerobic digesters while the primary effluent enters the reactors of the secondary treatment process. Recessed impeller centrifugal pumps withdraw the sludge from the 12 large tanks based on a timer. The sludge blanket is manually measured every four hours, and the pumping time is adjusted to maintain a blanket target set point. The blanket measuring location is at the head end of the long collector. The 12 small tanks are equipped with two diaphragm pumps that continuously withdraw the sludge from the hoppers. The number of strokes per minute is adjusted to maintain a blanket target. The City has found that maintaining a 20 to 40-inch deep sludge blanket in the long collector can yield a 4.0 percent dense primary sludge pumped to the Digesters. Therefore, this has eliminated the need for any Primary Sludge Thickening unit process.

Only three of the four primary batteries are tied to the Secondary system. One primary battery discharge flows dirctly to the plant outfall system. The three batteries that feed the secondaries are operated 24 hours a day and have the flow evenly distributed to them. The one battery that does not feed the secondaries is used as a flow balancing battery. It is only used during peak flow 9about 18 hours a day). During this period of time plan flow is split evenly among all the batteries. During low flow hours flow to this battery is shut off to maximize secondary flow.

The Hyperion Treatment Plant utilizes Advanced Primary Treatment to maximize primary treatment removal efficiencies. In Advanced Primary Treatment, chemicals are added to the influent sewage to facilitate the removal of settleable solids. At Hyperion Treatment Plant, ferric chloride followed by an anionic polymer solution is injected into the influent to facilitate coagulation and flocculation of solids. The ferric chloride is injected upstream of the Headworks, and is flocculated in the Aerated Grit Basins. The anionic polymer is injected just upstream of the Primary venturi meters to ensure good dispersion without needing to build any flocculating basins.

During 1995 and 1996, the Hyperion Treatment Plant maintained “best in class” primary treatment despite numerous construction activities which directly impacted the section. Primary treatment performance averaged 85% suspended solids removal efficiency and 54% BOD removal efficiency for 1995 and averaged 85% suspended solids removal efficiency and 54% BOD removal efficiency for 1996. Primary effluent suspended solids were maintained at an average of 50 mg/l for 1995 and 52 mg/l for 1996 while primary effluent BOD was maintained at an average of 137 mg/l for 1995 and 130 mg/l for 1996. The Design Surface Overflow Rate is 1,600 GPD/Sq. Ft., and has worked well up to 2,400 GPD/Sq. Ft. The removal efficiencies without chemical addition were 65 to 70 percent TSS and 35 to 40 percent BOD.

The main reason for the high performance of the Primary Tanks is their deep depth and long length. It has enabled the tanks to yield high removal efficiencies at very high SOR’s that are well above normal design standards. The basic design was done in 1947, and was revolutionary for its time.

Secondary Treatment

The primary effluent is pumped into the secondary treatment by the Intermediate Pump Station (IPS). Flow is combined from three of the four primary batteries to feed the IPS.

The IPS consists of ten Archimedes Screw Pumps. The pumps are 144 inches in diameter, rest on a thirty-degree incline with the horizontal, and lift the wastewater 15 feet. Each pump has a rated capacity of 125 MGD. Only two pumps are in operation at this time. The remainder are on standby until completion of the HFS project. Four pumps will be needed at peak flow in dry weather conditions, and up to eight in peak wet weather flow conditions.

Hyperion is a partial secondary treatment plant. This allows the secondaries to operate on an almost constant flow basis. The low flow period of 150 MGD lasts for only four hours. The rest of the time plant flow is over 200 MGD. This allows for very stable treatment conditions.

The last two years have been a challenging and historical period for Hyperion's secondary treatment process. In 1995, the first phase of Hyperion Full Secondary project was brought on line, and the old 1950 aeration tanks and rectangular clarifiers were decommissioned. This phase includes a High Purity Oxygen Activated Sludge (HPOAS) process comprised of an air compressor facility, air purification and three oxygen generation cold boxes capable of producing 765 Tons per day of Oxygen, followed by four (4) Secondary Reactor Modules with a total of sixty (60) draft tube mixers and sixteen 150 feet diameter circular clarifiers. Each Module is designed to handle 50 MGD of flow. Upon the completion of the second phase (total of nine reactor/ clarifier modules), the facility will have a design capacity of 450 MGD of primary effluent.

Since early 1995, Hyperion's secondary effluent has been reclaimed for industrial use and groundwater intrusion barrier injection, which requires continuous production of high quality/ low turbidity effluent. During start up, plant employees had to come up with innovative process changes to obtain acceptable effluent quality. Hyperion Secondary system during this period was run at a high rate system with a MLSS of 1000 to 1300 mg/l range and a mean cell residence time of 1.2 to 3.0 days with a end Dissolved Oxygen of 10-20 mg/l. All start up activities were carried out by city 's staff and like any other start up there were several challenges problems that had to overcome by staff. In particular, resolving severe foaming (Nocardia) problems during the start up was extremely challenging. Different Mixed Liquor Suspended Solids (MLSS), dissolved oxygen (DO) concentrations and Mean Cell Residence Time (MCRT) were tried to eliminate the massive thick and dark brown foam from the surface of the clarifiers. Comprehensive DO and Carbon Dioxide tests were performed to identify the cause of the problem. It was concluded that over-oxygenation due to prolonged detention time (DT) in the reactors was adversely affecting the foam formation and the effluent quality. Adjustments were made and one train of each reactor module was removed from service. As a result, the DT in the reactors was reduced by one third, which contributed towards better sludge settleability. This process optimization helped save in excess of $300,000 in electrical costs due to retiring of a total of twenty (20) 125 and 75 hp mixers.

Presently, the HPOAS process generates high quality effluent and with removal efficiencies of greater than 75% for suspended solids and BOD. Hyperion Secondary effluent flow has been increased to over 55% of the total plant flow during the past two years.

Tertiary Treatment

Hyperion Treatment plant does not provide Tertiary treatment however plant supplies Secondary treated effluent to West Basin Municipal District for tertiary treatment. Also the plant has a Service Water Facility where plant effluent is screened, filtered and chlorinated for in-house as well as irrigation purposes.

Sludge Thickening

Hyperion does not have any primary sludge thickening facilities
At the WAS Thickening Facility, three Dissolved Air Flotation Tanks (DAFT) and four thickening centrifuges are used to thicken Waste Activated Sludge from 0.5% leaving secondary treatment to 5% entering anaerobic digesters. Polymer is added to both DAFT and centrifuges to enhance process performance.

In 1997, capacity of DAFT was maximized to treat all wasting sludge from secondary treatment to save electricity and manpower. The centrifuge facility was on standby mode in 1997.

Digesters

The anaerobic sludge digestion process treats sludge and scum from both primary sedimentation tanks, and waste activated sludge from secondary treatment. The facility includes eighteen high-rate mesophilic digester tanks of 2.5 million-gallon capacity. The digester tanks are continually mixed with gas mixing compressors and are heated to 95 degrees Fahrenheit by direct steam injection. Sludge has been digested in a two-stage process (4 tanks as first stage and 2 as second stage in each battery) since modifications were implemented in 1994. The two-stage digestion process has been utilized to reduce pathogen and vector attraction to biosolids that are directly land applied. The two-stage process has reduced pathogens from a monthly average of 2.1 million MPN/gTS to 0.5 MPN/gTS as measured specifically by the fecal coliform count. Average fecal coliform count in 1996 was 413,000 MPN/g.

Since 1995, heavy construction has been in progress as a part of Hyperion Full Secondary /Digester Expansion Project. One of the elements of this $168 million contract provides for the construction of twenty digester tanks to meet the anticipated increase in TWAS and the community population growth estimated for the year 2010 per our Facilities Plan. This magnitude of construction has brought significant challenges while conducting daily operations. Some of these challenges include process disruptions and shutdowns, power shutdowns, temporary rerouting of piping, street closures, and alternate routing of biosolids hauling trucks.

Despite these challenges, the sludge digestion process has managed to operate above a 15-day detention time and achieve an average Volatile Solids destruction rate of 57% in

1996 (total solids destruction rate was 46%). In 1995, the average Volatile Solids destruction rate was 58% with a total solids destruction rate of 45%. Digester gas consisting of 64% methane was produced at an average rate of 6.7 MCFD in 1996 and 1997. The gas produced in the digestion process is used to generate the steam required to heat the sludge to the desired temperature and to generate electricity to be used to power other equipment within the plant.

Cleaning digester tanks contributes to the optimization of gas production and maximizes tank volume to meet the 15-day detention time process requirement. Digester cleaning is a routine operation at the plant. The tanks are rotated out of service for cleaning to recapture an average of 20% tank volume loss due to grit build-up. In 1996-97, nine of the eighteen tanks were cleaned. In the beginning of 1995, all digesters had been in service an average of 42 months. By the end of 1997, the average digester tank in-service time had been reduced to 31 months. The aggressive digester cleaning program not only prevented the further volume loss but it also increased the digestion system active volume by 5%.

The Digester Expansion Project includes eighteen anaerobic digester tanks and two blending tanks (flow equalization tanks). The new tanks are egg-shaped, 2.5 million-gallon capacity and are operated in two-stage mode. These high-rate digesters are continually mixed with mechanical mixers and are heated to 95 degrees Fahrenheit by direct steam injection. The two blending tanks (Flow Equalization Tanks) receive digested sludge from both old and new digester systems and stabilize flow between the digester and dewatering facilities. All eighteen new digesters and the blending tanks are currently under construction. The addition of eighteen new digester tanks will increase the Hydraulic Detention Time (HDT) to 25 days. The increase of the HDT should increase the Volatile Solids Destruction (VSD) rate, and increase gas production. The increase in VSD should also reduce the solids processing cost down stream of the digesters

Dewatering

At the Biosolids Dewatering Facility, 12 small Ingsersoll-Rand centrifuges and three Humboldt centrifuges that are equipped with polymer addition system were utilized to dewater anaerobically digested biosolids.
In 1996, three new dewatering centrifuges were installed as Centrifuge Expansion Phase-I project. With the help of these newly installed centrifuges, Hyperion achieved cake concentrations of 27%, and significantly reduced off-site hauling costs. Parallel efforts in negotiating lower polymer cost and biosolids reuse contracts have resulted in $8.0 million yearly savings as compared to our initial solids handling budget back in 1987.

Biosolids

During FY 96/97, Hyperion Treatment Plant (HTP) maintained their award-winning 100% beneficial reuse program of managing biosolids in an environmentally, economically and socially acceptable manner. Responses to Request for Proposals (RFP) that were received in Ju1y, 1996 showed the lowest reuse cost ever at $17.95/WT which brought down our average cost to 20.00/WT.

Of the 269,682 WT (wet ton) treated biosolids produced in FY 96/97 at HTP, 253,799 WT (94%) were used for agricultural land applications; 15,883 WT (6%) for composting. The on-site, Hyperion Energy Recovery System (HERS) processed only 196WT before it was placed on stand-by status due to economic reasons.

Land Application

Responsible Biosolids Management (RBM) of Kern County began land application of biosolids to desert land in October 30, 1996. The biosolids have greatly enhanced the growth of cotton, barley, hay, alfalfa and Sudan grass. During FY 96/97, RBM hauled a total of 67,081 WT from HTP at a cost of $1,266,757.

Wheelabrator Clean Water System (WCWS) of Riverside County has been applying biosolids into farming land in Riverside and Kern counties and Blythe, Arizona since June 1989. During FY 96/97, 58,019 WT from HTP were hauled to various sites and used to grow alfalfa, forage oats, feed and dry land wheat. The cost of application at the WCWS sites was $1,180,207 for HTP.

Land application by Gardner-Arciero (GA) of Kern County began on February 1994. During FY 96/97, a total of 128,699WT were applied to farms at a cost of $2,576,088. Forage mix, Sudan grass, alfalfa, feed oats and Sudan hay are some of the crops grown by these farms.

Composting

San Joaquin Composting Company (SJC) began biosolids composting in December 1990 at its 60-acre site in Lost Hills, California. On January 13, 1994, the operation was expanded to 80 acres. Biosolids are composted in windrows with turkey manure, sawdust, cotton gin wastes, almond trash and City-collected yard trimmings. The final compost product is marketed to agricultural and horticultural landscapers and retail outlets throughout the western United States. Yard trimmings that are collected from City residents are also composted with City biosolids by SJC to produce nutrient-rich organic compost called TOPGRO. Local retail outlets such as Fedco and Armstrong's Home and Garden Place are currently selling this City trademarked product. It is also available to landscapers, distributors, nurseries and City agencies such as the Tillman Japanese Gardens. During FY 96/97, a total of 15,037 WT of biosolids was composted at a total cost of $472,261.

A City owned and operated composting facility located in the heart of the City's largest park began operations in 1996. Green materials, zoo manure generated by park facilities and biosolids were composted in aerated static piles. The finished compost was used in the park for landscaping and soil conditioning. In FY 96/97, the Griffith Park Composting facility composted 846WT of biosolids.

Odor Control

Under the Hyperion Full Secondary and the Hyperion Solids Handling Capital Improvements Programs, the foul air from every process area within the Plant is collected and ventilated through odor control systems for treatment and release of clean air to atmosphere. These systems include covers or collection hoods over process equipment, fiberglass ductwork and ventilation fans that force the foul air through packed tower chemical scrubbers and/or activated carbon towers.

Twenty-four (24) packed tower chemical scrubber systems are in operation. These systems consist of a fiberglass reinforced plastic vessel containing plastic media in a vertical orientation, known as a countercurrent flow arrangement. The odorous air moves upward, in the opposite direction to the scrubbing liquid, which moves down through the inert packing material. The packing material provides significant surface area for air/liquid mixing, and this is where the chemical reactions between the scrubbing liquid, (sodium hypochlorite, sodium hydroxide and water), and the foul air, (predominately hydrogen sulfide) take place. The packed tower chemical scrubbers are periodically cleaned with hydrochloric acid to remove the carbonates and sulfur that can precipitate out onto the packing media.

The seventeen (17) carbon adsorption towers are usually in series as the second stage of a packed tower chemical scrubber system. The foul air or residual air from the packed tower scrubber passes through the activated carbon bed, and any odorous compounds are adsorbed into the pores in the carbon surface. The adsorption capacity of the activated carbon diminishes in proportion to the amount of sulfides or other organic odors adsorbed. When the carbon becomes saturated, odor breakthrough occurs, and the carbon must be replaced.

Hyperion also utilizes various chemicals, ferric chloride and ferrous chloride, in specific process area to enhance treatment that also have the benefit of reducing hydrogen sulfide emissions. Hyperion does not differentiate the cost of these chemicals between process enhancement and odor control. The ferric chloride is added at the aerated grit basins of the Headworks to aid in coagulation of suspended solids for enhanced removal in primary treatment. The ferrous chloride is added to the primary and waste activated sludge prior to anaerobic digestion to prevent struvite (Magnesium Ammonium Phosphate) formation in the digested sludge piping, (a metallic precipitate that hardens like concrete in pipes), and reduce hydrogen sulfide concentrations in the digester gas prior to combustion.

Hyperion also utilizes an odor neutralizer spray system for surface coating of the grit from the Headworks and the Digester Screening Facility. The grit material is spread on a small grit pad, covered with lime and continuously sprayed with a fine mist of odor neutralizer and water as it is allowed to dry. This material is then conveyed to a landfill.

Disinfection

Hyperion does not disinfect its wastewater discharge into the Pacific Ocean in Santa Monica Bay. The plant outfall (discussed in the next chapter) was designed in 1957 is such a way as to place the plant effluent at a depth of 170 feet five miles offshore. This allows the cold salt water of the ocean to kill off the freshwater bacteria without the need to use disinfectants before the bacteria has a chance to wash onto the beaches. Also, the outfall discharges the plant effluent under the ocean thermocline. This prevents the bacteria from rising to the surface for most of the year. The thermocline is caused by the Sun warming the upper water layer of the ocean. The water becomes less dense. The water under this layer is not warmed by the Sun, and stays quite cold and is denser. The thermocline is the name for the warm water/cold water interface that is an actual barrier to water and bacteria circulation. The main outfall takes advantage of this effect to allow the plant to use no disinfectant.

In the event of trouble with the Effluent Pumping system, an older (1950) One-Mile Outfall is available to supplement the gravity capacity of the main outfall. It requires the use of disinfectant. Sodium Hypochlorite is used. The outfall was not used in 1996-97 other than for regular functional testing of the bypass gates.

Effluent Pumping/Outfall

After clarification, secondary effluent is discharged into Santa Monica Bay through a five mile submerged outfall pipe. Flow is pumped during daily diurnal peaks above 325 MGD and flows by gravity the rest of the day. Five effluent pumps, each with a 180 MGD capacity, are available for use with a peak wet weather capacity of 900 MGD. Each pump is a 2,500 h.p. adjustable frequency pump. The pumps run on off of level control in their wetwell. The outfall is five miles long, and discharges to a wye shaped diffuser structure at a depth of 170 feet. The diffuser structure is 4000 feet long,

In the event of a partial or total pump or power failure, a One-Mile Outfall is used to provide enough gravity flow capacity of the Five-Mile Outfall to get all plant flow out of the plant. The One-Mile Outfall has a capacity of 600 MGD, but requires disinfection as its discharge point will allow bacteria to wash onto the beach.

Utilities

Hyperion has a fresh water supply system that has three separate loops. There is a fresh water loop for bathrooms, sinks and locker rooms, one for the fire protection water, and one for industrial water purposes. This is to minimize cross connections at the plant. All of the loops are tied to an Air Gap Facility that has a reservoir of 320,000 gallons split into four 80,000 gallon cells. Three different sets of pumps feed each separate loop. The fresh water is supplied by the City's Department of Water and Power.

There is a reclaimed water, or plant effluent loop. This provides so-called "high pressure effluent (HPE) which is used to conserve fresh water. The main uses are for washdown, cooling, chemical dilution and pump seal water.

Instrument air is set up in a common loop. One set of instrument air compressors draws off ultraclean cryogenic molecular sieve air and supply it to the entire plant. Each plant section has its own backup set of instrument air compressors.

Automation

The plant has several different levels of automation based on the age of the plant. The HFS is designed around using a Distributed Control System (DCS) to handle the process. The plant has each equipment capable of local control, and the equipment is tied to the DCS. Control logic resides in area Data Processing Units (DPU) and is tied by a data highway into an integrated system. Set points, monitoring and alarms can be monitored and adjusted at the control rooms that house the DCS Operator Interface Stations (OIS) The plant has two different systems. A Bailey Infi 90 DCS is used in the HFS liquid part of the pant, and is still under construction. A Westinghouse WDPF is used in the solids handling areas built in 1986 when the plant modernized its solids handling process areas. The systems will be tied to the DEC VAX cluster for administrative data collection. Ethernet is used as the communication links. Several older unmodernized portions of the plant still use the 1950 manual hard-wire control system.

Power/Energy

The plant used to have onsite cogeneration facilities that provided for 90 percent of the plant's 19 MW power demand. With the completion of a new contract with the plant's power provider, the City Department of Water and Power, a significant change has been made to how Hyperion operates its cogeneration system.

The new power pact allows Hyperion to export all of its digester gas to an adjacent City Department of Water and Power steam generation station. The plant buys power at the rate of 1.3 cents per kilowatt-hour for each 10,560 cubic feet of digester gas exported. Any remaining power can be purchased at $5.6 cents per kilowatt-hour. There are no peak, demand, or facility charges in the contract. Hyperion essentially buys power at a flat rate. This cost is significantly lower than what the plant's cogeneration facility can produce power for, so the cogeneration facility has been shut down and placed in a standby mode. This has allowed the plant to see tremendous costs savings on its O&M and Capital budgets for not needing any cogeneration facilities.

The plant buys Natural Gas to fire steam boilers that provide steam to heat the digesters. It is cheaper to buy Natural Gas than to use Digester Gas and not sell the Digester Gas for cheap electricity

Hyperion Information

I.) HAS Information

Population served		4,000,000	
Area served:		600 Square Miles	
Sewer Line Length		6,500 Miles	
Trunk lines into HTP		5	
Name	Size	Year Built	Type
NOS	12’ by 10.5’	1925	Semi-Elliptical Concrete Pipe
COS	4’	1908	Circular Brick Pipe
NCOS	12’	1957	RCP w/Plastic Liner
CIS	6’	1971	“
NORS	12’	1993	“

Plant Area 144 Acres

III.) Preliminary Treatment

Barscreens

Type	Climber Type
Number	8 (2 more can be added)
Bar Spacing	0.75 In.
Design Capacity	100 MGD

Grit Chambers

Type	Aerated Grit Basins
Number	6
Dimensions	150 Feet L x 22.5 Feet W x15 Feet D
Design Capacity	167 MGD

Primary Treatment

Type	Rectangular Clarifiers
Number	12 Large & 12 Small
Dimensions	300 Ft L x 56.5 Ft W x 15 Ft D (3 more under construction) 300 Ft L x 18.5 Ft W x 15 Ft D
SOR	1310 GPD/Sq. Ft.
Detention Time	1.8 Hours
Removal Efficiency	80-85 % TSS, 50-55 % BOD
Sludge Density	4.0 % TS

V.) Secondary Treatment

A.) IPS

-10 Archimedes Type Screw Pumps
-Size 12 Ft. W @30 Degree Incline to Horizontal;
-Capacity 125 MGD each
-Motor Size Constant Speed 600 h.p.

B.) Secondary Reactors

Type	Pure Oxygen
Flow treated (96/97)	160-200 MGD
Number of reactors	Four
Number of Mixer on each train	Five
Number of stages	Four (First is doubled-sized)
Number of trains	Three
Length of each train	54 Ft
Width of each train	54 Ft
Depth of each train	30 FT
Water depth	25 FT
BOD loading	130 mg/l
F/ M	0.80-1.2
MCRT	1.2-2.0 days
SVI	100 –150 ml/g
System Detention Time	6.0 hrs
MLSS	1000-1300 mg/l
%VS	85 %
Oxygen supply	150 tons /day

Secondary Clarifiers

Type	Center feed -Circular
Number	16
Diameter	150 Ft
Average depth	16.50
Overflow rate	700 GPD/ft^2
Detention time	3.50 hrs

RAS pump type	VFD Centrifugal
Number of RAS pumps	24
Capacity of each pump	0-12 MGD @ 250 HP

D.) Cryogenic Oxygen Plant

No of air compressors 5

Size of each compressor		4200 HP
No. of Mole sieves		Two sets
No. of Cold boxes	Three	
Capacity of each cold box	250 Tons/day	
No of LOX storage tanks	Two	
Size of LOX tanks each	320,000 Gallons	
Side products		LOX, LIN,GAN

E.) Service Water Facility

No. of low lift pumps	Seven	
No. of basket screens		Ten
No. of pressure filters		Four
No. of HPE pumps		Five @ 125
Size of HPE pump		150 HP
No of cooling water pumps		Eight
Total Flow treated	8-35 MGD	

F.) Effluent Pumping Plant and Submarine Outfalls

No. of pumps available	Five @ 180 MGD
Speed	0-2500 HP
Miles pumped to the Ocean	Five

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VI.) Anaerobic Digestion

A.) Old Digesters

-18 Cylindrical Digesters (American Conventional)
-Dimensions 110 Ft. Diameter x 30 Ft D
-Capacity 2.5 MG
-Mesophilic Operation @ 95 Degree F with Direct Steam Injection
-Mixing with Digester Gas Compressors
-Two Stage Digestion; Stage One 10 Days, Stage Two 5 Days
-Solids Destruction 51%, Volatile Solids Destruction 61.5%
-Sludge Feed 500 Tons/Day (10% TWAS)
-Gas production 15 Cu Ft. /Lb. VS Destroyed

B.) New Digesters (Under Construction)

-18 Modified Egg Shape Digesters, two surge/storage tanks
-Dimensions 110 Ft. Height x 85 Ft. Wide @Belt
-Capacity 2.5 MG

-Mesophilic Operation @ 95 Degrees F with Direct Steam Injection
-Mixing with mechanical mixer through Draft Tube
-Two Stage Digestion

VII.) Dewatering and Truck Loading

A.) Dewatering

- Solid Bowl, Continuously fed Centrifuges
-Feed Rate- Dice-I 3x600 gpm; Dewatering 3x500gpm, 12x125 gpm
-Feed Density 2.0 %

B.) Wet Cake Storage and Truck Loading

-Eight Wet Cake Storage Silos
-Capacity 300 tons
-Eight Truck Loading Silos
-Capacity 150 tons
-Four Loading Bays with Rate of 60 Trucks/Day
-Current Trucking about 30-35 Trucks per day

VIII.) On-Site Biosolids Processing (Placed in Standby Mode)

-Two Steam Dryers

IX.) Biosolids Combustion (Placed in Standby Mode)

-Three Fluidized Bed Combustion Burners

X.) Cogeneration (Placed in Standby Mode)

-Four Gas Turbines @4 MW Each.
-One Condensing Steam Turbine @15 MW
-One Non-Condensing Steam Turbine @0.250 MW

XI.) Auxiliary Processes

A.) Gas Handling
-Five Intermediate Pressure Compressors
-Two H2S LO-CAT Gas Phase Scrubber
-Three High Pressure Gas Compressors

Odor Control
24 Packed Tower Scrubbers utilizing NaOCl and NaOH
17 Activated Carbon Towers utilizing virgin activated carbon
Odor Neutralizing System at the Grit Pad

The foul air is ventilated and treated through the scrubber systems from the following processes:

Influent Sewers - Digester Screening Facility
Headworks Facility - Biosolids Blending Tanks
Primary Clarifiers - Biosolids Storage Facility
HPOAS Reactors - Biosolids Truck Loading Facility
Intermediate Pumping Station
Digester Gas Desulfurization Facility Oxidizer Tanks
The Scrubber Systems range in capacity from 960 -50,000 cfm (cubic feet per minute) each.

Donald C. Tillman Water Reclamation Plant

General and Plant Process Description

The Donald C. Tillman Water Reclamation Plant occupies 55 acres in the Sepulveda Flood Control Basin

Utilizes conventional activated sludge with filtration, chlorination, and dechlorination

Design flow 80 MGD, average daily flow of 65 MGD

All solids returned to AVORS sewer for processing at Hyperion Treatment Plant

Collection System

Service area; majority of San Fernando Valley

60% residential, 20% commercial, 10% industrial and 10% institutional

Population served: 1,000,000

Headworks and Influent Pumping

Eight 32 MGD capacity screw pumps with inlet gates

Seven enclosed 44 MGD capacity climber screens with 60 MGD capacity magmeters

Preliminary Treatment

Four 1.4 MGD capacity grit pumps which return flow to AVORS sewer

Primary Treatment

Eighteen 200ft x 20ft x 12ft deep rectangular covered tanks with submerged launders using plastic chains

Average surface overflow rate 1100 gpd/ft2

Detention time 1.94 hours

0.6 MGD raw sludge returned by gravity flow to sewer
Helical skimmers at outlet end of tanks; scum returned to sewer
Nine 200ft x 20ft x 12ft deep rectangular covered Flow Equalization Tanks

Secondary Treatment

Aeration:
Plug flow, fine bubble
Eighteen 300ft x 32ft x 16ft deep rectangular tanks
Detention time 3.2 hours
Average surface overflow rate 640 gpd/ft2
MLSS 930 mg/L
RASS 3040 mg/L
Phase II MCRT = 4.3 days
Testing for nitrification/denitrification in Phase I recently initiated
RAS sometimes chlorinated for filament control
MCRT Phase I = 107.6 days

Secondary Sedimentation Tanks:
Forty-four 150ft x 20ft x 12ft deep partially-covered rectangular tanks
Detention time 2.2 hours
V-notch weirs with plastic chains
RAS withdrawn from effluent end of tank
Six RAS pumps
Intermittent chlorination of RAS as needed
Average surface overflow rate 605 gpd/ft2

Tertiary Treatment

Rapid Sand Filtration:
Sixteen 110ft x 16 ft x 3ft deep automatic backwash filters
Intermittent chlorination as needed
Polymer addition prior to filtration

Odor Control

Foul air is evacuated from the Headworks, Channels 1 and 2, Primary Tanks, Flow Equalization Tanks and Grit pump rooms and is delivered into the plenum chamber of the Process Air Compressors

In addition, odor neutralizer is dispersed in the Headworks and Channels 1 and 2 for additional odor control

Disinfection

Chlorine Contact Basins

Four chlorine contact basins, thirteen 120ft x 10ft x 16ft deep bays

Detention time 2.3 hours

Chlorine dose 7.2 mg/L

Permit limits coliform organisms greater than 23 per 100 milliliters to one sample per month; median number 2.2 per 100 milliliters; chlorine residual in receiving waters not to exceed 0.1 mg/L

Evaporators/Chlorinators

Four 10,000 lbs/day capacity evaporators

Nine chlorinators; numbers 1 and 5 with a 2,000 lbs/day capacity, numbers 2-4 and 6-9 with a 6,000 lbs/day capacity

Two 17 ton chlorine storage tankers

Evaporators/Sulfonators

Four 10,000 lbs/day capacity evaporators

Four sulfonators; numbers 1 and 2 with 9,500 lbs/day capacity, numbers 3 and 4 with 7,600 lbs/day capacity

Two 23 tons sulfur dioxide storage tankers

Effluent Pumping/Outfall

The Effluent Pumping Station includes HPE, LPE, and JGF lake supply pumps

Currently 2 additional pumps supply 15 MGD of product water to Balboa Lake

A future pumping facility will supply product water near Hanson Dam for ground water recharge

Utilities

Potable water is provided to all buildings and emergency showers throughout the Plant

Plant product water is used for all Plant O&M, fire hydrants and Plant grounds irrigation

Gas used for heating and cooling

Plant is a core commercial feed from Southern California Gas Company

Automation

A distributed control system (DCS) means that various areas of the Plant have their own remote termination units (RTU) that receive their programming from a central unit, control their own area locally and pass data along to the central unit for historic storage and to operator stations (OPSta) where the data can be reviewed and controlled

Plant control is normally monitored by one operator from the Plant Control Room

Power/Energy

Dual redundant power feed of 4160 volts with auto switching and load shedding capability from separate sources to minimize power outages

A 2400 HP 1600 KW emergency generator is installed to operate one screw pump, one process air compressor and other necessary equipment to maintain a minimum flow through the Plant

Terminal Island Treatment Plant

General and Plant Process Description

The Terminal Island Treatment Plant (TITP) is located on Terminal Island in the Los Angeles Harbor area at the northwest corner of Terminal Way and Ferry Street. The plant site plan is shown in Figure 1 and the process flow diagram is shown in Figure 2. The plant is designed to treat an average dry-weather flow of 30 mgd and a peak dry-weather flow of 55 mgd. Treatment of the wastewater influent from four active forcemains includes influent screening, grit removal, primary sedimentation, aeration, final sedimentation and filtration. The plant effluent either flows by gravity or is pumped through a 60-inch diameter outfall into the outer Los Angeles Harbor. Solids removed from the treatment process are digested, dewatered, and reused offsite as a soil amendment to grow crops that are not directly eaten by humans and as an organic ingredient in the production of compost. **Because of receiving water standards, no effluent disinfection is practiced**. In 1997, the average flow, suspended solids and BOD5 for the TITP influent were 16.2 mgd, 185 mg/L, and 193 mg/L, respectively.

The TITP service area consists of the City of Los Angeles portion of the heavily industrialized Terminal Island in the Los Angeles-Long Beach Harbor plus the communities of Wilmington, San Pedro and a portion of Harbor City. This area is located approximately 20 miles south of downtown Los Angeles. Being geographically isolated from the rest of the City, the area requires a separate collection, treatment, and disposal system. The present land use of the service area is classified as 44 percent residential, 47 percent industrial, and 9 percent commercial. Terminal Island is zoned for heavy industrial use and is the location for several federal facilities, a prison, the Coast Guard, and the Customs House. Oil wells and docking and storage facilities are predominant among the private industrial uses of the land.

In Wilmington, about 58 percent of the land is zoned heavy industrial while only 37 percent is zoned for residential use. The remaining 5 percent is commercial zoning. The San Pedro community is zoned 20 percent industrial, 66 percent residential, and 14 percent commercial. The heavy industrial zoning reflects the need for land to accommodate port-oriented activities, oil production, and petroleum refining facilities.

Currently the major industrial users that contribute to the industrial loading into TITP are Tosco Corp (oil refinery), Heinz Pet Products, Tri-Union International (cannery), Juanita's Foods, U.S. Borax Inc (boron manufacturing).

Table 1 presents the design data and loadings for each of the unit processes discussed below.

Table 1. TERMINAL ISLAND TREATMENT PLANT
DESIGN DATA AND LOADINGS

Item	Value
BASIC DATA	
Design Population	136,000
Design Flow, mgd	30
BOD Loading, lbs/day	80,000
SCREENING	
Type	Bar w/Rakes
Number of Machines	2
Hydraulic Capacity, mgd/each	30
GRIT CHAMBERS	
Type	Aerated
Number	2 (plus 1 w/o rakes)
Width, ft	10
Length, ft	61
Depth, ft	10
Overflow Rate, gpd/sqft (Dry Maximum) (2 chambers)	45,100
Detention Time, min (Dry Maximum) (2 chambers)	2.36
PRIMARY SEDIMENTATION TANKS	
Number	6
Length, ft	250
Width, ft	20
Average Water Depth, ft	11.9
Overflow Rate, gpd/sq ft (Average)	1,000
Detention Time, hrs	2.16
AERATION TANKS	
Type	3-pass Step and Conventional
Number	9
Length, ft	300

Width, ft	30
Average Water Depth, ft	15
BOD (applied), lb/day	65,150
F:M, lb BOD/lb MLVSS	0.25

Table 1. (Continued)

Item	Value
SRT, hrs	5.5
MLSS, mg/l	3,000
MLVSS, mg/l	2,400
Air Supply, cu ft/lb BOD	1,740
FINAL SEDIMENTATION TANKS	
Number	18
Length, ft	**150**
Width, ft	20
Average Water Depth, ft	12
Overflow Rate (Average), gpd/sq ft	555
Detention Time, hrs	2.90
RAS, mg/l	5000
SECONDARY SLUDGE PUMPING	
Number of RAS pumps	3
Type	Vertical, centrifugal
Capacity each @ 26 ft, gpm	19000
Number of WAS pumps	1
Type	centrifugal
Capacity,gpm @ 40 ft	600
FILTRATION	
Type	Tri-media
Number	16
Length, ft	60
Width, ft	10
Filtration rate, gpm/sq ft	
Minimum Design flow (5 mgd)	2.0
Average Design Flow (30 mgd)	2.9
Maximum Design Flow (50 mgd)	5.0
Media Depth	
Gravel, in	18
Sand, in	22
Anthracite, in	20
SLUDGE THICKENER (Waste Activated Sludge)	

Type	Dissolved Air Flotation
Total Area, sq ft	1,194
Solids Loading, lb/hr/sq ft	1.27
Diameter, ft	40
Depth (side water), ft	9.3

Table 1. (Continued)

Item	Value
Detention Time, hr	1
Tank Capacity, gal	83,327
Polymer Dosage, lb/ton	5
WAS THICKENER PUMPS	
Type	air diaphragm
Number	2
Capacity,gpm each @ 45 ft	180
Required air, cfm @ 85 psig	90
SLUDGE BLENDING (Raw Sludge)	
Diameter, ft	40
Depth (side water), ft	15
Total Area, sq ft	1,256
Tank Capacity, gal	140,995
Sludge Storage Time,hr	13.1
BLENDED SLUDGE PUMPS	
Type	centrifugal
Number	2
Capacity, gpm @ 127 ft	75
DIGESTION (Anaerobic)	
Number (egg-shaped)	4
Diameter, ft	65.4
Side Water Depth, ft	98
Total Volume (each), cu ft	183,663
Unit Solids Loads, lb/VSS/cu ft	0.10
Temperature, degree F	over 95
Detention Time, days	over 16
Flow, gpd	150,000
Dry Solids in Feed Flow, %	4.3
Mixing System	
Sludge Recirculatation Pumps	
Number	4
Capacity, gpm	500
Horsepower	60

Gas Mixing Compressor	
Number	4
Capacity, cfm	500
Horsepower	100

Table 1. (Continued)

Item	Value
SLUDGE DEWATERING (centrifuge)	
Dry Solids, %	2.3
Polymer Dosage, lb/dry ton	20
Ingersoll Rand 280	
Number	2
Design Flow,gpm	150
Cake Solids, %	15
Sharples, high speed	
Number	1
Design Flow, gpm	300
Cake Solids, %	25
SLUDGE STORAGE	
Input, wet lb/day	90,000
Capacity, cu ft	3.430
Sludge Storage Detention Time, day	1.5
GAS STORAGE SYSTEM	
Low Pressure Gas Storage Tank (Cylindrical Single Lift)	
Number	1
Diameter, ft	40
Volume, cu ft	25,000
Maximum Pressure, in. w.c.	8
High Pressure Gas Storage Tank (Spherical)	
Number	1
Diameter, ft	40.5
Volume, cu ft	34,783
Maximum Pressure, psi	50
Capacity at 50 psi, cu ft	118,300
Sludge Gas Compressors	
Number	3
Capacity, cfm	350
Maximum Working Pressure, psi	50
Horsepower	60
POWER GENERATION AND HEAT RECOVERY SYSTEM	
Power Generating	

Engine Capacity, kw	650
Number (AQMD permits only one running engine @ 440 kw)	3
Engine Sludge Gas Fuel Consumption, cfm	130
Heat Recovery Equipment	
Waste Heat Recovery Silencer Capacity, BTU/hr	1,380,000

Table 1. (Concluded)

Item	Value
Lube Oil Heat Exchanger Capacity, BTU/hr	330,000
Load Shell and Tube Heat Exchanger Capacity, BTU/hr	3,375,000
Number Waste Heat Recovery Silencers	3
Number Lube Oil Heat Exchangers	3
Number Load Shell and Tube Heat Exchangers	3
EFFLUENT PUMPING PLANT	
Type	Variable Speed, centrifugal
Number of Pumps	3
Pumping Capacity, gpm each @ 29 ft	52,000
Wet Well Volume, gal	92,000
OCEAN OUTFALL	
Diameter, in	from 48, to 60, to 72
Length, ft	6,000

Collection System

Figure 3 shows the plant location, collection system configuration, and service area. The wastewater collection systems serving the area come under the jurisdiction of four separate entities: (1) the City of Los Angeles, (2) the Los Angeles County Sanitation District, (3) the Los Angeles Harbor Department, and (4) the United States Department of the Navy. Most of the area is served by the wastewater system of the City of Los Angeles.

Plant receives influent wastewater from four influent forcemains; there is no gravity influent. The active forcemains are Fries Avenue, San Pedro, Terminal Way and Navy forcemains.

Groundwater infiltration takes place in many of the sewers nearest to the Harbor shores due to the fact that most of the sewer system is quite old and reflects the type of sewer joint construction that prevailed many years ago. Groundwater infiltration appears to contribute to the high salinity of the wastewater and subsidence in portions of the area has changed the slope of sewers and created opportunities for surface inflow.

The plant sidestreams except filter backwash waste are collected at the in-plant lift station and pumped back to a channel immediately upstream of two bar screens in the headworks building. The plant sidestreams include centrifuge centrate, DAF subnatant, O&G pit subnatant, final tanks skimmings, sanitary waste, cooling water, and plant drainage. The filter backwash water is recycled downstream of the the primary tanks.

Preliminary Treatment

The pretreatment process involves the removal of large size solids from the influent by two mechanically raked bar screens. One bar screen is required for normal operation while the other serves as a standby. Flow to the screens is controlled by power operated slide gates just prior to each screen. There are three grit chamber channels downstream of the bar screens but only two are equipped with chain and bucket grit removal equipment and aeration units. Normal operation is with one channel in service and the second available as standby during wet weather flow. The screenings and the grit from two aerated grit chambers are transported to a sanitary landfill. The pretreated effluent is then distributed to the primary sedimentation tanks. About 20,000 lb of grit and screenings are disposed monthly.

Primary Treatment

The primary treatment system consists of six rectangular primary sedimentation tanks. The tanks are covered. Its inlet channel is 10 ft wide, 8 ft deep and approximately 120 ft long. The flow enters the center of the channel after passing through a 90 degree elbow downstream of the venturi tube used for metering plant flow. Flow distribution is obtained at the effluent end of the tanks by use of automatically controlled valves set to maintain water level with approximately the same degree of opening. Plastic flights transport settled solids to the inlet end of each tank while grease and other floatables are skimmed to the opposite end. The raw sludge, grease, and other floatables are then removed from the tanks and conveyed to the anaerobic digesters while the primary effluent enters the aeration tanks of the secondary treatment process. No chemicals are added since solids removal is adequate. In 1997, primary treatment removed on the average 73% of the suspended solids and 31 % of the BOD.

The raw sludge pumping routine is automatic. The standard pumping control system calls for opening the valves on each hopper (a tank has two hoppers) sequentially for one minute per valve. The pumps are set at 300 gpm. The computer control variable is the interval between the pumping sequences, which can be varied between about 15 minutes and 2 hours. However, in order for some tanks to have more sludge withdrawn than others, the pumping must be performed manually.

An oil refinery and fish processing plants are tributary to the TITP. Anticipating that crude oil or fish oil might be received from these sources, the primary sedimentation tanks were equipped with submerged launders in order that floating oil be trapped on the surface where it could be removed. Effluent is withdrawn from the primary tanks through two transverse submerged slotted launders at approximately one-half and two-third of the tank depth. The flow passes through a motorized control valve into a channel, which leads to the aeration tanks. The openings of the flow control valves are determined based upon the water level in the tank. The valves are operated by a local programmable logic controller (PLC).

Secondary Treatment

The activated sludge process involves activated sludge contact and aeration in nine aeration tanks. The stabilized organic materials are separated from the mixed liquor in 18 final sedimentation tanks. A portion of the sludge is returned to the head of the aeration tanks with the remainder going to the solids processing facilities. Current mode of operating the aeration tanks is three-pass serpentine flow. One pass is generally used for flow equalization of the primary effluent. The plant also has the option of running the tanks as single pass in a conventional or plug flow manner. Furthermore, the tanks are equipped with multiple feed port giving the ability to operate in a step-feed or contact stabilization modes. The addition of the anoxic zone is a recent development. The anoxic selector system helps reduce the amount of process air. Plant has the ability to operate the process air system either constant air control or dissolved oxygen control. Currently plant uses constant air control mode to minimize air and power demand fluctuation.

In 1991, the aeration tanks were retrofitted with fine bubble diffusers. Influent flow distribution among the tanks is difficult to achieve since the propeller meters initially installed at the entry points for the primary effluent were all disabled and removed. The only means of distributing flow is by adjusting the height of the rising stem on the slide gates.

The 18 final sedimentation tanks are divided into two batteries of 9 tanks each, arranged so that their effluent ends discharge into a common channel between the two batteries. Flow distribution is currently achieved by symmetry. The water level in the aeration tanks is controlled by two 50-foot long, 12-inch wide, broad-crested weirs discharging from a common channel into the feed channels for the final tanks. This arrangement seems satisfactory when the same number of final tanks are in operation in each battery. A manual bypass valves around the weir are used to balance the flow to the final tanks in service.

The final sedimentation tanks are arranged with their sludge hoppers at the effluent end, beneath the effluent weirs. This configuration is designed to take advantage of the natural density current that develops as the sludge separates from the water, but continues to move in the direction of the prevailing current aided by the movement of the flights (plastic). There are two hoppers per tank with sludge withdrawal piping manifolded to a common meter and control valve for each tank. A local PLC controls the rate of withdrawal. During the daytime the rate is usually set at 800 gpm per tank. The flow from each tank goes to a common header, which leads to the RAS wet well. Variable speed pumps withdraw RAS from the wet well and pump it back to the head end of each of the aeration tanks through a metered line containing a control valve operated by a local PLC. The return sludge rate is regulated to control sludge depth in the final tanks to set level. The transfer of waste activated sludge (WAS) is accomplished with a single centrifugal pump whose suction side is connected to the RAS piping. The WAS is pumped to a dissolved air flotation (DAF) unit. The pumping rate varies from 100 to 300 gpm.

Tertiary Treatment

The primary objective of filtration is the removal of suspended solids and any breakthrough settleable solids from the secondary effluent. In addition to the suspended solids removal, the filtraction provides the reduction of BOD and nutrients associated with the solids and turbidity reduction. Filtration improves the quality of the final effluent and ensures that the Plant meets the National Pollution Discharge Elimination System (NPDES) permit requirements for suspended solids (TSS - 15 mg/l for 30-day average, 40 mg/l for daily maximum) and for settleable solids (STS 0.1 ml/l for 30 day average, 0.3 ml/l for daily maximum). The filtration system also provides a necessary facility for the plant's future plans to adopt water reclamation. The facility is designed to treat an average flow of 30 MGD and a peak flow of 50 MGD and will allow for future expansion to treat an average flow of 50 MGD and a peak flow of 75 MGD.

Effluent from the secondary clarifiers flows through the extended secondary effluent channel to the filter influent wet well. As required by Title 22 of the California Code of Regulations, a coagulant is added to the filter influent. Cationic polymer, used as the coagulant, is injected into the secondary effluent as it enters the filter influent wet well. The secondary effluent is then pumped from the filter influent wetwell to an equalization channel and flows into the filters through slide gates.

Filtration is accomplished as the influent flows by gravity through a deep filter bed composed of three different layers of media where suspended solids are removed by various processes including straining, interception, implication and adsorption. Filter effluent flows through effluent channels and into a chlorine contact channel. A portion of the filter effluent is stored in the clearwell as backwash water supply.

Over time, solids collect in the filter until the head loss across the filter becomes excessive, and potential solids breakthrough occurs (filter effluent solids concentration/turbidity increases beyond an acceptable level). Also if extended time is left between filter cleanings, organic solid decomposition occurs, causing septic conditions within the filter. Accordingly, based on a maximum allowable head loss or maximum allowable time between cleanings, an individual filter is backwashed to clean out accumulated solids. The normal backwash consists of low rate pumped wash water (from clearwell) upflow combined with an air scour produced by dedicated blowers, and a high rate pumped wash water upflow. The dirty backwash water, called backwash waste (BWW), flows by gravity to the BWW tank where it is pumped to the primary influent and/or effluent channels.

To control algae growth and microorganisms in the filters, a temporary Sodium Hypochlorite facility is provided for chlorine disinfection of the filter facility and the individual filter cells. Chlorine solution is introduced into either the individual filters for shock chlorinating the filter bed or into the equalization channel to chlorinate the entire filter influent flow.

The process control strategy for the TITP filtration system are the following:

Maintain enough filters on-line to provide efficient filtration for the given flow.

Provide effective filtration as measured by the effluent turbidity.

Backwash the filters as needed to keep them operating efficiently at a filtration rate sufficient

to accept the influent flow rate.

Backwash in a manner so as not to upset media gravel or carry media over the backwash trough.

Backwash the filters as needed to prevent septic conditions from developing in the filters boxes.

Provide evenly distributed influent to all the filters.

Provide maintenance and cleaning to the influent tank, clearwell and storage tank without stopping the filtration system.

Sludge Thickening

Solids processing facilities include a dissolved air ‘flotation thickener, a sludge blending tank, anaerobic digesters, centrifuges, boiler, and power generation. Waste activated sludge is thickened by dissolved air ‘flotation and then blended with raw primary sludge prior to being pumped to two egg-shaped digesters for solids destruction and stabilization. Heat requirement of the digesters is supplied by engine generators (650 KW) fueled by methane gas, a by-product of the sludge digestion process. A boiler serves as secondary source of digestion heat requirement. Digested solids are mechanically dewatered using three solid bowl centrifuges, and then trucked to land applier or composter for reuse.

The DAF thickener receives WAS at rates varying from 100 to 300 gpm. A recycle stream of clarified effluent is saturated with compressed air and released back into the circular flotation unit to mix with incoming WAS. As dissolved air comes out of solution, the bubbles attach to solids and lift them to the surface. At the point of mixing, a small dose of cationic polymer is added to enhance the solids concentraiton of the float. The float is skimmed into a hopper and pumped to the sludge blending tank with air activated pumps. The system has no redundancy. The float varies from 3.5 to 6 % TS and the subnatant varies between 10 and 75 mg/l SS. Subnatant is returned to the headworks.

The sludge blending tank receives the thickened WAS and primary sludge as they are produced, and the blended mixture is pumped to the digesters. Ferrous chloride solution is injected into the primary sludge prior to being mixed with the WAS for reducing the hydrogen sulfide in the digester gas.

Digesters

TITP has four egg-shaped digesters (reinforced concrete). Each digester holds approximately 1,373,00 gallons. The side walls of each digester extend 68.2 feet above the ground and 32.3 feet below the ground. Sludge enters at the top of each digester through one of two lines. One line discharges directly onto the impeller of the screw mixer. The other line discharges dirctly into the substrate–approximately 16 feet below the surface. Only two of the digesters are used continuously for sludge digestion, while the other two serve as spares or storage for surplus sludge production. The mixed sludge feed automatically alternates between the two primary digesters every hour. In 1997, gas production averages 16 cubic feet per pound of volatile solids (VS) destroyed and VS destruction averages 47 %. The hydraulic detention time with two digesters ranges from 16 to 23 days. Occasional foaming problem occurs in the digesters and the operating level is lowered to prevent foam from passing into the gas lines. Nocardia type filamentous organisms from the activated sludge process appear to be the cause of the problem. Mixing in the digesters is accomplished by peripheral gas injection near the bottom of the digesters and sludge recirculation pumping. Heating is done by recirculating the sludge through conventional heat exchangers. One advantage of the egg-shaped digester is that the digester is self-cleaning

Dewatering

Digested sludge is currently dewatered with two Ingesoll Rand and one Sharples centrifuges. Sharples centrifuge is a high speed centrifuge that produces drier cake but requires dry polymer rather than mannich polymer to make it work. Existing polymer feed system is consists of two liquid polymer tanks and a batching equipment. In addition, there is dry polymer makedown system, which is used occasionally. Dewatering is a batch process that depends on the sludge hopper capacity, digester level, sludge hauling schedule and etc. Polymer added to enhance separation of solids averages 20 lb/dry ton. Percent recovery is usually 95 or higher.

Biosolids

Dewatered sludge is reused for agricultural land application or composted.

Odor Control

The following areas are controlled for odor:

Headworks (bar screen, aerated grit chamber, grit and screenings storage)

Sludge Blending Tank

Sludge Dewatering Building

Primary Tanks

For controlling odor in the headworks there is a system of ducting the exhaust headroom air over the covered areas to the aeration blowers. The same technique is used to exhaust air from the primary sedimentation tanks and primary influent channels. Connection of the exhaust ductwork for primary area is much closer and larger that those for the headworks. There are several open areas over the primary sedimentation tank effluent

channels. Approximately all the air supplied to the aeration blowers comes from the primary sedimentation tanks and primary influent channels. The foul air from the blender tank and sludge dewatering building is connected to a ducting system that ends up
In the aeration blower.

Outside the dewatering building, the foul odor associated with Sharples dewatering is minimized by the use of activated carbon odor adsorption system.

Effluent Pumping/Outfall

A pumping station with three variable speed pumps is used to pump treated effluent to the outer harbor. The effluent is conveyed via a 48-inch diameter conduit to a 60-inch conduit then to a 72-inch outfall that terminates in the outer harbor with a diffuser. The diffuser, installed in 1996 when the outfall was extended, improves dilution of TITP treated effluent to a ratio of 10 to 1. The discharge point of the outfall begins at 33 degree 43 min 27.34 sec latitude, 118 degree 14 min 40.15 sec longitude and ends 33 degree 43 min 21.81 sec latitude , 118 degree 14 min 33.37 sec longitude. Sufficient pumping capacity is installed to meet peak flow demands and ensure adequate standby capabi1ity.

Utilities

The electrical power to TITP is supplied directly from DWP's Industrial Substation IS-1852, which is located on the plant site. The substation receives 34.5 KV power from two lines both originating from the Harbor Generating Station. Line 1, known as the preferred feeder, is connected to TITP via Henry Ford Bridge, while Line 2 comes to TITP through an underwater conduit crossing the Main Channel.
At the DWP substation, the 34.5 KV power is stepped down to 4.16 KV before it is fed to TITP. There is one MVA transformer and one 10 MVA transformer. The two lines and the two transformers are arranged such that both lines and transformer can be used simultaneously or one at a time.

The 4.16 KV power supplied to TITP is then distributed to a dual bus system, MSA and MSB, which can be connected or isolated by a tie-beaker. Connected to MSA is an emergency 4.16 KV bus, MSEA. Similarly, another emergency 4.16 KV bus, MSEB is connected to MSB. Normally, TITP operates with the tie-breakers opened. Line 1 feeds MSA and MSEA while Lne 2 feeds MSB and MSEB.

There are several equipment items directly connected to the 4.16 KV buses. They are:

MSA – Blowers 1 & 2, two 480 V to 4.16 KV step-up transformers for portables rental generators (1500 KVA each)

MSB – Blower 3, Digester Gas Engine Generators 1, 2, & 3

MSEA – Efluent Pumps 1 & 2, standby generator (1100 KW)

MSEB – Effluent Pump 3

The rest of the equipment items receive power after the 4.16 KV power is stepped down to 480 V by various unit substations (US). The dual bus system at TITP allows each of the unit substations to be fed either from the “A” side or the “B” side.

The unit substations connected to MSA and MSB are as follows:

US1A & US1B – Blower Building except the blowers

US3A & US3B – RAS pumps and final tanks area

US5 – Dewatering Building

US6 & US6A – Digester gas compressors

US7 & US7B – Digester area

US8 – Blender, DAF, biosolids hoppers

US9A & US9B – Filtration area

Other unit substations are connected to MSEA and MSEB. They are:

USE1A & USE1B – Effluent Pumping Plant except the effuent pumps

US2 – Administration Building

USE2A & USE2B – Headworks, primary tanks, Inplant Lift Station

The average power usage for TITP for 1998 was 100kw with maximum 15-minute demand of 2146 KW.

Automation

The process control system at TITP is used to control the effluent valves of primary sedimentation tanks, control the timing of primary sludge pumping and valve opening, DO control in aeration tanks, control the distribution of RAS flow, automate digester feed, start and stop major equipment, and log selected plant operating parameters and equipment parameters.

The current control system at TITP is a client server system that has been serving the plant’s needs since 1991. The server is a DOS 6.2 based operating system that uses NOVELL 3.11 NETWARE as a network. The hubs are IOMbs connected with IOBASE -T (RJ-45 plugs) cabling in administration building which uses 62.5 fiber optic to a remote star concentrator at YIC-1. The following is a list of channels:

Intrument Shop

Control Room (Adm Bldg)

Lift Station (not used)

Unit-2 Control Room(Dewatering Bldg)

Engineering Trailer (not used)

YIC_9 (Generator Bldg)

Unit-2 and generator building use 62.5 fiber optic cable connected to fiber optic transducer manufactured by SMC (Standard Microsystems Corp) and Black Box Co.

The transducer is fiber optic 9N4M SMA to AUI (attachment unit interface) and this plugs into the ether card plus 8013 Manufactured by SMC in the HMI.

Instrument shop and engineering trailer uses 62.5 fiber optic connected to SMC fiber optic traducers. The AUI port plugs into the AUI port of a SMC 36O8T9 elite 10BASE-T hub that uses eight RJ-45 ports and provides full CSMA/CD at 10Mbps for HMI.
The control room (Adm) LAN consists of 3 FMI station and 3 high speed printers.

The ether card used is elite 16 series by SMC phone 1800-net-leader in each ALR 486 25NIHZ with 4m ram 120 hard drive desktop PC. The 10BASE-TRJ-45 connector is run under elevated computer floor to a SMC 10Mbps hub located in cabinet adjoining to servers under the control room. The graphic and event high speed printers use XIRCOM model PEP-10BT pocket ether net print server that plug into the printer port of the printer then uses RJ-45 directly to SMC hub under control room. The alarm printer use LPT- I port of HMI #2 to print all alarms.

One ALR 486 DX 25NIHZ HMI in plant managers' office is connected to
NOVELL LAN at the hubs under the Control Room for graphics trending only. It is not connected to DH+ PLC hwy.

The PLC -5 HWY is consist of 11 PLC-5 processors plus 7 KF2 and I KT-1 for a total of 18 active nodes. Utilizing standard DH+ cabling and 200uM fiber optic fiber to a central star configuration. The use of duel processors and primary and back-up high cabling ensure the network operating at 57.OK baud. All PLC-5 process and servers have their 120 VAC backed up by a UPS.

Power/Energy

The purpose and intent of the power generation and heat recovery system is to convert the sludge gas produced during the anaerobic digestion process into electrical energy for use at the plant and to provide heat energy for heating the digesters. The system primarily consists of three stationery gas engine generators, a hot water recovery and engine cooling, and a high pressure plant air and engine starting system. Currently, only one engine is run per AQMD permit. Gas scrubber is available for use when the hydrogen sulfide in the digester gas is still high inspite of ferrous chloride addition to the digesters. Excess digester gas is flared. The engine’s waste heat is removed and recovered by the hot-water-recovery and engine cooling system. The engine’s waste heat is used for heating the digesters in service.

Los Angeles-Glendale Water Reclamation Plant

General and Plant Process Description

Wastewater treatment consists of a series of processes that successively remove solids until the resulting water meets qualities specified by regulatory agencies. Approximately

20 million gallons of raw sewage enter the Los Angeles-Glendale Plant each day. Four levels of purification are provided: preliminary, primary, secondary, and tertiary treatment with disinfection.

Most solids are separated from the wastewater during the primary and secondary processes. The resulting sludge, a concentration of these solids, is collected and piped to the Hyperion Treatment Plant for further processing. The remaining wastewater is then further treated to eliminate any remaining impurities. The final product is used in reclaimed water programs or discharged to the Los Angeles River.

Preliminary Treatment

Course debris is removed during preliminary treatment by bar screens in the headworks facility. The purpose of removing large particles early on the treatment process is to protect mechanical equipment from clogging or damage.

After screening, wastewater is lifted approximately 18 feet by one of three 200-horsepower pumps to the primary influent channel where flows are distributed to the primary settling tanks.

Primary Treatment

Primary treatment removes at least 70 percent of organic and inorganic solids from raw wastewater. Screened wastewater is maintained in an undisturbed condition for two hours in primary settling tanks, as solids (primary sludge) settle by gravity to the bottom of the tanks, or float to the surface. The sludge and skimmings are collected and pumped to a sewer line that flows to the Hyperion Treatment Plant. The water that remains after this treatment, called "primary effluent" is distributed to secondary treatment facilities.

Secondary Treatment

*Secondary TreatmenSecondary*Secondary treatment removes organic and inorganic solids that remain in the primary effluent. Purification processes found in nature are duplicated, including biological treatment and clarification.

Biological treatment – Primary effluent is distributed to aeration basins. Living micro-organisms, called "activated sludge" feed on organic material in the primary effluent and multiply. Air, blown in through hundreds of diffusers, keeps the organics and micro-organisms mixed. Air also provides the oxygen necessary for the micro-organisms' life functions. These life functions then convert sludge to water, carbon dioxide, and more micro-organisms.

Clarification – After the micro-organisms deplete their food supply, treated wastewater flows into secondary clarifying tanks where the "fattened" micro-organisms settle out. Most of the settled micro-organisms are recycled to the aeration basins to repeat the process of purifying incoming primary effluent. Excess organisms (waste activated sludge) by-pass this return step and are discharged into the sewer system for final processing at the Hyperion Treatment Plant downstream.

Tertiary Treatment

In tertiary treatment, coagulant is added to secondary clarifier effluent to bind the smaller remaining particles together. The larger particles are then easily removed in filters.

Following the filtering step, tertiary effluent is disinfected with hypochlorite, then de-chlorinated with bisulfite. This ensures that the discharged reclaimed water is safe for contact with the environment.

Tertiary treatment allows the City of Los Angeles to develop water reclamation that ultimately will conserve potable water supplies.

CITY OF PORTLAND, BUREAU OF ENVIRONMENTAL SERVICES

General and Plant Process Description

The City operates two plants: Columbia Boulevard and Tryon Creek. Both are activated sludge, secondary treatment plants with capacities to treat 100 mgd and 8 mgd, respectively. Under Oregon Administrative Rule ("OAR") Division 340-45, a National Pollutant Discharge Elimination System ("NPDES") permit is required for the discharge of treated effluent from each treatment plant. The City has an effective permit for each treatment plant. The permits are certified by the Oregon Department of Environmental Quality ("DEQ") and the City is in compliance with their provisions pertaining to discharge from the treatment plants.

Dry weather sewage flows to both treatment facilities are currently in the range of 70% to 85% of treatment capacity. Facility plans for future expansion of the Columbia Boulevard plant were completed in 1995. The first phase of this facility’s capacity expansion was the replacement of the headworks, completed in 1998.

The City has two programs for biosolids use: composting and land application. Approximately 25% of the biosolids for both the Columbia Boulevard and Tryon Creek Plants are composted in an in-vessel composter, which began operation in 1985. The remainder of the biosolids are land applied on arid pasture in eastern Oregon.

To protect the quality of biosolids, treatment plant effluent and personnel working in the Sewer System, and to comply with United States Environmental Protection Agency ("EPA") and DEQ requirements, the City operates a comprehensive industrial waste program. There are currently 160 industries operating under City discharge permits, and compliance files are maintained on a total of 200 industrial users. Periodically, through its ongoing monitoring program, the City has detected chemical and radiological discharges that exceed established standards. In these cases, the City initiates a process of notification and enforcement requiring the industry to regain compliance. Lack of compliance by the offending industry can lead to imposition of fines or ultimately to the plugging of the industry's service lateral. The City Code also allows recovery of any damages to the Sewer System that result from, impermissible discharges.

The hub of Portland's system is the Columbia Boulevard Wastewater Treatment Plant (CBWTP), located at 5001 N. Columbia Boulevard. It is a 133-acre site and is approximately 2 miles west of Interstate 5 and 5 miles north of downtown Portland. As of July 1998, the CBWTP has been in total compliance with its NPDES permit for 53 consecutive months, and achieves effluent quality well below its permit limitations.

The CBWTP has a three-phase treatment of wastewater and a biosolids process. Figure 5-1 is a process schematic of the CBWTP. The first phase is preliminary treatment, where the wastewater enters and large debris, sand, and gravel are screened out and removed. This material goes to a solid waste landfill. In the next phase, primary treatment, grease; oil; and floatable solids are skimmed off and settleable solids are collected and thickened prior to further treatment.

In the secondary treatment phase, naturally occurring microorganisms feed on organic pollutants in the wastewater. The resulting residue is separated in clarifying tanks. The water is disinfected and the flows into the Columbia River.

The treatment of solids removed during the primary and secondary treatment processes produces biosolids. The goal in producing biosolids is to speed natural decomposition and to extract water to make a concentrated, stable material. Belt presses squeeze out water. Some of the biosolids are mixed with sawdust and composted in an oxygenated environment. This GardenCare® compost is used in the landscape nursery industry. Biosolids that are not composted are used as a soil supplement on dry pastureland.

New and innovative wastewater treatment technology is vital to meet the needs of Portland's growing population. The plant has been continually improved and expanded since it was built in 1951.

Selector technology incorporated into plug flow process mode added to the secondary phase in 1993 makes Columbia Boulevard one of the largest treatment plants in the country to convert to this process. The addition eliminates unwanted microorganisms and minimizes the need for chlorination, while increasing secondary treatment flow from the maximum of 100 million gallons per day to 160 million gallons per day.

To save on water use at the plant, CBWTP has the capability to recycle its effluent to use as wash down water and for irrigation around the plant grounds. An ultraviolet system decontaminates this reuse water.

The latest innovation for the facility is the headworks project, completed in 1998. The new headworks replace one of the oldest sections of the CBWTP.

Design criteria and a description of the capacity of the unit processes used at the CBWTP are summarized in Table 5-2.

Table 5-2. Design Criteria and Capacity at the CBWTP

Design Flow	
Average Dry Weather Capacity (ADWC)	100 mgd
Peak Wet Weather Capacity (PWWC)	300 mgd
Design BOD_5 Loading	
Average Dry Weather Month	159,294 lb/d
Maximum Dry Weather Month	241,860 lb/d
Design Effluent Requirements	
Maximum Monthly Average TSS	30 mg/L
Maximum Monthly Average BOD_5	30 mg/L
Influent Pumps (Replacement Headworks)	
Number	6
Type	Centrifugal
Speed	Variable speed rpm
Capacity	4 @ 75 and 2 @ 40 mgd
Horsepower	4 @ 450 and 2 @ 250 hp
Preliminary Treatment	
Trash Racks	
Number	4
Size	Clearance, 6-inch
Bar Screens	
Number	5
Spacing	Clearance, 5/8-inch
Grit Basins	
Number	6
Type	Mechanically induced vortex
Size	24 ft diameter
Efficiency	85 percent at 130 mgd
Primary Treatment	
Primary Clarifiers	
Number	8
Size	225 by 58 by 10 feet
Overflow Rates (1 unit out of service)	3,284 gpd/sq ft @ peak flow
	960 gpd/sq ft @ 100 mgd
	2,880 @ 300 mgd 3,284 gpd/sq ft w/ 1 unit out of service
Aeration Basins	

Number	8
Size	381 by 40 by 17 feet
Volume (each)	1.8225 million gallons
Capacity (each)	20.0 mgd at an SVI of 80 ml/g
Design Organic Loadings	
Instantaneous Peak	120,000 BOD and 17,800 NH_3 lb/d
Diurnal Peak	90,000 BOD and 13,350 NH_3 lb/d
Minimum	20,000 BOD and 3,000 NH_3 lb/d
Detention Time	3.5 hours at ADWC @ 100 mgd & RAS
Aeration Equipment	
Type	Fine bubble diffuser
Mixer	
Type	Submerged mixer/aerator
Secondary Clarifiers	
Number	8
Type	Square, peripheral-feed
Size	125 feet square
Side Water Depth	12.5 ft
Surface Overflow Rate	800 gal/d/ft^2 at ADWC @ 100 mgd
Solids Loading Rate	32.4 lb/d/ft^2
Detention Time	2.79 hours at 100 mgd
Sludge Removal	Revolving suction arm
Sludge Recirculation	
Number of Pumps, Each Clarifier	2
Type	1 variable speed, 1 constant speed
Combined Capacity	62.5 mgd
Chlorination	
Type	V-notch chlorinator
Control	Residual-paced
Reactor	Chlorine contact pipe
Detention Time	22 minutes @ 300 mgd
Effluent Pumping	
Number low-head pumps	3
Speed	1 variable speed, 2 constant speed
Rated Head	17 feet
Rated Capacity	78 mgd each
Number high-head pumps	2

Rated Head	32 feet
Rated Capacity	72 mgd each

Tryon Creek Wastewater Treatment Plant. Tryon Creek Wastewater Treatment Plant (TCWTP) is located within the City of Lake Oswego City limits adjacent to the Willamette River. The TCWTP is owned and operated by the City of Portland. Treatment is provided for both Lake Oswego and the City of Portland through an intercity contract.

Roughly, half of the flow to the TCWTP comes from the City of Portland's Tryon Creek basin, which discharges to the 30-inch Tryon Creek Interceptor. The other half originates in the city of Lake Oswego sewer service area and discharges to a 24-inch line. Two magnetic flow meters measure the flows from the Portland and Lake Oswego lines.

The TCWTP was designed for an average flow of 8.3 MGD with the ability to treat hourly peak flows of 35 mgd for short periods of time.

In addition, the Bureau of Environmental Services has received approval for the first Master Plan for the Columbia Boulevard Wastewater Treatment Plant campus, with an expanded campus boundary. The Master Plan is a 10-year plan but also incorporates the results of a long-range (40-year) Facilities Plan, completed in 1995. The CBWTP Master Plan outlines over 30 projects planned to be developed over a 10-year period, including a substantial program for odor control improvements. This plan provides the Bureau a road map for the future, which should result in excellent facility development.

The CBWTP site is bounded by Columbia Boulevard and the Union Pacific railroad tracks to the south, Burlington Northern main line railroad tracks to the west and Union Pacific railroad tracks to the east (Figure 5-1).

The City owns, operates, and maintains the sanitary and stormwater collection and transport systems within its boundaries. The drainage area served by these systems encompasses approximately 85,000 acres. The City also provides sanitary sewer service to approximately 9,000 acres outside the City corporate limits. The City provides sanitary sewer service to approximately 500,000 people, numerous commercial and industrial facilities, and several wholesale contract customers located adjacent to the City. The service area is located on both sides of the Willamette River, extending approximately 20 miles south of its confluence with the Columbia River. It is generally bounded on the west by low-lying hills paralleling the Willamette River, by other service areas serving the City metropolitan area to the south, by the City of Gresham to the east, and by the Columbia River to the north.

The existing Sewer System consists of a network of piping of approximately 2,251 miles, ranging in diameter from four inches to 144 inches. There are storm and sanitary sewers, each dedicated to carrying separate waste streams, and combined sewer lines that carry both stormwater runoff and sanitary waste. The Sewer System is served by 96 pumping stations and two wastewater treatment plants, which have a combined secondary treatment capacity of 108 million gallons per day ("mgd").

Collection System

Sanitary and Storm Collection System

Collection sewers transport wastewater from the receiving point (either the curb line or, in new construction areas, the property line) to the point of discharge into the interceptor sewers. Collection sewers comprise most of the footage and economic value of the Sewer System, fronting on most of the property in the City. Older collection sewers carry both storm and sanitary sewage. Collection sewers constructed since 1960 carry sanitary wastes only. Combined sewers comprise approximately 850 miles. The collection system is inspected by television cameras and cleaned on a routine basis. Sewer System maintenance and repair projects is scheduled according to the results of the inspection program.

The City's storm drainage responsibility covers approximately 85,000 acres divided into 18 unique drainage basins. Most of the drainage basins located within the west side of the City flow directly into the Willamette River with the exception of Fanno Creek and its tributary basins, which flow west out of the City, eventually discharging to the Tualatin River in adjacent Washington County.

The basins in North and Northeast Portland typically drain to the Columbia and Willamette Rivers. Some of these basins have highly permeable soils, however, and stormwater in these locations either drains to percolation sumps or ponds on the surface and slowly percolates through the ground to underlying soils. Most of the storm runoff in Southeast Portland drains to the Johnson Creek basin, which is the largest basin in the City's Urban Services Boundary, covering an area of approximately 54 square miles.

The City's earliest sewers were installed in 1860 and were intended to provide storm and sanitary sewer service to the early settlement along the Willamette River. Prior to 1947, additions to the storm and sanitary sewage collection system were constructed as combined sewers with untreated wastes discharged to the Willamette River and Columbia Slough.

Interceptor and Pump Station System

In 1947, construction began on a system designed to intercept all of the sanitary portion of the combined sewage and transport it to a new treatment plant. With construction of these first intercepting lines and a primary treatment plant on Columbia Boulevard, the City began treating its wastewater.

Today, large interceptor sewers, generally paralleling the Willamette River on the east and west, and extending along the south side of the Columbia Slough, are the major sewage-carrying conduits in the Sewer System. Sewer diversions are located at the intersections of combined trunk sewers and interceptor sewers. These diversions direct approximately three times the average dry weather combined sewer flow into the interceptor system. During rainfall, when combined sewage flow exceeds three times the average dry weather flow, a portion of the sewage flow bypasses the diversion structures and discharges directly to the Willamette River and Columbia Slough.

The 96 pump stations provide service where gravity sewers cannot function because of topographic restrictions. All pumping stations are monitored remotely through a telemetry system connected to a central computer system in the Control Console Room at the Columbia Boulevard Wastewater Treatment Plant.

Headworks and Influent Pumping

Flow enters the plant through a box-section-shaped influent line and is split into two equal portions just upstream of influent pumping (see Table 5.2). These flow streams can be isolated by two hydraulically operated sluice gates. There are also two emergency bypass gates to allow flow by gravity directly to primary treatment in the event of an influent pumping failure.

Preliminary Treatment

Preliminary treatment consists of magnetic meters (one at the discharge of each influent pump) for flow measurement, bar screens that remove objects greater than 5/8" followed by screening presses, grit basins with grit washer separators, and a new septage receiving station (see Table 5.2).

Primary Treatment

Flow enters primary treatment through the old screenings facility, and Parshall flumes measure flow once more in each of four channels exiting the screening house. The total of the four channels is considered to be plant influent flow, despite a contribution from some in-plant return streams that enter upstream of the old screening house. Individual flow measurements in the four channels are used to adjust flow-directing vanes to accomplish influent flow splitting. Remaining in-plant return streams enter the flow path just downstream of the Parshall flumes.

Flow splitting from the four Parshall flumes to the eight rectangular primary clarifiers is slightly different for the original four clarifiers than for the four clarifiers added during the 1968/1969 expansion. The original clarifiers depend on distribution control at the flumes for splitting, while newer clarifiers are individually fed via conduits to each tank. The split for the newer tanks is accomplished through sluice gates at the end of the influent channels downstream of the Parshall flumes.

All eight primary clarifiers are 225 feet long by 58 feet wide, with longitudinal chain and flight collectors and cross collectors at the inlet end. Thin sludge gathered in clarifiers is continuously pumped from the tanks to the raw sludge gravity thickeners. All eight tanks are designed for a surface overflow rate of 960 gallons per day per square foot (gpd/ft^2) at an average dry weather capacity (ADWC) of 100 mgd. Peak wet weather capacity (PWWC) design flow is 300 mgd.

Effluent from the four original primary clarifiers is collected in a common effluent channel and approaches the bypass divider gate through a short conduit. Primary effluent from the four newer tanks is collected in a common effluent channel and flows to the bypass divider gate through a long box channel. The bypass divider gate was designed to modulate at high flow rates, limiting secondary treatment flow to 200 mgd. Primary effluent in excess of what can be handled through secondary clarifiers is bypassed to the plant outfall system following disinfection and blending with secondary effluent.

Secondary Treatment

Activated sludge unit processes used for secondary treatment were designed for an ADWC of 100 mgd and a PWWC of 200 mgd. The flow difference between the 300 mgd PWWC for primary treatment and 200 mgd for secondary treatment peak flow to bypasses secondary treatment and is blended with secondary effluent for subsequent chlorination and discharge. Flow through the secondary treatment system is measured via magnetic flow meter and open channel contra-ultrasonic flow meter.

Primary effluent receiving secondary treatment is divided among eight aeration basins. Each basin is 381 feet long by 40 feet wide and operates with about 17 feet of water depth. Secondary influent, under plug flow mode of operation, enters the basin with the return activated sludge (RAS) at the head end of the basin. RAS can either be directed to the secondary influent channel or the head end of each basin. Under step-feed mode of operation, secondary influent is directed down the length of the basin through any of eight gates per basin. The RAS is directed to the head end of each basin in step-feed mode. The units are designed to provide selector technology at the front end of each basin via mixers, which allow regions of basins to be operated in either an aerated or non-aerated mode.

The effluent launders run the width of the end of each basin. Aeration is provided by fine-bubble diffused aeration with full floor coverage of the basin. Aeration air is supplied by two large centrifugal blowers and two medium blowers.

The aeration basins must be operated in pairs. Basin pairs cannot be drained separately except for Basins 7 and 8. Structural design limitations of the center common wall in Basins 1 through 6 dictate that there be no differential head.

Each aeration basin has a dedicated secondary clarifier. The eight secondary clarifiers are 125-foot-square tanks with 12.5 feet of side water depth and flat bottoms. The flow path through the clarifiers is peripheral feed and peripheral overflow. Sludge is withdrawn by direct pumping through articulated sludge collector arms. The clarifiers are designed for a surface overflow rate at 100 mgd of 800 gallons gpd/ft^2 and a peak overflow rate of 1,600 gpd/ft^2

Two RAS pumps, one constant speed and one variable speed, are connected to each clarifier. Both discharge into a common line containing a flowmeter and flow control valve. Under the original design, RAS was returned only to the basin associated with the clarifier from which it was drawn, resulting in eight independent activated sludge plants, side by side. A modification to the system permitted combining RAS from all eight clarifiers and returning the combined flow to the secondary influent channel upstream of the aeration basins. This modification limited RAS capacity and increased hydraulic head losses in the secondary influent channel, but it is now the normal flow path. Modifications were recently made to plug flow configurations to redirect RAS to several points at the head end of aeration basins.

Sludge Thickening

Unit processes currently used for solids handling at CBWTP include degritting, screening, gravity thickening (primary sludges); two-stage anaerobic digestion, belt press dewatering and composting or land application of primary solids; and gravity belt thickening, two-stage anaerobic digestion, belt press dewatering and land application or composting (small quantities) of secondary solids. Digested solids are composted throughout the year. Some digested primary solids and most digested secondary solids are blended with previously digested, lagoon stabilized biosolids, dewatered and land applied at the Madison Farms approximately 320 days per year (339 days during 1997). The remainder of the year (≈ 45 days/yr between mid-December and early February) digested solids not used for composting are pumped to the Triangle Lake Lagoon for storage and additional stabilization.

Primary solids are settled in primary clarifiers, resulting in a solids density of approximately 0.5%, and then thickened to about 5% total solids in three 55-foot-diameter gravity thickeners (Table 5-3). Thickened solids are then passed through in-line grinders and pumped to anaerobic digesters.

Waste activated sludges (WAS) are thickened on one of three gravity belt thickeners to about 4% total solids (TWAS), then pumped to anaerobic digesters.

Table 5-3. CBWTP Solids Processes

Item	Value
Gravity thickening of primary sludge	
Thickeners	
Number	3
Diameter, each, feet	55
Sidewater depth, feet	10
Gravity Belt thickening of secondary sludge	
Thickeners	

Number	3
Width, each, meters	3
Feed flow rate, each, gpm	900
Anaerobic digesters[1]	
Number	8
Diameter, feet	4 at 90
	4 at 105
Sidewater depth, feet	4 at 25.3
	4 at 37
Effective volume, each, cubic foot	4 at 160,000
	4 at 320,000
Triangle Lake Biosolids Lagoon	
Area, acres	37
Effective Sidewater depth, feet	14
Dredge capacity, gpm	800
Mechanical dewatering	
Belt filter presses	
Number	4
Belt width, meters	2
Solids loading rate, lb/hr/meter	750 to 1,000
Composter	
Rated Capacity, dt/d	60
Practical Capacity, dt/d	10

- [1]Including Digester 3, the blend tank used to collect newly digested and older lagoon solids prior
- to dewatering.

Digesters

Seven of eight anaerobic digesters are used to stabilize primary and secondary solids. Two are always used for first-stage digestion of primary solids (Figure 5-1; Digesters 1 and 2) and two are normally operated for first-stage digestion of TWAS (Figure 5-1; Digesters 5 and 6). Of the remaining four, one is used for second-stage primary solids digestion, settling and gas storage (Figure 5-1; Digester 4); two are used as second-stage digesters for additional TWAS stabilization and settling (Figure 5-1; Digesters 7 and 8); and an eighth digester has been converted to a solids-blending tank (Figure 5-1; Digester 3). Digested secondary biosolids, small quantities of digested primary biosolids, and harvested lagoon solids are mixed and held in the blend tank pending dewatering.

No supernating takes place from primary anaerobic Digesters 1 and 2, nor does any supernating take place from first or second phase Digesters 5, 6, 7, or 8. Some supernating occurs out of the second-stage primary Digester 4.

Digesters 5 and 6 are consecutively fed TWAS in 32,500-gallon aliquots in a rotating fashion. Once 32,500 gallons TWAS have been pumped to a particular digester, an automatic air actuating valve closes the valve to the digester being fed and concurrently opens a feed valve to another digester, redirecting solids to that digester. A flow totalizing meter registers the combined flow fed to TWAS digesters on an ongoing basis and volumes wasted to digesters daily are recorded.

Grab samples of raw thickened primary and secondary digester feed sludges are collected separately at 2-hour intervals. A composite of the two digester streams feed sludges made from twelve daily subsamples is used to determine the mean total and volatile solids levels entering the primary solids digestion system.

Between 180,000 to 200,000 gallons second-phase digested TWAS are transferred from Digester 8 to Digester 3 daily. During each transfer of digested solids from Digester 8 to the blend tank (Digester 3), at least one grab sample is collected to determine biosolids total and volatile solids levels.

Biosolids feed estimates from second stage digesters to the blend tank (Digester 3) and between first and second stage digesters are based on the height of tank cover drawdown which occurs during digested solids transfer operations. The volume of solids moved to and from Digesters 1, 2, 4, 5, 6, 7, and 8 is estimated by measuring digester cover displacement. These digesters are equipped with floating covers and staff gauges.

Dewatering

Anaerobically digested primary and secondary biosolids are dewatered via four belt filter presses yielding an 18 to 25% cake. A portion of the dewatered primary biosolids and occasionally a small quantity of digested secondary biosolids are fed to the Taulman-Weiss (Davis) within-vessel composting system (Table 5-3).

Biosolids

Blended dewatered biosolids from the Triangle Lake Lagoon, some primary digested solids, and most secondary digested solids are trucked to Madison Farms for land application at agronomic rates (5 dry tons/acre/year) (Section 13).

Disinfection

Chlorination requirements are met by injecting chlorine solution into outfall lines and utilizing detention time in the lines for chlorine contact. Chlorine, delivered to the plant site in 90-ton railcars, is metered through three evaporators and one 10,000-lb/d and two

2,000-lb/d chlorinators into the outfall lines. There are two 8,000-lb/d chlorine injectors at the effluent pump station.

The 102-inch outfall line to the Columbia River provides sufficient detention time to meet chlorine contact requirements if flow rates are within design limits.

Effluent Pumping/Outfall

As long as river stages remain normal, under most operating conditions, a 2-mile long 102-inch-diameter gravity outfall line carries up to 130 mgd from the CBWTP to a 350-foot-long flow diffuser structure in the Columbia River. Flow discharged to the 102-inch-diameter pipe is divided into a 54-inch and 72-inch pipe in a siphon box near the south bank of the Columbia Slough and recombined into a 102-inch line in a junction box on the opposite bank of the Slough. Similar structures divide and recombine flow as it enters and leaves the Oregon Slough. The gravity system discharges to a flow diffusion manifold equipped with multiple discharge outlets via rubber duckbill valves.

Under certain conditions of high river levels or increased plant flow, effluent pumping is required. Three 78-mgd pumps can be actuated to discharge through the 102-inch gravity line system. Two additional pumps can be engaged to transport excess effluent through a separate 72-inch-diameter pressure line which parallels the 102-inch gravity line and connects to the 72-inch gravity line entering the Oregon Slough just beyond a flow splitter box located on the south bank of the Slough. Flow from the 72-inch line is combined with flow from the 54-inch gravity line on the north bank of the Slough and directed to the effluent discharge assembly via the 102-inch gravity pipe.

Siphon boxes at each slough are equipped with emergency bypass flow diversion structures capable of discharging a portion of the flow directly to either slough. The diversion structure discharging to the Columbia Slough is not engaged unless the flow exceeds 300 mgd. Rarely used, this outfall was last operated for a short time in 1978 and for approximately 7.25 hours during peak flood and flow conditions on February 9, 1996.

The configuration of the wet well and control gates at the CBWTP effluent pump station permits only secondary effluent to be pumped by the high-head pumps, while the low-head pumps can pump secondary effluent, primary effluent, or a combination of the two. Low-head pumping is required less than 3 percent of the time. Although high-head pumping was never required prior to a February 1996 flood, the high-head pumps have been operated in a backup capacity mode when the 102-inch line has been shut down for maintenance.

EAST BAY MUNICIPAL UTILITY DISTRICT

General and Plant Process Description

Special District No. 1, a separate district within EBMUD governed by the same Board of Directors, was established in 1944 and is administered by the District's Wastewater

Department. The Wastewater Treatment Division is responsible for the operation and maintenance of the District's wastewater treatment facilities.

Domestic, commercial and industrial wastewater is treated for the cities of Alameda, Albany, Berkeley, Emeryville, Oakland and Piedmont, and for the Stege Sanitary District, which includes El Cerrito, Kensington and part of Richmond. These customers include more than 20,000 commercial and industrial accounts.

Facilities include two wet weather treatment plants and the Main Wastewater Treatment Plant (Main Plant). The Main Plant, located in Oakland near the entrance of the San Francisco-Oakland Bay Bridge, provides secondary treatment for a maximum flow of 168 MGD. Primary treatment can be provided for up to a peak of 415 MGD. The average annual flow is approximately 83 MGD.

The treatment steps are pre-chlorination (for odor control), screening (to remove large objects), grit removal, primary sedimentation, secondary treatment using high-purity, oxygen-activated sludge, final clarification, sludge digestion and dewatering. The treated effluent is then disinfected, dechlorinated and discharged one mile off the East Bay shore through a deep-water outfall into San Francisco Bay. The dewatered sludge is land-applied. The Main WWTP generates some of its electricity at its own power generation station, and treats a small fraction of its flow for reuse through reclamation facilites.

Collection System

The Main Plant treats sanitary sewage only; city storm drains are separate. EBMUD's industrial load is about 15% of total flow.

1400 miles of community sewers discharge into one of five EBMUD interceptors. The District's interceptors are 29 miles of reinforced concrete pipes ranging from 12 inches to 9 feet in diameter. Fourteen pumping stations, ranging in capacity from 1.5 to 60 million gallons a day (MGD), lift wastewater throughout the interceptors as it travels to the Main Plant.

Headworks and Influent Pumping

Wastewater enters the plant at the influent pumping station (IPS). The IPS is located at the eastern end of the Plant. It was upgraded to handle 415 mgd (from 290 mgd) of raw sewage. The IPS consists of 3 sub-structures: the Intake Chamber, the Pump Station Building, and the Fine Screen Building.

The Intake Chamber has two chambers for flow isolation and flow re-routing leading to five Inlet Channels. Each Channel corresponds to a Pump and has its own Isolation Sluice Gate. The five Inlet Channels can be interconnected and each Inlet Channel has a manually cleaned Coarse Bar Screen. The air in the Inlet Channels and Intake Chambers is constantly replaced to remove dangerous gases (such as hydrogen sulfide) associated with wastewater. Prechlorination is provided as a part of Odor Control.

The Main Pump Station Building has five dry-pit, variable speed, vertical, mixed flow, non-clog wastewater Pumps. Each Pump is rated for 85 mgd capacity at a 35 foot TDH. The pump speed is controlled by the Load Commutated Inverter (LCI) Drive, the latest in Variable Frequency Drive technology. Each pump has a 42-inch Hydraulic Discharge (Isolation) Valve, a 48-inch Magnetic Flow Meter and discharges into its own separate channel in the Fine Screen Building.

Preliminary Treatment

The Fine Screen building has five Fine Screens, one on each IPS Pump Discharge Channel. The Grit Handling System for the Main Wastewater Treatment Plant is located at various areas in and adjacent to the Plant's Influent Pump Station. The system is made up of four major components each of which has its own role during dry and wet weather operations.

Wastewater enters the Grit Handling System by way of a channel into the Aerated Grit Influent Channel. During dry weather flow periods, wastewater enters either Aerated Grit Tanks 7 or 8 where grit settles out of the wastewater. Degritted wastewater leaves the Grit Tanks through the Aerated Grit Effluent Channel and enters the Primary Sedimentation Basins. During wet weather operations, all eight (8) Aerated Grit Tanks are in service. When the peak flow entering at the Aerated Grit Effluent Channel exceeds 320 mgd, excess flow (up to 95 mgd) is diverted to the Wet Weather Storage Basin via the Diversion Structure and Fill/Drain Channel. When the peak flows subside, the stored flows are returned to the IPS.

Grit settles into Grit Hoppers, located at the center of each tank. The Grit Pumps pump the grit slurry from the Grit Hoppers to the Grit Dewatering Building. The Grit Dewatering building contains six (6) Grit Classifier/Cyclone systems. The number of Grit Classifiers placed in service depends on the amount of flow and grit in the system. The dewatered grit is conveyed to a Grit Hopper by a Conveyor which is located between the two rows of Classifiers and is disposed of in a dumpster truck for transport to a landfill. The Classifier overflow discharges to the plant drain which returns to the IPS intake chamber.

Primary Treatment

The Main Plant has a peak hydraulic treatment capacity of 415 MGD. Primary treatment is provided for a maximum wet weather flow of 320 MGD and removes floating material such as oil and grease, and heavier materials such as sand, silt, and organic solids which settle from the wastewater.

The effluent from the aerated grit tanks flow through aerated channels to 16 primary sedimentation tanks. The wastewater is distributed to the sedimentation tanks in service through four channels. In normal operation the flow will be through all four channels. Some grit does accumulate in the channels, so periodically one channel is closed off and the influent sluice gates to Tanks No. 1-10 are closed and the accumulated grit is flushed into Tanks No. 11-16.

The sedimentation tank influent channels are aerated by three blowers located in the Blower Building. The air is adjusted to maintain the solids in suspension without wasting air. Flow meters are provided in the air headers to monitor the air flow rate. The flow rate is shown on indicators near each meter. Thermometers and manometers are also provided to monitor the temperature and pressure.

Wastewater enters each primary sedimentation tank through two sluice gates. Metal deflector plates and wood baffles inside each tank help to distribute the flow evenly across the width of the tank. The velocity of the wastewater is slowed sufficiently so that solid material settles to the floor of the tank throughout its length. The slow moving wastewater flows over V-notched or saw-toothed weirs into the effluent troughs. From the troughs effluent flows into a collector channel and out into the main primary effluent channel.

Solids that settle to the floor of the tank are moved to the head end of the tank by mechanical sludge collectors. Plastic planks attached to a chain continually scrape the bottom of the tank and slowly move sludge to the influent end of the tank where it slides down a sharp incline into a cross channel. The sludge in the cross channel is moved by a cross collector with plastic flights across the width of the tank to a hopper on one side. From this hopper sludge is periodically pumped during normal "non-storm" conditions to the digesters. Sixteen positive displacement type pumps - one for each tank hopper--are provided for this purpose.

The scum, grease and other floating solids that accumulate on the surface of the sedimentation tanks are continuously moved to troughs at approximately mid-point of each tank by the sludge collector flights so they rotate at the water surface around the tank. The scum is skimmed off periodically for disposal through scum wells and concentrators. The scum is concentrated from a 95% water content by weight to 50% by weight.

The sludge withdrawn from the sedimentation tanks is normally pumped to the digesters. Two density meters are provided to monitor the sludge density and provide control of the sludge pumping operation. A sludge magnetic flow meter is provided in the sludge line to monitor the flow rate. The signals from the density meter and flow meter are combined to calculate the raw sludge mass.

Large amounts of silt enter the plant during high flow conditions that accompany a storm. While most of this is removed in the grit chambers, grit still accumulates in the primary tanks. Because of the large volume of silt and its inorganic nature, it is neither necessary nor desirable to pump it to the digesters. During storms, primary sludge is routed to the grit removal cyclones prior to being pumped to the digesters.

Secondary Treatment

Secondary treatment can be provided for a maximum wet weather flow of 168 MGD. Secondary treatment utilizes a high purity oxygen activated sludge (OAS) system which biologically removes most of the remaining suspended and dissolved organic and chemical impurities. EBMUD produces pure oxygen for the oxygenation tanks at an onsite cryogenic plant. EBMUD oxygenation tanks consist of eight parallel trains, each having four stages. Oxygen is fed to the tanks at an average of 87.5 tons per day. Twelve circular clarifiers treat the wastewater after oxygenation.

The high purity oxygen activated sludge reactors at the EBMUD plant are configured in eight parallel trains with four reactor-cell (stages) in each train. Secondary influent is fed to the reactors from the secondary influent channel via a step feed channel that allows the operator to divide the secondary influent between the first and second reactor cell.

Each reactor stage is equipped with a surface aerator and draft tube to dissolve the oxygen and agitate the mixed liquor. A tilting weir at the outlet of each reactor train controls the water level in the reactor to optimize oxygen transfer and energy conservation. The mixed liquor channel conveys the mixed liquor from the reactor trains to the secondary clarifiers. The solids that settle out in the clarifiers flow by gravity to the sludge well. Return activated sludge pumps pump the sludge from the sludge well to the influent end of the aeration train. Waste activated sludge can be directed to either the sludge thickener or the plant influent.

The distinctive feature of the EBMUD secondary system is the use of the tilting weir to control the water surface level in the oxygenation reactors. The surface aerator impellers are liquid-level sensitive. The oxygen transfer rate and the power draw increase with the water level over the available 8 inch range. The water level is therefore adjusted to match organic loading and flow by raising or lowering the tilting weir. As the flow through the reactor changes the tilting weir is automatically raised or lowered to maintain the desired water level.

The EBMUD secondary process uses pure oxygen to aerate the activated biomass. The oxygen is extracted from the air in a cryogenic oxygen generation plant in order that high purity (approximately 95%) oxygen can be fed to the reactor. Since air is only 21 percent oxygen, using high purity oxygen means that less total gas needs to be dissolved in the water. Pure oxygen aeration tanks are smaller and less energy is required to dissolve the oxygen into the water. The aeration basins are enclosed to contain the oxygen.

As oxygen passes through the four stages of the reactor train it becomes less and less pure. The settled sewage coming into the reactor contains gases, which are released into the reactor head space diluting the oxygen. The organisms in the reactor give off carbon dioxide some of which is also released and dilutes the oxygen. The oxygen is finally vented from the last stage of the reactor at about 40% purity.

The oxygen feed to each reactor train is controlled by the pressure in the train's head space, which are only a few inches of water column higher than the ambient pressure. If the dissolved oxygen is low, the operator can open the vent valve, which drops the pressure in the reactor train head space which will cause the oxygen feed valve to open to bring the pressure back up. The oxygen purity then increases which raises the dissolved oxygen concentration.

The EBMUD oxygenation reactor trains are divided into four stages in order to minimize the possibility that the sewage will short circuit through the reactor. This configuration approximates a "plug-flow" mode. Most of the oxygen demand is satisfied in the first and second stages. The settled sewage can either be fed directly into the first stage of the reactor train or divided between the first and second stages. A gate valve at the outlet in the second stage can be adjusted to control how much goes to each stage.

Predesign modeling and testing showed that the oxygen demand would exceed the capacity of the aerator if all of the settled sewage was fed to the first stage. Surface aeration dissolution systems develop a spray "umbrella" in order to provide more surface area for oxygen transfer. Each surface aerator has a draft tube so that water low in oxygen is pulled up from the bottom of the reactor.

Surface aeration equipment requires the development of this spray "umbrella" to efficiently achieve the oxygen transfer. The 3 feet available from the water surface to the bottom of the deck as well as the 1.6 feet available from the water surface to the bottom of the beams is less than at other similar installations because the surface aerators at the EBMUD facility are retrofit into existing oxygenation reactors. The aerators were tested prior to purchase to assure that they are capable of meeting the oxygen transfer requirements.

The aerators have liquid-level sensitive impellers. The standard oxygen transfer rate (SOTR) and power draw vary in a linear fashion with water level. The aerators at EBMUD are designed for a maximum variation in water level of 8 inches. The tilting weir controls the water level in response to flow and organic loading.

The aerators also mix the activated sludge solids with the incoming flow allowing the organisms to come in contact with the food supply. The turbulence caused by the aerators keeps the solids in suspension. Most of the oxygen demand is in the first and second stages, the aerators in the third and fourth stages use smaller motors in order to conserve energy.

A tilting weir located at the outlet of stage 4 of each oxygenation reactor train controls the water level in the reactors. The depth of water in the reactor trains is critical to the functioning of the surface aerators. As the submergence of the aerator blades increases the loading on the motor increases using more energy. Oxygen transfer rates also increase with increasing aerator submergence. Conversely, the lower the water level, the less submerged the blades are and the lower the oxygen transfer.

Secondary effluent flows to twelve secondary clarifiers. The flow from the mixed liquor channel to each clarifier is controlled by a regulating butterfly gate which receives its signal from a magnetic flow meter located in the clarifier effluent line. The flow to the clarifiers can be proportioned either equally or unequally depending on the operating mode.

The mixed liquor enters the tank at the outer edge and flows down through holes in the influent raceway. The solids settle to the bottom of the clarifier where they are continuously removed by a suction-type collector mechanism. The clear liquid supernatant overflows the v-notch effluent weir then flows through a 30-inch pipe to the effluent channel. A surface skimmer attached to the sludge collector mechanism removes the grease and any other floating material and directs it to the scum collector.

Static head due to the difference between the water level in the clarifier (108.14') and that in the return sludge well (104') causes the solids in the bottom of the clarifier to flow through the openings in the sludge collector arm. The solids flow through the arm to the center column and then into a 16-inch pipe, which goes from the center of the clarifier to the sludge well. Each of the sludge withdrawal lines has a flow meter and control valve. In automatic mode the system modulates the valves to balance the solids flow from each of the operating clarifiers.

Each of the sludge withdrawal lines extends to the return sludge well located in the Operations Center basement. The well can be divided into three sections, depending on the operating mode selected. Sluice gates are located between the sections to provide flexibility. The two smaller sections of the sludge well are served by one pump.

Four variable speed Return Activated Sludge (RAS) pumps draw sludge from the sludge well and pump it to the oxygenation reactors. The variable speed drive RAS pumps are each capable of pumping up to 20 mgd. In automatic, the pump speed is controlled as a ratio of secondary influent flow. RAS flow rate can also be set at a constant rate. The RAS flow to each oxygenation reactor is monitored by a magnetic flow meter located in the RAS distribution pipe to each tank. The signal from each meter is transmitted to a controller that adjusts regulating valves to the reactors. The RAS can be proportioned either equally or unequally to the reactors in service.

The volume of RAS that should be returned to the reactors is a function of both the solids concentration of the RAS, the secondary influent characteristics, and the capacity of the secondary clarifiers. The operator determines the return ratio based on experience with the EBMUD plant.

There are three variable speed Waste Activated Sludge (WAS) pumps. Magnetic flow meters and density meters are located in the pump discharge lines to monitor and control the pumping rates. The WAS can be pumped to either the sludge thickeners or the plant influent. The amount to be wasted will vary depending on influent loading.

Tertiary Treatment

The Main Plant is required to meet NPDES Permit limits for BOD and TSS of 30 mg/l each. The effluent discharged to the Bay is allowed no measurable chlorine residual and 240 most probable number (MPN) total coliform per 100 milliliters (ml) on a five-day running median. The Main Wastewater Treatment Plant includes an onsite water reclamation station. The reclamation plant reclaims over 500,000 gallons per day of treated effluent for seal water, landscape irrigation, and washdown of plant facilities. This water is called No. 2 Water.

Thickening

Waste activated sludge (WAS) is thickened at two centrifuges and one gravity belt thickener. The liquid discharge is recycled to the primary sedimentation tanks, while the thickened sludge is digested.

Digesters

Anaerobic digestion consists of five primary, two secondary, and four dual purpose 95 foot diameter digesters of approximately 2 million gallons each. Ten digesters have a floating cover, while one digester has a fixed gas reservoir type cover. Each primary digester has a hot water heat exchanger and provisions for gas mixing.

Feed sludge, consisting of primary or waste activated sludge, passes through magnetic flow meters and/or density meters, which are used to automatically control allocation of sludge to each primary digester, on a pounds of solids basis using clock timers. Sludge from a digester flows through spiral counter current heat exchangers supplied with residual hot water from the power generation station cooling system. Digesters are operated in the mezophilic stage at approximately 95 degrees F.

All sludge is transferred from the primary digesters to secondary digesters by one of six dual speed transfer pumps. Provisions are available to pump digester contents to the plant headworks, to a primary sedimentation tank, or the normal sludge dewatering holding tank, by any of four 500 gpm transfer pumps. Sludge may also flow to the holding tank by gravity.

Methane gas produced in anaerobic digestion is collected in gas domes on each digester and compressed and boosted in pressure for delivery to either flares, the backup hot water heating system, the digester gas mixing system, or for use as fuel at the power generation system.

Dewatering

Biosolids at EBMUD are dewatered using four medium speed Humboldt centrifuges running at 150 gpm. Cationic emulsion polymer is added to enhance dewatering.

Digested sludge flows to the Sludge Dewatering Facilities holding tank, monitored by level probes located in the tank. Alarms are provided to warn the operators of high and low liquid level conditions. If the liquid level should reach a preset high elevation the air operated inlet valve to the tank will close and the digested sludge transfer pumps will stop. If the liquid level drawoff in the tank should reach a preset low level the sludge feed pumps and grinders will stop.

A combustible gas monitor is provided at the sludge well to continuously monitor the atmosphere in the tank. If a combustible gas is detected an alarm is sounded at the Dewatering Station Alarm Panel and at the Meter Room Data Logger. Exhaust fans are provided to ventilate the holding tank.

The sludge is pumped from the holding tank to the centrifuge by four positive displacement, progressive cavity type sludge pumps. Grinders are provided in the line between the pumps and the holding tank to reduce the size of any solids, rags, etc., to prevent clogging the centrifuge.

The sludge feed pumps are equipped with variable speed drives. The speed of the pump operation will be determined by the operation of the centrifuges. One pump serves each centrifuge, each with a magnetic flowmeter. The outputs from each metering system are transmitted to an indicator-recorder, summators and totalizers.

The polymer batching system consists of the polymer storage units, the mixing units, aging units and the associated transfer and feed pumps. The polymer system is equipped to use polymer delivered to the plant in liquid form. The liquid polymer is pumped by two liquid polymer feed pumps to the mixing-aging tanks. No. 2 water is added to the polymer solution in the mixing-aging tanks. The flow of No. 2 water to the polymer mixing-aging tanks is monitored by a metering system.

From the mixing-aging tank the polymer is pumped to the feed tank by the three polymer transfer pumps. The feed tank serves as a reservoir or day tank from which the prepared polymer can be pumped to the centrifuges. The polymer is injected into the sludge line ahead of the centrifuge, or directly into the bowl.

The dewatered sludge is pumped by four variable speed dewatered sludge pumps to the dewatered sludge hopper facility. Trucks receive the sludge from the hoppers for off-site disposal or reuse.

Biosolids

In 1994, EBMUD began applying biosolids to agricultural lands. More than 90 percent of the biosolids generated during wastewater treatment are being applied in California's Central Valley to grow cotton. This work is accomplished through a private contractor at a cost of $16.19 per wet ton, a substantial cost savings to EBMUD, compared with the cost of the District's previous practice of landfill disposal and local composting.

Odor control

Odor control is achieved by adding sodium hypochlorite upstream of the IPS, in the north and south IPS wet wells, after aerated grit, and by dual chemical scrubbers at the IPS and dewatering building. Hypochlorite is also added to the influent of the wet weather storage basins.

Disinfection

EBMUD uses sodium hypochlorite for disinfection and sodium bisulfite for dechlorination. Disinfection occurs downstream from the secondary clarifiers. The effluent discharged to the Bay is allowed no measurable chlorine residual and 500 most probable number (MPN) fecal coliform per 100 milliliters (ml) on a five-day log mean and the 90th percentile value can not exceed 1100 MPN per 100 mls.

The Plant permit for effluent chlorine residual is 0.0 mg/l. The dechlorination system feeds sodium bisulfite, in liquid or gaseous form, into the plant effluent prior to discharge to San Francisco Bay. The liquid fed system performs most of the effluent dechlorination. The liquid feed system consists of two identical feed trains with flow control loops, two liquid injectors, three injector water pumps, and four outfall diffusers. The sodium bisulfite is supplied from liquid storage tanks, that have a vent gas system designed to remove gas build-up from the storage tanks and inject it into outfall. Cross connecting pipes and valves are provided to allow various combinations of injectors and diffusers to be operated together.

The bulk storage system consists of three 15,200 gallon polyethylene tanks located in a concrete containment basin for up to 24 days operation. Each tank and connected piping is insulated and heat traced. A truck unloading station with transfer pumps and associated connections, basket strainers, isolation valves, sump pumps, and control panel are also provided.

Three 600 gpm vertical, dry-pit, non-clog, centrifugal pumps supply effluent to the water injection system. Liquid sodium bisulfite is metered through injectors and delivered to the diffusers. Precise sodium bisulfite metering in maintained by a flow control loop consisting of a flowmeter, two control valves, and controllers. The controllers can use a combination of flow, dosage or residual to apply sodium bisulfite. The flow control loop cycle repeats continuously. There are also provisions for local and remote manual operation of the metering system.

An effluent sampling system consists of one chlorinated effluent analyzer, two redundant final effluent analyzers, and associated pumps and piping. This system provides chlorine and bisulfite residual data for both laboratory testing and process dosage control.

Effluent Pumping

The Effluent Pump Station is located at the western end of the Main WWTP. The EPS consists of an Inlet Chamber, Bypass Outlet Structure, Main Effluent Pump Building, Discharge Transition Channel, and Surge Chamber. The Inlet Chamber is a concrete structure located at the bottom of the EPS. The Inlet Chamber is roughly divided into two components -- the Inlet Channels in the east and the Wet Wells in the west. The Inlet Channels direct the wastewater into the north and south Wet Well. The Bypass Outlet Structure is located on the north side of the Inlet Chamber. During peak wet weather flows, the Inlet Chamber will receive up to 168 mgd of treated Secondary Effluent from the Secondary treatment Process and up to 152 mgd of primary effluent from the Primary Sedimentation Basins via the Bypass Outlet Structure.

The Effluent Pump Station Building is a 3-story structure, with two of the three stories underground. The EPS has four vertical variable speed, non-clog, mixed-flow pumps. Each Pump is rated at 107 mgd at 44 feet TDH. Only three Pumps are required to pump 320 mgd of treated effluent to the Plant Outfall. The fourth Pump is a stand-by Pump. Each Pump has a 48-inch discharge elbow, a check valve, and a butterfly valve. The speed of each Pump is controlled by the Load Commutated Inverter (LCI) Variable Frequency Drives.

There are two (2) Discharge Transition Channels. The North Chamber receives the treated effluent from the EPS either through the North Gravity Discharge Flap Gate or through Effluent Pumps Nos. 1 and/or 2. The South Chamber receives treated effluent from the EPS either through the South Gravity Discharge Flap Gate or through Effluent Pump Nos. 3 and/or 4. Each chamber can be isolated by the Stop Gate at the west end of the Chamber.

There are two (2) Surge Chambers, one for each Discharge Transition Channel. Each Surge Chamber is a vertical concrete structure sitting on the top of the Discharge Transition Channel. The Surge Chamber absorbs and dissipates any surge energy that arises in the Plant Outfall due to changes in the effluent velocity in the Outfall.

Utilities

Plant Utilities include No. 1 Water, No. 2 Water, No. 3 Water, High Pressure Air, Fire Protection, Natural Gas, Steam, Cathodic protection, and Power Distribution.

No. 1 Water in the main WWTP (Plant) is supplied by a 6-inch water main. The supply enters the Plant at the Influent Pump Station into two Air Gap Tanks. The Air Gap Tanks are water storage tanks with an air gap to prevent the backflow of the water into the water main. From the Air Gap Tanks, the No. 1 Water is pumped to two Hydropneumatic Tanks for constant pressure before finally entering the Plant's distribution system.

The Process Water Plant (PWP) supplies No. 2 water in the Plant. Secondary effluent is treated with sand and anthracite filtration and chlorination, and distributed around the Plant for Pump seal water, Cooling water, Landscape water, and Washdown water. Provision is made for using No. 1 Water in case of emergency.

The Secondary No. 3 Water Pump Station taps off the secondary effluent channel between Clarifiers No. 2 and No. 10 by means of a 20-inch line to the wet well in the basement. There are two (2) vertical turbine pumps that serve secondary No. 3 water plumbing. No. 3 water is chlorinated and distributed from the Operations Center to the Oxygen Production Facility for cooling water and Secondary Clarifiers for washdown and flushing water. The Primary No. 3 Water Pump Station consists of three (3) vertical turbine pumps that supplies No. 3 Water to the Digesters, Sedimentation Basins, Dewatering, Thickening, the Wet Weather Primary Sludge Thickeners, the Wet Weather

Storage Basin, and the Post-Chlorination Station. The two pump stations can be interconnected if necessary.

Atmospheric air is compressed to a range of 75 to 110 psig by compressors at three locations at the Plant: the Sedimentation Tank Pipe Gallery near Tanks No. 5 and No. 6, the Digester Gallery near Digester No. 5, and the Operations Center basement. The compressed air is used to operate pneumatic eccentric plug valves, valve controllers, supply air to bubbler control systems, temperature control systems, and laboratory service outlets.

The Fire Protection System provided to the main WWTP a 10-inch water supply system and hydrant and a Halon Fire Protection System in the Operations Center. The Halon Fire Protection System in the Operations center includes modifications to the system in the Computer Room and the Control Room of the building and consists of Halon cylinders, discharge nozzles, smoke detectors, horn/strobe light and manual pull stations.

The Plant is served by a 1 1/2-inch natural gas line that enters the Plant on the east side of the Wet Weather Grit Dewatering Building. The Laboratory at the Administration/Laboratory Building is served by a 2-inch diameter line that is routed from the Grit Dewatering Building south to the south side of the Oxygen Production Facility, then east in the roadway on the south side of the Reactor Deck to the west side of the Laboratory. Natural gas is also distributed to the south side of the Primary Sedimentation Tanks at the Primary Sedimentation Blower Building to serve the steam generator.

A steam system is located in the Primary Sedimentation Blower Building. The system is comprised of a water boiler, steam accumulator, hot well, blow-down separator, chemical mix tank, automatic controls for water softener and brine tank. The steam system generates high pressure steam for distribution to: Eleven cleaning stations on the catwalk above the Primary Sedimentation Tank, five cleaning stations in the north Pipe Gallery for cleaning the Primary Sedimentation Facilities, and the Scum Handling Facilities for cleaning the facilities.

Due to the corrosive nature of the site soils, an effective Cathodic Protection system is vital for the prevention of electrochemical corrosion in buried metal pipe and fittings. Cathodic Protection is the process of directing corrosion to a designated sacrificial magnesium material.

The Plant Power System is arranged so that total plant operation cannot be jeopardized by the loss of a single power source, feeder cable, or pierce of electrical equipment. The majority of plant loads are energized from dual feed unit substations, which can be powered from either of two or three busses of the main plant 4,160 volt distribution switchgear. Though failure of either bus or feeder will take a unit substation out of service, power can be quickly manually re-routed from the alternate bus or feeder.

The plant receives 12,470 volt electrical service from two 3 phase, 60 hertz Pacific Gas and Electric (PG&E) lines (designated as PG&E Line No. 1 and PG&E Line No. 2) connected to Switchgear H1 (SWGR H1) via an underground conduit. SWGR H1 consists of two 12,470 volt main circuit breakers that control the flow of power into the plant. A third PG&E line, controlled by PG&E, backs up either of the two primary PG&E lines and normally can be switched into service (by PG&E) to feed either PG&E Line No.1 or PG&E Line No. 2 within ten minutes of PG&E failure.

The two SWGR H1 12,570 volt main circuit breakers are connected to two Main Plant transformers converting the incoming PG&E service to 4,160 volts where it feeds plant Switchgear.

The plant also generates 4,160 volt electrical service at the plant Power Generation Station (PGS)that is connected to the 4,160 volt Power Generation Station Switchgear. Under emergency conditions, the engine-generators can be run on diesel fuel to supply power to the plant.

The 4,160 volt service from SWGR M1 is distributed to numerous switchgear panels (SWGR) and unit substations (SUB).

Under normal conditions, the total plant load is divided between the two PG&E lines with added load on the PG&E line that is operating in parallel with SWGR PGS. Each of the switchgear panels and unit substations (except SUB U22) can be fed from either of two SWGR M1 circuit breakers.

PG&E has a load limit on each of the two line (PG&E Line No. 1 and PG&E Line No. 2), which must not be exceeded under normal conditions. PG&E Line No. 1 has a load limit of 400 amps at 12,470 volts (1,200 amps at 4,160 volts). PG&E Line No. 2 has a load limit of 550 amps at 12,470 volts (1,650 amps at 4,160 volts). The third PG&E line has a load limit of 400 amps at 12,470 volts (1,200 amps at 4,160 volts). In the event that any of the limits are exceeded, the automatic load shedding system will automatically reduce the load on the affected source line.

To prevent inadvertent operation of main circuit breakers and switches that would parallel two sources, a system of Kirk Key interlocking is used. Each of the main circuit breakers or switches in the system has a lock for which only a limited number of Kirk Keys are available.

Automation

The Treatment Facilities have a distributed control system (DCS) extending throughout the Main WWTP and to remote Dechlorination Facility, wet weather treatment facilities, pump stations and interceptor monitoring stations. The DCS units at all locations are interconnected to form an integrated system. Each process area has its own local process control units with no dependency on a central unit. The Operations Center at the Main WWTP is part of the distributed system and other process areas have not dependency on it.

DCS units at the Main WWTP are interconnected by a redundant data highway, consisting of two co-axial cables. All units connect onto both cables, but only one is needed for communication. This provides very high reliability since one is redundant acting as a standby. The communication speed is very high and communication is almost instantaneous.

A DPU, an industrial computer, is distributed to the process area that it serves. The DPU can perform all the monitoring and control functions of an instrument panel, except that instead of displaying data, it stores it in its database. It constantly updates its database with current values or alarms.

Each DPU on the data highway takes a turn at broadcasting data from its database over the data highway to all other units on the highway. The individual distributed databases thus form a global database -- one that is globally available anywhere on the highway. Each DPU will have access to the highway every second and will update point data according to pre-determined criteria. Point data can be set to be broadcast every second, or on request. Global data on each highway can include 16,000 regularly broadcast data points and 16,000 on request data points every second.

Each DPU also monitors the highway for information relating to its database, e.g., alarm acknowledgements, change of control set points, or manual process operations. If a DPU is isolated from external communication, it will continue to perform its automatic control functions unaffected. DPUs which are used for process monitoring and control are in redundant configuration for increased reliability.

Operator or Engineer Consoles are computers dedicated to providing the Man-Machine Interface (MMI). They perform the functions of an instrument panel face - display, control or configure, but with greater sophistication. Each Console is configured with the graphic screens required to monitor and control its assigned process area. The graphic screens provide static background information which, when displayed, have current "dynamic" data added. Each Operator Console monitors the highway and collects current data that is required for its current display, all its trend displays, and its alarm lists. Current data is repeated on the highway once every second.

A VAX system stores historical process data for the purpose of compiling reports of process operation and statistics. The VAX system comprises two VAX computers in redundant configuration. On one side, they can be accessed by VAX terminals (CRTs) via a terminal server and Ethernet highway. On the other side, they can be accessed by the DCS via the DCS data highway and a redundant VAX Interface (VXI).

The VXI is a computer, which translates between the DCS communication protocols and those of the VAX. The VXI contains a database, which has been configured for data that the VAX requires. The VXI monitors the DCS highway and collects the current data required by the VAX into its database. The VXI transfers this data to the VAX at the required intervals.

The VAX stores repeated sets of current data in its historical database, time and date stamped. As data becomes older, the VAX may compact it to save storage space by such means as data averaging. Data averaging can typically use minute, 5 minute, hourly or daily values.

Transfer of data from the VAX to the DCS is limited to that required for trend displays -- graphs showing how process values have varied over time. A request from the Operation Console for a particular trend is received by the VXI, translated, and sent to the VAX. The data from the VAX is received by the VXI, translated, broadcast on the DCS highway, and received by the Operator Console.

Power/Energy

The Main Plant includes a 4.2 megawatt firm capacity power generation station that recovers 85 percent of the energy available from methane gas produced in the sludge digestion process. This energy provides approximately half of the treatment plant's power needs.

KING COUNTY DEPARTMENT OF NATURAL RESOURCES

East Section Reclamation Plant at Renton

General and Plant Process Description

The East Section Reclamation Plant (ESRP) is a 72-mgd, air activated sludge secondary plant with primary sedimentation and chlorine disinfection. It serves a 140-sq mi area with a population equivalence of 600,000. The plant discharges to the Puget Sound via a 12-mile force main. The basic effluent requirements are 30-mg/L BOD, 30-mg/L TSS, 200/100-ml fecal coliform bacteria and 0.5-mg/L total residual chlorine. No nutrient removal is required.

Figure 1 is a process schematic of the ESRP. Unique features of the plant include:

High rate primary clarifiers (High overflow rate and continuous sludge withdrawal)

Anaerobic selector for SVI control in secondary process

Deep secondary clarifiers (18 feet)

The "One Plant Concept" (All flows are combined after each unit process)

Co-thickening of primary sludge, scum and WAS in DAFTs.

Continuously fed digesters, followed by a blending storage tank

Scrubbing of digester gas for sale to gas utility
Heat pumps for digester and plant heating

During 1997, the ESRP was in the midst of an enlargement to increase its design capacity to 115 mgd and its peak capacity to 340 mgd. Four primary sedimentation tanks were added to the eight existing tanks. A fourth aeration tank was completed. This, along with new aeration blowers and diffusers, and mixers and baffles for anaerobic selector capability, increased secondary reactor capacity by 50%. Four secondary clarifiers were brought on-line for a 25% increase in secondary sedimentation capacity. These additional facilities increased ESRP's capacity to 103 mgd for the last half of 1997. In the solids stream, two new dissolved air flotation thickeners (DAFTs) were added in August 1997.

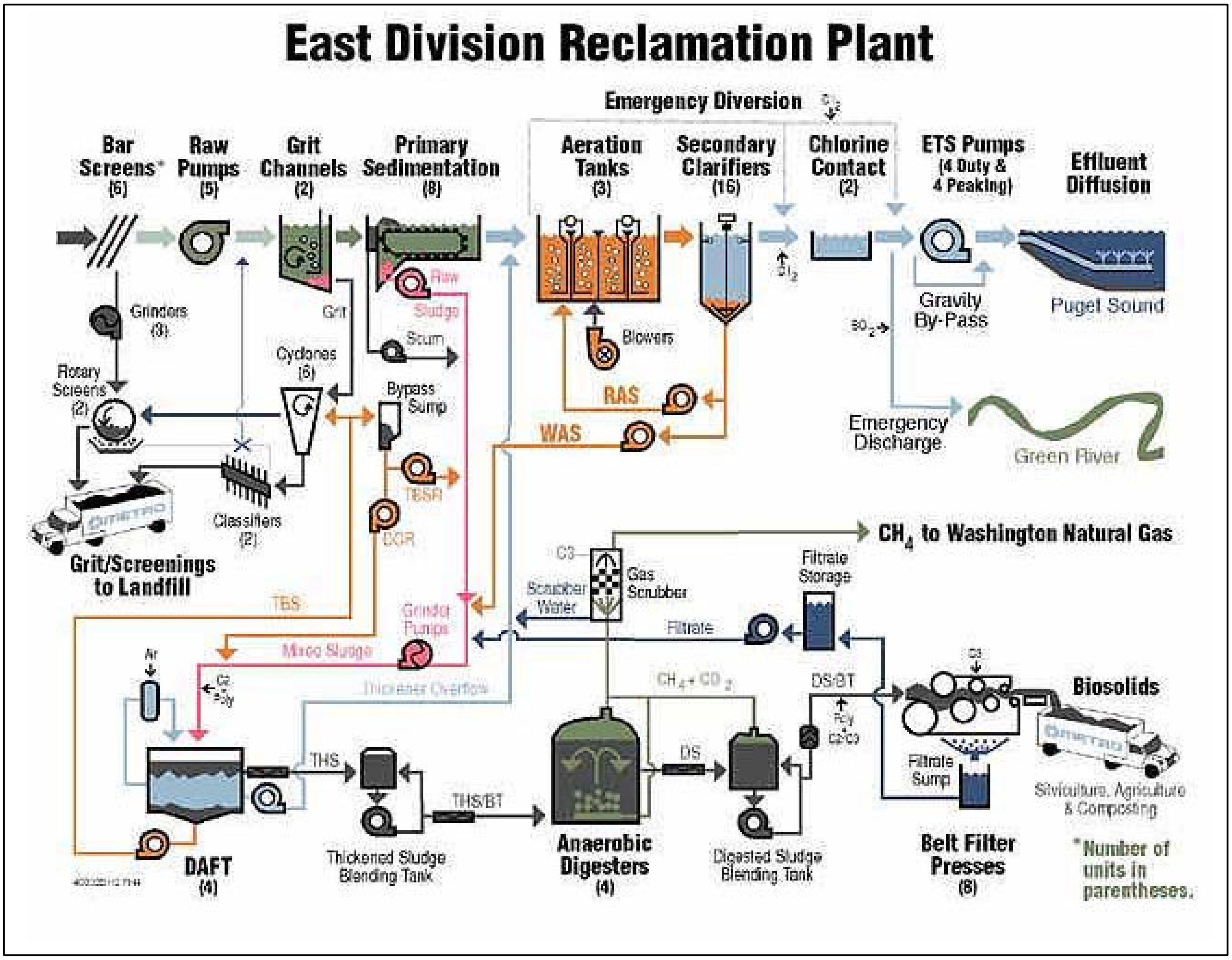

FIGURE 0-1 ESRP PROCESS SCHEMATIC

<u>**Collection System**</u>

The ESRP is mainly served by a separated sanitary sewer system. However, a significant amount of inflow and infiltration occurs due to past construction practices and high water tables in the collection area. Summer flows are 50 to 70 mgd and nonstorm winter flows are 90 to 110 mgd. Storm-influenced 24-hour flows reached 210 mgd in 1997 with sustained peaks as high as 280 mgd.

ESRP's collection system basically is comprised of two major interceptor trunks (ending at 108-inch and 96-inch-diameter pipes) and 21 Pumping Stations.
The collection system is relatively long, with summer travel times up to 24 hours.
Two connection points between the West Point Treatment Plant collection system and ESRP's system allows some flows (5-20 mgd) to be switched between systems.

Headworks and Influent Pumping

The ESRP has a 120-inch-diameter influent sewer and four hydraulically operated influent gates leading to four 72-inch-diameter raw sewage conduits. There are five variable speed non-clog centrifugal influent pumps downstream of the bar screens. Three of these pumps have a 100-mgd capacity, one has a 62.5-mgd capacity and one has a 37.5-mgd capacity.

Preliminary Treatment

ESRP has six mechanically cleaned bar screens, each 6-ft wide. Four screens have 3/8-inch spacing between bars and two have ¾-inch spacing. Screenings drop into a sluiceway where they are flushed into a sump. Three screw centrifugal pumps pump the screenings to two 2,000-gpm rotary overflow screens. Dewatered screenings drop into a hopper with the grit. Grit and screenings are hauled to a landfill every 2 to 3 days.

There are three covered 0.4-MG preaeration tanks and 17 pumps for grit removal. Twelve of the grit pumps run at any one time. The grit is pumped to cyclone separators. The thickened bottom sludge from the DAFTs is also pumped to cyclones. The cyclones discharge to two rotary screw grit dewatering units. The 4,526 wet tons of grit and screenings were removed in 1997. The 1997 Disposal costs were $80 per wet ton.

Primary Treatment

The ESRP has 12 primary sedimentation tanks, divided into two sides--north and south. Four newly constructed tanks are on the north side and eight tanks are on the south side. The influent pumps discharge into a covered division channel that distributes flow to each side. The flow to each side is controlled using primary tank level, and the level is controlled by two butterfly valves in the discharge channel for each side. The division channel can also be split so that flow can be distributed by which raw sewage pumps are on-line.

The primary sedimentation tanks are uncovered rectangular tanks, 34 feet wide, 164 feet long, and 9 feet deep. The design overflow rate (OFR) at average wet weather flow (AWWF) is 1,720 gallons per day per square foot (gpd/sf) and at peak wet weather flow (PWWF) is 4,860 gpd/sf. The maximum hydraulic capacity of each primary tank is 32.5 mgd. Sludge is removed continuously from the primaries, averaging about 8,000 mg/L solids. Primary effluent is collected via a launder with submerged orifices and overflow weirs and flows to a covered collection channel.

The north primaries have reinforced thermoplastic resin drive and collector chains and fiberglass flights. The south primaries have steel drive and collector chains and wooden flights. (These are being replaced with non-metallic chain and flights in 1998.)

The north primaries have midpass baffles and use the return flights and tipping troughs for scum collection. The south primaries use counterflow surface spray water with a spiral collector scum collection system at the head end of the tank. There are two recessed impeller centrifugal pumps for the north primary scum and four progressive cavity pumps for the south primary scum.

Secondary Treatment

The ESRP has an air activated sludge secondary process with anaerobic selector for SVI control. SRT is approximately 3 days in the summer and four days in the winter. The secondary aeration tanks can be operated in plug flow or contact/reaeration modes. The MLSS ranges from 1,400 to 2,000 mg/L, and the hydraulic retention time from 3.5 to 5 hours.

Secondary aeration is provided by nine aeration blowers: four single-stage, mixed-flow 23,300 cfm Turblex blowers, two single-stage, radial-flow 14,000 cubic feet per minute (cfm) blowers, two multistage 14,000 cfm blowers and one multistage 23,300 cfm blower. The aeration tanks use a full-bottom grid diffuser system with Sanitaire 9-inch fine-bubble diffusers with EDPM membranes.

There are four aeration tanks consisting of four passes each. Each pass is 30 feet wide by 317.5 feet long by 15 feet average water depth, resulting in a total volume per tank of 4.27 million gallons. The first two passes of each tank have baffles at the quarter length marks, and seven low-speed submersible propeller mixers for selector operation.

The plant has 16 secondary sedimentation tanks (20 by July 1997) divided into four pods of four tanks each. All of the tanks have submerged launders. The four tanks of a pod discharge to a common magnetic flow meter and flow control butterfly valve. The butterfly valves control flow using both an aeration tank level setpoint and a pod flow setpoint. One of the four pods has four 100-foot-diameter peripheral-feed tanks with a sidewater depth of 14 feet. These tanks have a design OFR at AWWF of 687 gpd/sf and at PWWF of 1050 gpd/sf. The remaining tanks are 100-foot-diameter center feed tanks with a sidewater depth of 18.2 feet. They have a design OFR at AWWF of 610 gpd/sf and at PWWF of 1,400 gpd/sf . The tanks generally operate at 600 to 800 gpd/sf.

RAS is withdrawn from the secondary sedimentation tank floor through six orifices in the sludge remover ("Towbro" design). The Towbro sweep arm makes a rotation every 40 minutes. Each secondary sedimentation tank has two RAS pumps. Each is variable speed, nonclog centrifugal pumps with a range of 250 to 2,500 gpm.

The philosophy of operation of the ESRP secondary process is to avoid nitrifying and to pass peak storm events through secondary by switching to step feed and contact/reaeration operation.

Sludge Thickening

ESRP had four 55-foot-diameter DAFTs. In August of 1997, two 65-foot-diameter DAFTs came on-line and the four smaller DAFTs went off-line for refurbishing. The DAFTs have a sidewater depth of 11 feet

Primary sludge, scum and WAS are co-thickened in the DAFTs. Polymer is added to improve thickening and clarification; clarified effluent turbidity is used to control polymer addition. Bottom sludge from the DAFTs is degritted in grit cyclones and returned to the DAFTs as part of the mixed sludge feed. Clarified underflow from the DAFT is returned to the activated sludge system. In 1997, the mixed sludge feed averaged 6,450 mg/L total solids (TS), the solids loading rate averaged 24 lb/ft^2/day, and the thickened sludge produced averaged 6.44% TS with a volatile solids content of 80.1%. The thickened product from each DAFT is blended in a storage tank before being pumped to the anaerobic digesters. The thickened sludge-blending tank provides 1 to 2 hours detention time.

The polymer system for the DAFTs is capable of utilizing either mannich or dry polymer. In 1997, a number of different dry polymers were used. The majority of the time Cytec 453 and Cytec WP1002 were used. Cytec 453 and Polydyne 3860 were also used for approximately 1 month each. Polymer dose averaged about 2.5 lb/dry ton in 1997.

Digestion

The plant has four 100-foot-diameter mesophilic anaerobic digesters with an average sidewater depth of 43.5 feet. With floating covers that can travel 5.5 feet, each digester can hold up to 2.8 MG. Thickened sludge is continuously pumped to the digesters with dedicated feed pumps. The digesters are continuously mixed using digester gas recirculation (gas compressors send gas through diffusers located on the digester floor) and digested sludge recirculation. Each digester has a 900-gpm sludge pump that recirculates sludge from side to side and a 1,200-gpm pump that recirculates sludge from the bottom of the digester to the top. Both recirculation loops have in-line grinders. The 900-gpm-recirculation loop passes through a 1.75-million Btu/hr heat exchanger. Four 6-million Btu/hr heat pumps (water to water) extract heat from plant effluent and provide heat for the digesters and plant facilities. Digested sludge is withdrawn from the recirculation line that draws from the digester bottom. During 1997, only three digesters were in service at any one time.

1997 average digester operating conditions:

Feed TS (Thickened sludge):	6.44%
Feed VS/TS Percent:	80.1%
Digester Operating Temperature:	97°F
Digester pH:	7.6
Solids Detention Time:	28.2 days
Solids Loading Rate:	0.12 ppd VS per cubic foot
Digested Sludge TS:	3.05%

Digested Sludge VS/TS Percent: 61.0%

Volatile Solids Reduction, %: 58.7%

Digested sludge from the four digesters is continuously pumped to fixed-cover digested sludge blending storage tank (DS/BST - 2.75 MG capacity). In 1997, the detention time in the DS/BST averaged 4.4 days. Usually, the DS/BST is not heated, but the capability exists for heating, e.g., if there are problems with another digester. For most of 1997, the DS/BST temperature was 95°F or below. Because this temperature is still relatively high, additional digestion and gas production occur. For 1997, this ranged from about four to 10% VS reduction. The DS/BST is mixed in the same manner as the digesters - gas recirculation and digested sludge recirculation. The mixing pump that draws from the bottom of the DS/BST recirculates through the dewatering area and back. The floating covers of the digesters and blending storage tank provide flow equalization and storage prior to the dewatering process.

Dewatering

Dewatering is performed with 2.2-meter Andritz SMX belt filter presses. Feed is drawn from one of the DS/BST recirculation lines. Eight presses are available, but only four were usually in operation at sludge feed rates of 45 to 55 gpm per press. Polymer is added to the digested sludge feed just prior to the presses. Plant effluent is used to clean the belts. Filtrate can be returned to the aeration tanks or the DAFTs. In 1997, the belt press feed sludge averaged 3.05% TS, and the dewatered cake averaged 21.24% with a VS/TS of 62.8%. Polymer use averaged 25 lb/dry ton. Polydyne 3885 polymer ($1.80 per pound) was used in 1997. Solids capture averaged 93%. (%Capture = 100 * (lb dry solids fed - lb dry solids in filtrate)/lb dry solids fed.) Dewatered cake is transferred by conveyer belts directly to trailers, which the operators move with a yard tractor. Cake storage is provided by an inventory of trailers.

Biosolids

The King County biosolids management program is an in-house program that uses contract hauling. The 100% of the biosolids are recycled. The biosolids are hauled to various agricultural and forest land application sites. These sites include hops fields in Yakima County and wheat fields in Douglas County (both in Eastern Washington), forest application in Western Washington, and 10% to a local company which uses it to produce a Class A compost for commercial sale.

A total of 58,480 wet tons (12,425 dry tons) of biosolids were hauled from the ESRP in 1997.

Odor Control

In 1997, odor control at the ESRP consisted of prechlorination, and activated carbon adsorption for the septage facility, the DAFT tanks and the dewatering building. Upstream of the plant, caustic soda dosing is the primary means of odor control. (Four new wet-scrubbing systems built in 1996 and 1997 were not on-line in 1997.)

Prechlorination is usually practiced between May and September with dosing rates averaging 2-4 mg/L of chlorine.

ESRP's new air permit will require ESRP to have no more than five odor units at the plant's fenceline, and will set H_2S discharge limits on the four odor control units. ESRP is not located in a residential area, but our neighbors are increasing in numbers and proximity. ESRP's goal is zero odor complaints and its policy is to respond quickly to any complaints we receive.

Disinfection

The ESRP uses 90-ton railcars of chlorine for disinfection. Chlorine is applied at the control valve of each Secondary Pod using a feedback residual control setpoint and an in-line diffuser. Chlorine dose averaged about 3.5 mg/L in 1997. The plant used four and a half 90-ton railcars. The cost of chlorine in 1997 was $330 per ton. Hach colorimetric residual analyzers measure chlorine residual.

The ESRP permit requires a fecal coliform count of 200/100 ml, and a Cl_2 residual (monthly average) of .66 mg/L and 787 lb/day. The maximum daily residual concentration permitted is 1.7 mg/L. The chlorine reactions that take place in the 12-mile outfall make these requirements easy to meet without dechlorination. ESRP does have SO_2 available in the event of an emergency discharge to the Green River outfall.

Effluent Pumping

The ESRP effluent transfer system (ETS) consists of a pumping station and a 12-mile long, 8-foot inside diameter, reinforced concrete force main from the plant to the Puget Sound. The pumping station is designed for a discharge head of 150 feet. The firm capacity of the ETS is 225 mgd at low tide and 255 mgd at high tide. The gravity flow capacity of the ETS is 40 to 60 mgd. The outfall consists of two 64-inch pipes that extend 10,000 feet into the Puget Sound that each end in a 500-foot diffuser. The diffuser depth is 580 feet below mean sea level. Sustained peak flows as high as 280 mgd were pumped in 1997 with all four peaking pumps operating.

Utilities

The ESRP has six water systems:

Potable city water – supplies sinks, toilets, drinking fountains, etc.

Nonpotable city water – used for seal water, equipment cooling and polymer makeup.

City water for fire protection

Final Effluent – supplies disinfected final effluent at 15" WC pressure to the ESRP's high and low pressure plant effluent systems, heat extractors and chillers, DAFTs, and digester gas scrubbers.

Final Effluent Low Pressure - provides large volumes of water at 60-psi for flushing lines, sprays, equipment cooling and belt filter press cleaning.

Final Effluent High Pressure – provides 105-psi water for chlorination, washdown, plant irrigation and utility stations.

A water reuse facility was completed in 1997, but it was not run for an appreciable amount of time during the year. The "Class A" water from this facility can be used in place of nonpotable city water and for plant irrigation.

The ESRP also has two air systems:

Service air – supplies compressed air at 115-psi for control valve operation, DAFTs, pneumatic tool operation, and utility stations.

Instrument air – Provides clean, dry, compressed air to operate process instruments and controls and to supply the laboratory air needs. The instrument air system operates at 70 psi.

The ESRP electrical system consists of two similar power distribution subdivisions. Under normal operating conditions, they are separate and each provides electricity to about half of ESRP's equipment. Each subdivision is fed by a tap-line to Puget Power's 115 kV line. The voltage is reduced to 12.5 kV before the first switchgear bank is encountered. Multiple feeders extend from this switchgear to other switchgear and transformers throughout the treatment plant. In each area of the plant are tie circuit breakers between the two switchgear busses that can be closed in the event of a loss of power to one bus.

Automation

In general, the plant automation system was designed as a three-layer system consisting of local control, backup panel control, and computerized control. Each layer of automation adds increasing functionality and requires the lower layer to be operational. Local controls generally are hardwired ON/OFF switches. Backup panel controls include PLCs, analog controllers and alarm panel displays. The computerized control system works in conjunction with the backup panels and provides advanced control features and archiving of plant operating data. Backup panel controls must be operated from the area control centers while computerized control allows for operation from a centralized control room as well as local area operation if necessary.

Power/Energy

The ESRP relies on power from Puget Sound Power and Light Company. The ESRP is supplied from two physically separated substations, either one of which can carry the entire plant load. Loss of primary power to the ESRP could result from simultaneous faults on both legs of the 115 kV line but this is extremely unlikely.

There is a 400-kW diesel-powered essential services generator in the ESRP that provides emergency power to safety related equipment such as lights and sump pumps in the event of a primary power loss.

The ESRP digesters produce about 1.4 million ft^3/day of digester gas. The digester gas is scrubbed and sold to the local natural gas utility. The scrubbing system consists of two 600,000 standard ft^3 per day (scfd) compressors, a scrubbing tower and a dryer. During 1997, the gas scrubbing system was expanded to double its capacity to 2.4 million scfd. Due to this construction, the scrubbing system was off line for approximately 2 months during the year. Digester gas that is not sold, is flared. When the scrubbers were on-line, daily scrubbed gas production averaged 0.6 million scfd in 1997.

King County West Point Treatment Plant

General Description

The West Point Treatment Plant (WPTP) is a 133 mgd (design average wet weather flow) HPO activated sludge secondary plant with primary sedimentation, chlorine disinfection, and dechlorination. It serves a 126 sq. mi. area with a population equivalence of 670,000. The plant discharges to the Puget Sound via a 3650 foot long, 240 foot deep outfall. During the typically wet months of November through April, the basic effluent requirements are 30 mg/L BOD, 30 mg/L TSS, 200/100-ml fecal coliform bacteria and 0.216 mg/L total residual chlorine. From May through October, an 85% removal requirement for BOD and TSS is also in effect. No nutrient removal is required.

Collection System

WPTP receives wastewater from the West Division Collection System, a series of sanitary and stormwater sewers, related trunks and interceptors, and pump and regulator stations. Two influent tunnels -- the 144" Fort Lawton Parallel tunnel and the 132" Old Fort Lawton tunnel -- bring the collected wastewater into WPTP. The tunnels also provide a place for storing wastewater.

The flow through the West Division Collection System is monitored and controlled automatically by CATAD, the computer augmented treatment and disposal computer system. By controlling wastewater flows in the collection system, CATAD minimizes surges and combined sewer overflows.

Summer flows are typically 60 - 100 mgd and non-storm winter flows are 70 -120 mgd. Storm-influenced daily flows reached 377 mgd in 1997 with sustained peaks as high as 440 mgd.

Two connection points between the West Point Treatment Plant collection system and ESRP’s system allows some flows (5-20 mgd) to be switched between systems.

Headworks

The two influent tunnels feed an influent control structure that discharges into four 72-inch side raw sewage conduits. There are four variable speed methane/propane driven raw sewage engines that power non-clog centrifugal influent pumps downstream of the bar screens. The pumps have a capacity of 120 mgd each.

Preliminary Treatment

The Plant has six mechanically cleaned, climber-type bar screens, each six foot wide. The screens have vertical bars spaced 5/8-inch apart. The screenings drop into a sluice way where they are transported to be re-screened by a Hycor step screen. The screenings are then pressed by a hydraulically driven ram press and dropped into a 20 yard dumpster.

There are four covered 0.35 MG preaeration tanks and 20 pumps for grit removal, five per tank. The grit is pumped to cyclone separators, two separators per five pumps. The cyclones discharge to four rotary screw grit dewatering units.

The Plant removed 4684 wet tons of grit and screenings in 1997. 1997 hauling and disposal costs totaled $448,000.

Primary Treatment

The WPTP has twelve Primary sedimentation tanks, six per side. The influent pumps discharge into a covered division channel which distributes the flow to each side. The flow is then split to each side's two preaeration tanks. From the preaeration tanks, the flow will enter a distribution channel which allows flow to enter any of the six Primary sedimentation tanks on each side.

The Primary sedimentation tanks are covered rectangular tanks, 38 feet wide, 254 feet long, and 10 feet deep. The design overflow rate at Average Wet Weather Flow (AWWF) is 1148 gal/day/ft2 and at Peak Wet Weather Flow (PWWF) is 3799 gal/day/ft2. The maximum hydraulic capacity of each Primary tank is 110 mgd. Sludge is removed continuously from the primaries, averaging 2.6% solids in 1997. Primary effluent is collected by submerged effluent launders and flows into each side's covered collection channel. A large weir gate at the end of each primary effluent channel controls the water level in the sedimentation tanks.

Each tank contains two longitudinal sludge collectors that continuously move sludge along the bottom of the tank, towards the sludge hoppers at the head of the tank. The collectors have plastic chains and wooden flights. A helical screw cross collector in each tank then moves the sludge into the sludge hopper, from where it is pumped out.

As the collectors return to the back of the tank, they rise to the surface of the wastewater to push floatables towards the scum trough. Helical scum skimmers operate periodically to push scum towards and into the scum trough. The scum trough bridges the six tanks on each side and flushes the scum to a collection sump. The sump is periodically decanted with a centrifugal pump, one per sump. The scum is pumped by one of two progressive cavity pumps on each sump.

Intermediate Pump Station / Flow Diversion Structure

West Point is designed to handle a peak combined sewer flow of 440 MGD, but only 300 MGD through Secondary treatment. Primary effluent flows to the flow diversion structure (FDS). From the FDS, up to 300 MGD is sent to the intermediate pump station to be pumped on to the aeration trains. The remainder is diverted to disinfection (chlorination).

Secondary Treatment

The WPTP has an HPO activated sludge Secondary process. SRT is 1.5 to 2.5 days in the summer and 2.5 to 4.0 days in the winter. The Secondary aeration trains can be operated in plug flow mode or one of three "degrees" of contact/reaeration modes (75/25, 50/50, 25/75). The MLSS averages 1000 to 2000 mg/L, and the HRT is 4.8 hours at 133 MGD with a 40% Return rate. Design capacity for Secondary treatment is 300 MGD; flows in excess of 300 MGD (design peak Plant flow is 440 MGD) receive Primary treatment, then are diverted around Secondary to be disinfected and dechlorinated.

Secondary aeration is provided by mechanical mixers, one in each stage of each train; the mixers in stages 1 and 4 are single speed, the mixers in stages 2 and 3 are two-speed.

Oxygen for aeration is generated on site in two Vacuum Swing Adsorption (VSA) trains, each rated at 70 tons per day. Liquid oxygen is trucked in and stored on site for supplemental use, or if the VSA trains are out of service.

There are six covered aeration trains, consisting of four stages each. Each stage is 56 feet wide by 56 feet long with an average water depth of 25 feet, resulting in a total volume per train of 2.35 million gallons.

The Plant has 13 circular Secondary sedimentation tanks, each 16 feet deep with a diameter of 142.5 feet. The tanks have a mixed liquor distribution box, a scum collection sump, V-notch weirs with weir chlorination system, and RAS pumps. Overflow rates are 641 gal/day/ft^2 at 133 MGD and 1447 gal/day/ft^2 at 300 MGD.

RAS is collected via submerged, rotating suction headers. Each Secondary sedimentation tank has two RAS pumps. They are variable speed, non-clog centrifugal pumps with a flow range of approximately 800 to 3900 gpm.

The philosophy of operation of the WPTP Secondary process is to keep Secondary biomass in the system by switching to contact/reaeration operation during prolonged or repeated peak storm events, or at times of Secondary process upset.

Disinfection

The WPTP uses chlorine for disinfection. The chlorine is applied at the head of each of four chlorine contact channels using a feedback residual control setpoint. The chlorine dose is generally about 3.5 mg/L. The Plant used 600 tons of chlorine in 1997, at a cost of $322 per ton.

The WPTP NPDES Permit limits the average monthly fecal coliform count to 200/100 ml, and the weekly average count to 400/100 ml. The monthly average Cl_2 residual limit is 0.216 mg/L, with daily limits of 0.546 mg/l and 387 lb/day. Chemical dechlorination (sodium bisulfite) is utilized.

Effluent Pumping

The WPTP effluent pump station consists of four vertical, non-clog centrifugal pumps rated at 150 MGD each, which discharge to the marine outfall in Puget Sound. Effluent can be discharged via gravity flow during favorable flow and tide conditions.

Overview Of the Solids Handling Processes

Solids handling processes treat the sludge and scum removed from the Primary and Secondary wastewater treatment processes at WPTP.

Primary sludge collected from twelve Primary sedimentation tanks and waste activated sludge from thirteen Secondary clarifiers is blended together in the raw sludge blend tank (RSBT). From the RSBT, the solids are thickened by gravity belt thickeners prior to being pumped from the Thickened sludge blend tank (TSBT) to one of six anaerobic mesophilic digesters. Following digestion, digested solids are dewatered by one of four centrifuges and hauled to land application sites by truck.

An additional Thickening process, recuperative thickening, can be used to increase the SRT (or solids handling capacity) of the digesters during periods of high hydraulic loadings. In this process, digested sludge is fed, via the digested sludge loop, into the recuperative thickening centrifuge, then pumped to the primary digesters.

The side streams from all the Solids processes are recycled back through the Plant via gravity flow.

Polymer is added to the sludge during Thickening and Dewatering processes to facilitate the removal of water.

Sludge Thickening

Primary sludge, WAS, and Secondary scum are mixed in the RSBT, then co-thickened on 3-meter gravity belt thickeners. Ten belts are available for operation, although in 1997 only four belts were typically in service at any one time. In 1997, 37,946 tons of sludge feed was processed. The average feed solids was 1 percent total solids and thickened to an average total solids content of 5.4 %TS, 76.9 %VS. Primary scum is pumped directly into the digester feed line.

The polymer system for the gravity belt thickeners is capable of utilizing mannich, emulsion, or dry polymer. In 1997, a mannich polymer was used. For 1997, the polymer dose averaged 3.2 lb active/ton.

From late February to late April of 1997, the Thickening process was modified to thicken waste-activated sludge only. The Primary sludge was thickened within the Primary sedimentation tanks and pumped directly to the digesters, bypassing the RSBT. This process modification was made to provide a combination of digested sludge and waste-activated sludge for process testing by the onsite privatized sludge drying facility.

Digestion

The Plant has five 100-foot diameter, floating cover, conical bottom, mesophilic anaerobic digesters with a sidewater depth of 35.5 feet at maximum operating depth. A sixth digester has a fixed cover, but is otherwise of the same dimensions. The maximum total volume of each digester is 2.1 MG. Each of the five primary digesters cycles between feed, recirculation, and transfer (drawdown). Digested sludge is transferred to the blend/storage (secondary) digester. Sludge is removed from the blend/storage digester, and pumped via the digested sludge loop to the Dewatering centrifuges. The sludge not fed to the centrifuges is returned to the blend/storage digester. All digesters are continuously mixed using digester gas recirculation and digested sludge recirculation. Heat exchangers in the digester feed line and in the recirculation lines raise the digester temperatures to 96 degrees F.

1997 average digester operating conditions:

Feed TS (Thickened sludge):	5.41%
Feed VS/TS Percent:	77.0%
Digester Operating Temperature:	96°F
Digester pH:	7.4
Solids Detention Time:	27.2 days

Solids Loading Rate:	0.10 ppd VS per cubic foot
Digested Sludge TS:	2.8%
Digested Sludge VS/TS Percent:	56.2%
Volatile Solids Reduction, %:	60.3%

Dewatering

Dewatering at West Point Treatment Plant is performed by four centrifuges, one of which is a high solids (HS) unit. Digested sludge is withdrawn, via the digested sludge loop, to feed the centrifuges. On a routine basis, the HS unit is run at a feed rate of 150 gpm and the regular centrifuges are run at a feed rate of 150 – 250 gpm. Polymer injection into the sludge feed can be external/internal for the HS unit and internal for the regular units. Centrifuges are taken off line and flushed with plant effluent after two consecutive days of operation. The centrate stream can be returned to the headworks or to the Primary effluent flow stream. Dewatered cake is transferred by a series of conveyers to trailers under loading bays. Loading of dewatered cake is fully automated. Upon reaching the pre-set gross weight for a trailer under a bay, loading of an empty trailer under the other bay begins. Operators move the completed trailers with a yard truck to the staging area. In 1997, the dewatering feed TS averaged 2.78%, and dewatered cake averaged 21.07% with a VS content of 55.74%. Polymer use averaged 74 lbs (neat)/dry ton feed solids. Solids capture averaged 92%. An emulsion polymer was used.

Biosolids

The King County Biosolids Management program is an in-house program which uses contract hauling. 100% of the biosolids are recycled. The biosolids are hauled to various agricultural and forest land application sites. These sites include hops fields in Yakima County and wheat fields in Douglas County (both in Eastern Washington), forest application in Western Washington, and 10% to a local company which uses it to produce a Class A compost for commercial sale.

A total of 14,888 dry tons of solids were hauled from West Point in 1997. Of this total, 13,438 dry tons (63,788 wet tons) were processed through the West Point (King County) facility. The remainder, 1450 dry tons, was processed at the onsite privatized sludge drying facility.

Power/Energy

The WPTP relies on power from Seattle City Light. The Plant is supplied from two physically separated substations, either one of which can carry the entire Plant load. In the event of loss of power from the preferred feeder, the Plant is automatically transferred to the alternate feeder. Loss of power to the Plant could result from simultaneous faults on both feeders, but this is not considered likely.

The WPTP digesters produce about 1.4 million ft^3/day of digester gas. The digester gas is burned in the raw sewage engines, boilers, and CoGens, with the remainder incinerated in the waste gas flares. There are three CoGens, each rated at 1250 kw; one or two are typically in service at a time. Power generated is sold back to Seattle City Light. The CoGens are fitted with heat recovery systems that provide hot water for Plant heating.

Utilities

West Point has six water systems:

C1 - Domestic (potable) water

C2 - Non-potable city water – used for interior washdown, cooling systems, primary heat loop, and other uses requiring high quality, clean water.

CW - Non-potable city water dedicated to supply of water for fire protection

C3 - Chlorinated Secondary effluent – used for pump shaft seals, raw sewage pump engine cooling (auxiliary to C2), sprays, flushing, exterior washdown, and other uses requiring medium quality water. Supplied from EPS wet well.

C4 - Non-chlorinated Primary effluent - provides backup water to chlorination injectors in the event C3 is not available.

RW (Reclaimed water) - Up to 0.65 MGD of Plant effluent receives tertiary treatment. Replaces C2 in some applications, also used for summertime irrigation of Plant landscaping.

West Point also has two air systems:

Service air – supplies compressed air at ~120 psi for utility purposes, such as unclogging pumps and powering pneumatic tools and equipment.

Instrument air – Provides clean, dry compressed air to operate process instruments and controls, and to supply the laboratory air needs. The instrument air system operates at ~80 psi.

West Point's primary power distribution system originates at the 15 kV main electrical substation and operates at 13.8 kV. Main breakers and feeders run to unit substations, switchgear, medium voltage switchgear, and capacitors located near the various process load centers around the Plant. The secondary distribution system operates at 480 kV, and includes switchgear, unit substations, and associated local distribution panels and motor control centers.

Other sources of electrical power:

The CoGen system adds to the electrical power supply. The generators run at 4160 volts, which is stepped up to 13.8 kV through a transformer at the 15 kV main electrical station.

The Emergency generator runs at 480 volts, providing electric power to Plant critical loads when Seattle City Light power is unavailable. Critical loads include the chlorine building, the Administration building UPS (for SCS and CATAD), and the Solids Handling building (Emergency chlorine scrubbers and transformer area lighting).

Automation

In general the plant automation system was designed as a three-layer system consisting of equipment control, backup or local panel control, and computerized control. Each layer of automation adds increasing functionality and requires the lower layer to be operational.

Equipment controls generally are hardwired on/off/remote switches located at the equipment. Local or area panel controls include on/off/remote switches, backup analog loop or PID controllers, and alarm panel displays.

The computerized control system consists of eleven PLCs and a SCADA system. All actual controls, interlock and control functions are done by the PLCs. The SCADA system provides a window into the PLCs for setpoint downloading and visual graphic display of system equipment and processes. The SCADA consoles are scattered through the plant and the four area control centers. The SCADA system provides both current and historical trend displays and historical archiving of process data.

Odor Control

Odor control at West Point consists of prechlorination, plus two main odor control systems, one serving the Preliminary and Primary treatment processes, and the other serving the Solids Handling processes. The odorous air is scrubbed with a solution of NaOH and/or H_2O_2 in the scrubber towers before being exhausted to atmosphere. Ferric chloride can also be added directly to the liquid stream, to control odors in the wastewater and sludge, as well as to prevent formation of struvite in the centrifuge centrate lines.

West Point is located in Discovery Park, a natural park on the shoreline of Puget Sound. Community involvement is high, and control of odors is a very high priority. West Point's policy is to respond quickly to any odor complaints.

ORANGE COUNTY SANITATION DISTRICT

General and Plant Process Description

The Orange County Sanitation District (OCSD) operates the third largest wastewater management agency west of the Mississippi River. The OCSD serve a population of approximately 2.2 million people in a 470 square mile area. The collection, treatment, and disposal facilities are worth over $1 billion. OCSD owns more than 650 miles of major trunk sewers, 175 miles of collection sewers, 22 pumping stations, and two major treatment plants with disposal facilities to discharge the treated effluent. Participating cities and agencies own and operate 97% (approximately 5,500 miles) of the sanitary sewer systems tributary to the two treatment plants.

Approximately 90% of the wastewater influent is domestic and commercial and the remaining10% is industrial. The two major OCSD treatment plants jointly use a 120-inch in diameter deep-sea outfall.

The District has a waiver from the 1972 Clean Water Act. This 301(h) waiver allows the District to discharge high quality, but-less-than-full-secondary-treated effluent into the ocean. As part of the Environmental Impact Report hearings during the 1989 NPDES Permit process, OCSD has committed to treat at least 50% of influent wastewater to secondary treatment levels prior to ocean discharge. Advanced primary treatment, chemical coagulation of wastewater in the primary treatment process, improves removal efficiency and is the primary basis for qualifying for this waiver. The NPDES Permit limits allow five-day biochemical oxygen demand (BOD) and total suspended solids (TSS) levels of 100 milligrams per liter (mg/L) and 60 mg/L respectively. The plants are not required to chlorinate their effluent. There are no limits for coliform bacteria in the final effluent.

Reclamation Plant No. 1 is located in Fountain Valley, about four miles from the ocean and adjacent to the Santa Ana River. The plant has a rated capacity of 108 million gallons per day (MGD) and was operated at 89 MGD during the study year. Approximately 6.8 MGD is made available to water reclamation treatment plants operated by the Orange County Water District for the Seawater Intrusion Barrier Project (direct reverse osmosis and groundwater injection system) and Green Acres Project (water reclamation plant).

Wastewater Treatment Plant No. 2 is located on the Pacific Ocean at the mouth of the Santa Ana River in Huntington Beach. The plant has a rated capacity of 168 MGD and treated 155 MGD of wastewater during the study year. The ocean outfall is rated at 480 MGD.

The District spent $47,265,000 (not including most Collections and Source Control costs) during that fiscal year to operate the two treatment plants and administer the agency. Approximately $28 million is spent in the O&M Department for operating and maintaining the two wastewater treatment plants and disposing of solids.

Collection System

The area served by the OCSD covers approximately 470 square miles of northern and western Orange County. The twenty-one cities and three sanitary water districtsoperate 97-percent of the sanitary sewer systems tributary to the OCSD. Irvine Ranch Water District (IRWD) also operates a wastewater reclamation plant to produce reclaimed water for the City of Irvine and the properties owned by the Irvine Ranch company. Residuals from the IRWD facilities and well as 49.8% of the wastewater generated from the IRWD service area was processed at OCSD during the study year. Since then, the flow to OCSD has decreased to 36% because of increased use of reclaimed water. Rainfall generated runoff is collected, handled and/or stored by a separate storm water and flood control facility operated by the participating cities and the County of Orange.

The OCSD owns and operates over 650 miles of trunklines and 175 miles of sanitary collection sewers. In addition, OCSD owns and operates 22 pumping stations, appurtenances and associated force mains. Approximately 25% of the wastewater tributary to the two treatment plants is pumped. The distance from the outlying OCSD boundary to the treatment facilities is approximately 30 miles and conveyance time from the outlying area exceeds 18 hours. Caustic soda (50-percent sodium hydroxide) is periodically added to the upstream reaches of the trunkline system for the control of sulfides and odors.

The average daily flow tributary to the wastewater facilities was 244 MGD during the study year. The wastewater is 90-percent residential and commercial sources and the remaining comes from industrial sources. Wastewater temperatures range from 73 degrees F to 80 degrees F in the winter and summer, respectively, and tend to be septic except during rainstorms. Inflow and infiltration from rainfall accounts for the peak storm flows. Peak flows as high as 550 MGD have been successfully conveyed, treated, and discharged to the ocean.

Headworks and Influent Pumping

The headworks at each treatment plant generally comprise flow metering facilities, barscreens, influent pumping, aerated grit chambers, and odor control and chemical addition systems. Reclamation Plant 1 has diversion and bypass capabilities associated with the flow metering facility. Influent flows may be metered at Plant 1 then diverted to Wastewater Treatment Plant 2. In addition to being used for operating the respective treatment plants, the influent meter data is used to allocate operating expenses to the ratepayers.

Reclamation Plant 1

Six major trunk lines ranging from 42 to 90-inches convey wastewater to the Reclamation Plant 1 Metering and Diversion structure. Influent flows are measured by magnetic flow meters prior to discharge into a common influent channel. Due to the allocation of rates, operations needs, and the NPDES permit, the meters are routinely calibrated and verified for accuracy.

Influent flows are conveyed via the common channel to the barscreen facility. The barscreen facility comprises seven barscreen channels: four for existing barscreens, two for future expansion, and one emergency bypass channel. Each of the four mechanical-type barscreens has rated capacity of 70 mgd. Generally two of the barscreen units are in service at a time. The barscreens are stainless steel and have openings that are one inch on center. The barscreens are operated on water level differential and/or a timer. Channel width is 8 feet with peak-hour water depth of 9 feet. Screenings are conveyed to a special rolling-type dumpster for storage; a service provider transports the material to a landfill.

Plant influent is then pumped via centrifugal pumps to the grit chamber. Each of five pumping units is rated at 70 MGD at 45 feet Total Dynamic Head (TDH). Four pumps are driven by 450-hp variable frequency motors and a constant speed motor drives one pump. The influent pump speed is based on desired plant influent, with remaining flow being diverted to Wastewater Treatment Plant 2. Each pump has an associated forcemain that discharges into a common grit chamber influent channel.

The grit chambers comprise five aerated-type rectangular units. Grit is drawn off the bottom of each grit chamber via a series of four hoppers and ports. Grit is conveyed to washers and augered into the storage bins that hold the barscreen material. Each grit chamber is rated at 84 MGD and is 38 feet long, 20 feet wide, and 14 feet deep. One or two are normally in operation.

Approximately 92 tons of grit and screenings are removed and disposed of monthly. These residuals are hauled to a sanitary landfill.

Wastewater Treatment Plant 2

Five major trunk lines composed of reinforced PVC-lined concrete pipe ranging from 42 to 96-inches in diameter convey wastewater to the Plant Metering structure. Influent flows are measured by magnetic flow meters prior to discharge into a common influent channel. Like Plant 1, the meters are routinely calibrated and verified for accuracy.

Influent flows are conveyed via the common channel to the barscreen facility. The barscreen facility comprises five barscreen channels equipped with barscreens. Each of the five mechanical-type barscreens has rated capacity of 70 mgd. Generally four of the five units are in service at a time. The barscreens are of similar design and configuration to Plant 1. The barscreens are operated on water level differential. Channel width is 8 feet with peak-hour water depth of 9 feet. Screenings are conveyed to a special rolling-type dumpster for storage; a service provider transports the material to a landfill.

Plant influent is then pumped via twelve centrifugal-pumps to the grit chamber from two headworks pumping stations. Pumping capacity for each unit ranges from 40 to 50 MGD. Five pumps are driven by 350 to 400 hp constant speed electric motors; seven pumps are driven by 350 to 400 variable frequency motors. Rated capacity based upon 3 units on standby is 412 MGD. All tributary wastewater must be conveyed into the Plant. Unlike Plant 1, flow cannot be diverted or bypassed. Each pump has an associated forcemain that discharges into a common grit chamber influent channel.

The grit chambers comprise eight aerated-type rectangular units. Grit is drawn off the bottom of each grit chamber via a series of four hoppers and ports. Grit is conveyed to washers and augered into the storage bins that hold the barscreen material. Each grit chamber is rated at 65 MGD and is 28 feet long, 20 feet wide, and 12 feet deep.

Approximately 123 tons of grit and screenings are removed and disposed of monthly. These residuals are hauled to a sanitary landfill.

Primary Treatment

Primary Treatment comprises five process trains or areas, three at Plant 2 and two at Plant 1. Primary influent is split at the discharge of the grit chamber via a system of weir gates. The purpose of this structure is to automatically maintain a prescribed split of wastewater to the various primary trains. The automation of the splitting unit is currently non-functioning; therefore, weir gates are set manually.

OCSD employs advanced primary treatment which is the addition of coagulation chemicals to the primary influent. Ferric chloride is added to the liquid stream at the discharge of the grit chambers. Anionic polymer is added to the liquid stream prior to entering each primary basin. The dose rate varies depending on sewage strength and composition, but typically is dosed at 20mg/l and 0.12 mg/l, respectively for iron salts and polymer. The addition of coagulation chemicals enhances the biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS) removal by approximately 40 to 50-percent, respectively. The OCSD typically achieves 50-percent and 75-percent removal of BOD and TSS.

Reclamation Plant 1

Primary treatment at Plant 1 comprises two trains, referred to as the East-side primary basins and the rectangular primaries. The East-side train comprises three circulars and two rectangular basins and the P1-33 primaries comprise ten rectangular basins.

The three circular basins are each rated at 12 MGD and the two East-side rectangular basins are each rated at 6 MGD for a total of 48 MGD on the East Side. P1-33 rectangular basins are rated at 6 MGD for a Plant 1 total of 60 MGD through the primary processes. The circular basins are 140 feet diameter, 9-foot side depths with a conical bottom. Sludge is withdrawn from a central hopper at the bottom of the cone and pumped directly to the digestion process. The East-side rectangular basins are 188 feet long, 40 feet wide, and average water depth of 9 feet. All rectangular basins consist of two 20-foot wide cells, which can be isolated for maintenance purposes. Sludge is conveyed via chain and flight mechanism to hoppers at the influent end of the basins. Raw sludge from the 60 MGD primary basins is pumped directly to the digesters or to the circular basins for improved sludge thickening.

Circular basins have effluent launders around the perimeter that consist of v-notch weirs. Each rectangular basin has four launders with v-notch type overflow weirs. All basins have devices to back water up to maintain a selected water surface in the launder for odor control purposes.

Scum skimmers located on the sludge rake device push floating material onto a scum beach and into a hopper. Scum is then dewatered manually and pumped to the digestion facility with the raw sludge. The scum removal process is similar for the rectangular basin, except that the sludge chain and flight mechanism push the floating material to a helical skimming device, which pushes the scum into a small channel. The scum travels down the channel to a pit were the water is removed manually and pumped to digesters.

Chain and flight mechanisms in the rectangular basins are fabricated of plastic-type material; most were manufactured by Budd Inc.

Wastewater Treatment Plant 2

Primary treatment at Plant 2 comprises three trains, referred to as the A-side, B-side, and C-side primaries. The A-, B-, C-sides comprise four, five, and five circular basins, respectively

Each basin is each rated at 12 MGD and is 140 feet diameter with 8 to 9 foot side depths with a conical bottom. The rated flow through the primary processes is 168 MGD. Sludge is withdrawn from a central hopper at the bottom of the cone and pumped directly to the digestion process. The basins have effluent launders around the perimeter that consist of v-notch overflow weirs. A liquid level device is used to measure launder level in order to modulate a valve maintaining a selected water surface in the launder for odor control purposes.

Scum skimmers located on the sludge rake device push floating material onto a scum beach and into a hopper. Scum is then dewatered manually and pumped to the digestion facility with the raw sludge.

Secondary Treatment

The OCSD employs three types of secondary treatment: trickling filters; air-activated sludge facilities at Reclamation Plant 1; and oxygen-activated sludge facilities at Wastewater Treatment Plant 2. The trickling filters are the most land intensive, yet the least energy and labor intensive process. The pure oxygen facility is the least land intensive, yet most energy and resource intensive of the three processes. The cryogenic facility comprises two systems, each capable of producing 72 tons of 98-percent pure oxygen per day. One of the two systems is currently moth-balled . The cryogenic plant is contract operated by Air Products, Inc. Air Products is responsible for maintaining and operating the facility. (Refer to Table _ for specific process information.)

Trickling Filters (Plant 1)

The trickling filter plant comprises four high-rate type filters and one secondary clarifier. Primary effluent is pumped to the trickling filter distribution box via three submerged vertical turbine pumps. A constant speed motor drives one pump and two pumps are driven by two-speed electric motors, ranging from 75 hp to 200 hp depending on speed. The rated pumping capacity, including recycled flow is 80 MGD at maximum speed with all units in operation.

Each trickling filter is rated at 5 MGD capacity and is 180 feet in diameter. The rock media is 6 feet deep, with clay under-drains. Three of the units are thirty years old and the forth is twenty.

Each filter is currently operated at 7.5 MGD. One circular clarifier currently serves the facility. The clarifier is 140 feet in diameter with a sidewall depth of 9 feet. It has a rated capacity of 10 MGD. Biological sludge is collected in the center hopper and pumped to the digestion facility. A second clarifier serving the facility was removed in 1990 in order to construct a new biosolids truck loading facility. Effluent from the highly loaded trickling filter system ranges from 40 to 50 mg/l BOD. A major refurbishment/rehabilitation project is scheduled to start in the year 2000. The project will retrofit the reactors with plastic media and underdrains; construction of additional secondary clarifiers is also included in the scope of the project.

Air Activated Sludge Plant

Primary effluent is conveyed either via gravity from the rectangular primary facility or pumped from the East-side primaries. The secondary plant currently has a rated capacity of 46 MGD and is under construction expansion to 80MGD. The facility is operated at very low sludge age (approximately 2 days) in order to control nocardia and nitrification. Dissolved oxygen content is typically kept very low in order to discourage nitrification. Food-to-microorganism ratios and return activated sludge rates tend to be typical for plant of this type. (Refer to Table ___ for specific information.)

Primary effluent flow is split via overflow weir to one of ten aeration basins. The aeration basins can be operated in plug-flow or step-feed modes. The current operation is step-feed. Air is conveyed to the mixed liquor via one of four 1500 hp blowers and fine bubble diffusers. Typically no more than one blower is operated to provide the required air. The aeration basin is covered and designed for conversion to a pure-oxygen reactor should the OCSD desire to do so.

Mixed-liquor suspended solids are settled in fourteen rectangular clarifiers. Each clarifier is 150 feet by 40 feet by 14 feet deep. Side water depth averages 10 feet. Chain and flight systems convey secondary sludge and floating material. Sludge is collected at the influent end and floating material prior to the effluent launders at the effluent end. An actuated gate and weir system is automatically operated to remove scum and other floating material. Secondary clarifiers are not covered.

The OCSD will complete a facility improvement during calendar year 1998. The capital improvement will increase the aeration basin capacity to 80 MGD by installing Turblex brand blowers and densely arranged fine-bubble diffusers. An anaerobic selector will also be designed as part of the improvements. Ten additional partially covered secondary clarifiers of similar configuration to the existing are included as part of the project.

Oxygen Activated Sludge

Primary effluent is pumped to the secondary treatment facility. The secondary plant has a rated capacity of 90 MGD. The facility is operated at very low sludge age (less than one day) in order to control nocardia and nitrification. . Dissolved oxygen values in the effluent end of the reactor range from 5 to 8 mg/L. Dissolved oxygen is not used for control. Control of oxygen addition is based on vent purity from the reactor and pressure in the reactors. Food-to-microorganism ratios tend to range from 1.5 to 2.0; sludge retention time is typically less than 1 day with return activated sludge rates being typical for plant of this type. (Refer to Table ___ for specific information.)

Primary effluent flow is split via weir to one of eight reactor basins. The reactor basins are operated in the plug-flow mode. Oxygen is mixed into the mixed liquor via four aerator-type mixers, one mixer per stage (two 75 hp and two 40/18 hp two-speed mixers). Currently, the second stage reactor is off to conserve electricity. Actual treatment is about 60 MGD in one half of the reactor trains using 450 kW of the 1800 kW installed.

Mixed-liquor suspended solids are settled in twelve rectangular clarifiers. Each clarifier is 300 feet by 60 feet by 16 feet deep. Side water depth averages 14 feet. Chain and flight systems convey secondary sludge and floating material. Sludge is collected at the influent end and floating material prior to the effluent launders at the effluent end. An actuated gate and weir system is automatically operated to remove scum and other floating material. Secondary clarifiers are not covered.

Tertiary Treatment

Tertiary treatment is not currently used at OCSD. The OCSD provides about 6 MGD of secondary effluent to Orange County Water District (OCWD) for water reclamation purposes. The OCSD and the OCWD are jointly planning a 100 MGD wastewater reclamation project to recharge the local ground water aquifers.

Sludge Thickening

Primary sludge is thickened to 5% or more in the primary basins and pumped directly to the digestion process. Dissolved air floatation thickeners (DAFT) are used to thicken waste activated sludge. Coagulant (cationic polymer) is used to enhance the capture in DAFT process. DAFT units are operated similarly at the two treatment plants.

Plant 1 and 2 employ three and four circular DAFT units, respectively. Plant 1 units are 40 feet diameter and 8 feet water depths. Air to solids ratio and the solids loading rate for the Plant 1 units are approximately 0.025 and 15 pounds per cubic foot per day, respectively. The Plant 2 units are 55 feet diameter and 9 feet water depths. Air to solids ratio and solids loading rate are 0.030 and 15 pounds per cubic foot per day, respectively. Plant 1 uses approximately 7.5 dry pounds of polymer per dry ton of solids. Plant 2 has the equipment to feed chemical, but does not presently need polymer addition to achieve process goals.

Digesters

Each treatment plant employs high-rate, mesophilic-type anaerobic digestion for the purpose of volatilization of organic solids and reduction of pathogens. Primary and thickened waste activated sludge is blended (co-mixed) in each digester. The OCSD digesters are circular in shape with conical bottoms and fixed concrete covers. Depending on digester size, 50 or 60 hp axial-flow type pumps are used for mixing digester contents. Each digester has redundant pumping equipment, spiral-type heat exchangers, digester gas collection piping and appurtenance, and chemical addition systems.

Piping layout on each unit provides flexibility for selecting withdrawal and return sludge locations, heating digester contents, and feeding locations. Glass-lined ductile iron pipe is used for conveying the residuals. Digesters are heated to 98 degree F with retention times averaging between 20 to 30 days, depending on the Plant.

Loading rates are typically range between 0.09 to 0.15 pounds of volatile matter per day per cubic foot of volume. Volatile matter destruction averages 58.5%. Hot water from the cogeneration plants provides heat for maintaining digester temperatures.

The OCSD uses the digester gas produced by the stabiliization process for fueling the cogeneration plants. In order to burn the methane, the local air quality management district mandates that sulfide levels in the gas be less than 40 parts per million. The OCSD add iron salts to the residuals for controlling the sulfides content. Ferric Chloride used in the primary treatment coagulation process generally controls the sulfide levels in the digester gas. Periodically, iron salts (ferric or ferrous chloride) may be added directly into each digester for additional sulfide control if the concentration of hydrogen sulfide in the digester gas exceeds 10 mg/l. Direct chemical addition is based on the sulfide concentration in digester gas within the individual digesters.

An overflow pipeline maintains level in each digester. The digested biosolids overflow to holding digesters where it is stored until dewatered. The holding digesters provide for the steady flow of sludge to dewatering, for emergency storage, for storage options required for maintenance activities, and for the accommodation of four day per week dewatering schedules.

Plant 1 has ten working digesters and two holding tanks for a total volume of 2,650,000 and 209,000 cubic feet, respectively. Two working digesters are 90 feet diameter, 30 feet side depth, with a 15 feet deep conical bottom. Eight working digesters are 110 feet diameter, 30 feet sidewall depth, with 15 feet deep conical bottoms. The holding digesters are 90 feet diameter, 30 feet side-wall depth, with conical bottoms.

Plant 2 has thirteen working digesters, five holding digesters, and two units used for emergency purposes for a total working volume of 3,041,000 cubic feet and holding volume of 333,000 cubic feet. Seven working digesters are 80 feet diameter, two are 90 feet diameter, and four are 105 feet diameter; the two emergency digesters are 80 feet in diameter. Holding digesters are 80 feet diameter. All digesters have 30 feet side-wall depth, with 15 feet deep conical bottoms. The configuration, equipment layout, and operational philosophy are similar to Plant 1.

Dewatering

The OCSD employs Ashbrook brand 2.2-meter belt filter presses for dewatering digested biosolids. Digested biosolids are pumped from holding digesters to the dewatering facilities at each plant. Belt presses are typically fed at a rate between 100 to 120 gpm. Manic-type cationic polymer is diluted and mixed with the sludge feed prior to dewatering. Polymer feed rates are based on the operators eye and experience and is adjusted throughout each day. The average dose rate is approximately 7.5 dry pounds of polymer per dry ton of biosolids. Dewatered material drops onto a conveyer for transport to cake storage hoppers or to cake storage via transfer pumps, depending on the plant.

Cake solids range from 20-percent to 24-percent depending on ratio of waste activated sludge to primary sludge at each plant. Filtrate at Plant 2 is pumped to a clarifier for thickening and returned to the dewatering facility. The plants generate approximately 500 wet tons of cake each day.

Biosolids

The OCSD handles residuals in two manners. Screenings and grit removed in preliminary treatment are transported to sanitary landfills. All biosolids cake is currently being beneficially used on farmland as a soil amendment for non-food crops.

The biosolids cake is transported to storage hoppers via cake pumps or conveyers. From the storage hoppers, cake is loaded onto semi-tractor trailer trucks for transport. A truck scale indicates the gross vehicle weight, which is used to control the biosolids loaded into the vehicle. Contractors provide Biosolids hauling, application, and management of the material. Compliance with the various regulations is monitored and ensured by OCSD.

Agreements with multiple contractors ensure flexibility in biosolids management and reliability in the event a contractor or contractors experience interruptions to their respective operations. The OCSD will be evaluating other management options such as purchasing dedicated land for handling material or composting operations.

Odor Control

The most odorous process areas are covered in order to collect and scrub (clean) odorous compounds prior to discharge into the air. These areas primarily comprise the headworks, preliminary treatment, and primary treatment processes. Hydrogen sulfide is the main odor causing compound removed from the foul air. Packed-tower chemical scrubber systems are employed for the odor removal process. Caustic soda is currently the chemical used for removing the sulfides; however, bleach and hydrogen peroxide are used at specific locations in relatively small quantities.

Odor scrubbers are controlled off pH sensors in the scrubber sumps. As pH drops, caustic is added. The caustic solution is recirculated to the top of each unit. Plastic media is used for packing.

Hydrogen peroxide is used to control aqueous sulfide in the plant influent. The peroxide is added on the basis of one part peroxide for one part of sulfide in the liquid. Sulfide levels are usually maintained below 0.5 mg/L.

The OCSD is located within and regulated by the South Coast Air Quality Management District. The OCSD also has adopted a good neighbor policy that requires that all odor complaints and odor related issues are addressed expediently and effectively. The OCSD has a goal of maintaining no odor complaints. Between 0 to 10 odor complaints per plant are received each year.

Disinfection

Disinfection of plant effluent is not required or allowed by the NPDES permit. A small amount of secondary effluent is chlorinated for use in the plant water system.

Effluent Pumping/Outfall

The plant effluent system comprises two pump stations, two ocean outfalls, and an emergency overflow to the Santa Ana River. Effluent wastestreams from Plant 1 and 2 combine in the Ocean Outfall Booster station (OOBS) and are pumped to receiving waters via a five-mile long, 120-inch reinforced concrete pipe outfall (the primary outfall). The ocean outfall discharges at approximately 200 feet of water. OOBS comprises five 120 MGD pumps rated for high high tide conditions, and for a total capacity of 480 MGD with standby.

A second outfall pumping station, named Foster Pump Station, provides emergency or backup service for OOBS. The Foster station also supplements OOBS, should OOBS reach maximum capacity. In this unlikely event, Foster PS would discharge plant effluent via the emergency ocean outfall. The emergency outfall is one mile long and discharges at 75 feet of water. The Foster PS comprises four 100 MGD rated pumps for a total capacity of 340 MGD plus standby. The actual capacity (capability) of Foster PS installed depends on the discharge conditions and outfall pumping arrangement. Based on pumping arrangement the capability may be as low as 260 MGD.

A third extreme emergency outfall comprises two overflow weir structures to the Santa Ana River. This discharge option is intended to be used only if the OOBS and Foster Station cannot operate or have failed.

Utilities

Plant utilities generally consist of three water systems, a plant air system, and an electrical distribution system. Plant air is piped throughout each treatment facility for instrument air and for thew operation of pneumatic gates or valves. A small quantity of backup or standby power is provided in strategic process areas, such as the headworks. Electrical distribution starts at the 12kv level service and is reduced to lower voltage as required. Most equipment operates at 480 volt level service or less. Only the very largest mechanical equipment, specifically the ocean-outfall pumps, gas compressors, pure-oxygen main air compressors, and the air AS blowers operate at 4160 or 2300 volt levels.

Potable (City) water service is provided by local cities. . Potable water is purchased for industrial as well as domestic uses as well as fire protection. For example, potable water is used for polymers and other chemicals sensitive to residual chlorine contained in plant water. The potable water system is separated from the local community through an air-gap tank. The OCSD city water pump station maintains the potable water system at 60 psi. On average, Plants 1 and 2 use 460,000 and 1,300,000 cubic feet of potable water, respectively, each month.

Reclaimed water service is provided by the Orange County Water District; this water is used primarily for industrial applications like cooling water makeup. The OCSD reclaimed water distribution system is separated from the local service by reduced-pressure principal type back-flow preventers. The local supplier maintains system pressures typically near 100psi.. Plants 1 and 2 use 2.7 and 3.4 MGD of reclaimed water.

Chlorinated secondary effluent is used at throughout each plant for wash down and very large industrial water demands such as wash water for the belt filter presses. The Plant water pump station delivers and maintains the water at 110 to 120 psi. The plants use 2.5 and 5.0 MGD of plant water at Plant 1 and 2, respectively.

Automation

The automation system generally comprises two layers, local control and SCADA control. Local control includes the PLC's and field devices. Control logic typically resides at the PLC level devices; however, the remote interface, set-point changes, and other types of control can be made through SCADA. The SCADA system allows for control from a central location as well as local control as necessary and is a VAX based server. The SCADA control also allows for the archive of plant data and information. A ModBus-plus highway provides communication between the VAX server and PLC systems. An Ethernet system provides communication between the VAX server and the VAX workstation throughout the plant and between the other OCSD computer systems, like the Laboratory Information Management System. See attached exhibit.

Power/Energy

The OCSD employs three levels of reliability for energy needs comprised of cogeneration, public utility supplied electricity, and emergency/standby generation of critical process streams. Each treatment plant has a cogeneration facility for the purposes of producing electricity at 12 kV service level to meet the demands of the respective treatment plant. Natural gas is purchased to supplement the digester gas in order to fuel the cogeneration facilities. The local utility, Southern California Edison provides 66 or 12 kv standby service and electricity purchased during planned outages or maintenance. Emergency engine-generator sets automatically start and provide electricity at 1 kV or 480 volt level for essential process operation and appurtenances.

The Plant 1 cogeneration facility comprises three 2.5 megawatt (MW) internal combustion driven generator sets. The Plant 2 cogeneration facility comprises five 3.0 MW internal combustion driven generator sets and one 1.0 MW steam turbine. Each facility is designed to operate with all units producing electricity for a total of 7.5 MW and 16 MW, respectively. However, the local air quality management district issued permit restricts operations to two engines and four engines plus the steam turbine at Plant 1 and 2, respectively. The local air quality management board has granted a waiver to operate in full power production during declared emergencies, whether OCSD, local, or state declared.

Typical Plant 1 and 2 electrical demands are 3.4 mW and 7.8 mW, respectively. Excess electricity can be sold to the local utility. These sales typically amount to approximately $400,000 each year. Annual costs of cogeneration operations, including fuel, labor, materials, and overhead, are approximately $2.5 million each year. This offsets the $6.5 million in electricity purchases that occurred prior to commissioning the cogeneration facilities.

SACRAMENTO REGIONAL COUNTY SANITATION DISTRICT

General and Plant Process Description

The Sacramento Regional County Sanitation District (SRCSD), in conjunction with County Sanitation District #1 (CSD #1), provides sewage collection, treatment, and disposal services for the County of Sacramento and some of the neighboring communities, serving a customer base of over 1 million residents. The Districts provide funding to operate the Sacramento Regional Wastewater Treatment Plant (SRWTP) and the associated collection systems. The collection system is operated by County Sanitation District #1 (70% of the service population) the City of Sacramento (26%), and the City of Folsom (4%). SRCSD operates the interceptors and the treatment facilities.

Located on 900 acres of a 3,500-acre site, the Sacramento Regional Wastewater Treatment Plant (SRWTP) serves an estimated 1,026,800 residents. The balance of the property (2,600 acres) serves as a buffer against urban encroachment. The capacity of SRWTP is 181-MGD average dry weather flow and 400-MGD peak wet weather flow. The design criteria for the regional treatment facility demanded a high level of reliability, including multiple and backup treatment units, and a large (80-acre, 200-million gallon) storage basin for emergency use.

SRWTP is required to meet NPDES permit limits for BOD and TSS of 30 mg/L each. Chlorine residual of effluent entering the Sacramento River is allowed no more than 0.018 mg/L as a daily average. Total coliform counts are allowed a maximum of 23 MPN/100 ml, based on a monthly median.

Major treatment processes include aerated grit removal, primary sedimentation, pure oxygen activated sludge, secondary sedimentation, chlorination for disinfection, and dechlorination prior to discharge to the Sacramento River via an 8,000-foot outfall. Influent and effluent pumping is provided. The plant layout also provides space for future nutrient removal and effluent filtration.

SRWTP oxygen activated sludge tanks consist of 12 parallel trains, each having 4 stages. To supply the plant with oxygen, there are two cryogenic oxygen generation plants with a total production range of approximately 70 to 290 tons of oxygen per day. Oxygen is fed to the tanks at an average rate of 111 tons per day. Oxygen is dispersed in the tanks utilizing 32 submerged turbine units and/or 16 surface aerators. A project to replace the submerged turbine units with surface aerators is under design.

The wastewater is allowed to settle in 24 circular secondary clarifiers. Waste activated sludge (WAS) from the secondary clarifiers is thickened at four DAF thickeners before being blended with primary sludge and undergoing anaerobic digestion.

The digested biosolids are pumped to 125 acres of facultative lagoons, or solids storage basins (SSBs). SSB supernatant is recycled back to the plant headworks. The digested sludge is temporarily stored for an average period of 3 to 5 years. Stabilized sludge is dredged and pumped to dedicated land disposal units (DLDs) during the 6 dry months from May to October. The stabilized biosolids are injected below the soil surface by means of a tractor-like machine.

The vented gas from the covered primaries and the screen and grit dewatering facilities is routed through a packed media trickling filter type of odor removal tower (ORT) and/or through mobile and fixed activated carbon filters before being discharged to the atmosphere. Foul air collected from the covered RAS and mixed liquor channels is ducted to a mist tower or mobile ventilation unit.

SRWTP uses gaseous chlorine for disinfection and sulfur dioxide for dechlorination. Both systems are equipped with scrubbers for safety. A backup sodium bisulfite dechlorination system located near the river outfall also provides peaking capability during sudden flow changes. Transit time in the sulfur dioxide vacuum feed lines is approximately 20 minutes.

The local electric utility operates an off-site cogeneration facility. The District sends digester gas to the cogeneration plant, and receives steam from the cogeneration plant, which is used to heat the digesters and run the plant HVAC system. For all other equipment, electricity is purchased from the local electric utility at 6.5 cents/kWh.

Collection System

The area served by the Regional Plant covers approximately 250 square miles, and includes the City of Sacramento and the urbanized areas north, east, and south of the City. The cities of Sacramento and Folsom operate their own collection systems, with the remainder of the County (70%) being served by County Sanitation District (CSD) #1. The CSD #1 collection system covers an area of 183 square miles, and has 3,250 miles of pipe, including 90 miles of major interceptors and 70 pumping stations. The areas served by CSD #1 and the City of Folsom have separate sanitary and stormwater systems. The City of Sacramento has combined sewers in portions of the city. Included in the SRWTP operating budget is a charge ($1.14 million in FY97) from the City of Sacramento for operation and maintenance of several upstream sumps/pumping stations.

The distance from the outlying portions of the District to the treatment plant is approximately 20 miles, and transit times can exceed 24 hours. Chlorine gas or sodium hypochlorite is added at various points within the collection system to prevent the wastewater from becoming septic.

During the last few years, several large canneries have left the Sacramento area. Seasonal canning loads, which were at one time significant, have been reduced greatly. This has also reduced the plant BOD loading and the amount of biosolids production at SRWTP in recent years.

Headworks, Influent Pumping, and Emergency Storage Basins

All the influent to the treatment plant passes through an influent junction structure, and is then transferred via a large conduit to the influent/effluent pump building. A septage disposal facility is located upstream of the influent junction structure on one of the major interceptors. Prechlorination facilities are provided at the influent junction structure. At the influent/effluent pump building, the influent conduit divides into three smaller conduits, with each conduit being provided with double isolation gates. Just upstream of the isolation gates, plant wastewater is returned to the influent conduit for recycling through the treatment plant. Downstream of the isolation gates the three channels divide into six bar screen channels. Four of the six bar screens have mechanically cleaned screens, with manually cleaned trash racks at the other two locations as backups. Influent wastewater passes through the selected bar screens and discharges into the influent pump wet well; the wet well channel is common to all influent pumps. Each bar screen channel can be isolated from the wet well by means of slide gates. The wet well channel is aerated to keep material from settling in the channel.
Five influent pumps of a possible six are installed in the influent/effluent pump building. The influent pumps lift screened wastewater from the influent pump wet well channel and transfer it to the primary influent channel in the primary treatment structure (which includes the aerated grit chambers and primary sedimentation tanks). A series of slide gates in the influent pump wet well allow a pump inlet to be isolated from the others. Each of the five influent pumps is 1,250 hp, and can pump 125 mgd at a total head of 36 feet. A variable speed drive on each pump provides for automatic regulation of pumping in accordance with influent flow.

The plant site also has three emergency storage basins (ESBs), with a total area of 80 acres and a total storage capacity of greater than 200 million gallons, which allow for storage of primary or secondary effluent on site. These basins can be used for diversion of primary effluent if secondary treatment units are out of service or if secondary settling problems are encountered. More commonly, they can be used for diversion of secondary (final) effluent if low flow conditions in the Sacramento River prevent effluent discharge (river dilution ratios of less than 14:1). This can occur up to twice a day, depending on river flows and tidal influences. Diverted wastewater first enters a concrete-lined basin "A" (ESBA), and can overflow to a larger earthen basin ESBB, and finally to a much larger earthen basin, ESBC, if necessary. Wastewater, which has been diverted to the ESBs, is returned to the headworks of the plant via a 60-inch gravity line to a point near the influent junction structure. Flow is from ESBC to ESBB, from ESBB to ESBA, and from ESBA to the influent junction structure. Return flow is controlled by a modulated sluice gate. A fourth basin is currently under construction. This basin will be used for diversion of final effluent during low river flow conditions. It will have pumps, which can return this water to the outfall rather than to the plant headworks.

Preliminary Treatment

Included in preliminary treatment are the bar screens (located upstream of the influent pumps) the aerated grit tanks (located downstream of the influent pumps) and the grit classifiers (located in the influent/effluent pump building). For Sacramento's benchmarking data, a portion of the costs (37.5%) for operating and maintaining the channel aeration system are also included in preliminary treatment.

The four mechanically cleaned bar screens each have a ¾-inch spacing between bars. Each screen is capable of handling a flow of 120 mgd. Screenings are routed to grinders, which are capable of grinding 60 cu ft of screened material per hour. Ground screenings are then pumped to dewatering rotary screens and dewatering presses, and the dewatered screenings are trucked to an off-site landfill.

Each of the four aerated grit tanks is 32-foot wide and 108-foot long, with an average depth of 18 feet. The tanks are enclosed and ventilated to an odor removal tower. Air is supplied to the tanks via the channel aeration system to six air headers per tank. Each grit tank contains five collection hoppers along the bottom of the west wall (outlet). Service air and high-pressure reclaimed water lines are provided to each hopper for agitation air and water. Each of the 20 (five per tank) has an associated 30 hp (250 gpm at 88 feet of head) grit pump, which pumps grit through eight 4-inch lines to the grit classifiers, which are located approximately 600 feet and away and three stories up. Normally, one grit pump per tank is in continual operation, and the other four pumps cycle on and off.

Grit passes through eight cyclonic grit separators arranged in pairs above four belt-driven screw type grit classifiers. From the classifiers, the grit is conveyed via two screw type conveyors to small grit hoppers, and from there to larger grit hoppers via pneumatic ejectors and 6-inch transfer lines. The large grit hoppers are located above a truck loading area, for transport to an offsite landfill. For FY97, the combined quantity of grit and screenings disposal was 1165 wet tons at a unit cost of $28/ton.

The channel aeration system includes three 1,750-hp blowers located in the influent/effluent building. Each blower can provide 40,000 cfm at 8.5 psig. The channel aeration system serves several purposes: (1) agitation of channels (preliminary, primary, and secondary areas) to prevent solids deposition, (2) aid in primary scum removal, and (3) aeration of the grit tanks. For the purposes of the benchmarking study, channel aeration costs have been allocated 3/8 to preliminary treatment, 1/8 to primary treatment, and ½ to secondary clarifiers. In FY 1997, the channel aeration blowers used approximately 11 million kWh of electricity at 6.5 cents per kWh. The energy costs for operating the channel aeration blowers ($13/MG in FY 97) represents a significant portion of the total preliminary treatment, primary treatment, and secondary clarifier costs.

Primary Treatment

Primary treatment includes 12 adjacent covered rectangular tanks. Each tank is 38-foot wide and 254-foot long, with an average water depth of 9.5 feet. Each tank has six effluent launders, which are submerged and capped 24-inch-diameter pipes with entrance orifices. The launders are 77 feet long with two rows of 37 orifices located 45 degrees from the crown. Each launder terminates at a slide gate, which is used to control the flow to the primary effluent channel. A computer control strategy maintains the proper water elevation in the primary tanks by opening and closing the slide gates.

Scum is removed from the surface of the primary tanks by longitudinal scum skimmers and by a grid of water/air jets which direct it toward a rotary scum skimmer at the inlet end of the tanks. Skimmers are paired so adjacent tanks use a common scum hopper, piping, and pump. Scum is pumped to the mixed sludge system. It is combined with primary sludge and thickened waste activated sludge before being sent to the digesters.
Primary sludge is collected with the aid of wooden flights and longitudinal steel chains, which transport the solids to the inlet end of the tank. Drive sprockets are provided with shear pins and limit switches for protection of equipment in case of excessive loading. The variable speed drive unit is capable of providing flight speeds of ½ to 5 feet per minute. At the inlet end of the tanks, helical cross collectors move the sludge to a primary sludge hopper. Primary sludge is pumped to the mixed sludge system, using twelve 25-hp variable speed pumps. It is combined with primary scum and thickened waste activated sludge before being sent to the digesters.

Secondary Treatment

The entire plant flow is routed through secondary treatment, which consists of 12 covered pure oxygen activated sludge basins and 24 circular secondary clarifiers. Oxygen is supplied by an on-site cryogenic facility. For the eight basins with submerged turbines, oxygen is recycled through the tanks by recirculation compressors. Channels for secondary influent, mixed liquor, and RAS are kept mixed by air supplied via the channel aeration system.

The secondary process can be operated in various modes, but generally is operated in a conventional plug flow mode, with an average MLSS of 1,300 mg/L, MCRT of 2.3 days, BOD F/M ratio of 1.4, and detention time in the basins of 1.6 hours. Water temperature can approach 85ºF during the summer. Basins are placed in service or removed from service when there are seasonal changes in loading. Seasonal canning loads, which were significant in the past, have diminished in recent years, as most of the canneries have moved out of the county.

Since the aeration basins use pure oxygen, they are covered. Aeration is tapered to match demand. Eight of the basins use submerged turbines, with oxygen being recycled from the headspace through recirculation compressors and back to the turbines. Four of the tanks, which were recently constructed, use surface aerators. Due to construction-related issues which are still being addressed, these tanks have not yet been routinely used.

All of the aeration basins have the same geometry, with four stages in series. Each stage is 48'x48'x30'. For the eight tanks with turbine mixers, the mixers are 75 hp in the first stage, 60 hp in the second stage and 40 hp in the third and fourth stages. The recirculation system includes three 350-hp, three 250-hp, and two 125-hp compressors. Approximately three compressors are used during normal operations.

The four new tanks with surface aerators have 200 hp mixers in the first and second stages, 100 hp mixers in the third stage, and 60 hp mixers in the fourth stage. Mixers can be run at high or low speed, and power draw is also dependent on water level in the tank. The design consultant states that the power draw will be slightly higher than for the existing turbine mixers, but this will be compensated by the fact that recirculation compressors are not required. It may also be possible to operate these tanks at a lower dissolved oxygen concentration due to improved mixing.

The plant has 24 circular secondary clarifiers. Each clarifier has a diameter of 130 feet, a sidewater depth of 20 feet, and a volume of 2 million gallons. The inlet to each tank is through a butterfly valve and drop structure through a 48-inch line that goes under half the tank and rises in the middle to empty into a 32-foot-diameter mixed liquor diffusion well. Two sets of V-notch effluent launders are located are located in concentric circles approximately 10 feet and 25 feet from the outside edge of each tank. These launders are interconnected on the tank side nearest the mixed liquor channel, and direct the effluent to the effluent collection channels, which are located just under the mixed liquor channels. The average overflow rate is 750 gpd/ft2, which equates to a detention time of 4.8 hours. Clarifiers are placed in service as needed depending on flow.

Return activated sludge (RAS) is collected through ports located along the double arm sludge collector. The collector is driven by a center shaft, with a motor and reduction gear mounted at the top of the shaft. The settled sludge flows by gravity into a 30-inch line, which carries the flow to RAS pump suction wells. Each tank has two 50-hp RAS pumps. Total RAS flow averages approximately 50 MGD, or 32% of the plant daily flow. The average solids concentration of the RAS is 5,500 mg/L. RAS can be chlorinated if necessary to control the growth of filamentous organisms.

Secondary scum is collected by a skimmer, which is located between the centerwell and first set of effluent launders. It skims the water surface and collects the scum into a hopper. A scum baffle prevents scum from getting to the outer part of the tank. Secondary scum is pumped from the collection hopper to the mixed sludge system.

Waste activated sludge (WAS) is pumped to four dissolved air flotation thickeners, where it is thickened prior to being mixed with primary sludge in the mixed sludge system. Average WAS flow is 3.5 MGD.

The oxygen facility consists of two cryogenic generation plants. Generally, only one plant is on-line, with the other on standby (alternated yearly each summer). Each plant can be fed by a small (2,000 hp) or large (3,000 hp) air compressor. With a small compressor, up to 100 tons/day of oxygen can be produced, and with a large compressor, up to 145 ton/days of oxygen can be produced. Average oxygen production for FY97 was 111 tons/day. The two plants provide full redundancy. In addition, there is 800 tons of on-site liquid oxygen storage capacity.

Tertiary Treatment

Tertiary treatment is not currently used at SRWTP. Based on the master plan, if tertiary treatment becomes necessary, these facilities could be built in the area immediately west of the existing secondary facilities.

Sludge Thickening

Waste activated sludge (WAS) is thickened in four 70-foot-diameter dissolved air flotation thickeners (DAFTs). Two gravity belt thickeners (GBTs) are also available, but are not presently used in normal operations. Chemicals are not used in DAFT operation. Flow to each DAFT averages slightly less than 1.0 MGD. Water from the thickeners is either returned to the plant headworks or to the solids storage basins. WAS is thickened to 3.5-4.0% (float) or 2.0-2.5% (bottom sludge) in the DAFTs before it is combined with primary sludge in the mixed sludge system.

The purposes of the mixed sludge system include: (1) blending of primary sludge and thickened waste activated sludge into a uniform mixed sludge, (2) preheating of the mixed sludge prior to anaerobic digestion, and (3) grinding of sludge prior to digestion. Primary sludge and thickened waste activated sludge are blended in two 40,000-gallon mixed sludge tanks. Circulation pumps are used to mix the sludge and cycle it through heat exchangers and grinders. The mixed and heated sludge is then transferred to the digesters by four 700 gpm mixed sludge transfer pumps. Each digester also has a separate feed pump.

Digesters

The SRWTP digestion system includes three batteries of digesters, with nine conventional anaerobic digesters, and two blending digesters. Minimum detention time is 15 days and temperature is maintained at 97ºF. Digesters are currently being rotated in and out of service during construction and retrofitting. Existing floating cover digesters in Batteries I and II are being retrofitted to fixed covers. Newly constructed digesters in Battery III have fixed covers. Floating covers will be retained at the two blending digesters.

Total flow through the digesters is slightly less than 1 MGD. Mixed sludge feed averages 3.5% solids, with a volatile solids content of 82%. Digested sludge averages 1.7% solids and 64% volatile solids content. Average volatile solids loading is 0.12 lb/cu ft, and average volatile solids reduction is 60%. Average gas production is 13 SCF/lb of volatile solids destroyed. Average Btu content of the gas is 610 Btu/SCF.

Battery I, which consists of three digesters, is designed to handle 20% of the mixed sludge flow. Each digester is 95 feet in diameter, with a sidewater depth of 31 feet, a center water depth of 38 feet, and a volume of 1.8 million gallons. Each digester has a 40,000-gpm internal draft tube mixer, a 1,250-gpm sludge mixing pump, a 310-gpm sludge circulation pump/1,500 Btu/hr heat exchanger loop, a 150-gpm mixed sludge feed pump, and two 150-gpm digested sludge withdrawal pumps (one for the tank bottom and one for the standpipe). Hot water for the heat exchanger is heated by steam received from the off-site cogeneration plant. On-site boilers are available as a backup system.

Battery II, which consists of three digesters, is designed to handle 35% of the flow. Each digester is 110 feet in diameter, with a sidewater depth of 38.5 feet, a center water depth of 50.5 feet, and a volume of 2.9 million gallons. Each digester has two 1,200 cfm gas recirculation compressors for mixing, a 1,500-gpm sludge circulation pump/2,500 Btu/hr heat exchanger loop, a 235-gpm feed pump, and two 235 gpm withdrawal pumps. The battery also has a 1,000-gpm-drain pump and a 600-gpm recirculation pump common to all the digesters.

Battery III, which consists of three digesters, is designed to handle 45% of the flow. Each digester is 115 feet in diameter, with a sidewater depth of 43 feet, a center water depth of 56 feet, and a volume of 3.7 million gallons. Each digester has one 21,800-gpm internal draft tube mixer, five 17,000-gpm external draft tube mixers, three 1,200-Btu/hr heat exchangers, one 1,000-gpm circulation pump, one 305 gpm feed pump, and two 305-gpm withdrawal pumps. The battery also has a 1,200-gpm tank drain pump and an 850-gpm recirculation pump common to all the digesters.

Digested sludge from Batteries I, II, and, III is sent to two floating cover blending/storage digesters, which provide additional mixing and digester detention time. Each of these digesters is the same size as the Battery II digesters, and also has similar gas compressors, circulation pumps, and heat exchangers as those of Battery II. Six 2,000-gpm digested sludge transfer pumps are provided for transfer of the digested sludge to the solids storage basins.

Dewatering

SRWTP does not have dewatering facilities. Digested sludge is sent directly to on-site facultative lagoons. While in the lagoons, solids content of the sludge increases from 1.7% to approximately 6 to 8%.

Biosolids

The current biosolids program includes (1) on-site storage and on-site disposal, and (2) contracted operation of temporary belt press dewatering facilities and hauling to off-site disposal sites. The contracted operations have been conducted to reduce the on-site solids inventory to allow for capital improvements of these facilities, and for the purposes of this study are considered part of the capital improvement program.

Digested sludge is storage on site for 3 to 5 years in 125 acres of facultative lagoons, or solids storage basins (SSBs). There are a total of 20 basins. Stabilized sludge is from these basins is dredged and pumped to 200 acres of on-site dedicated land disposal areas (DLD) during the 6 dry months from May to October. The stabilized biosolids are injected below the soil surface by means of a tractor-like machine. Biosolids are applied to the DLD at a high rate (100 to 150 dry tons per acre annually). Crops are not grown on the DLD. Naturally occurring soil microbes degrade the applied solids.

In FY97, approximately 22,000 dry tons of digested solids were sent to the SSBs. An equivalent amount of solids (there is some additional reduction of volatile solids in the SSBs) were land applied to the DLD.

Due to the presence of nitrates in the groundwater, the District will not be able to indefinitely continue its current method of on-site biosolids disposal. Options being evaluated for the future include lining of the existing DLD, construction of a centrifuge dewatering facility and trucking of dewatered biosolids to off-site disposal areas, or some combination of the two.

Odor Control

Sodium hypochlorite is added at various locations within the collection system to prevent H2S formation. Chlorine gas is added at the influent junction structure and city interceptor. The plant odor control system collects air from covered basins and channels and treats the air in biological filters and/or carbon beds before it is discharged to the atmosphere. It is designed to maintain the measured odor at the fence line below one odor unit.

There are two odor-removal towers (ORTs), one located at the influent/effluent pump building, and the other at the primary treatment structure. These are plastic media trickling filters. Chlorinated secondary effluent is pumped to the top of each ORT, and is distributed at the top of the filter media. The foul air is collected by ductwork and fans and routed to the ORT plenum, where it enters diffusers and travels up through the media. Fixed carbon units are also provided at both locations for backup, and also at other locations throughout the plant. Mobile GAC units are also provided as required.

Disinfection

At the effluent observation structure (EOS), located in the secondary effluent channel between the secondary clarifiers and the effluent pumps, chlorine gas is added to the secondary effluent to provide for disinfection. The chlorinated effluent travels 1.5 miles to the Sacramento River, where it is dechlorinated prior to discharge. Sulfur dioxide gas is used for dechlorination, with sodium bisulfite used for trimming or emergency backup.

A high chlorine residual is required to meet the plant's discharge permit requirement of less than 23 MPN/100 ml total coliform (monthly median). In FY97, the average chlorine dose was 13.3 mg/L. Since then, the plant has been able to reduce the chlorine dose to approximately 8 mg/L without adverse impact. Chemical cost for post-chlorination in FY97 was $13.87/MG. Unit cost for chlorine was $238/ton.

The plant's discharge permit also requires complete dechlorination, with discharge of no more than 0.018 mg/L of chlorine as a daily average. SRWTP typically dechlorinates to a negative chlorine residual of approximately 3 mg/L. Control is maintained by continuous chlorine residual monitoring of effluent before dechlorination and a 50-50 mix of effluent before and after dechlorination. The negative chlorine residual is calculated from these two readings. A sulfur dioxide vacuum line runs the full distance from the plant to the outfall, and is the primary means for dechlorination. Supplemental sodium bisulfite dechlorination facilities are located at the outfall. Transit time for sulfur dioxide to the outfall is approximately 20 minutes, so the local sodium bisulfite system is used for peaking during rapid flow changes or returns from effluent diversion. In FY97, the average sulfur dioxide dose was 12.9 mg/L and the average sodium bisulfite equivalent dose was 0.7 mg/L. These doses have been reduced since then because of the lower chlorine dosing discussed above. FY97 chemical costs were $13.81/MG for sulfur dioxide ($247/ton) and $1.23/MG for sodium bisulfite ($0.55/gal, 25% solution).

Effluent Pumping/Outfall

Secondary effluent is routed to effluent pumps. Depending on river elevation and plant flow, effluent is either pumped or gravity fed 1.5 miles through the outfall to the Sacramento River. Four of a possible six effluent pumps are installed in the influent/effluent pump building. Each pump is 1,500 hp, and can pump 25 to 125 MGD at a maximum head of 41 feet. A variable speed drive on each pump provides for automatic regulation of pumping in accordance with effluent flow. Pumps are controlled automatically by maintaining a constant water elevation in the secondary effluent channel. Modulating discharge valves on the effluent pumps are designed to keep the units operating within the design range at low effluent head conditions.

Gravity discharge, used when river elevations and plant flows allow it, is also controlled based on water elevation in the secondary effluent channel. Water is bypassed around the effluent pumps through four 72-inch valves. A vacuum system at the outfall is used to help siphon the water over the levee and into the river. A backflow control valve, located at the top of the levee, can be closed to allow for diversion of effluent to the emergency storage basins, and prevent water from siphoning from the river back through the outfall line.

An acoustic flowmeter, located at the river, is used to determine river flowrates and river-to-effluent dilution ratio. When the river-to-effluent dilution ratio drops below 14:1, the plant diverts effluent to its emergency storage basins, as described earlier.

Effluent is discharged to the river through a multiport outfall diffuser. The diffuser extends 400 feet, or about 2/3 of the way across the Sacramento River. The diffuser is a 120-inch concrete pipe at the bottom of the river, with 49 open nozzles (and 50 additional sealed ports for future use) spaced equidistant along the entire length of the diffuser.

Utilities

Plant water systems include potable water (WP), nonpotable water (WN), high and low-pressure reclaimed water (WRH and WRL), and waste-heat cooling water (WHW). Potable water is purchased from the City of Sacramento. Nonpotable water is currently supplied from the same source as the potable water. Reclaimed water and waste-heat cooling water are plant secondary effluent, which is pumped as required. In FY97, the average usages were:

WP	0.02 MGD
WN	0.50 MGD
WRH	2.9 MGD
WRL	3.3 MGD
WHW	11.1 MGD

The plant's WN system is separated from the WP system by an air break. WN is used throughout the plant for clean water applications, such as pump seal water, cooling water, and utility station water. Cost of purchased water (WP and WN) in FY97 was $190,000. WN will eventually be supplied by a water reclamation plant, which is currently in design.

Uses for WRH (130 psig) include water supplies for hydrants, sprinklers, sprays, flushing, utility stations, chemical eductors, and grit agitation. Uses for WRL (45 psig) include water for cooling, chemical injectors, sprinklers, and foam suppressant spray. WHW (45 psig) provides cooling water for the oxygen plant, the influent and effluent pumps, chillers, and other equipment located in the influent/effluent pump building.

Plant air systems include the channel aeration air (CAA), service air (SA), utility air (UA), pad air for chlorine and sulfur dioxide railcars, and WAS thickener air. The CAA system is a low-pressure system (described earlier in preliminary treatment); costs have been allocated to preliminary, primary and secondary treatment. The remaining systems are high-pressure (100 to 125 psig) systems. SA supplies the plant with clean, dry air for air operated valves, gates, and pneumatic equipment and instrumentation. UA supplies agitation air, ejectors, and other applications where SA quality air is not required. Dedicated systems are provided for chemical pad air and for WAS thickening.

Automation

Equipment can be controlled locally, at area control centers (ACCs), or at the central plant control center (PCC). For details of the automation system, please refer to the process benchmarking survey question on automation. The plant will be installing a new distributed control system, which will provide for increased automation throughout the facility.

Power/Energy

Electricity for the plant is purchased from Sacramento Municipal Services District (SMUD). SMUD operates a generation facility adjacent to the plant, and uses a combination of purchased natural gas and plant digester gas to generate electricity. The plant is given priority over other customers for purchase of electricity. SRWTP sells digester gas to SMUD and purchases steam from them. The steam is used for heating the digesters and for general plant HVAC. On-site boilers provide backup if steam is not available.

The main components of the gas management system include: the low pressure sludge gas (LSG) collection piping and holder tanks, the LSG scrubbers, the medium pressure sludge gas (MSG) compressors and heat exchangers, the MSG storage spheres, the delivery piping to SMUD's cogeneration facility, the backup boiler system, and the flares/waste gas burners.

Digester gas is collected in the LSG piping and sent to the LSG holder tanks. A pressure of 6.25 inches W.C. is maintained in the LSG system. From the LSG holder tanks, the gas goes through iron oxide media scrubbers to remove H2S to concentrations below 50 ppm, and then to the MSG compressors. Pressure in the MSG system is maintained at approximately 10 psig. Gas is cooled by heat exchangers to remove moisture, and is stored in the MSG storage spheres until delivery to the SMUD cogeneration plant. Gas can also be delivered to the onsite boilers, or can be sent to flares or waste gas burners.