Fisherman Bay Sewer District
Wastewater System Master Plan
(DRAFT)

Prepared For:
Fisherman Bay Sewer District
35 Weeks Point Road
P. O. Box 86
Lopez Island, WA 98261
Phone: 360-468-2131 (office)
360-468-2724 (plant)

Revised July 2008

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Wastewater System Master Plan - DRAFT

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MISSION STATEMENT

Fisherman Bay Sewer District was formed in 1974 by San Juan County Commissioners, by Resolution No. 30-1974 and approved by District residents' in a special election on April 30, 1974. The intent of the District and its mission was to protect the entire Fisherman Bay environment and the health of its residents by providing secondary wastewater treatment at a centralized facility. The planning area included in the first comprehensive plan, written in 1976 by ARC Engineers of Redmond, WA, reflect that intention. Recent San Juan County planning policy, to have a UGA designation for an area that largely coincides with the Districts present service area in the Village core, should not prevent the District from projecting service requirements and, ultimately, service for the original planning area; to fulfill its mission to protect the Fisherman Bay environment and its water resources; and to protect the health of the occupants of the residences and development the County has permitted in the planning area. The planning area remains unchanged from the first comprehensive plan. Figure 3-1 from the new plan, which came from the original comprehensive plan, indicates the long range scope of the District, surrounding and protecting Fisherman Bay. The original comprehensive plan and prior amendments to the comprehensive plan have all been approved by the County.

Fisherman Bay Sewer District
Board of Commissioners

Note: If this document is included with San Juan County's Comprehensive Plan, it does not constitute an interlocal agreement with the Fisherman Bay Sewer District.

EXECUTIVE SUMMARY

This "Wastewater System Master Plan" report reviewed the environmental conditions in the District's service area; described the District's planning area, the service area, the major developments, and existing zonings within the planning area; estimated the existing population, analyzed the existing flows, organic loadings, peaking factors and other characteristics of the plant influent wastewater; and established following criteria based on the historical data for projected future flow and organic loading conditions:

- ERU flow loading: 100 gal/ERU, summer
  93 gal/ERU, winter
- ERU organic loading: 0.15 lbs BOD_5/ERU, summer
  0.11 lbs BOD_5/ERU, winter
  0.14 lbs $CBOD_5$/ERU, summer
  0.10 lbs $CBOD_5$/ERU, winter
- TSS: 37 mg/l
- pH: 7.06 s.u.
- Ammonia: 57 mg/l
- Temperatures: 46^{o}F (7.8^{o}C) winter; 63^{o}F (17.2^{o}C) summer
- Peaking factor: 3.5

A 5.6% growth rate up to 2020 and 3.8% after within the proposed Urban Growth Area (UGA), and 2.5% for all other areas were assumed for projecting the future ERUs, flows and organic loadings. Listed in the tables below are summaries of the projections:

Table 1 –ERU Summary and Population Projections

Area Descriptions	UGA area	Area: Outside UGA, but within FBSD service area	Subtotal: UGA and FBSD service area	Eastshore South Area	Grand total
Area (acres)	197	220	**417**	367	**784**
Existing ERU	173	136	**309**	130(1)	**439**
Estimated New ERU Based on lot unit	346	138	**484**	10	**494**
Estimated New ERU with 20% Increase	415	166	**581**	12	**593**
Total Buildout ERU	588	301	**890**	142	**1032**
Estimated Existing Population Equivalent (people)	367	288	**655**	276	**931**
Estimated Future Population Equivalent Increase (people)	880	351	**1,231**	25	**1,256**
Estimated Buildout Population Equivalent (people)	1,247	639	**1,886**	301	**2,187**

(1): Estimated existing developed units, but they are not connected to the District's sewer system.

Table 2 – Summary of Projected Loadings

Year	Areas / Parameters	UGA Summer	UGA Winter	Total of UGA and FBSD Summer	Total of UGA and FBSD Winter	Eastshore South[(1)] Summer	Eastshore South[(1)] Winter	Total Summer	Total Winter
2020	ERU	333		516				658	
	Average flow (gpd)	33,286	30,956	51,557	47,948			65,757	61,154
	Peak flow (gpd)	116,502	108,347	180,448	167,816			230,148	214,037
	BOD_5 loading (lbs/d)	50	37	77	57			99	72
	$CBOD_5$ loading (lbs/d)	47	33	72	52			92	66
2028	ERU	449		671				813	
	Average flow (gpd)	44,858	41,718	67,119	62,421			81,319	75,627
	Peak flow (gpd)	157,004	146,014	234,916	218,472			284,616	264,693
	BOD_5 loading (lbs/d)	67	49	101	74			122	89
	$CBOD_5$ loading (lbs/d)	63	45	94	67			114	81
Build-out	ERU	588		890		142		1032	
	Average flow (gpd)	58,813	54,696	88,958	82,731	14200	13206	103,158	95,937
	Peak flow (gpd)	205,846	191,437	311,354	289,559	49700	46221	361,054	335,780
	BOD_5 loading (lbs/d)	88	65	133	98	21	16	155	113
	$CBOD_5$ loading (lbs/d)	82	59	125	89	20	14	144	103

(1): It is assumed that if the Eastshore South area is to be serviced by the District eventually, it will not be connected to the District prior to 2028.

This report described and evaluated the existing conditions of the collection system and the plant, assessed the performance of the plant, and provided recommendations for improvements to the existing plant. Listed in the following Table 3 is a summary of the estimated capacities for the major plant units and projected future needs:

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Table 3– Capacity of Major Units and Projected Future Needs

<table>
<tr><th>Item description</th><th>Estimated Capacity</th><th>Current Permits (winter/Summer)</th><th>Year 2020 Loadings(1)</th><th>Year 2028 Loadings(1)</th><th>Build-out Loadings(1)</th><th>Notes</th></tr>
<tr><td>Influent Flow Metering</td><td>213,120 gpd</td><td rowspan="8">23,000 gpd/
34,000 gpd</td><td>180,000 gpd</td><td>235,000 gpd</td><td>361,000 gpd</td><td>Summer peak flows</td></tr>
<tr><td>1000-gallon Influent Flow Tank</td><td>n/a</td><td rowspan="5">49,000gpd/
53,000 gpd</td><td rowspan="5">63,000 gpd/
68,000 gpd</td><td rowspan="5">97,000 gpd
104,000 gpd</td><td>Split flow and remove grease, scum/floatables</td></tr>
<tr><td>Anaerobic Pretreatment Cell</td><td>41,424 gpd</td><td>Based on 2 days HRT</td></tr>
<tr><td>Aerated Cell #1 and Cell #2</td><td>33,200 gpd/
41,400 gpd</td><td>Based on 20 mg/l $CBOD_5$ effluent</td></tr>
<tr><td>Polishing Cell #3</td><td>62,880 gpd</td><td>Based on 2 days HRT</td></tr>
<tr><td>Constructed Wetland</td><td>41,424 gpd</td><td>Design capacity</td></tr>
<tr><td>Chlorine Disinfection System</td><td>144,000 gpd</td><td>181,000 gpd</td><td>236,000 gpd</td><td>362,000 gpd</td><td>Based on 30 minutes HRT for summer peak flows</td></tr>
<tr><td>Plant Effluent Metering System</td><td>172,800 gpd</td><td>181,000 gpd</td><td>236,000 gpd</td><td>362,000 gpd</td><td>Summer peak flows</td></tr>
<tr><td>Aerators</td><td>109 lbs BOD_5/d</td><td>38 lbs BOD_5/d
56 lbs BOD_5/d</td><td>63 lbs BOD_5/d
73 lbs BOD_5/d</td><td>80 lbs BOD_5/d
107 lbs BOD_5/d</td><td>119 lbs BOD_5/d
161 lbs BOD_5/d</td><td>2.2 lbs O_2/lbs BOD_5 /d</td></tr>
</table>

(1) Projected flows in Table 5.7 were rounded up to 1000s.
(2) 1,000 gallons was added to the projected flow and 6 lbs was added to the projected BOD loading for the septage supernatant contributions.

However, preliminary estimates show that actual capacities of the L-2 lagoon and the wetland may be substantially larger than the currently permitted capacity. Therefore, re-rating the plant capacity is recommended.

This report developed and evaluated alternatives for meeting present, the projected year 2020 conditions, the year 2028 and buildout condition in 2041. Table 4 is a summary of the recommended alternatives and costs in 2008 dollar value.

Table 4 – Summary of Recommendations and Costs

Conditions	Present	Year 2020	Year 2028	Buildout
Scenario I Recommendations	• Re-rating the plant's capacity • Construction of a septage receiving station • Upgrading the existing plant	• Replace the existing chlorine disinfection with UV disinfection • Re-evaluate the plant capacity	• Upgrade the effluent pumps to large pumps • Construct the 2nd train of anaerobic pretreatment cell, aerated cell and	• Add a new train of UV system

	influent flow metering system. • Installation of floating cover for the anaerobic pretreatment cell • Construction of an effluent pump station • Upgrading the emergency gen. set • Replace the existing plant effluent meter with a magnetic flow meter		polishing cell if the rated capacity is as large as estimated in the Appendix E.	
Scenario II Recommendations	• Re-rating the plant's capacity • Construction of a septage receiving station • Upgrading the existing plant influent flow metering system. • Installation of floating cover for the anaerobic pretreatment cell • Construction of an effluent pump station • Upgrading the emergency gen. set • Replace the existing plant effluent meter with a magnetic flow meter	• Replace the existing chlorine disinfection with UV disinfection • Construct the 2nd train of anaerobic pretreatment cell, aerated cell and polishing cell if the rated capacity is less than the estimated maximum capacity.	• Upgrade the effluent pumps to large pumps	• If the rated capacity is less than the estimated maximum capacity construct the 3rd train of anaerobic pretreatment cell, aerated cell and polishing cell • Add a new train of UV system
Scenario III Recommendations	• Re-rating the plant's capacity • Construction of a septage receiving station • Upgrading the existing plant influent flow metering system.	• Build the first train of SBR system • Replace the existing chlorine disinfection with UV disinfection	• Build the 2nd train of SBR system • Upgrade the effluent pumps to large pumps	• Add a 2nd train of UV

	• Construction of an effluent pump station • Upgrading the emergency gen. set • Replace the existing plant effluent meter with a magnetic flow meter			
Scenario I Cost	$245,000	$34,000	$847,000	$34,000
Scenario II Cost	$245,000	$861,000	$20,000	$861,000
Scenario III Cost	$194,000	$988,000	$974,000	$34,000

Preliminary analysis of the District's financial conditions show that the District's future revenues appear adequate for meeting the projected future improvement and expansion needs for the scenario I and II situations, but would require additional funding for the scenario III situation, which involves replacing the existing lagoon system with a SBR system.

1.0 General Information

Fisherman Bay Sewer District (the "District") is located on the Lopez Island in San Juan County, State of Washington. The District operates a wastewater treatment plant and a sewer collection system that serves a portion of the residents on Lopez Island. Users in the District include residents, a school, a few retail businesses, restaurants, hotels, and offices. The District's collection system consists entirely of a septic tank effluent pumping (STEP) system. The wastewater treatment plant is an aerated lagoon facility located at 620 Lopez Road North on the island. A constructed wetland is used to polish the lagoon effluent prior to plant effluent disinfection and final discharge. Treated effluent is piped approximately half mile and discharged through a bay outfall diffuser into the San Juan Channel. The District operates the plant under a discharge permit (WA-003058-9, See **Appendix A**) issued by the Washington State Department of Ecology (DOE). The current permit was issued on March 27, 2006 and will expire on March 27, 2011. The permitted capacity of the plant is 23,000 gpd and 38 lbs BOD_5/day for the winter season (December to March), and 34,000 gpd and 56 lbs BOD_5/day for the summer season (April to November). Figure 1.1 is a location map for the plant, and Figure 1.2 is aerial map of the plant. Figure 1.3 is the vicinity map.

Effluent limitations for the plant are as follows:

- $CBOD_5$: 25 mg/l (monthly average); 40 mg/l (weekly average)
- TSS: 75 mg/l (monthly average); 110 mg/l (weekly average)
- Fecal coliform: 200/100 mg/l (monthly average); 400/100 mg/l (weekly average)
- Total residual chlorine: 0.5 mg/l (monthly average); 0.75 mg/l (weekly average)
- pH: 6.0 to 9.0 s.u.

In the past several years the District has completed several major improvements to the plant and the collection system. Performance of the plant has improved noticeably without any permit violations.

Lopez Village is the commercial center of the Lopez Island and the core of the District's service area. The Lopez Village area is recently proposed by the San Juan County to be designated as the Urban Growth Area (UGA). The District is concerned with the impact of the UGA designation and its ability to meet the future growth needs in the District. Therefore, the District retained Stantec (8211 South 48th Street, Phoenix, Arizona 85044, phone No. 602-438-2200, fax No. 602-431-9562) to prepare a master wastewater system planning report. This report will review the existing conditions of the plant, project future wastewater needs, develop alternatives for meeting the near term and long term needs, and estimate the costs for implementing the recommended alternatives. This report should provide with the District a mechanism for implementing a plan for meeting the future needs.

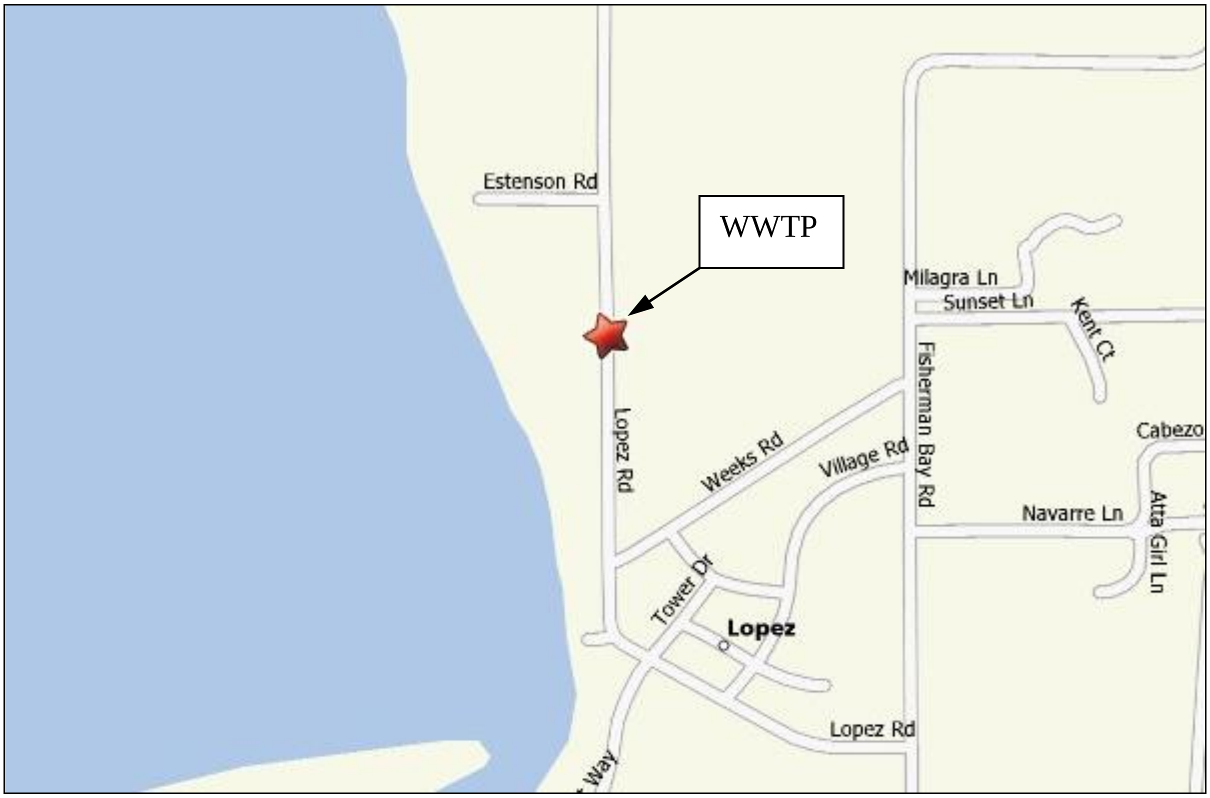


Figure 1.1 – WWTP Location Map

Figure 1.2 – WWTP Aerial Map

Figure 1.3 – Vicinity Map

2.0 Environmental Conditions

An environmental checklist[1] was prepared on July 22, 2005 for the construction of the constructed wetland for the District's wastewater treatment plant. This checklist was submitted to the San Juan County and the DOE for review and approval. The following environmental conditions were prepared on the basis of the approved checklist.

2.1 WATER RESOUCES

Surface water supplies are widely used on the island for agricultural purposes. The streams on the island are intermittent due to relatively small watersheds. Therefore, reservoirs are required.

Domestic water supplies on the island are obtained from groundwater sources and to a less extent by sea water with desalination water treatment process. The groundwater aquifer is essentially an underground reservoir recharged by rains infiltrated to the underground.

The underground water is basically limited water resource. As population grows on island, water supply may be a challenge unless sea water can be treated economically. Another water resource that should be considered is the treated wastewater effluent reuse.

There is no year-round or seasonal surface water body or stream on or in the immediate vicinity of the plant site. There is also no year-round or seasonal surface water body or stream within the District's service area except some storm runoff conveyance channels.

Groundwater level at the plant site varies throughout the year. Groundwater level is generally higher in the wetter months (October through May). According to the 1994 geotechnical engineering study by Earth Consultants [2], six (6) test pits were excavated on the plant site in May 1994. No groundwater was encountered in any of the test pits, which were extended to a maximum depth of ten (10) feet below the existing surface.

2.2 AIR AND SMELL

Ambient air quality on the Lopez Island is excellent. The plant is in the proximity of residents on the west. The District is very serious regarding odor control. However, there have not been many odor complaints in recent years.

2.3 GEOLOGY, LAND AND SOILS

The planning area is comprised of two types of rock derived from different geologic periods. The most prevalent is quarternary Pleistocene which makes up approximately 97% of the area. These rocks were placed in two distinct zones or layers by the glaciations that prevailed in the area at various times. The first zone is glacial outwash that was placed ahead of the advancing glacier. This layer is composed of sand and gravel, therefore is permeable. The second layer is glacial till consisting of clay and silt that is nearly impermeable to water.

There is no prime or unique farm land within the District's service area. Zonings in the District's service area include Lopez Village Urban Growth Area (UGA), Marine Center LAMIRD (limited area of more intense rural development), Growth Reserve, Village Commercial (VC) District and Rural Farm Forest (RFF). Adjacent lands of the plant site include farming and residential uses.

The site was underlain by eight (8) to fourteen (14) inches of silty topsoil. Beneath the topsoil layer is about two (2) to four (4) feet of a medium stiff to stiff, mottled gray and rust brown sandy and clayey silt. This layer is underlain by a wet, stiff to very stiff, brownish gray clay with some rounded gravel and occasional cobbles.

2.4 FLOODPLAINS AND WAVES

The 1994 Engineering Report [(3)] prepared by Anne Symonds & Associates, Inc states that the existing plant site is located at 45 to 50 ft, a minimum of 42 feet above the Mean Higher High Water. The plant is 540 feet from the San Juan Channel, located on a mild slope above the localized drainage areas. Based on FEMA flood maps, the plant site and the surrounding properties are well outside the 100 year flood or wave impacted areas.

2.5 WETLANDS

Isolated wetlands exist within the District's service area. There are wetland areas within the village core that show up on the County's critical areas maps. The amount of wetland acreage is about 7 acres according to the County report [(4)]. A constructed wetland was built in 2005 on the plant site for polishing the plant lagoon effluent.

2.6 WILD AND SCENIC RIVERS

There are no wild or scenic rivers within the District's service area.

2.7 HISTRORIC AND ARCHAEOLOGICAL SITES

The earliest inhabitants of the San Juan Islands were primarily Indians of the Lummi and Samish nations. British and Spanish explorers discovered the islands in the 18th century but White settlers did not arrive until the 1850s. Lopez Island was named after Lopez Gonzales de Haro, the Spanish captain who discovered the islands in the late 1700s. Among the first White settlers in the area were British sailors who jumped ship to stake claim to the agriculturally rich land of Lopez Island. The sailors typically married native women and settled down to farming and fishing. Beginning in the mid to the late 19th century the island was also settled by Scandinavian fishermen, British trappers and sheepherders, and Americans returning from gold explorations in Canada. The island's gentle topography encouraged agriculture and when White settlers began to arrive in the San Juans in the 1850s many chose to establish homes on Lopez. Historically, as a whole, the islands have been populated by hard-working farmers, fishermen, seafarers, and others.

James and Amelia Davis were the first white couple to settle on Lopez. Their land was originally claimed under British patent by Samuel Clark Davis, James' older brother, around 1854. The land claim stretched from Richardson along Davis Bay almost to Shark Reef., on the southwestern side of the island. James Earnest Davis, the son of James and Amelia, and his wife Maybell Troxell Davis built a large farmhouse in 1913. Family legend says it was paid for by a single successful season on a fish trap off the south end of the island. While many of James and Amelia's children went to sea, James Earnest worked the fish traps during the salmon runs on Lopez. John Troxell, James Earnest's brother-in-law, was the most famous of the local "fish trap men." Fish traps appeared on the islands in the 1890s and were the easiest and most popular method of taking salmon until they were banned by the State in 1934.

The waters around the San Juan Islands are extremely popular with boaters from both the U.S. and Canada. Also because of their strategic location, they have proven attractive to smugglers and rum-runners transporting illegal aliens, drugs, wool, liquor, and other commodities. However these traditional occupations became less profitable in the 1970s and the tourism industry began to prosper in the islands. Lopez Island, which is relatively flat compared to the other islands, is popular among bicyclists. The main village, located on the center of the western coast, has several shops, an inn, and other professional services. Unlike most of the other islands, several profitable working farms still operate on Lopez Island.

There are no known historic or archaeological sites on the plant site or in the immediate vicinity of the site.

2.8 ENDANGERED OR THREATENED SPECIES AND HABITAT

Hawk, heron, eagle and songbirds have been observed in the District area. But no endangered or threatened species or habitats have been observed or existed in the District area.

2.9 SEISMIC CONDITION

The Puget Sound region is classified as Zone 3 by the Uniform Building Code (UBC). The largest earthquakes in the region have been sub-crustal events, ranging in depth from 50 to 70 kilometers. Such deep events have not caused surface faulting. Based on the site soil conditions and the geology of the area, the geotechnical engineer has recommended a site coefficient of 1.4 for seismic concern designs.

2.10 TOPOGRAPHY

Fisherman Bay lies on the west side of the Lopez Island along the San Juan Channel. The bay is formed by a peninsula which nearly closes the mouth at the north end.

The District's planning area has steep land slopes at 10 to 20% on the south easterly perimeter of the bay. Elsewhere the land is gently rolling with moderate slopes except in the immediate vicinity of the shoreline north of the bay. That portion of the shoreline is an escarpment dropping as much as 100 feet on a one to one slope to the beach. Approximately 75% of the planning area drains into the bay. The remainder drains over escarpment directly to the San Juan Channel. Lopez Hill is highest point on the island. The highest point in the planning area is just over 300 feet.

2.11 CLIMATE

The climate of the San Juan area is characterized by short, cool, dry summers and mild moderately wet winters. The controlling factors are Pacific weather systems and the orographic influence of the Olympic and Cascade Ranges.

Winter temperature systems are dominated by high frequency maritime lows and maritime zonal flows influenced by the jet stream. The system generally moves from southwest to northeast with high gusty winds and periods as short as 48 hours. The Olympic Range provides shelter for the San Juan area by squeezing massive amount of precipitation from the air mass as they are lifted up the western slopes. The descending air on the lee side of the Olympics is drier and warmer but orographic influences still dominate the precipitation patterns on the islands. Summer weather patterns are dominated by massive stationary maritime highs centered off the Washington coast. These high pressure systems block the flow of maritime air into the area resulting in dry summer.

Average annual precipitation on the island is approximately 23 inches. Average highs in the summer months are in the mid-seventies. Winter lows are generally in the 30’s to 40’s with an occasional cold blast from the north that brings a few inches of snow and temperatures below freezing. If snow does occur it rarely last more than a few days before temperatures rise, bringing rainfall. The wettest months are usually November and December with January and February close behind.

2.12 DEMOGRAPHIC PROFILE AND ECONOMY

According to the 2000 U.S. Census the population of Lopez Island was 2179. In the same year the percentage of males and females was 50.1% and 49.9% respectively. The racial composition of the population in 2000 was predominantly White (95.1%), followed by American Indian and Alaska Native (1.3%), Asian (0.8%), and Black or African American (0.1%). Only one individual identified themselves as a Pacific Islander in 2000. Few individuals (0.4 %) classified themselves as belonging to some other race. Overall, 2.2% of the population identified themselves as belonging to two or more races. Less than five percent of the population (2.7%) identified themselves as Hispanic or Latino.

The median age of the population in 2000 was 48.9, which was higher than the national median of 35.3 for the same year. In 2000 30% of the population was between the ages of 45 and 60. A small percentage (6.2%) of the population was foreign-born; of the foreign-born population 19% were born in Canada and 16.2% in Columbia. Approximately 80.4% of the population of Lopez Island was living in family households in 2000. The 2000 U.S. Census reports that 76.6% of the population over 18 years of age had received a high school degree or higher, 37.2% had received a Bachelor’s degree or higher, and 14.3% received a graduate or professional degree; as compared to the national averages of 79.7%, 22.3%, and 7.8% respectively.

At the time of the 2000 U.S. Census, 18% of the employed civilian population 16 years of age and over was employed within local, state, or federal governments for industries other than agriculture, fishing, forestry, and hunting. The majority of Lopez Island’s employed civilian population 16 years of age and over (21.7%) was employed in "education, health, and social services." Slightly less (16.8% and 16.0%) were employed in "construction" and "arts, entertainment, recreation and accommodation" respectively. According to the 2000 U.S. Census natural resource jobs including agriculture, forestry, fishing, and hunting employed 3.3% of the population.

According to 2000 U.S. Census data 54.1% of the potential labor force was employed and there was a 4.2% unemployment rate (calculated by dividing the unemployed population by the labor force). A total of 43.5% of the population over 16 years of age were not in the labor force in 2000 as compared to the national average of 36.1% for the same year. The 2000 U.S. Census reports that in 1999 the income of 10.2% of the population was below the poverty level. The median household income in 1999 was $38,594 and the per capita income was $26,789.

In 2000 there were 1775 housing units on Lopez Island. The percentages of occupied housing units that were owner versus renter occupied were 79.1% and 20.9% respectively. Approximately 42% percent of the housing units were vacant, of which 91.2% were vacant due to seasonal, recreational, or occasional use.

3.0 Service Area

3.1 PLANNING AND SERVICE AREAS

The Fisherman Bay Sewer District was established by San Juan County resolution 35-1974 and resulting special election. A draft Comprehensive Plan was prepared in July 1976, then scaled down in May 1977, and adopted by the Commission of the District in 1978. The General Sewer Plan and the Engineering Report were approved by the Department of Ecology (DOE) in August 1979. Amendment No. 1 to the Comprehensive Sewer Facilities Plan(5) was prepared in April 1984 by James E. Wilson & Associates. When the original lagoon plant was expanded in 1994, an Engineering Report was prepared by Anne Symonds & Associates, Inc. and approved by the DOE.

Figure 3.1 depicted the original Planning Area from the 1976 Draft Comprehensive Plan. The Planning Area generally consists of three main areas: the Lopez Village, the Eastshore North (ESN) and the Eastshore South (ESS). The Planning Area shown on Figure 3.1 appears to be a general outline without specific references to a street, section lines or property lines, or detailed description of defining the planning area boundary.

The District's service area initially consisted of the Lopez Village area only. In August 1983, the Eastshore North area was annexed into the District. To this day, the service area is still limited to these two areas. Sewer service has not extended to the Eastshore South area at present.

The boundary of the service area is still evolving due to periodic annexation petitions by property owners. Currently the far north boundary of the service area is approximately ¼ mile north of the Sunset Lane. The San Juan Channel shoreline is generally the west boundary of the service area. The Whisky Hill Road is the far south boundary, and Fisherman Bay Road (County Road #103) and Charlie Lane are the east boundary. It is estimated that District's service area encompasses approximately 300 acres of land. Figure 3.2 shows the service area in the 1994 engineering report. Figure 3.3 shows the current service area.

The service area boundary shown on Figure 3.3 is delineated based on present available information. This boundary and the description for the District's service area in this report are not intended to be a legal description or to be used as such. For exact descriptions of the District's planning area and service area, readers shall contact the District or their representative.

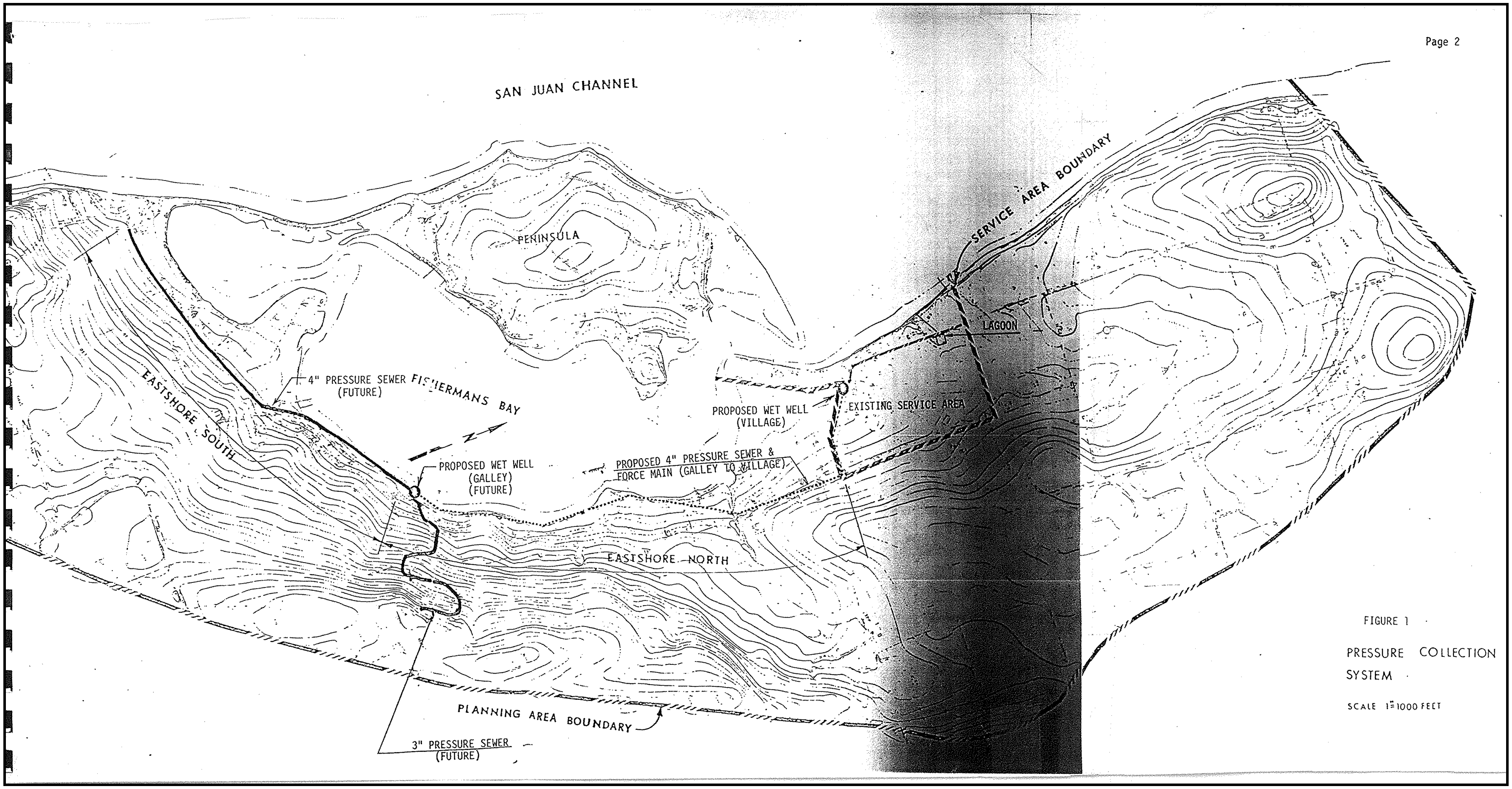


Figure 3.1 – FBSD Planning Area

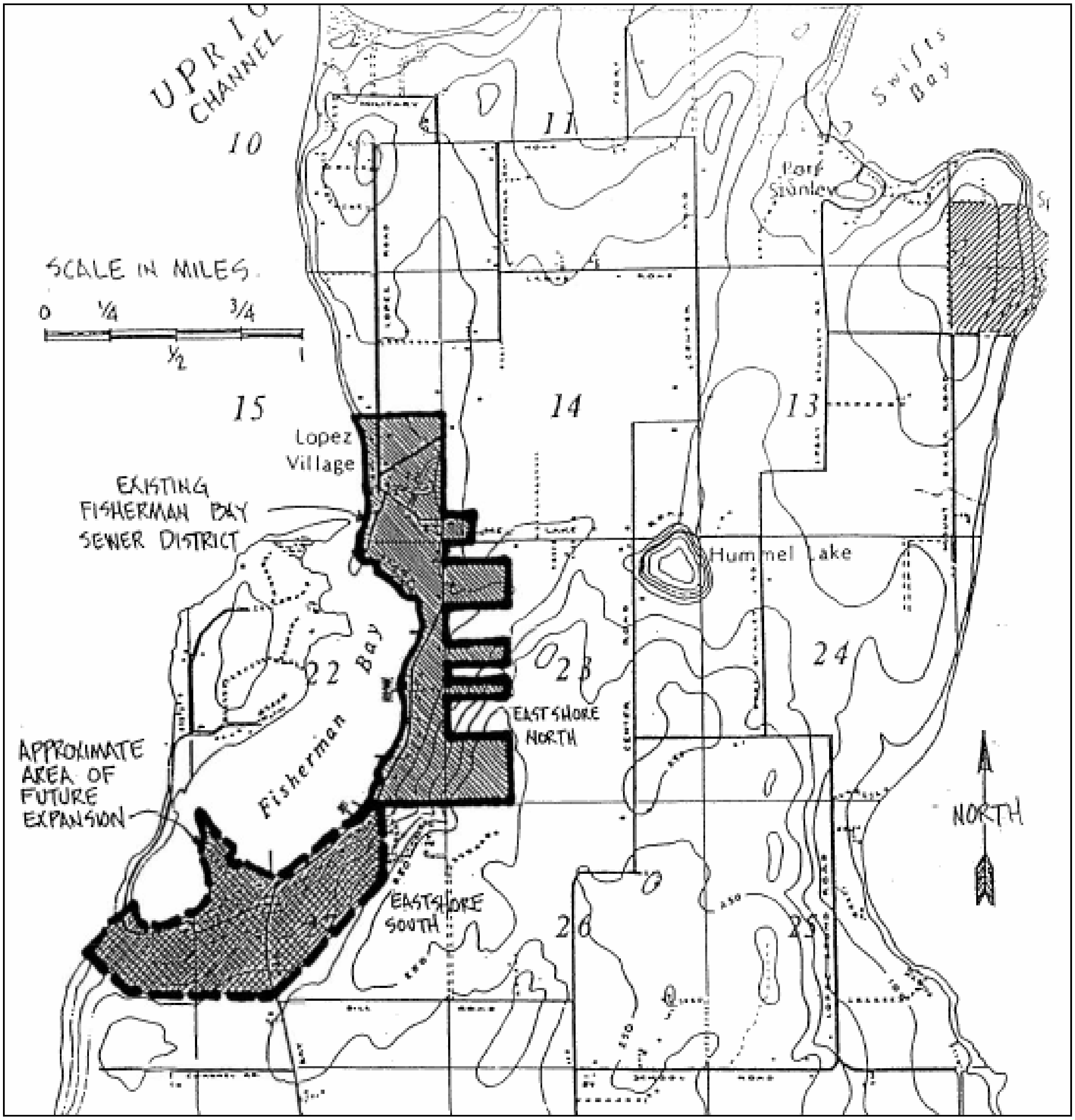


Figure 3.2 – 1994 Service Area Map

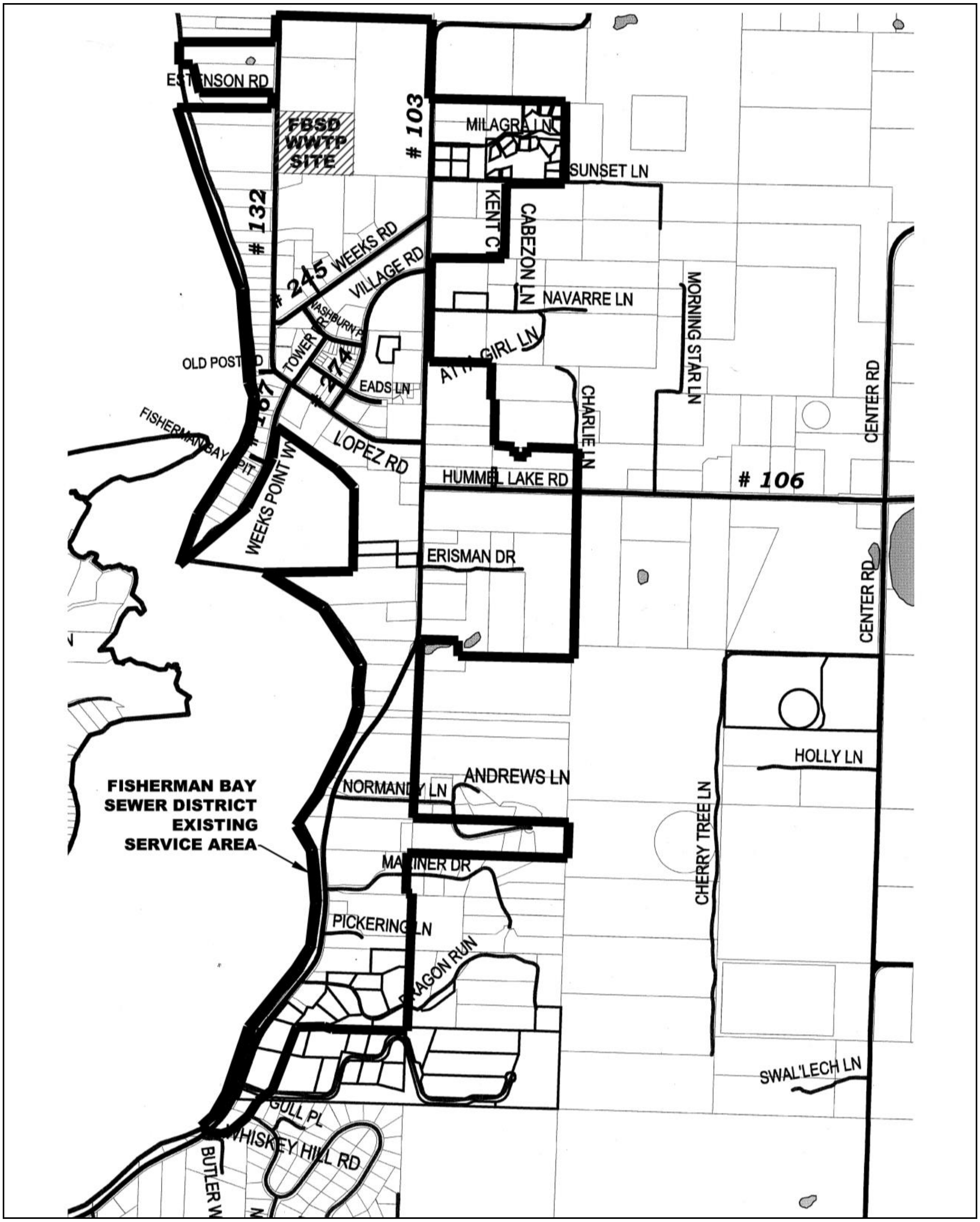


Figure 3.3 – Current Service Area

3.2 EXISTING DEVELOPMENTS IN THE SERVICE AREA

Most of the existing developments in the District are located around the Lopez Village area. Figure 3.4 is a map prepared by the Lopez Island Chamber of Commerce showing the existing establishments in the village area.

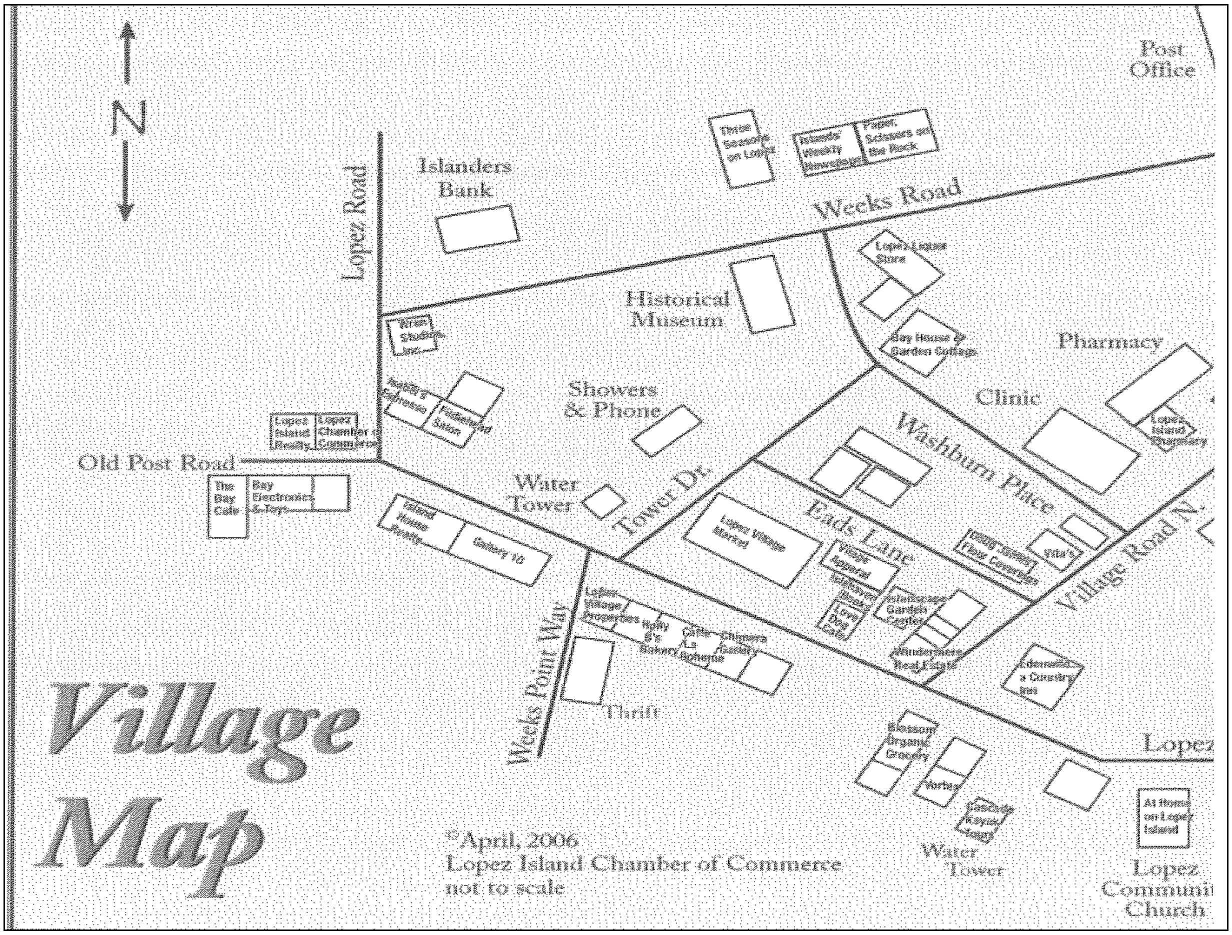


Figure 3.4 – Lopez Village Map

In addition to residential developments, major commercial and institutional developments in the service area include:

- The Islander Resort (Restaurant, Bar and Marina)
- The Lopez Village Market
- The Galley Restaurant and Bar
- Lopez School System – serviced by contract.
- The Church
- Auto repair shop
- The post office
- Lopez Center for Community and the Arts
- The Lopez Island Library

- Fire hall and senior center
- San Juan County Public Works Department Lopez Island Yard

Currently there are existing 320 equivalent residential units (ERU) in the District's service area, which includes the Lopez school that are serviced by contract. The existing 320 ERUs include 130 residential users and 190 commercial and institutional users. 309.2 ERUs were active users in early 2008. 30 new ERUs were expected to be connected in early 2008. The 30 new ERUs included 25 residential ERUs and 5 commercial ERUs.

3.3 ZONING AND POTENTIAL MAJOR DEVELOPMENTS

The San Juan County is proposing an Urban Growth Area (UGA) in the Lopez Village area in compliance with the State's Growth Management Act (GMA). The original Lopez Village Urban Growth Area (UGA) was adopted by San Juan County in October of 2000. The UGA covered an area of about 466 acres and included the Lopez Village Commercial Core as well as properties north and south of the village core.

The adoption of the Lopez Village UGA was appealed to the Growth Management Hearing Board (GMHB). In May, 2001, the GMHB issued a final decision and order (FDO) in the matters under appeal. In response to the 2001 GMHB order the county initiated a number of activities to satisfy the hearings board order, and created a new UGA boundary in Ordinance 9-2005, July 2005. The 2005 UGA boundary enclosed an area of a total of 206 acres. The boundary was further revised in 2008. Figure 3.5 shows the most recently proposed UGA. Majority of the UGA lies within the District's current service area.

Zonings in the District's service area include Lopez Village Urban Growth Area (UGA), Marine Center LAMIRD (limited area of more intense rural development), Growth Reserve, Village Commercial (VC) District and Rural Farm Forest (RFF).

The UGA consists of approximately 198 acres of land and 143 parcels according to the estimate from San Juan County Planning Department. Approximately 102 acres in the UGA is developable, 75 acres has no further development potential, and 21acres of land are within public right-of-way (ROW). Base density for single family residential development in the UGA is four (4) dwelling units per acre. The density can be increased to maximum eight (8) units per acre planned unit development provided some special conditions (water conservation and affordable housing) are met.

The LAMIRD consists of approximately 26 acres. Density in the LAMIRD is governed by the VC land use district as listed in SJCC18.30.040, Table 3.1., Allowable and Prohibited Uses in Activity Center Land Use Districts, which allow a residential density of four (4) dwelling units per acre.

The Growth Reserve area showing on Figure 3.5 covers approximately 100 acres of land. Density in the Growth Reserve area as well as the RFF zoning area is one residential dwelling unit per five (5) acres.

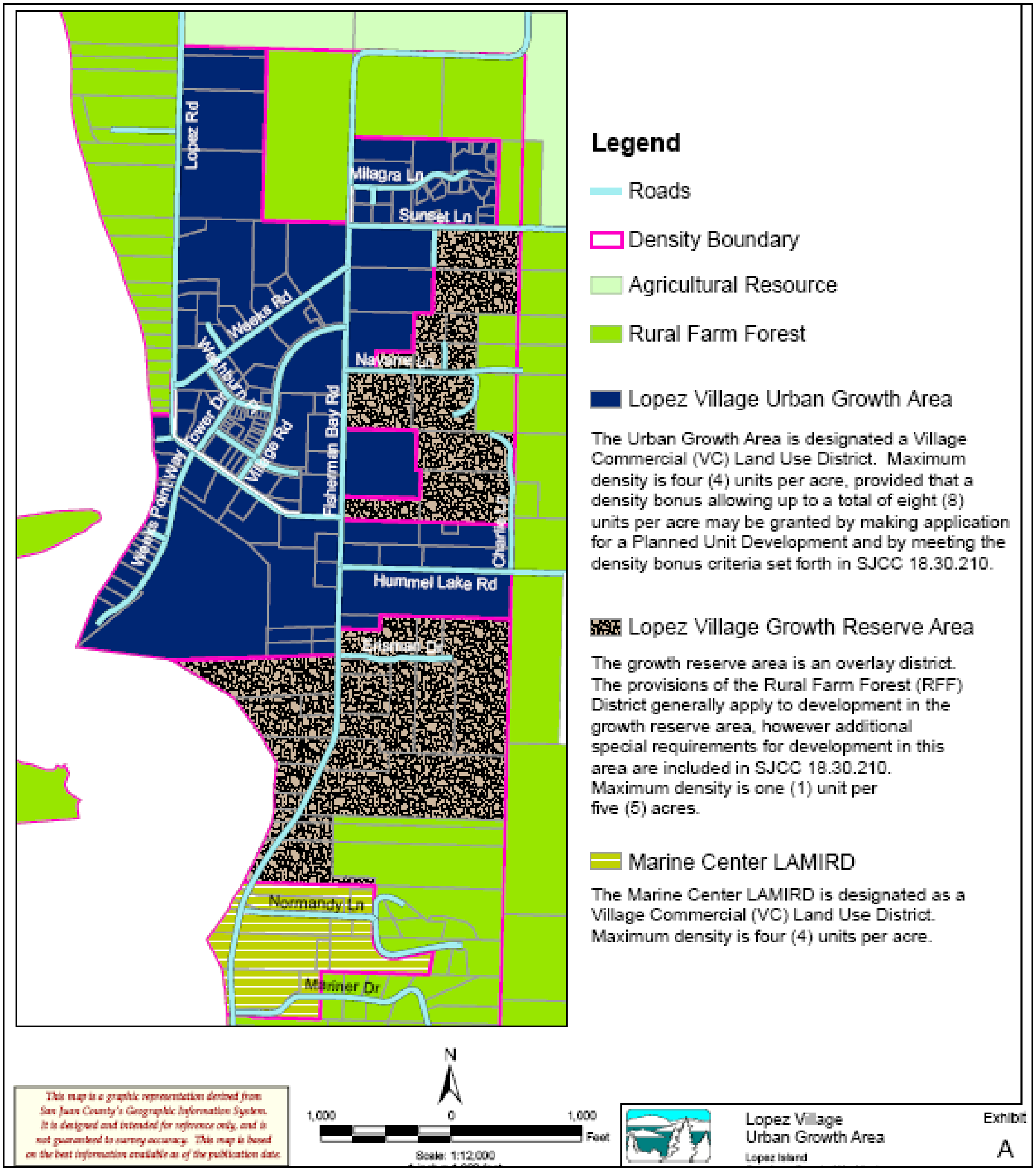


Figure 3.5 – Lopez Village UGA Map

The 2005 UGA boundary projected for a 2020 population of about 697 persons, or an increase of about 483 persons from 2004 to 2020. This represents an average annual growth rate of about 7.65 percent over the 16 year period.

4.0 Existing Population, Flow and Loading

In order to project future population, flow and organic loading conditions, it is critical to review and analyze the historical data. The historical data will provide basis for forecasting future growth trends, establishing design criteria, and projecting future needs.

4.1 EXISTING POPULATION

There are no direct or specific population data for the District. Federal governmental census data or the County data do not have a particular population estimate for a special district. The County staff report (4) indicates a residential population of 214 people in 2004 within the 2005 UGA boundary. Assuming a 4% growth rate, the estimated population in 2007 was 241 people within the UGA. This population data should be fairly close to the permanent population of District because the UGA and the District service area do not differ much.

The existing population within the District's service area can also be estimated by other available data. There are two rational methodologies for estimating the population within the District. The first method is to use the ERU data for population estimate. Like many other cities, towns or districts, the District uses the ERU for determining septic tank size requirements, connection fees, certain charges and billing rates. The use of ERU was first proposed in the District's 1976 Draft Facility Plan. The definition of the ERU was 2.3 occupants in a single residence at 60 gpd /capita wastewater flow based on the San Juan County demographics at the time. Therefore, 1 ERU equates to 138 gpd flow. The District's Draft Comprehensive Plan, the 1984 Amendment No.1 to the Comprehensive Sewer Facilities Plan, and the 1994 Engineering Report continued the use of ERU. The District classifies a single residential unit with up to three (3) bedrooms as 1 ERU. A business unit is classified as 1 ERU minimum, or estimated based on total wastewater production, then divided by 138 gpd to derive the number of ERUs. A restaurant is classified 3 ERUs minimum, or estimated from total wastewater production, then divided by 138 gpd to derive the number of ERUs.

ERU record data from 1996 to 2007 were listed Table 4.1. The ERU data shows an increase of more than 45% in the last 12 years or an annualized average growth rate of 3.16% from 1996 to 2007.

Populations for each year were calculated based on 2.3 people per ERU for the last 12 years. Because of the relationship with the ERU, the estimated population has the same growth rate as the ERU in the last 12 years.

Table 4.1 – ERU Record Data and Estimated Population

Years	Number of Active ERUs	Estimated Population Equivalent
1996	213	490
1997	223.7	515
1998	224.25	516
1999	234	538
2000	234	538
2001	234	538
2002	254.95	586
2003	257.45	592
2004	258.45	594
2005	294.6	678
2006	296.6	682
2007	309.2	711

The calculated population equivalent based on ERUs appears very high. This high population is due to the high commercial ERUs which represent almost 58% of the total ERUs for the year of 2007. The calculated population equivalent includes several elements: residents in the District, visitors and tourists to the District, employees living outside the District and people who live and work within the District. The actual residential population within the District is much smaller. For example, the 2007 total ERU contains 130 residential ERUs. This equates to a residential population of 299 people using 2.3 persons per ERU. This means that an equivalent population of 437 people is non-residential users in the District in 2007. This non-residential population appears extremely high.

The average household size on Lopez Island has changed since the adoption of 2.3 people per ERU in the 70s. Based on the 2000 census, there were about 2.12 persons per household on the Lopez Island [(4)]. Though ERU and the average household population are not exactly the same concept, 2.3 persons per ERU appear high for present demographic conditions. Assuming a 2.12 person per ERU, then the residential population in the District is estimated at 276 people in 2007. Therefore, the use of 2.3 persons per ERU also contributed to the calculated high population. But regardless, the ERU growth rate is still the same.

The second method of estimating the existing population is to use the plant influent flow record data. Unlike the ERU data, flow data were actually recorded data with direct correlation with population increase. But the relationship of plant influent flow with the population is not proportionally linear due to storm events influence through infiltration and inflow (I/I) contributions to the sewer lines and septic tanks.

Shown in Table 4.2 are 11 years plant influent flow data. Table 4.3 is the calculated population data based on 60 gpd per person for each month in each year. The calculated populations were also graphically shown on Figure 4.1 and Figure 4.2.

Table 4.2 – Monthly Record Flow Data

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Month	Flow (1000 gal)	Flow (1000 gal)	Flow (1000 gal)	Flow (1000 gal)	Flow (1000 gal)	Flow (1000 gal)	Flow (1000 gal)	Flow (1000 gal)	Flow (1000 gal)	Flow (1000 gal)	Flow (1000 gal)
Jan	24	25	27	14	11.1	21.3	14.1	17.2	21.9	23.0	23.0
Feb	19	12	19	12	13.2	13.4	11.5	13.1	17.9	16.0	15.0
Mar	12	18	17	14	12.8	12.0	12.8	14.2	14.6	14.0	17.0
April	11	14	14	15	13.9	15.1	14.2	13.1	15.2	17.0	15.0
May	12	16	17	14	15.8	15.8	14.0	14.6	16.4	14.0	14.0
June	21	12	19	15	13.9	13.7	15.2	16.4	17.0	16.0	16.0
July	16	16	26	19	17.5	20.2	19.3	21.7	21.3	21.0	22.0
Aug	17	16	19	16.5	20.8	19.8	19.5	21.3	23.6	22.0	23.0
Sept	13	13	8	16.9	15.9	13.0	15.1	16.0	19.3	16.0	18.0
Oct	12	10	11	14.5	13.2	15.1	13.8	14.2	15.0	14.0	14.0
Nov	10	13	13	11	13.0	10.7	17.5	16.8	15.4	18.0	15.0
Dec	18	30	16	14.6	20.2	11.6	12.8	19.0	14.6	20.0	13.0
Yearly Total (Mgal)	5.642	5.969	6.294	5.390	5.541	5.556	5.490	6.037	6.476	6.442	6.261

Table 4.3 – Calculated Monthly and Yearly Population

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007

Month	Pop. (people)	Pop. (people)	Pop. (people)	Pop. (people)	Pop. (people)	Pop. (people)	Pop. (people)	Pop. (people)	Pop. (people)	Pop. (people)	Pop. (people)
Jan	400	417	450	233	184	355	236	287	365	383	383
Feb	317	200	317	200	220	224	191	218	298	267	250
Mar	200	300	283	233	213	199	214	237	243	233	283
April	183	233	233	250	232	252	236	218	253	283	250
May	200	267	283	233	264	264	234	243	273	233	233
June	350	200	317	250	231	229	253	273	283	267	267
July	267	267	433	317	292	336	322	362	355	350	367
Aug	283	267	317	275	347	330	324	355	393	367	383
Sept	217	217	133	282	265	217	252	267	322	267	300
Oct	200	167	183	242	221	252	231	237	250	233	233
Nov	167	217	217	183	216	178	291	280	257	300	250
Dec	300	500	267	243	337	194	214	317	243	333	217
Yearly Ave.	**258**	**273**	**287**	**246**	**253**	**254**	**251**	**276**	**296**	**294**	**286**

Figure 4.1 - Calculated Monthly Population (Based on 60 gpd/person)

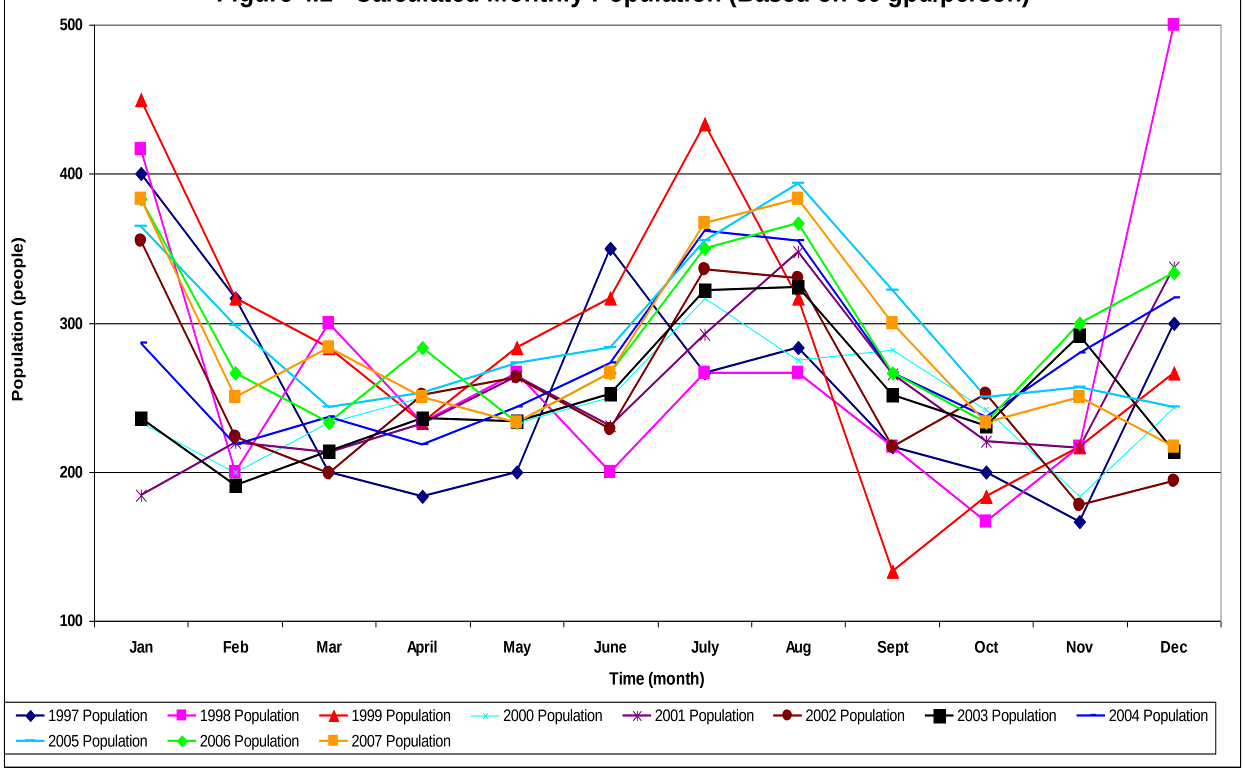
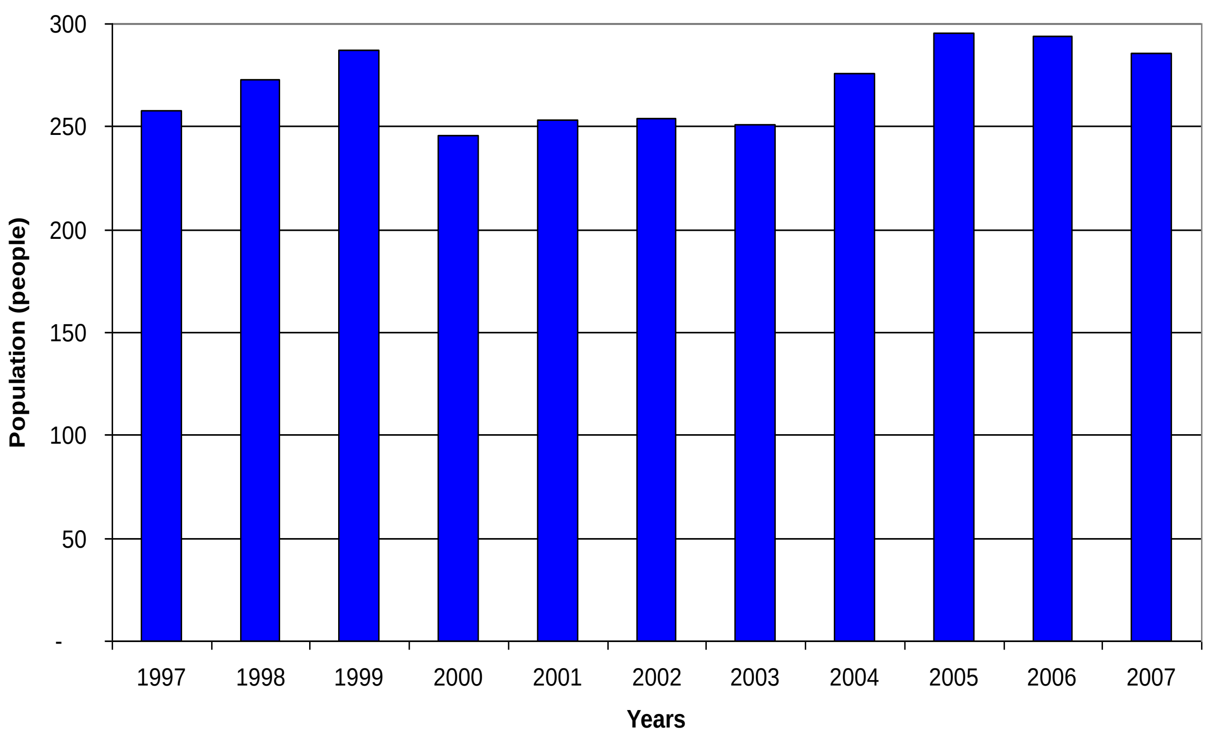


Figure 4.1 shows that the calculated population based on flow data varies from 133 people to 500 people. The 133 people and 500 people population data appear extreme, may be from

questionable flow data. In general, the calculated population is higher in December, January, July and August. December and January generally have heavy rains in the region. Therefore, the number of population in these two months is inflated because of heavy rains. July and August are the two months that have the most visitors from outside of the island. Additionally, about 38% of the housing units on the Lopez Island are seasonally occupied according to the 2000 Census. Majority of the seasonal housing units are used in the summer months. Therefore, the calculated July and August population can be considered to represents peak users in the District.

Figure 4.2 - Calculated Population



4.2 PEAK FLOWS AND PEAKING FACTOR

Approximately four years of peak flow data were complied for this study. Listed in Table 4.4 were peak flows and the calculated peaking factors, as well as average flows for comparison purpose. The data were also presented graphically on Figure 4.3.

Table 4.4 – Peak Flow and Peaking Factor

Month and Year	Average Monthly Flow (1000 gal)	Maximum daily Flow (1000 gal)	Peaking factor
May-00	14	17.6	1.3

Jul-00	19	28.1	1.5
Aug-00	16.5	20.9	1.3
Oct-00	14.5	19.9	1.4
Nov-00	11	16.2	1.5
Dec-00	14.6	22.9	1.6
Apr-01	13.9	17.2	1.2
May-01	15.8	22.0	1.4
Oct-03	13.8	34.0	2.5
Nov-03	17.5	61.0	3.5
Dec-03	12.8	17.0	1.3
Jan-04	17.2	36.0	2.1
Feb-04	13.1	18.0	1.4
Mar-04	14.2	31.0	2.2
Apr-04	13.1	16.0	1.2
May-04	14.6	21.0	1.4
Oct-04	14.2	18.0	1.3
Nov-04	16.8	31.0	1.8
Dec-04	19.0	53.0	2.8
Jan-05	21.9	54.0	2.5
Feb-05	17.9	41.0	2.3
Mar-05	14.6	20.0	1.4
Apr-05	15.2	22.0	1.4
May-05	16.4	24.0	1.5
Jun-05	17.0	24.0	1.4
Jul-05	21.3	30.0	1.4
Aug-05	23.6	30.0	1.3
Sep-05	19.3	27.0	1.4
Oct-05	15.0	19.0	1.3
Nov-05	15.4	22.0	1.4
Dec-05	14.6	23.0	1.6
Jan-06	23.0	51.0	2.2
Feb-06	16.0	30.0	1.9
Mar-06	14.0	21.0	1.5
Apr-06	17.0	22.0	1.3
May-06	14.0	21.0	1.5
Jun-06	16.0	21.0	1.3
Jul-06	21.0	30.0	1.4

Aug-06	22.0	26.0	1.2
Sep-06	16.0	22.0	1.4
Oct-06	14.0	20.0	1.4
Nov-06	18.0	40.0	2.2
Dec-06	20.0	38.0	1.9
Jan-07	23.0	61.0	2.7
Feb-07	15.0	23.0	1.5
Mar-07	17.0	37.0	2.2
Apr-07	15.0	20.0	1.3
May-07	14.0	20.0	1.4
Jun-07	16.0	20.0	1.3
Jul-07	22.0	32.0	1.5
Aug-07	23.0	27.0	1.2
Sep-07	18.0	26.0	1.4
Oct-07	14.0	18.0	1.3
Nov-07	15.0	21.0	1.4
Dec-07	13.0	21.0	1.6

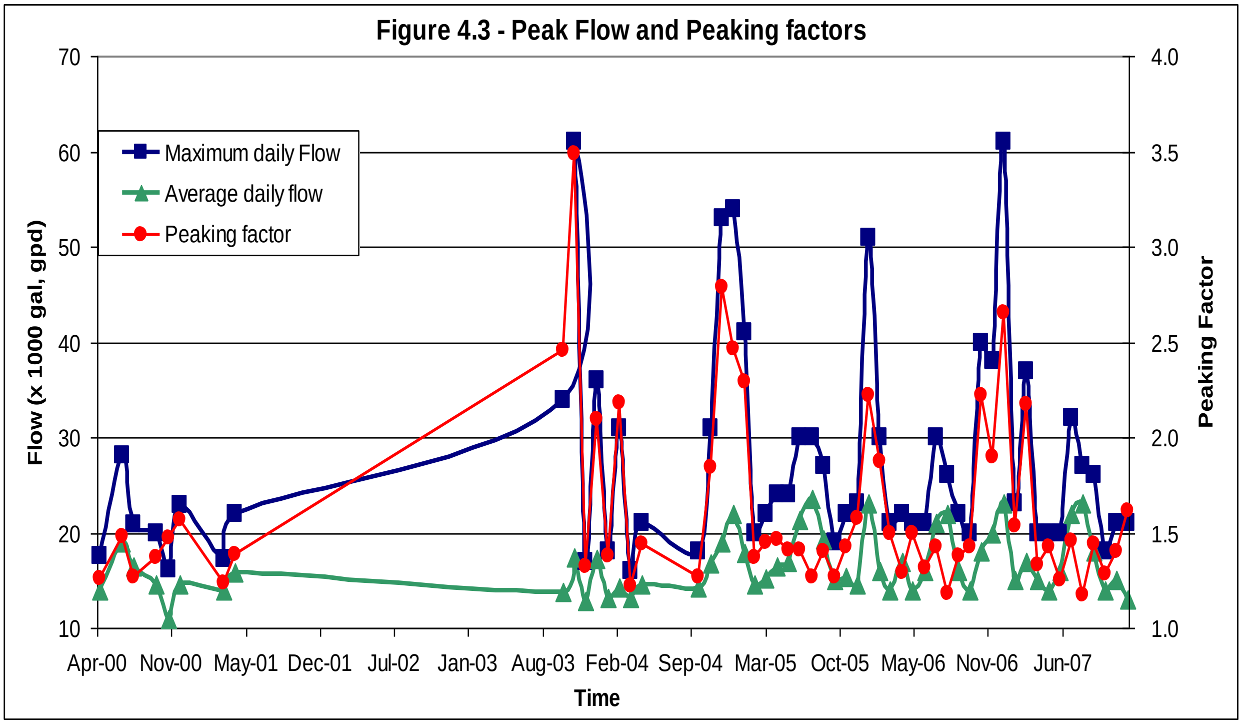


Table 4.4 and Figure 4.3 show that peak flows generally occur from October to March, which is rainy season on the island. This indicates that the peak flows were the results of excessive I/I contributions due to rains, and they have little to do with peak usage by users in the District. The calculated peaking factors were below 3 except one was 3.5. Peak factors in the dry season were approximately 1.5 on average.

4.3 EXISTING ORGANIC LOADING

Influent organic concentration measured in five days biological oxygen demand (BOD_5) to the existing plant was relatively weak due to septic tanks in the STEP collection system. Shown on Table 4.5 and 4.6 were 11 years of influent d BOD_5 data. These data were also shown graphically on Figure 4.4 and 4.5.

Figure 4.4 shows that BOD_5 strength was generally high in the summer months. This correlates to the peak population in those months because of tourists and high occupancy of the seasonal residential units.

Table 4.5 – FBSD Plant Influent BOD_5 Data

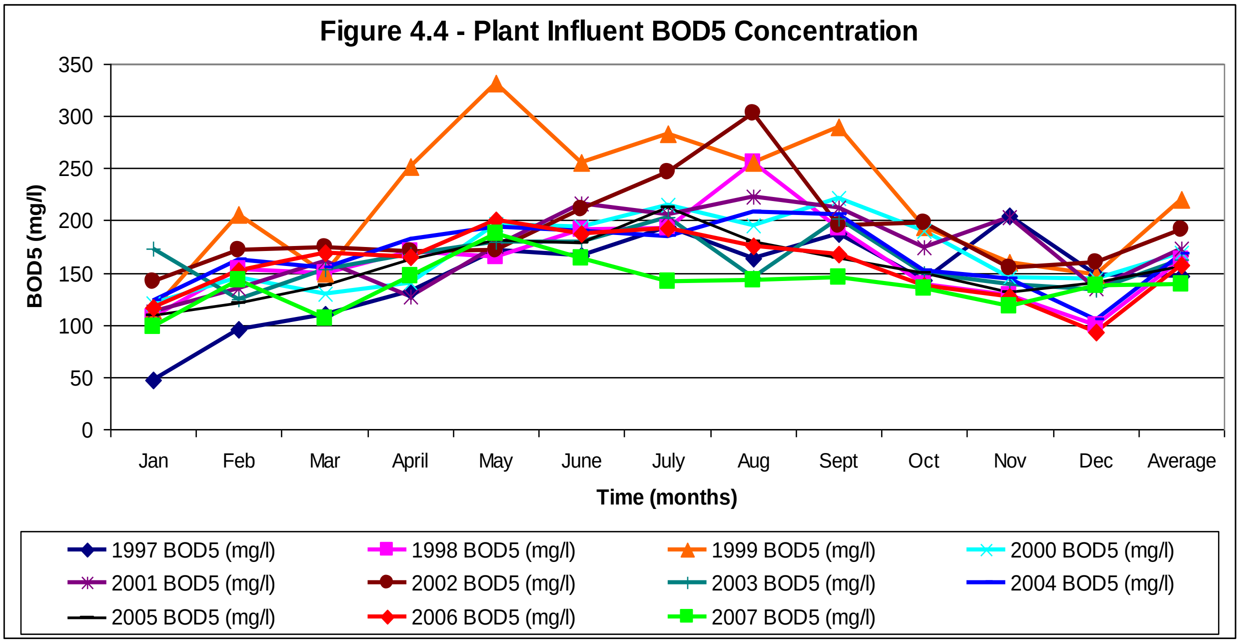
Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Month	BOD_5 (mg/l)	BOD_5 (mg/l)	BOD_5 (mg/l)	BOD_5 (mg/l)	BOD_5 (mg/l)	BOD_5 (mg/l)	BOD_5 (mg/l)	BOD_5 (mg/l)	BOD_5 (mg/l)	BOD_5 (mg/l)	BOD_5 (mg/l)
Jan	47	107	114	120	113	141	173	123	109	117	98
Feb	96	154	206	145	135	172	125	162	121	152	143
Mar	110	150	149	130	161	175	153	155	138	169	106
April	133	171	252	140	127	170	168	182	162	165	147
May	172	165	331	196	176	172	179	194	181	200	188
June	167	192	255	194	216	211	179	190	178	188	163
July	194	193	283	215	206	247	203	185	212	193	142
Aug	164	256	256	195	223	303	145	209	180	175	143
Sept	188	193	290	222	213	195	202	206	164	168	145
Oct	143	139	194	190	174	198	150	152	150	138	135
Nov	205	129	160	146	203	155	139	144	131	127	118

Dec	148	99	148	144	135	160	134	105	140	93	138
Average	**147**	**162**	**220**	**170**	**174**	**192**	**163**	**167**	**156**	**157**	**139**

Table 4.6 – FBSD Plant Influent BOD_5 Loading Data

Year	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Month	BOD_5 (lbs/d)	BOD_5 (lbs/d)	BOD_5 (lbs/d)	BOD_5 (lbs/d)	BOD_5 (lbs/d)	BOD_5 (lbs/d)	BOD_5 (lbs/d)	BOD_5 (lbs/d)	BOD_5 (lbs/d)	BOD_5 (lbs/d)	BOD_5 (lbs/d)
Jan	9.4	22.3	25.7	14.0	10.4	25.0	20.4	17.6	19.9	22.4	18.8
Feb	15.2	15.4	32.6	14.5	14.8	19.3	11.9	17.7	18.1	20.2	17.9
Mar	11.0	22.5	21.1	15.2	17.2	17.4	16.4	18.4	16.8	19.7	15.1
April	12.2	20.0	29.4	17.5	14.8	21.4	19.8	19.9	20.5	23.4	18.3
May	17.2	22.0	46.9	22.9	23.2	22.7	21.0	23.6	24.8	23.4	21.9
June	29.2	19.2	40.4	24.3	25.0	24.2	22.6	26.0	25.2	25.1	21.8
July	25.9	25.8	61.4	34.1	30.1	41.5	32.7	33.5	37.7	33.7	26.0
Aug	23.3	34.2	40.6	26.8	38.8	50.1	23.5	37.1	35.4	32.1	27.4
Sept	20.4	20.9	19.3	31.3	28.3	21.2	25.4	27.5	26.4	22.4	21.8
Oct	14.3	11.6	17.8	23.0	19.2	25.0	17.3	18.0	18.8	16.1	15.8
Nov	17.1	14.0	17.3	13.4	22.0	13.8	20.3	20.2	16.8	19.0	14.7
Dec	22.2	24.8	19.7	17.5	22.8	15.5	14.4	16.6	17.0	15.6	15.0
Average	**18.1**	**21.1**	**31.0**	**21.2**	**22.2**	**24.8**	**20.5**	**23.0**	**23.1**	**22.8**	**19.5**

FISHERMAN BAY SEWER DISTRICT
WASTEWATER SYSTEM MASTER PLAN – DRAFT



It is not surprising that BOD_5 strength in January and December are generally the weakest. This correlates well with the high flow in these months, which dilute the BOD_5 concentration. Occupancy of the seasonal housing units and visitors in these two months is also generally low because of undesirable weather condition on the island.

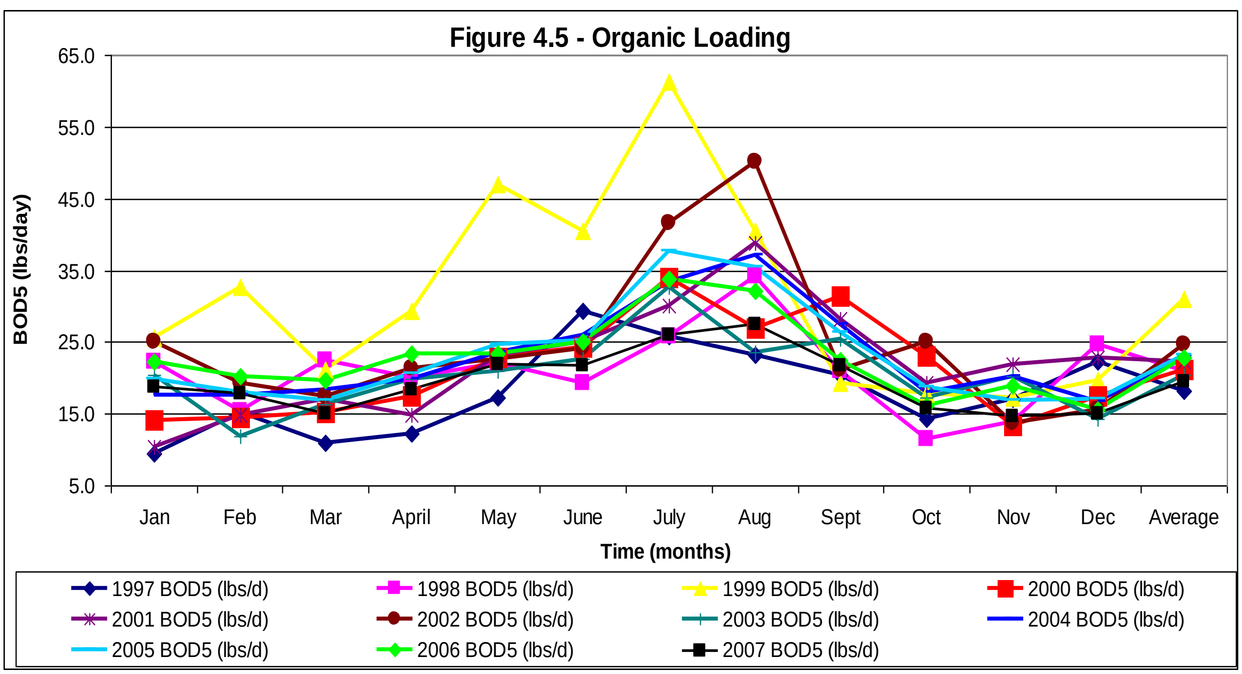


Figure 4.5 shows that the highest organic loadings occur in July and August. This is a further confirmation of the peak population in the two months.

Though ERUs have increased significantly from 1997 to 2007, the organic loadings to the plant vary erratically in the last 11 years, and have not shown much increase. It's not clear why organic loading has not increased consistently over the years. Good maintenance of the septic tanks can increase their BOD_5 removal efficiency. But it's difficult to understand that the improved efficiency can almost completely offset the BOD5 contribution from the new ERUs.

For typical municipalities in the US, BOD_5 production varies from 0.18 to 0.26 lbs/capita/day with a typical value of 0.22 lbs/capita/day [(6)]. Theoretically, population can also be estimated using the BOD_5 loading data and 0.22 lbs/capita/day value. But the lack of septic tank BOD_5 removal efficiency makes it impossible to have a meaningful estimate of the population using this methodology. Therefore, this report will not attempt to estimate the existing population with the BOD_5 data.

In spite of the fact that BOD_5 is a key parameter used for many wastewater treatment plant designs and discharge permits, it is often misleading. This is especially true for the lagoon based plant effluent BOD_5 data as the result of being inflated by nitrification that occurs in the BOD_5 test itself. Because of this concern and the fact that the District has a STEP system, the District started carbonaceous BOD_5 ($CBOD_5$) testing in April 2004. $CBOD_5$ is a true measurement of the organic loading without the influence of the nitrification. Shown in Table 4.7 and 4.8 are plant influent CBOD data for the last several years.

Table 4.7 – Plant Influent $CBOD_5$ Data

Year	2004	2005	2006	2007
Month	$CBOD_5$ (mg/l)	$CBOD_5$ (mg/l)	$CBOD_5$ (mg/l)	$CBOD_5$ (mg/l)
Jan		97	105	85
Feb		105	133	124
Mar		130	156	94
April	141	148	158	130
May	167	165	181	181
June	144	158	168	153
July	150	203	178	135
Aug	181	174	150	130
Sept	168	158	152	140
Oct	117	143	117	126

Nov	119	132	113	112
Dec	91	130	75	126
Average	**142**	**145**	**141**	**128**

Table 4.8 – Plant Influent CBOD5 Loading

Year	**2004**	**2005**	**2006**	**2007**
Month	$CBOD_5$ (lbs/d)	$CBOD_5$ (lbs/d)	$CBOD_5$ (lbs/d)	$CBOD_5$ (lbs/d)
Jan		18	20	16
Feb		16	18	15
Mar		16	18	13
April	15	19	22	16
May	20	23	21	21
June	20	22	22	20
July	27	36	31	25
Aug	32	34	28	25
Sept	22	25	20	21
Oct	14	18	14	15
Nov	17	17	17	14
Dec	14	16	13	14
Average	**20**	**22**	**20**	**18**

Figure 4.6 - BOD5 and CBOD5 Comparison

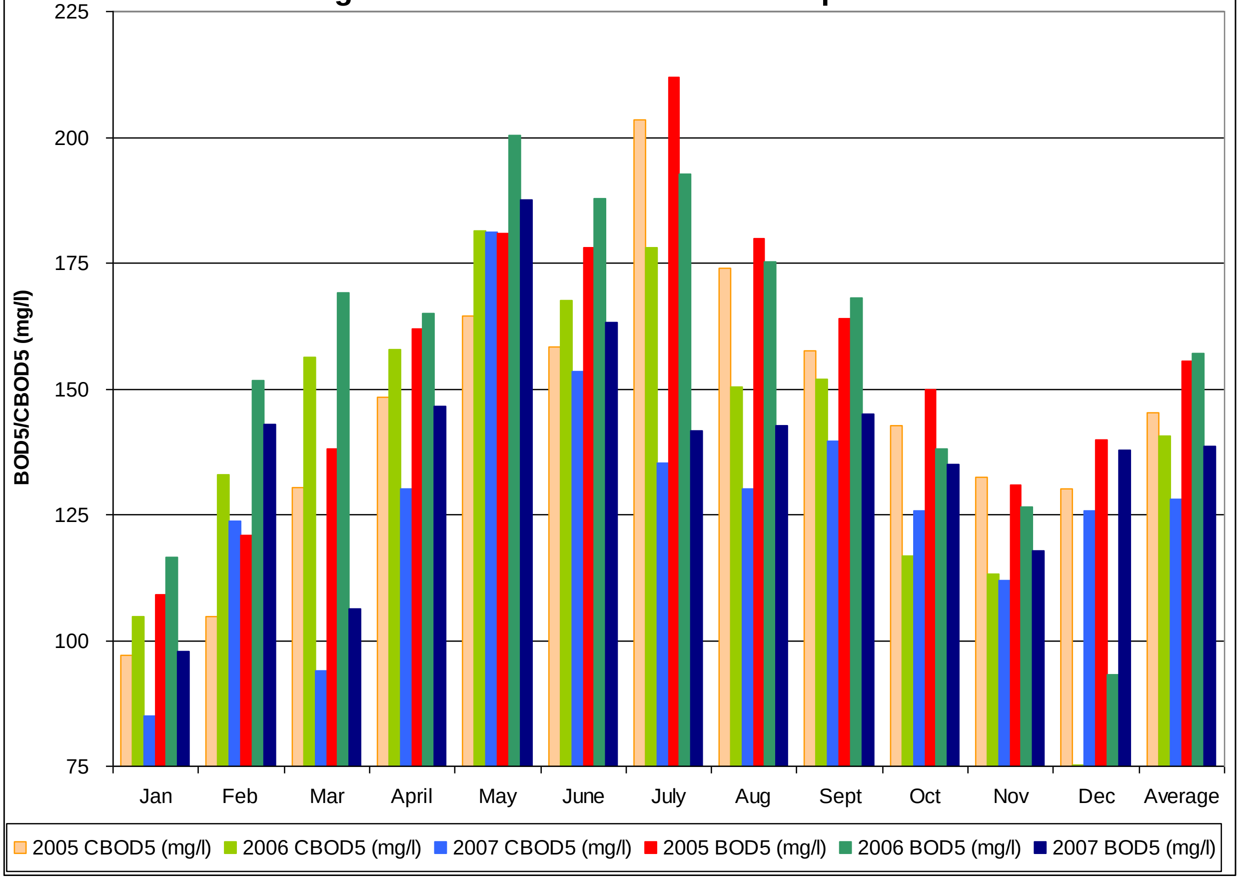


Figure 4.6 is a graphical comparison of the BOD_5 and $CBOD_5$ for the last 3 years. The $CBOD_5$ values generally were 3 to 19% lower than the BOD_5 values from 2005 to 2007. On average, $CBOD_5$ was 9% below the BOD_5 value.

4.4 OTHER CHARACTERISTICS OF THE PLANT INFLUENT

In addition to flow, BOD_5 and $CBOD_5$ data, other monitoring data that characterize the plant influent wastewater include total suspended solids (TSS), pH, ammonia (NH_3) and wastewater temperature. These data were listed in Table 4.9 and graphically shown on Figure 4.7 and Figure 4.8.

Table 4.9 – Plant Influent Data

Date	Influent TSS	Influent NH3-N	pH	Influent Temp	Summer	Winter
	mg/l	mg/l	(su)	(^{o}F)	(^{o}F)	(^{o}F)
Jan-97	25			46		46
Feb-97	21			47		47

Mar-97	20			48		48
Apr-97	30			53	53	
May-97	27			59.9	59.9	
Jun-97	32			64	64	
Jul-97	36			67	67	
Aug-97	29			69	69	
Sep-97	31			66	66	
Oct-97	23			61	61	
Nov-97	23			55	55	
Dec-97	26	42		50.3		50.3
Jan-98	15			47		47
Feb-98	14	65		49		49
Mar-98	17	56		51		51
Apr-98	20	62		55	55	
May-98	18	43		59	59	
Jun-98	28	65		67	67	
Jul-98	31	68		64	64	
Aug-98	63	54		69	69	
Sep-98	37	54		68	68	
Oct-98	29	64		62	62	
Nov-98	17	44		56	56	
Dec-98	15	47		49		49
Jan-99	14	29		47		47
Feb-99	16	44		46		46
Mar-99	23	50		48		48
Apr-99	23	66.4		53	53	
May-99	36	65		56	56	
Jun-99	35	71		62.5	62.5	
Jul-99	32	66		65.6	65.6	
Aug-99	33	68		67	67	
Sep-99	46	52		65	65	
Oct-99	37	66		60	60	
Nov-99	37	54		55	55	
Dec-99	47	45		51		51
Jan-00	29	40		47		47
Feb-00	38	64		47.8		47.8
Mar-00	45	55		49.7		49.7
Apr-00	50	68		54	54	
May-00	50	60		57	57	
Jun-00	52	65		62	62	
Jul-00	45	62		66	66	
Aug-00	62	72		67	67	
Sep-00	55	54		64	64	
Oct-00	36	60		60	60	
Nov-00	33.8	58		51	51	
Dec-00	34	51		48		48

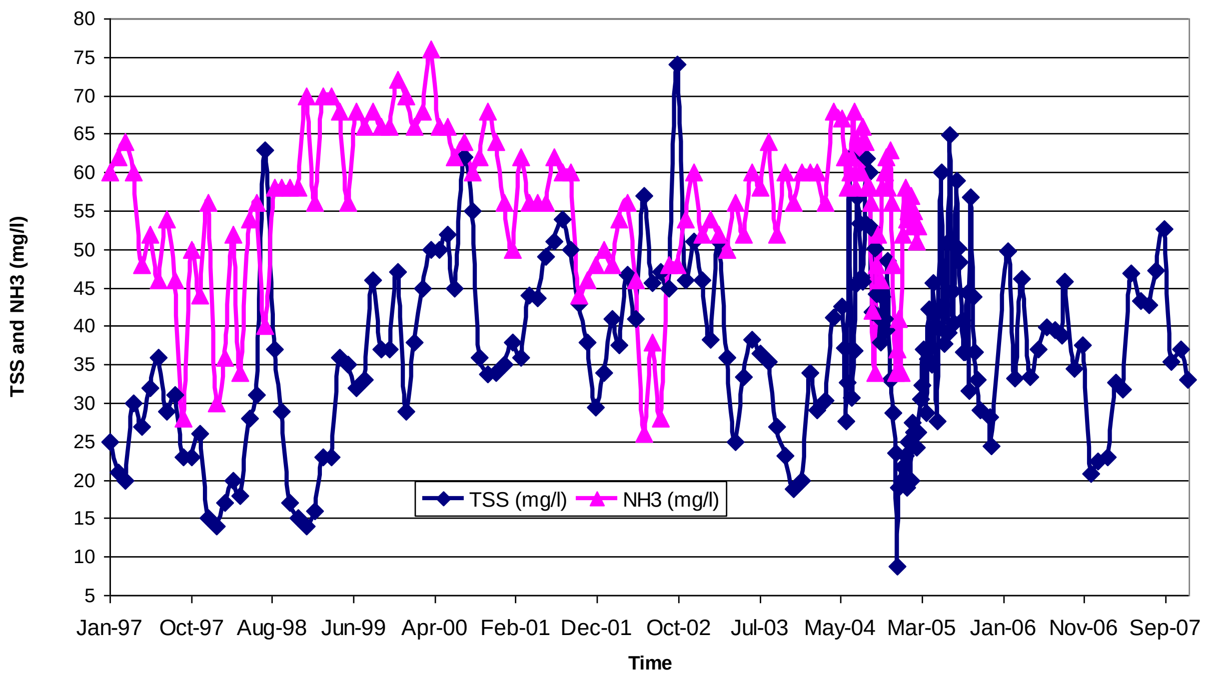
Jan-01	35	57		47		47
Feb-01	38	55		46		46
Mar-01	36	53		48		48
Apr-01	44	65		52	52	
May-01	43.6	71		57	57	
Jun-01	49	65		61	61	
Jul-01	51	68		65	65	
Aug-01	54	68		66	66	
Sep-01	50	52		65	65	
Oct-01	43	67.5		60	60	
Nov-01	38	58.4		53.5		53.5
Dec-01	29.5	51		49		49
Jan-02	34	51		46.5		46.5
Feb-02	41	51		45		45
Mar-02	37.5	43		45		45
Apr-02	46.7	64		51	51	
May-02	41	70.4		55	55	
Jun-02	57	67		62	62	
Jul-02	45.7	67		63	63	
Aug-02	47	71		67	67	
Sep-02	45	51		65	65	
Oct-02	74	62		60	60	
Nov-02	46	65		54	54	
Dec-02	51	60		51		51
Jan-03	46	54		48.5		48.5
Feb-03	38.3	61		48		48
Mar-03	51	55		49.2		49.2
Apr-03	36	47		53	53	
May-03	25	61		57.6	57.6	
Jun-03	33.5	59		63	63	
Jul-03	38.3	59.2		67	67	
Aug-03	36.5	59		67.9	67.9	
Sep-03	35.4	55		65.6	65.6	
Oct-03	26.9	53.6	7.10	59.9	59.9	
Nov-03	23.1	49.5	7.18	51.2	51.2	
Dec-03	18.9	49.5	7.25	46.9		46.9
Jan-04	19.9	41.6	7.18	45.4		45.4
Feb-04	34	44	7.33	47.7		47.7
Mar-04	29.1	54	7.24	51.2		51.2
Apr-04	30.3	63.5	7.12	55.5	55.5	
May-04	41.2	65.6	6.98	60.6	60.6	
6/1/2004	42.6	66	7.13	62	62	
6/8/2004	37.2	68	7.01	63	63	
6/15/2004	27.7	66	6.95	64	64	
6/22/2004	32.7	66	7.04	65	65	
6/29/2004	62.1	72	7.02	68	68	

7/6/2004	30.7	70	7.02	68	68	
7/13/2004	36.8	66	6.70	70	70	
7/20/2004	45.4	68	7.10	70	70	
7/27/2004	56.8	76	6.91	70	70	
8/3/2004	53.4	66	6.88	71	71	
8/10/2004	46.3	66	6.99	70	70	
8/17/2004	45.9	62	6.96	72	72	
8/24/2004	53.4	64	6.96	70	70	
8/31/2004	61.8	60	6.98	68	68	
9/7/2004	60.1	62	7.08	68	68	
9/14/2004	52.9	68	6.83	66	66	
9/21/2004	41.9	64	6.91	64	64	
9/28/2004	50.2	56	6.91	65	65	
10/5/2004	44.2	50	7.06	63	63	
10/12/2004	41.3	62	7.01	62	62	
10/19/2004	38	56	6.86	60	60	
10/26/2004	44	56	7.11	60	60	
11/2/2004	40.9	56	7.24	58	58	
11/9/2004	39.5	62	7.22	56	56	
11/16/2004	48.6	60	7.22	56	56	
11/23/2004	33	60	6.99	55	55	
11/30/2004	33.3	44	7.12	53	53	
12/7/2004	28.7	46	7.25	51		51
12/14/2004	23.6	48	7.08	53		53
12/21/2004	8.7	50	7.19	52		52
12/28/2004	19.1	48	7.12	48		48
1/4/2005	20	54	7.27	50		50
1/11/2005	21.7	56	7.13	46		46
1/18/2005	23.2	46	7.17	46		46
1/25/2005	19.1	26	7.23	50		50
2/1/2005	24.9	38	7.17	51		51
2/8/2005	19.9	28	6.97	50		50
2/15/2005	27.5	48	7.10	47		47
2/22/2005	26.2	48	7.08	46		46
3/1/2005	24.3	54	7.23	49		49
3/8/2005	26.2	60	7.00	52		52
3/15/2005	30.6	52	6.95	53		53
3/22/2005	32.3	54	7.19	53		53
3/29/2005	37	52	7.25	53		53
4/5/2005	28.8	50	7.05	54	54	
4/11/2005	35.7	56	7.10	53	53	
4/19/2005	42.3	52	6.98	54	54	
4/26/2005	35	60	6.98	59	59	
5/3/2005	45.7	58	6.91	60	60	
5/10/2005	41.6	64	6.99	61	61	
5/17/2005	27.6	52	7.10	62	62	

5/23/2005	39.8	60	7.20	63	63	
5/31/2005	60	56	7.14	65	65	
6/6/2005	42.7	60	6.79	65	65	
6/14/2005	37.8	60	7.00	66	66	
6/21/2005	50.9	60	6.99	69	69	
6/28/2005	39.1	56	7.00	68	68	
7/5/2005	64.9	68	7.10	69	69	
7/12/2005	44.6	67	6.94	62	62	
7/19/2005	40.5	62	7.13	68	68	
7/26/2005	59	62	6.81	71	71	
8/2/2005	50.1	58	6.91	72	72	
8/9/2005	48.4	60	7.03			
8/16/2005	40.8	62	6.86	72	72	
8/23/2005	36.6	68	6.99	71	71	
8/29/2005	36.7	58	6.93	69	69	
9/5/2005	44.3	64	7.03	68	68	
9/13/2005	31.6	60	7.13	69	69	
9/19/2005	56.8	60	7.08	67	67	
9/27/2005	43.9	66	6.93	66	66	
10/4/2005	36.7	64	7.06	63	63	
10/11/2005	33	58	7.04	62	62	
Oct-05	29.1	58	7.19	61	61	
Nov-05	28.2	56	7.22	52	52	
Dec-05	24.4	42	7.15	49		49
Jan-06	49.7	34	7.10	48		48
Feb-06	33.2	48		46		46
Mar-06	46.2	52	7.08	49		49
Apr-06	33.4	46	7.06	54	54	
May-06	37.1	58	7.11	60	60	
Jun-06	39.9	60	6.96	65	65	
Jul-06	39.5	62	7.06	68	68	
Aug-06	38.8	58	7.09	67	67	
Sep-06	45.9	63		65	65	
Oct-06	34.5	56		59	59	
Nov-06	37.5	48		51	51	
Dec-06	20.9	34		47		47
Jan-07	22.5	37		46		46
Feb-07	23	41		47		47
Mar-07	32.7	34		48		48
Apr-07	31.8	52		52	52	
May-07	46.9	58		59	59	
Jun-07	43.3	54		63	63	
Jul-07	42.8	55		67	67	
Aug-07	47.2	57		67	67	
Sep-07	52.6	53		65	65	
Oct-07	35.4	55		60	60	

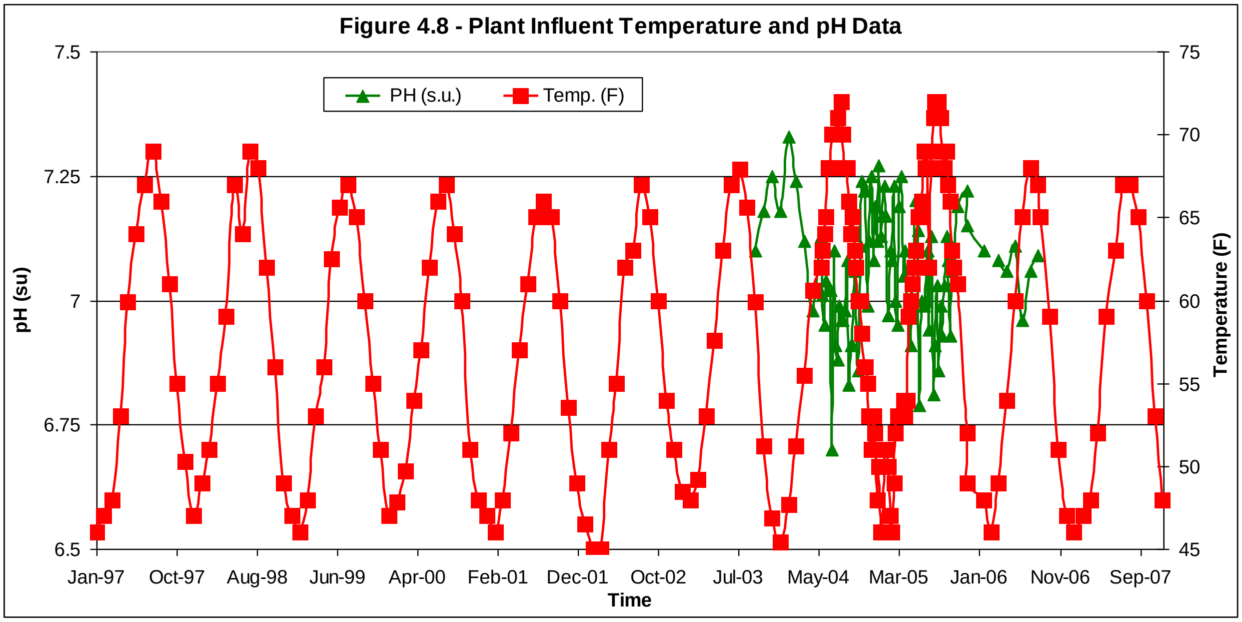
Nov-07	37	51		53	53	
Dec-07	33	53		48		48
Average	**37.1**	**57**	**7.06**	**58**	**62**	**49**

Figure 4.7 - Plant Influent TSS and NH3 Data



Typical weak strength domestic wastewater contains approximately 100 mg/l TSS and medium strength domestic wastewater contains approximately 220 mg/l TSS. Data in Table 4.9, on Figure 4.7 and Figure 4.8 show that the plant influent TSS varied from low teens to approximately 70 mg/l with a simple average value of 37 mg/l. This means that the septic tanks in the District are very effective and have removed majority of the TSS.

Influent ammonia were generally very high, varying from 25 mg/l to 75 mg/l, with a simple average value of 57 mg/l, exceeding typical strong strength domestic wastewater ammonia value. The high influent ammonia was probably the results of organic nitrogen oxidation to ammonia in the septic tanks.



The influent pH was near neutral. Influent wastewater temperature varied from 45°F in the winter to 72°F in the summer. The summer season (April to November) simple average temperature was 62 °F and winter season (December to March) simple average was 49 °F.

4.5 CRITERIA DEVELOPMENT AND DETERMINATION

The District has complied 11 years of monitoring and operational record data. These data were considered sufficient for establishing criteria that can be used for projecting future flows and organic loadings.

Since both the weather and user patterns differ significantly from the winter season to the summer season, the District's plant permit has two sets of influent limits. The summer season (April-November) influent limit is 34,000 gpd flow and 56 lbs BOD_5/day. The winter season (December-March) influent limit is 23,000 gpd flow and 38 lbs BOD_5/day. Therefore, two sets of criteria will be developed accordingly herein.

The criteria can be established by using simple arithmetic average of historical data, flow weighted average or percentile analysis. For this project, TSS and pH criteria will be based the simple arithmetic average values as shown in Table 4.9 because they have no effect on the size of the plant, or equipment or operations. Ammonia and organic loading will be determined using flow weighted average method. Extreme high ammonia and organic loading are often temporary events; rarely occur on long period sustainable basis. In addition, the lagoon is capable of accepting short term high ammonia and organic loading because of its excellent buffering capability. Flow and temperature criteria will be determined by performing percentile analysis using the historical data. Generally the 95th percentile value is used as design value, but other percentile values will also be used based on special circumstances.

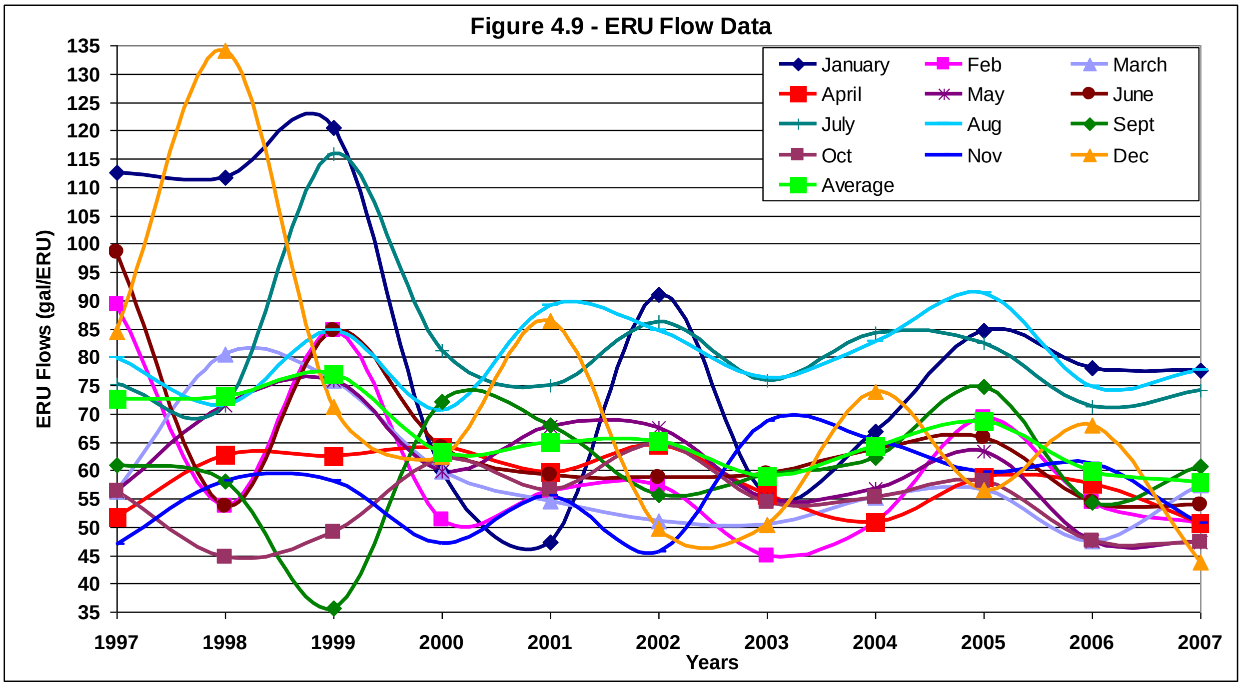
The District has used ERU for many years for billing and fees purpose. For consistency, we expect the District will continue to use ERU for these purposes in the future. Therefore, it's critical to establish the flow criterion based on ERUs using the historical record data. Table 4.10 is the calculated flow per ERU. The ERU flow data for each year was calculated using the previous year's ERU data for a conservative estimate.

Table 4.10 –Calculated Monthly, Seasonal and Yearly Average ERU Flows

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Month	Gal /ERU	Gal /ERU	Gal /ERU	Gal /ERU	Gal /ERU	Gal /ERU	Gal /ERU	Gal /ERU	Gal /ERU	Gal /ERU	Gal /ERU
Jan	113	112	120	60	47	91	55	67	85	78	78
Feb	89	54	85	51	56	57	45	51	69	54	51
Mar	56	80	76	60	55	51	50	55	56	48	57
April	52	63	62	64	60	65	56	51	59	58	51
May	56	72	76	60	68	68	55	57	63	48	47
June	99	54	85	64	59	59	59	64	66	54	54
July	75	72	116	81	75	86	76	84	82	71	74
Aug	80	72	85	71	89	85	76	83	91	75	78
Sept	61	58	36	72	68	56	59	62	75	54	61
Oct	56	45	49	62	57	65	54	55	58	48	47
Nov	47	58	58	47	55	46	69	65	60	61	51
Dec	85	134	71	62	87	50	50	74	56	68	44
Winter season Average	86	95	88	58	61	62	50	62	67	62	57
Summer Season Average	66	61	71	65	66	66	63	65	69	59	58
Yearly average	73	73	77	63	65	65	59	64	69	60	58

Data in Table 4.10 shows that yearly average flow loading varied from 58 gal/ERU to 77 gal/ERU, and the highest loading was 134 gal/ERU that occurred in December 1998. The second highest loading was 120 gal/ERU that occurred in January 1999, and the third highest loading was 116 gal/ERU in July 1999. The highest and the second highest loadings certainly appeared to be caused by I/I contributions due to heavy rains in those months. But none of the months in the last 11 years has exceeded the original design loading of 138 gal/ERU.

Figure 4.9 shows that ERU flow was generally stabilized between 45 gal/ERU to 90 gal/ERU since year 2000. In general, January, July and August had the highest ERU flows.



The District has been rehabilitating the sewer system in the last several years, and is committed to continue rehabilitation for mitigating the I/I flows. The District also requires the use of modern construction techniques for the new sewer system and septic tanks construction to prevent the I/I flow contribution. As shown on the Figure 4.9, annual average ERU flow loading was trending low since year 2000. This is the evidence that the rehabilitation and the new construction technique requirements are effective and I/I flow is decreasing.

However, in order to not under design the plant hydraulically, the summer flow criterion will be determined based on a 98th percentile analysis of the historical data. The percentile analysis is included in **Appendix B** of this report. The 98th percentile value is 97 gal/ERU, which is higher than any monthly record ERU flow since year 2000. For this report, we recommend 100 gal/ERU as the design criterion for the summer season for projecting future summer season flows.

The 95th percentile value for the winter season was calculated to be 115 gal/ERU. This value is very high because unusual high flows in year 1998 and year 1999 skewed the result. We felt that data before 2000 were not representative of the current sewer system condition. Additionally, the ERU flow is trending down because of sewer system rehabilitation. If the data before 2000 were not included in the analysis, the 98th percentile value is 90 gal/ERU. Therefore, we performed the 90 percentile analysis using all data for establishing the winter flow design criteria. The 90th percentile value for the winter season is 93 gal/ERU. The recommended flow criterion for the winter season is 93 gal/ERU for projecting future winter season flow. The recommended 93 gal/ERU value is higher than monthly recorded flow since year 2000. It can be seen from Table 4.10 that the recommended ERU flows are very conservative in comparison with the historical seasonal ERU flows.

Table 4.11 – Calculated ERU BOD5 Loading

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Month	lbs/ ERU	lbs/ ERU	lbs/ ERU	lbs/ ERU	lbs/ ERU	lbs/ ERU	lbs/ ERU	lbs/ ERU	lbs/ ERU	lbs/ ERU	lbs/ ERU
Jan	0.04	0.10	0.11	0.06	0.04	0.11	0.08	0.07	0.08	0.08	0.06
Feb	0.07	0.07	0.15	0.06	0.06	0.08	0.05	0.07	0.07	0.07	0.06
March	0.05	0.10	0.09	0.06	0.07	0.07	0.06	0.07	0.07	0.07	0.05
April	0.06	0.09	0.13	0.07	0.06	0.09	0.08	0.08	0.08	0.08	0.06
May	0.08	0.10	0.21	0.10	0.10	0.10	0.08	0.09	0.10	0.08	0.07
June	0.14	0.09	0.18	0.10	0.11	0.10	0.09	0.10	0.10	0.09	0.07
July	0.12	0.12	0.27	0.15	0.13	0.18	0.13	0.13	0.15	0.11	0.09
Aug	0.11	0.15	0.18	0.11	0.17	0.21	0.09	0.14	0.14	0.11	0.09
Sept	0.10	0.09	0.09	0.13	0.12	0.09	0.10	0.11	0.10	0.08	0.07
Oct	0.07	0.05	0.08	0.10	0.08	0.11	0.07	0.07	0.07	0.05	0.05
Nov	0.08	0.06	0.08	0.06	0.09	0.06	0.08	0.08	0.07	0.06	0.05
Dec	0.10	0.11	0.09	0.07	0.10	0.07	0.06	0.06	0.07	0.05	0.05
Winter season Average	0.07	0.10	0.11	0.07	0.07	0.08	0.06	0.07	0.07	0.07	0.06
Summer Season Average	0.09	0.09	0.15	0.10	0.11	0.12	0.09	0.10	0.10	0.08	0.07
Yearly Average	0.11	0.09	0.14	0.09	0.09	0.11	0.08	0.09	0.09	0.08	0.07

Table 4.11 and Figure 4.10 show that the highest organic loading was 0.27 lbs BOD_5/ERU that occurred in the month of July 1999. 1999 was also the year that had the highest loading in majority of the months and highest average yearly loading. In general, July and August have the

highest BOD_5 loading in the last 11 years. The ERU BOD_5 loading was also trending low since 2000. Based on the analysis of historical record data, the flow weighted value for the summer season is 0.11 lbs BOD_5/ERU, and the flow weighted value for the winter season is 0.08 lbs BOD_5/ERU (see **Appendix C**). The recommended ERU BOD_5 criteria are 0.15 lbs BOD_5/ERU for the summer season and 0.10 lbs BOD_5/ERU for the winter season.

Figure 4.10 - ERU BOD5 Loading Data

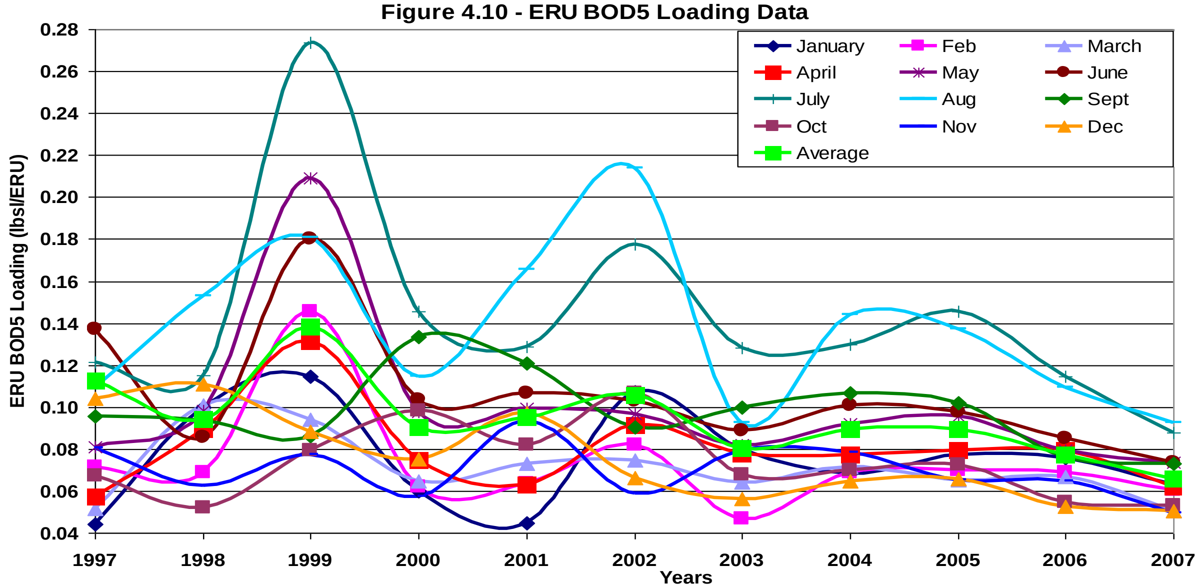
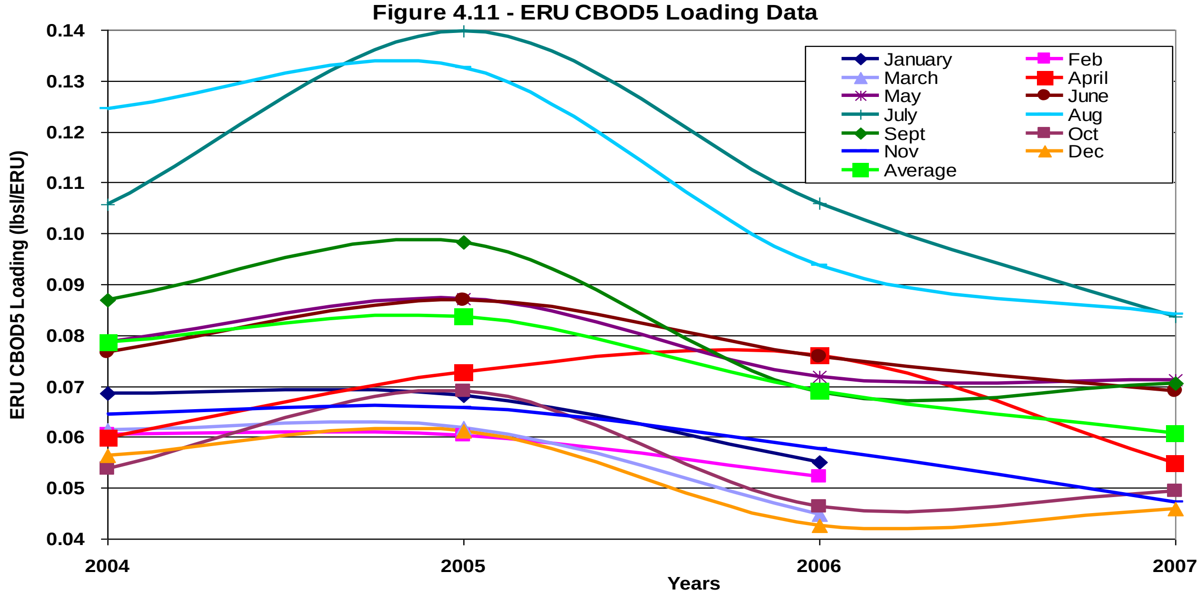


Figure 4.11 - ERU CBOD5 Loading Data



Available $CBOD_5$ data was limited from 2004 to 2007. The ERU $CBOD_5$ loading generally have the same pattern as the ERU BOD_5 loading as shown on Figure 4.10 and Figure 4.11. Section 4.3 of this report has stated that $CBOD_5$ values generally were 3 to 19% lower than the BOD_5

values. Therefore, 0.14 lbs $CBOD_5$/ERU and 0.10 lbs $CBOD_5$/ERU appear to be reasonable conservative criteria for use for projecting the future $CBOD_5$ loadings for the summer and winter seasons respectively.

The flow weighted influent ammonia average is 57 mg/l based on the last 10 years available data (see **Appendix C**). The flow weighted ammonia average happens to be the same as the simple arithmetic average as shown in Table 4.9. The 57 mg/l will be used as the design criterion for the ammonia.

Wastewater temperature has significant influence on BOD removal rate. Therefore, percentile analysis was performed for the historical temperature data to determine the design temperatures (see **Appendix D**). The purpose of the percentile analysis is to determine the minimum acceptable temperatures for both seasons. The winter season is 4 months, relatively short. So a 5^{th} percentile analysis was performed for the winter season, and the 5^{th} percentile value is 46^oF. The summer season is long with 8 months. So a 50^{th} percentile analysis was performed and the 50^{th} percentile value is 63^oF.

In summary, the following criteria will be used in this report to characterize the influent wastewater for the District's plant:

- ERU flow loading: 100 gal/ERU, summer
  93 gal/ERU, winter
- ERU organic loading: 0.15 lbs BOD_5/ERU, summer
  0.11 lbs BOD_5/ERU, winter
  0.14 lbs $CBOD_5$/ERU, summer
  0.10 lbs $CBOD_5$/ERU, winter
- TSS: 37 mg/l
- pH: 7.06 s.u.
- Ammonia: 57 mg/l
- Temperatures: 46^oF (7.8^oC) winter; 63^oF (17.2^oC) summer
- Peaking factor: 3.5

5.0 Population, Flow and Loading Projections

5.1 ERU AND POPULATION PROJECTIONS

Future condition projections include ultimate condition and the rate of growth. The ultimate condition and the rate of growth are affected by many ever-changing variables such as zoning, service area, specific type of developments, macro and local economic conditions, demographic changes, etc. The rate of growth can fluctuate considerably with short term rapid growth or very little growth depending on local economic conditions. Therefore, accurately projecting future conditions have proven to be very difficult.

5.1.1 A review of the Previous Projections

Previous studies dating back to 1976 have made projections for the future conditions. The "Draft Wastewater Facilities Plan" (19) in 1976 projected a total population equivalent of 2518 people by 1995 at aggressive 7% growth rate, with a total flow of 151,080 gpd in the planning area. The Amendment No.1(5) in 1984 projected a total population equivalent of 562 people by 2005 or 244 ERU using 2.3 people/ ERU. The 562 population equivalent included 117 tourists, 260 commercial and 185 residents. The Eastshore South area was forecasted to have 101 people by 2005.

The 1994 Engineering Report (3) projected a total population equivalent of 680 people without the Eastshore South area, 1,022 people with the Eastshore South area by 2010. This report also projected an ultimate buildout ERU of 578 without the Eastshore South area, and 928 ERU with the Eastshore South area with a population equivalent of 1,329 people without the Eastshore South and 2,134 people with the Eastshore South.

A report prepared by Pacific Surveying & Engineering (PSE) (7) in 2002 for the San Juan County Planning Department projected approximately 377 residential ERUs and 30 commercial ERUs by 2020, and 943 residential ERUs and 74 commercial ERUs at buildout condition based on the UGA boundary at that time.

Mr. Ronald Mayo in 2004 (10) projected 385 ERUs by 2020 using a growth rate of 2.5% with the approval of UGA. In 2007, Mr. Ronald Mayo projected a maximum addition of 358 connections within the UGA boundary and 406 maximum additional connections within the UGA and the District's service area. He projected total 336 non-metered connections within the UGA, and 406 total no-metered connections within the UGA and the District's service area by 2020, 8 new metered connections, and the ultimate buildout connections of 736 within the UGA and the service area.

The San Juan County Planning Development projected 365 ERUs and 697 people within the UGA by 2020 in a recent report [9]. However, the County didn't provide any ultimate buildout projections. Table 5.1 is a summary of various projections for the UGA, the year 2020 and the ultimate buildout conditions.

Table 5.1 –Previous ERU and Population Projections Summary

Area Descriptions	UGA area ERU by 2020	Buildout UGA ERU	FBSD Service Area Buildout ERU	FBSD Service Area and UGA Buildout ERU	Eastshore South Area ERU	FBSD Service Area Buildout Population	Eastshore South Area Population
1994 Eng. Report			578		350	1329	805
PSE	407	1017					
R. Mayo (2007)	385	491[(a)]		736[(b)]			
San Juan County	365						

Note: (a) Based on 8 existing metered connections from the Lopez Village Market, 125 existing non-metered connections and 358 new non-metered connections.
(b) Based on 77 existing metered connections, 8 new metered connections, 173 existing non-metered connections and 406 new non-metered connections.
(c) UGA boundary has changed since Mr. Mayo completed his report.

5.1.2 ERU and Population Projections

Previous projections in the above Section 5.1.1 show that projected future conditions can vary significantly. The variations were mainly caused by assumptions made in accordance with available information at that time. For this report, the projections are made based on present available information including current boundary, zoning requirement and growth rates.

UGA is a significant component of the District's future growth. Though UGA boundary is not completely overlap with the District's boundary, it is assumed that the whole UGA area will be serviced by the District in the future. According to the San Juan County's Comprehensive Plan [9], the goal of the UGA is to control future growth sprawl in rural areas and orderly grow in the County's towns, and accommodating approximately 50% growth within the UGA. This means that significant future growth on the Lopez Island will be in the vicinity of the Lopez Village area, and within the District's service area.

This report divides the existing and buildout condition estimates into three (3) areas: UGA area, the District's service area outside of UGA and the Eastshore South. These areas are shown on Figure 5.1, Figure 5.2, Figure 5.3 and Figure 5.4. As shown on Figure 3.1 and Figure 3.2 in Section 3 of this report, the Eastshore South area is within the District's planning area, but its boundary is not clearly delineated or described. Therefore, the boundary for the Eastshore South area shown on Figure 5.4 is approximate, intended only for ERU estimate for this study. Final definitive boundary delineation for this area is beyond the scope of this study.

Figure 5.1 – Lopez Village Area Map

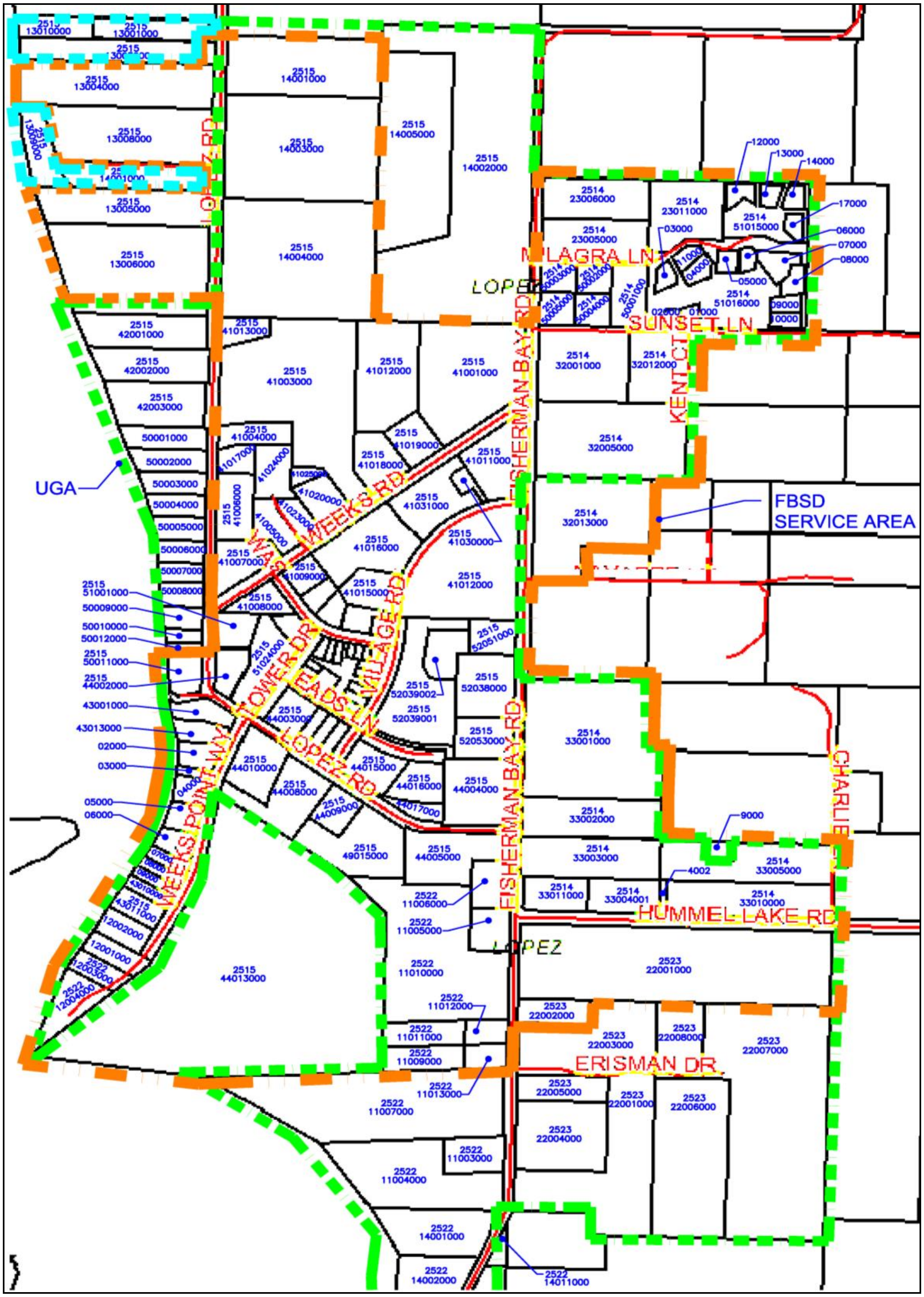


Figure 5.2 – UGA and FBSD Service Area Map

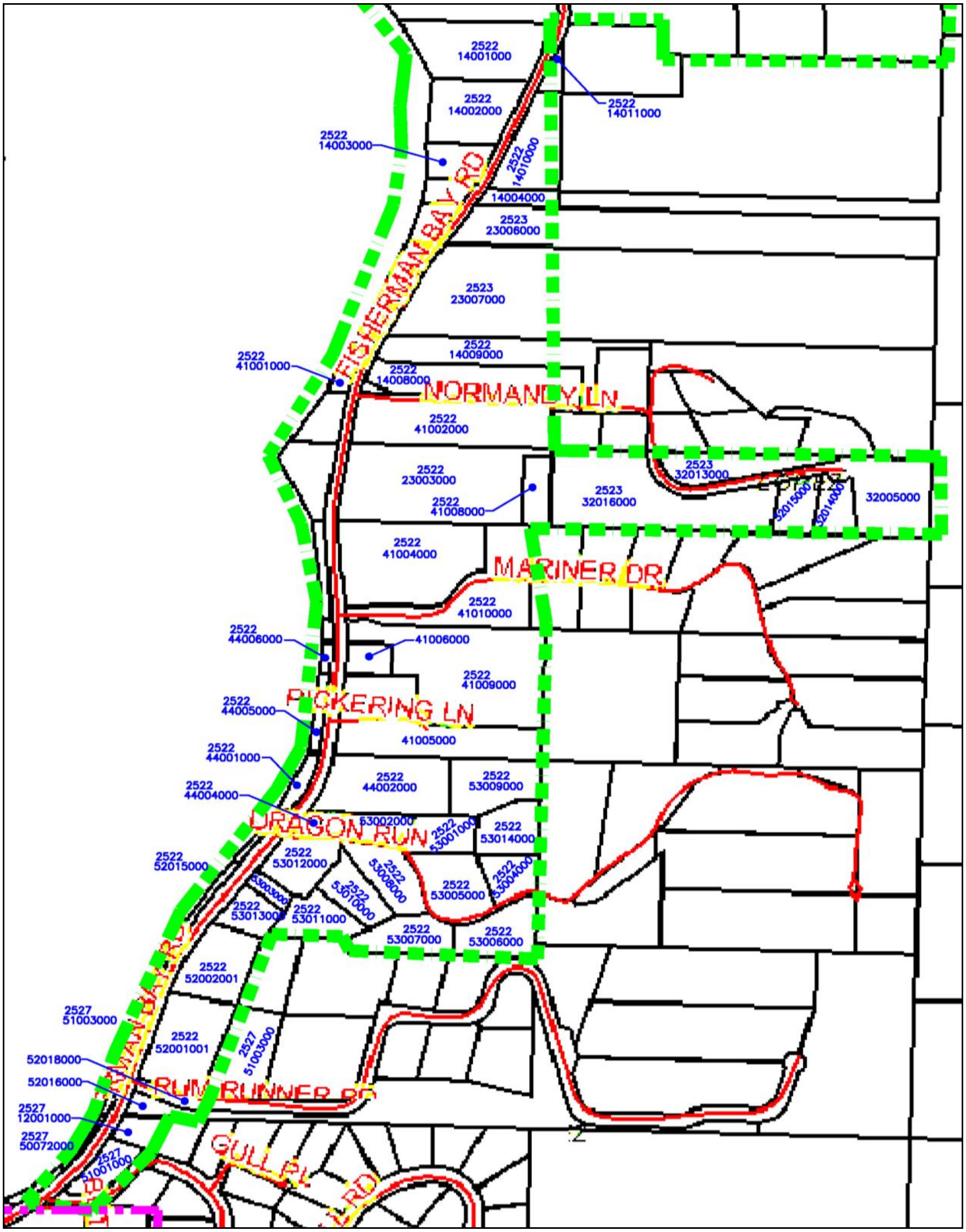


Figure 5.3 – FBSD Service Area Map (South of UGA)

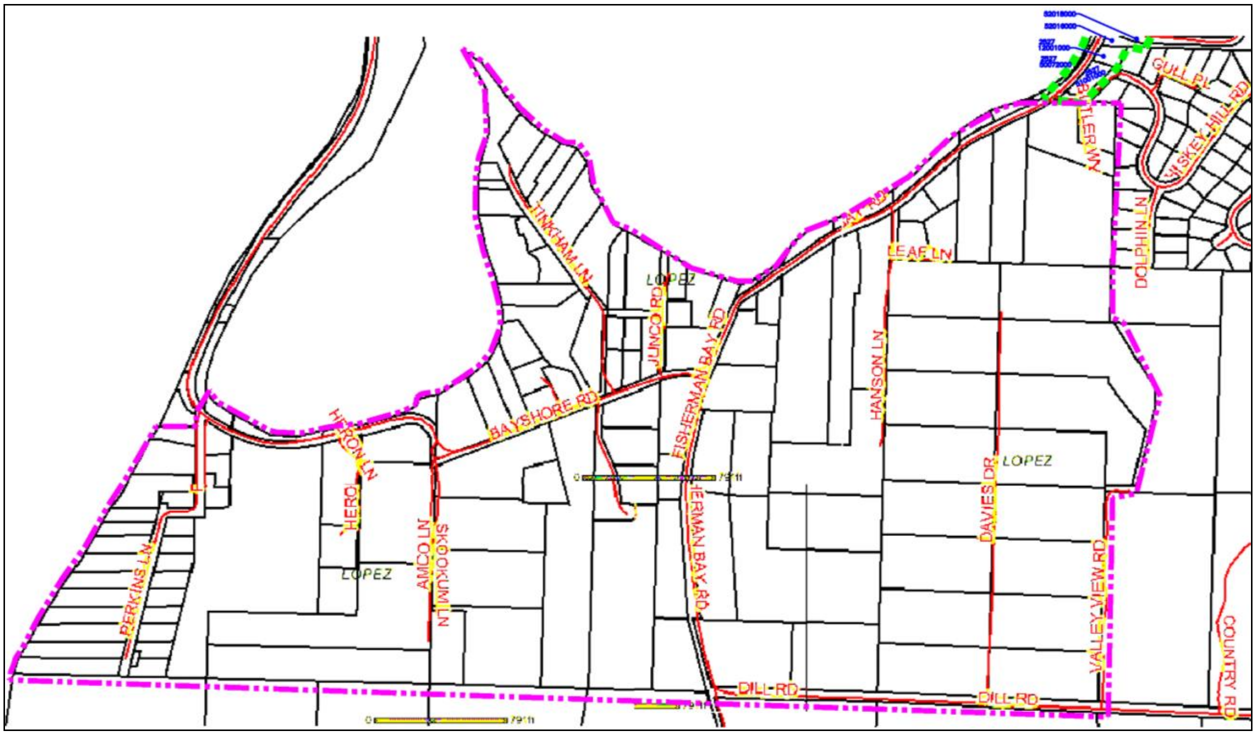


Figure 5.4 – Eastshore South Area Map

Mr. Ron Mayo's study included an area that is located immediately west of the plant site, in between the Lopez Road and the shoreline (cyan lined boundary in Figure 5.2). This area consists of five (5) lots that are not currently serviced by the District. Although this area is in close proximity of the plant site, it will not be serviced by the District because they are currently outside of both the District's service area and the UGA. Therefore, the ERU estimates didn't include this area.

The ERU estimates for these areas are presented in Table 5.2, Table 5.3, and Table 5.4. San Juan County Assessor's website is the primary source for property owner information, parcel number and the property acreages. The District has reviewed and checked the existing ERU count and the service area boundary. For future ERU estimate, generally each connection is first assumed to be one (1) ERU except for few commercial developments. Then 20% is added to derive the total ERU estimate since the District classifies a single resident unit with up to three (3) bedrooms as 1 ERU and a business unit as 1 ERU minimum, and new houses tend to be larger, having more than three (3) bedrooms. The 20% addition is based on current connection count and the ERU count.

The ERU estimate for the UGA area is based on four (4) units (connections or ERU) per developable acre of land, and largely per Mayo's estimates. The existing ERU count for the UGA area is 171. The estimated potential new ERU is 423. Therefore, the total buildout ERU for the UGA area is 594.

The ERU estimate for the areas outside of UGA, but within the District's service area boundary is generally also based on Mr. Mayo's estimates. The new ERU estimate is generally based on one ERU per lot. The existing ERU count for the area within the District's service area, but outside of the UGA is 149. The estimated potential new ERU for the same area is 160. Therefore, the buildout ERU for the area is 309. The ERU estimate for the Eastshore South area is based on one ERU per lot for properties that are less than ten (10) acres or one ERU per five (5) acres for properties that are larger than ten (10) acres in accordance with the County's Rural Farm Forest (RFF) zoning requirement. Most of the existing lots in the Eastshore South area are smaller than ten (10) acres. Therefore, further development in this area is limited based on current zoning. Estimated buildout ERU for the Eastshore South area is 142.

Table 5.2 – UGA Area ERU Estimates

No.	Property Owner/Parcel No.	Property Area (acres)	Exist. ERU	Estimated New ERU	Develop. Potential	Notes
1	LOHO/251514001000	3.84	0	15	Yes	Petitioned for annexation
2	Lopez Community Land Trust/251514003000	6.74	0	15	Yes	15 lots, petitioned for annexation
3	FBSD/251514004000	7.75	1	-	No	plant site
4	Budlong/251423006000	1.86	0	7	Yes	
5	Arntson/251423005000	1.90	1	6	Yes	
6	Bauer/251450003000	0.50	1	0	No	In the process of annexation, 3/8/07
7	Palmer/251450005000	0.50	0	1	Yes	
8	Hylton/251450002000	0.50	0	1	Yes	
9	Palmer/251450004000	0.51	0	1	Yes	
10	Duncan/251450001000	1.01	0	3	Yes	
11	Milagra Lot 1/251451001000	0.16	0	1	Yes	MILAGRA PARTNERS, LLC
12	Milagra Lot 2/251451002000	0.13	0	1	Yes	BETTE ANNE SHUH, TTEE
13	Peterson 3/251451003000	0.20	1	0	No	BRET & SYDNEY PETERSON
14	Milagra Lot 4 /251451004000	0.20	0	1	Yes	J. DICKELMAN & LAWRENCE
15	Metzga 5/251451005000	0.20	1	0	No	S. A & T. A METZGER, in process
16	Milagra Lot 6/251451006000	0.17	0	1	Yes	MILAGRA PARTNERS, LLC
17	Milagra Lot 7/251451007000	0.39	0	1	Yes	VARGA
18	Milagra Lot 8/251451008000	0.26	0	1	Yes	MILAGRA PARTNERS, LLC
19	Milagra Lot 9/251451009000	0.22	0	1	Yes	J&C LOPEZ PROPERTIES LLC

20	Milagra Lot 10/251451010000	0.21	0	1	Yes	J&C LOPEZ PROPERTIES LLC
21	Milagra Lot 11/251451011000	0.21	0	1	Yes	MILDRED L FREY
22	Milagra Lot 12/251451012000	0.25	0	1	Yes	MILAGRA PARTNERS, LLC
23	Milagra Lot 13/251451013000	0.19	0	1	Yes	MILAGRA PARTNERS, LLC
24	Milagra Lot 14/251451014000	0.20	0	1	Yes	MILAGRA PARTNERS, LLC
25	Milagra limited common area	0.19	0	0	No	MILAGRA PARTNERS, LLC
26	Innesfree (Lopez Community Land Trust)/251423011000	2.00	8	0	No	137 Milagra Ln
27	Milagra Partners LLC Commons B/251451015000	1.27	0	0	No	
28	Milagra Partners LLC, Commons A/251451016000	3.52	0	0	No	
29	FBSD Lot by STP/251541013000	0.51	0	0	No	
30	Richey (Lopez Living LLC) /251541003000	7.16	0	28	Yes	
31	Diller-A/251541002	2.83	0	10	Yes	
32	Diller-B/251541001000	4.53	0	16	Yes	
33	Diller-C/251541018000	1.01	0	3	Yes	
34	Post Office/251541019000	0.78	1	0	No	
35	McGee/251541004000	0.69	1	1	Yes	
36	Creps/41024000	0.87	0	3	Yes	342 PORT STANLEY ROAD
37	Creps/41005000	0.67	0	3	Yes	
38	Gaddis/41017000 (251541017)	0.43	1	0	No	478 LOPEZ RD
39	Lopez Apt Association/251541006000	0.98	18	0	No	
40	Islander Bank/251541007000	1.02	1	3	Yes	
41	Cawley/41023000	0.44	1	0	No	
42	Berg/41020000	0.75	2.25	0	No	
43	Berg/41025000	0.20	0	0	No	
44	Episcopal Church/2514-32001000	2.96	2	0	No	
45	Anerdeon/251432012000	1.27	0	5	No	
46	B. Smith/251432005000	4.90	0	16	Yes	Petitioned for annexation

47	Apostolidid/251432013000	4.09	0	14	Yes	annexation petition
48	Ledger Investments LLC/251541011000	1.51	2	4	Yes	
49	Lopez Housing Options/251541030000	0.23	2.5	0	No	
50	Lopez Housing Options/251541031000	1.55	0	16.5	Yes	14 street addresses
51	Dye/251541016000	2.10	0	8	Yes	
52	Lopez Village/251541009000	0.46	0	1	Yes	
53	LCCA/251541012000	5.08	6	8	Yes	
54	LCCA/251552039001	2.85	1	10	Yes	
55	Lopez Children Center/251552039002 (251544001)	0.78	2.5	2	Yes	
56	County Lot/251552051000	0.70	0	0	No	
57	Morgantown (LCLT) (251554001 to 251554007)	1.59	7	0	No	251552038000
58	Coho(LCLT)/251553001 to 3007	1.00	7	0	No	251552053000
59	Park (Catholic Property)/251544004000	2.06	0	0	No	
60	Pickering Yard/44017000	0.37	0	0	No	
61	Pickering House/251544016000	0.83	1	0	No	
62	Edenwild/251544015000/017	0.90	5	0	No	
63	Lopez Village Market (TLC Lopez LLC)/251545002	0.67	8	0	No	251544003000 metered site, ERU equivalent
64	Nursery (Village center building LLC)/251551020000	0.22	1	0	No	251551021000
65	Shops (Love Dog Café, et al, Stewart)/251551021000	0.22	1	0	No	251551022000
66	Offices (Real E., et al, Albritton)/251551023000	0.22	2.5	0	No	
67	SJC/251544014000	0.46	0	0	No	Street ROW, Eads Lane
68	SJC/251552008000	0.18	0	0	No	Street ROW, Eads Lane
69	SJC/251551027000	0.40	0	0	No	Street ROW, Eads Lane
70	SJC/251551029000	1.00	0	0	No	Street ROW, Village Rd

71	SJC/251551026000	0.75	0	0	No	Street ROW, Washburn Pl.
72	SJC/251551025000	0.58	0	0	No	Street ROW, Tower Dr
73	Drury/251551004000	0.09	0	1	Yes	Lopez Village Center
74	Drury/251551005000	0.08	0	1	Yes	Lopez Village Center
75	Drury/251551006000	0.08	0	1	Yes	Lopez Village Center
76	The Bay Co./251551007000	0.05	0	1	Yes	Lopez Village Center
77	The Bay Co./251551008000	0.05	0	1	Yes	Lopez Village Center
78	Catherine/251551009000	0.05	0	1	Yes	Lopez Village Center
79	Catherine Washburn mem assn/251551010000	0.05	0	1	Yes	Lopez Village Center
80	Catherine Washburn mem assn/251551011000	0.05	0	1	Yes	Lopez Village Center
81	Catherine Washburn mem assn/251551016000	0.10	0	1	Yes	Lopez Village Center
82	Goode/251551017000	0.10	1.25	0	No	Lopez Village Center
83	Hilton Gerger /251551018000	0.10	2.25	0	No	Lopez Village Center
84	Hilton Gerger /251551019000	0.10	0	1	Yes	Lopez Village Center
85	James/251551020000	0.10	1	0	No	Lopez Village Center
86	Arnston/251551014000	0.21	4	0	No	Lopez Village Center
87	Lopez Thrift shop/251551013000	0.05	0	1	Yes	Lopez Village Center
88	Krant family properties LLC/251551012000	0.05	0	1	Yes	Lopez Village Center
89	Quay/251551012000	0.05	0	1	Yes	Lopez Village Center
90	Lopez village association/251551028000	0.47	0	0	No	common area
91	Liquor Store (ledger Investments LLC)/251541022000	0.29	3.5	0	No	
92	Pharmacy/Law (Lopez professional center)/251541015000	0.82	3.75	0	No	

93	Coffelt's Yurts/251541014000	0.29	1.5	0	No	
94	Clinic Building (Catherine Washburn member assn)/251544011000	0.37	1	0	No	
95	Clinic H Pad (Catherine Washburn mem assn)/251551003000	0.17	1	0	No	
96	Historic Museum/251541008000	0.57	1	0	No	
97	Wren Studios/251551001000	0.56	1	1	Yes	
98	Colombo/251544002000	0.55	2.75	0	No	
99	Parking Lot (Hanson, et al)/251551002000	0.35	0	1	Yes	
100	Village Park (LV Assn)/251551024000	1.35	1	0	No	
101	Stephens/251550011000	0.57	2.85	0	No	
102	Bay Café etc(The Bay Company LLC)/43001000, Roser	0.53	5.5	0	No	
103	Westlund/43013000	0.47	1	0	No	
104	Durocher/02000	0.47	1	0	No	
105	Settles/03000	0.13	1	0	No	
106	Burgess/04000	0.37	1	0	No	
107	Carpenter/05000	0.40	1	0	No	
108	Sorensen/06000	0.42	1	0	No	
109	San Juan County/07000	0.26	0	1	Yes	
110	Porter/08000	0.23	1	0	No	
111	Stowe/09000	0.24	1	0	No	
112	Wren/43010	0.29	1.5	0	No	
113	Gilbert LLC/25154301	0.54	1	0	No	43010000
114	Plath/252212002	0.63	1	0	No	2515011000
115	Weeks/252212001	0.62	1	0	No	12001000
116	Locke/252212003000	0.55	1	0	No	
117	Sorenson/252212004000	1.08	1	0	No	
118	SJC Land Bank/251544013000	23.88	0	0	No	Wetland
119	Sorenson/252211011000	0.87	0	2	Yes	
120	Sorenson/252211012000	0.45	0	1	Yes	
121	Montgomery/252211009000/ 252211008	0.87	1	1	Yes	

122	Montgomery/252211013000	0.45	0	1	Yes	
123	Weeks Barn LLC/252211010000/Joe Angel	6.50	1	22	Yes	
124	Weeks Garage LLC/252211005000/Joe Angel	0.73	1	0	No	
125	Fire Department/252211006000 (251544006)	0.83	1	0	No	
126	Lopez Island Community Church/251544005000	2.00	3	0	No	
127	Condo's West of Community Church/251549015000	2.23	14	0	No	127 Lopez Road
128	Williams/251544009000	0.66	2.5	0	No	
129	Lopez Village HMB LLC/251544008000	1.71	10	0	Yes	
130	Lopez Village HMB LLC/251544010000	1.19	1	0	No	
131	Foss/252322003000	0.76	1	1	Yes	
132	Forester/252322001000	9.93	0	36	Yes	
133	Porter/251433010000	2.39	0	8	Yes	
134	Nichols/251433005000	2.51	0	8	Yes	
135	McDaniel/251433004002	0.11	0	1	Yes	
136	McDaniel/251433004001	1.04	1	2	Yes	
137	Lopez Island Library District/251433011000	0.94	1	0	No	
138	Cade/2514330030000	2.43	1	8	Yes	
139	FBWA-Reservoirs/251433009000	0.22	0	0	No	
140	Grant/251433001000	6.75	0	26	Yes	Petitioned for annexation
141	Lopez Rd in Vill.	2.09	0	0	No	ROW
142	Lopez Rd (Half)	1.77	0	0	No	ROW
143	Weeks Rd	2.18	0	0	No	ROW
144	Weeks Point Rd	1.61	0	0	No	ROW
145	Fish Bay (Full)	4.14	0	0	No	ROW
146	Fish Bay (Half)	1.14	0	0	No	ROW
147	Hummel Lake	1.77	0	0	No	
Total Within UGA Boundary		197	174.5	346		

Note: (1) For most recent updated accurate existing ERU data, contact the District.
(2) Property areas are approximate only. For exact acreage, please see the County's record.

Table 5.3 – Outside UGA within FBSD Service Area ERU Estimate

No.	Property Owner/Parcel No.	Property Area (acres)	Exist. ERU	Estimated New ERU	Develop. Potential	Notes
1	Turunen/251514005000	5.96	0	24	Yes	
2	Pickering/251514002000	13.68	0	52	Yes	
3	Summers/251542001000	1.82	1	0	No	
4	Hobart/251542002000	1.64	0	1	Yes	
5	Spieker/251542003000	1.81	1	0	No	
6	Weeks/251550001000	0.82	1	0	No	
7	Cramer/251550002000	0.72	1	0	No	
8	Dickison/251550003000	0.63	1	0	No	
9	Savage/251550004000	0.55	1	0	No	
10	Skidmore/251550005000	0.49	1	0	No	
11	Baseman/251550006000	0.46	1	0	No	
12	Phillips/251550007000	0.39	1	0	No	
13	Bjornerud/251550008000	0.46	1	0	No	
14	Hayner/251550009000	0.39	1	0	No	
15	Cowan/251550010000	0.22	1	0	No	
16	Mcdevitt/251550012000	0.17	1	0	No	
17	Smith/251433002000	2.15	1	1	Yes	
18	Mottola/252322007000	10.76	1	1	Yes	
19	Ruggles/252322006000	4.99	1	2	Yes	
20	Holmes/2523220008000	1.54	1	0	No	
21	Webb/252322003000	8.76	0	8	Yes	
22	SJC Public Works/252322005000	1.00	1	0	No	Single septic tank
23	SJC Public Works/252322004000	2.66	0	0	No	
24	Forester/252322001000	9.93	1	4	Yes	
25	Alberty/252211007000	6.98	1	3	Yes	A prelim. plat for total of 4 lots was filed
26	Roth/252211004000	3.90	1	0	No	
27	Meacham/252211003000	0.93	1	0	No	
28	Aitken/252214001000	2.06	1	0	No	
29	Stridsberg/252241002000	1.53	1	1	Yes	Moving to guest house
30	Reeves/252214003000	0.62	1	0	No	

31	Currie/252214011000	0.20	0	1	Yes	
32	Currie/252214010000	1.35	1	0	No	Office with Facilities
33	Currie/252214004000	0.72	1	0	No	
34	Nordhoff/252214006000	5.68	1	0	No	majority of property is outside FBSD
35	Nordhoff/252214007000	14.25	0	3	Yes	majority of property is outside FBSD
36	Meng, Island Marine center/252214009000	2.04	2.75	0	No	approx 30% property is outside FBSD
37	Meng, Island Marine center/252214008000	2.11	2.5	0	No	
38	Meng/252241001000	0.16	1	0	No	
39	Diller/252241002000	3.41	0	0	No	Have asked for 1 more site – part of islander resort
40	Diller/252223003000	4.90	0	0	No	have 3 addresses – part of islander resort
41	Diller/252241008000	0.56	1	0	No	
42	Meng/252332016000	3.64	0	3	Yes	Has filed Plat for 2 Res .& 12 Multi
43	Harold A. Anthony living trust/252332013000	1.03	1	0	No	
44	Meng/252332005000	2.51	0	0	No	Common-Cannot be platted
45	Behan/252332015000	0.65	1	0	No	
46	Meng/252332014000	0.61	0	0	No	
47	Diller/252241004000	3.40	42	8	Yes	Islander Resort, metered, ERU equivalent
48	Diller/252241010000	2.38	0	2	Yes	
49	Farris/252241009000	4.28	0	3	Yes	
50	Leaf/252241006000	0.56	1	0	No	
51	Diller/252241005000	3.19	2	3	Yes	5 street addresses
52	Grimsby/252244002000	2.32	1	0	No	has 2 residences
53	McRoberts/252253009000	1.31	0	1	Yes	
54	McRoberts/252253001000	0.77	1	0	No	
55	Rosell/252253014000	0.90	1	0	No	
56	Strachan/252253002000	0.55	1	0	No	

57	Diller/252244004000	0.43	1.5	0	No	
58	McRoberts/252253012000	1.01	1	0	No	
59	McRoberts/252253003000	0.25	1	0	No	
60	Juntunen/252253011000	0.85	1.5	0	No	
61	McRoberts/252253008000	1.00	0	1	Yes	
62	Shively/252253010000	0.81	0	1	Yes	
63	Thomas/252253005000	1.29	1	0	No	
64	McRoberts/252253004000	0.69	0	1	Yes	
65	Bailey/252253006000	1.08	0	1	Yes	
66	McRoberts/252253007000	0.97	0	1	Yes	
67	McRoberts/252253013000	0.60	0	1	Yes	
68	McRoberts/252244001000	0.07	0	1	Yes	
69	Blue Herron Ridge Comm./252252015000	0.40	0	1	Yes	
70	Blue Herron Ridge Comm/252252002001	1.34	0	1	Yes	
71	Blue Herron Ridge Comm/252252001001	1.81	0	1	Yes	
72	Harbor fisherman bay mntc corp/252751003000	0.45	0	0	Yes	majority of property is outside FBSD
73	Biwal Inc/25275007200	0.17	0	0	No	
74	Blue Herron Ridge/252252001001	3.85	0	0	No	access roadway
75	Blue Herron Ridge/252252001001	3.92	0	0	No	common area
76	Nichols/252712001000	0.43	3.6	0	No	Galley, metered, ERU equivalent
77	Pullen/252751001000	0.60	0	0	No	
78	Roundy/251513006000	5.72	1	3	Yes	
79	Estensen C./251513008000	1.50	1	0	No	
80	Estensen B./251513004000	3.79	1	2	Yes	
81	Lukahnovich 251513005000	2.64	0	2	Yes	
82	Lopez School District #144	32.70	23	0	No	metered, ERU equivalent
83	Unidentified users, serviced by contracts		14			serviced by contracts
Total Within FBSD Not in UGA		**220**	**136**	**138**		

Note: (1) For most recent updated accurate existing ERU data, contact the District.
(2) Property areas are approximate only. For exact acreage, please see the County's record.

Table 5.4 – Eastshore South Area ERU Estimate

No.	Property Owner/Parcel No.	Property Area (acres)	Exist. ERU(1)	Estimated New ERU(2)	Develop. Potential	Notes
1	Eastshore South area	367.0	130	10	Yes	Assuming average 5acres/lot, not connected
Total outside of UGA and FBSD		367.0	130	10		Total 140 ERUs

(1): Estimated existing developed units, but they are not connected to the District's sewer system.
(2) Estimated potential new future units.
(3) This study assumed that the area will not be serviced until the existing service area and UGA is approaching buildout condition if this area is to be serviced in the future.

Although ERU and typical household used by the US census are different concepts, we felt they should be fairly close in terms of the number of persons in each ERU or household. Therefore, we assumed that each ERU is equal to a typical household of the Lopez Island for this study purpose. We also felt that the original definition of each ERU equates to 2.3 people was higher for the present demographic condition on the Island based on historic data and discussions presented in Section 4 of this report. Hence, 2.12 people per ERU are used for population projection. Table 5.5 is a summary of the estimates for the various sub areas and projected populations.

Table 5.5 –ERU Summary and Population Projections

Area Descriptions	UGA area	Area: Outside UGA, but within FBSD service area	Subtotal: UGA and FBSD service area	Eastshore South Area	Grand total
Area (acres)	197	220	**417**	367	**784**
Existing ERU	173	136	**309**	130(1)	**439**
Estimated New ERU Based on lot unit	346	138	**484**	10	**494**
Estimated New ERU with 20% Increase	415	166	**581**	12	**593**
Total Buildout ERU	588	301	**890**	142	**1032**
Estimated Existing Population Equivalent (people)	367	288	**655**	276	**931**
Estimated Future Population Equivalent Increase (people)	880	351	**1,231**	25	**1,256**
Estimated Buildout Population Equivalent (people)	1,247	639	**1,886**	301	**2,187**

(1): Estimated existing developed units, but they are not connected to the District's sewer system.

5.1.3 Future Growth Rates

Future growth will fluctuate in accordance with local and or national economic conditions. Previous studies have proven that it's very difficult to forecast future growth rates because growth is affected by many factors. Historically, the District's ERU record data in Table 4.1 showed an annualized average growth rate of 3.45% from 1996 to 2007. This period included a macro booming economy in the 1990s driven by internet based technologies and a booming house market in recent years. It is reported that the San Juan County Planning Department has proposed a 5.6% growth rate through the year 2020, and a 3.8% growth grate thereafter within the UGA. The growth rate outside of the UGA is proposed to be 2.5% per year. These assumed growth rates appear reasonable based on past growth rates and the present condition. Therefore, the County's growth rates are used to project the future ERU and populations for the year 2020, 20 years (year 2028) and the time needed to reach the buildout conditions. Results of the projections are presented in Table 5.6 and Figure 5.5.

Table 5.6 –Growth Rates and Population Projections

No	Area Description	Year 2008 (Existing) ERU	Assumed Growth Rates Up to 2020	Year 2020 ERU	Assumed Growth Rates after 2020	Year 2028 ERU	Projected Buildout ERU	Year to Reach Buildout
1	**UGA**	173	5.6%	333	3.8%	449	588	2036
2	**Within FBSD But outside of UGA**	136	2.5%	183	2.5%	223	302	2040
3	**Total of FBSD and UGA**	309		516		671	890	
4	**Eastshore South**(1)	130(2)	2.5%	142		142	142	2012
5	**Grand Total**	439		658		813	1032	

(1): The Eastshore South area is not currently within the service area of the FBSD.
(2) Estimated existing developed units, but they are not connected to the District's sewer system.

Based on the assumed growth rates, the UGA area will reach buildout condition by 2036 or 28 years from now, and the current service area will reach buildout condition by 2041 or 33 years from now.

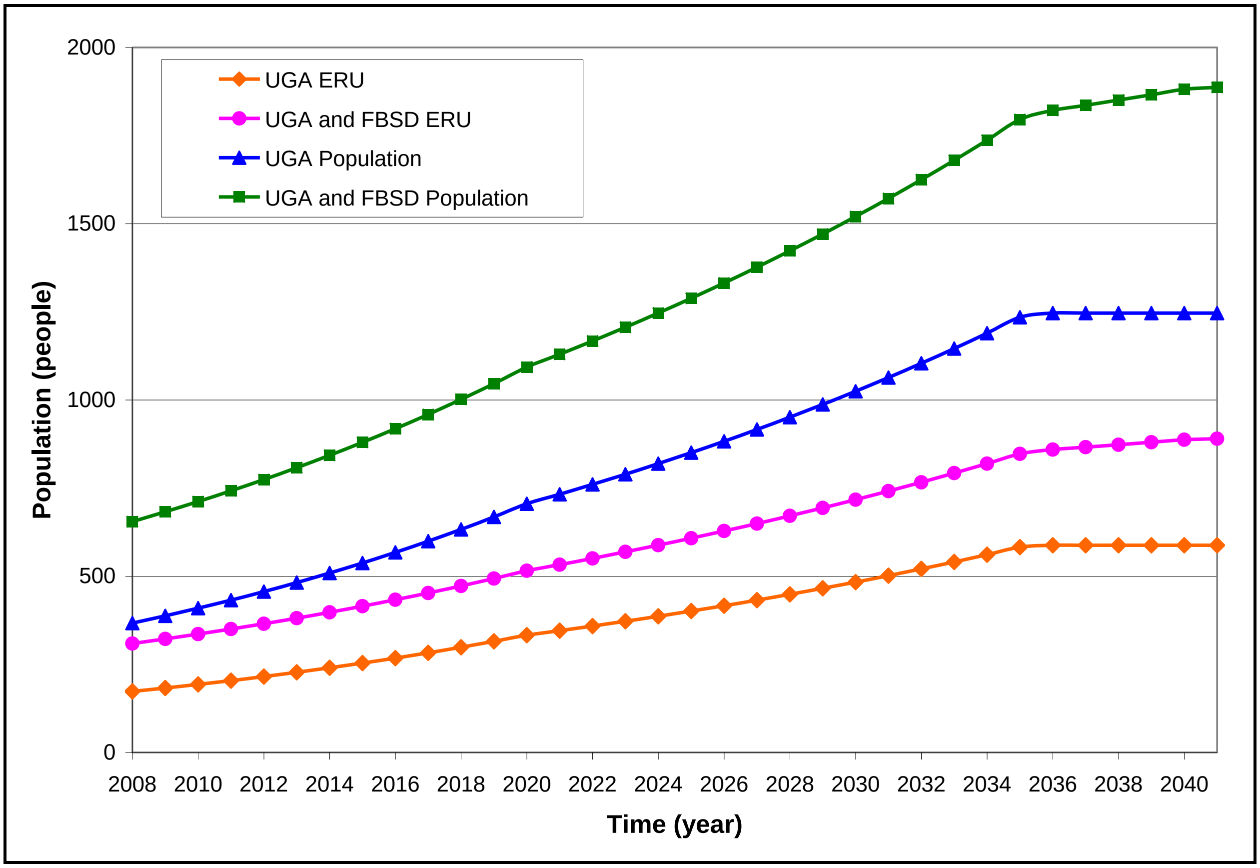


Figure 5.5 – ERU and Population Projections

5.2 FLOW AND ORGANIC LOADING PROJECTIONS

Historical data analysis in Section 4 has determined the following design criteria for the District's plant influent flow:

- ERU flow loading: 100 gal/ERU, summer; 93 gal/ERU, winter
- ERU organic loading: 0.15 lbs BOD_5/ERU, summer; 0.11 lbs BOD_5/ERU, winter
  0.14 lbs $CBOD_5$/ERU, summer; 0.10 lbs $CBOD_5$/ERU, winter
- TSS: 37 mg/l
- pH: 7.06 s.u.
- Ammonia: 57 mg/l
- Temperatures: 46^{o}F (7.8^{o}C) winter; 63^{o}F (17.2^{o}C) summer
- Peaking factor: 3.5

Using the above the design criteria and the projected ERU data in Table 5.6, future hydraulic loadings and organic loadings for year 2020, 2028 and the buildout conditions were estimated and listed the following Table 5.7:

Table 5.7 – Summary of Projected Loadings

Year	Areas / Parameters	UGA Summer	UGA Winter	Total of UGA and FBSD Summer	Total of UGA and FBSD Winter	Eastshore South[1] Summer	Eastshore South[1] Winter	Total Summer	Total Winter
2020	ERU	333		516				658	
	Average flow (gpd)	33,286	30,956	51,557	47,948			65,757	61,154
	Peak flow (gpd)	116,502	108,347	180,448	167,816			230,148	214,037
	BOD_5 loading (lbs/d)	50	37	77	57			99	72
	$CBOD_5$ loading (lbs/d)	47	33	72	52			92	66
2028	ERU	449		671				813	
	Average flow (gpd)	44,858	41,718	67,119	62,421			81,319	75,627
	Peak flow (gpd)	157,004	146,014	234,916	218,472			284,616	264,693
	BOD_5 loading (lbs/d)	67	49	101	74			122	89
	$CBOD_5$ loading (lbs/d)	63	45	94	67			114	81
Build-out	ERU	588		890		142		1032	
	Average flow (gpd)	58,813	54,696	88,958	82,731	14200	13206	103,158	95,937
	Peak flow (gpd)	205,846	191,437	311,354	289,559	49700	46221	361,054	335,780
	BOD_5 loading (lbs/d)	88	65	133	98	21	16	155	113
	$CBOD_5$ loading (lbs/d)	82	59	125	89	20	14	144	103

(1): It is assumed that if the Eastshore South area is to be serviced by the District eventually, however it will not be connected to the District prior to 2028.

6.0 Existing Conditions and Evaluations

6.1 GENERAL

This section describes the District's existing wastewater systems, provides assessments for the current conditions of the existing systems, identify deficiencies and improvements for meeting the needs for the present conditions, year 2020 condition, the projected 20-year condition and the ultimate buildout conditions.

6.2 WASTEWATER COLLECTION SYSTEM

Description: The District's wastewater collection system consists of more than five (5) miles of 2", 3", 4" and 6" pressurized PVC sewer pipes, isolation valves, air vents, septic tanks and pumps. The collection system starts from the Butler Way at the south end of the District's current service area. The sewer main along the Fisherman Bay Road in the Eastshore North area consists of 4" and 6" mains. They were originally sized to allow servicing the Eastshore South area. There are two 4" mains going to the plant. This arrangement provides operational and maintenance flexibility for emergency bypass or repair needs. Figure 6.1A and6.1B shows the District's collection system.

The collection system is a septic tank effluent pumping (STEP) system. Each individual user connection includes a septic tank, a pump with controls and discharge pipe to the sewer main flowing to the District's wastewater treatment plant. The District pumps the septic tanks on a regular schedule. The STEP system is operated and maintained by the District. There are appropriately a half dozen different types of submersible pumps in use, but all have the same motor. The District receives about one or two calls each month from the users for assistance. All pumps are equipped with audible alarms. The District reviews and approves new connections, and enforces septic tank maintenance requirements.

Evaluations: The existing wastewater collection system is generally in fairly good condition. Some air vents and valves in the collection may need repair or replacement due to hydrogen sulfide corrosion. The main problem with the collection system is inflow/infiltration (I/I) to the sewers. Because the sewer main is a pressured system, it is suspected that the I/I occur mainly through connections/joints with structures and septic tanks. As discussed in Section 4 of this report, the District has been mitigating the I/I contributions in the last several years, and is committed to continue rehabilitation for reducing the I/I flows. The District also requires the use of modern construction techniques for the new sewer system and septic tanks construction to prevent the I/I flow contribution. Record data analysis in Section 4 of this report has shown that I/I flow is decreasing.

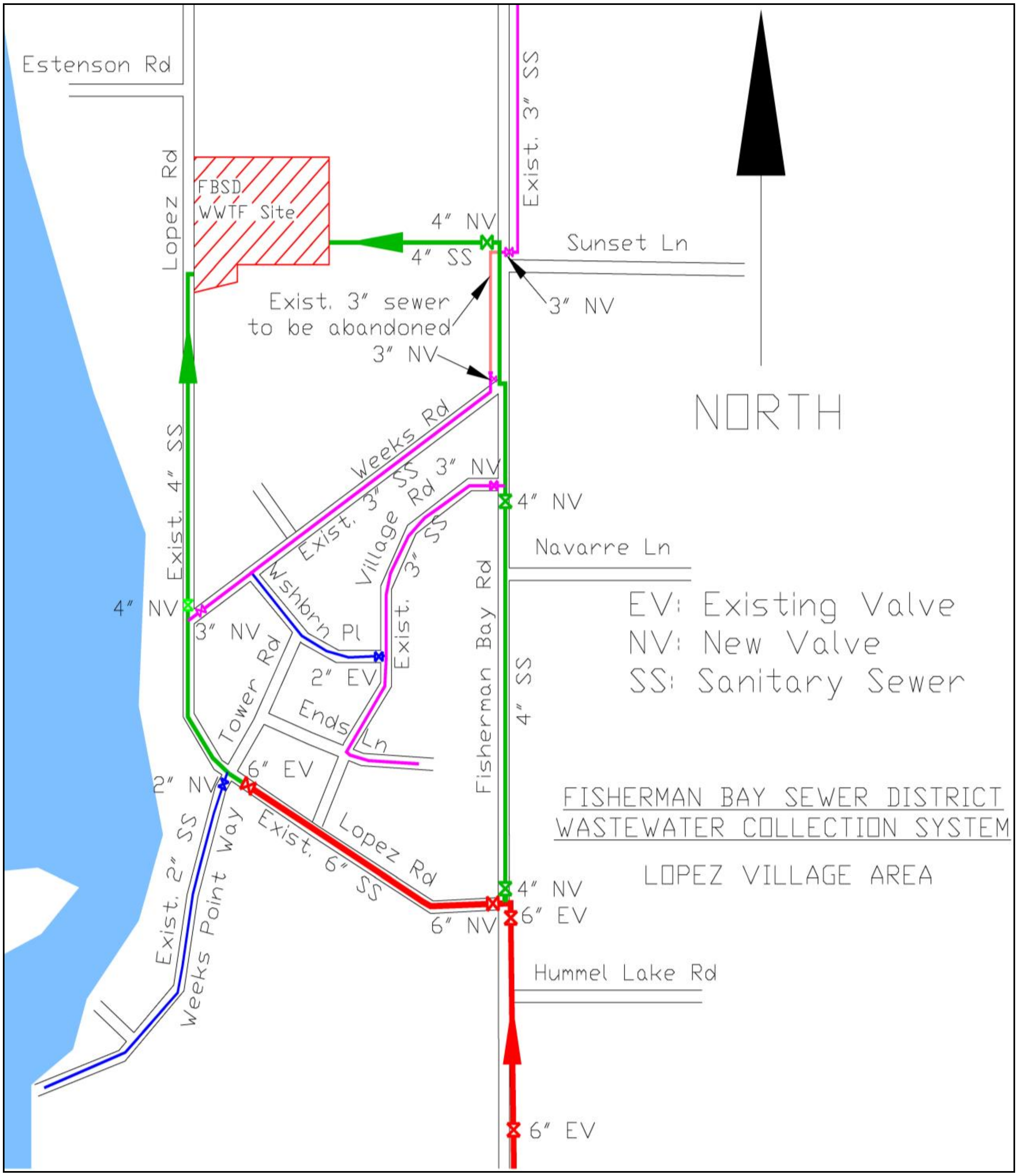


Figure 6.1A – FBSD Wastewater Collection System Plan

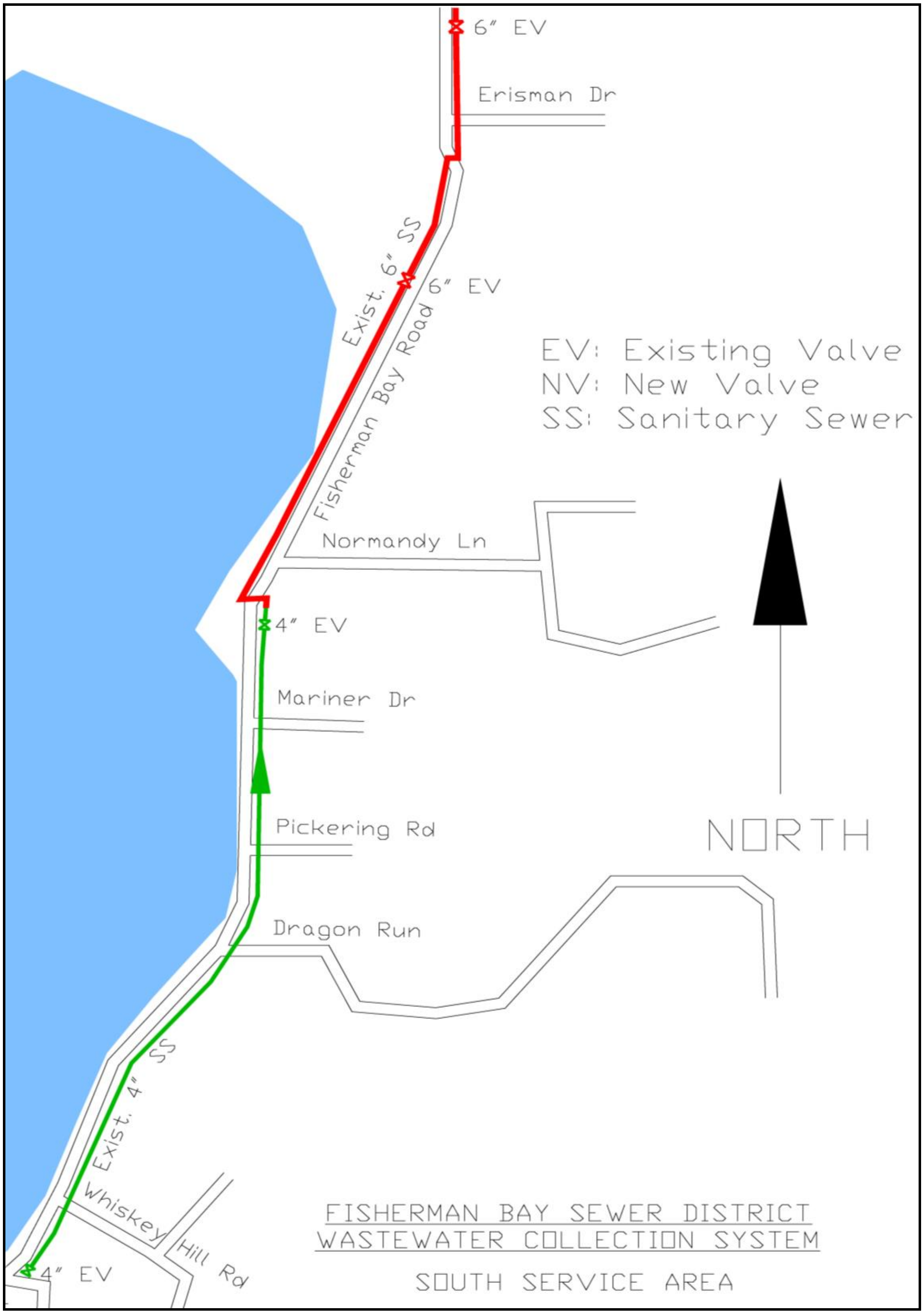


Figure 6.1B – FBSD Wastewater Collection System Plan

The optimal flowing velocity in a force main is generally 4 to 6 ft/s. Based on this range of optimal velocity, a single 4” sewer main is estimated to have a conveyance capacity of 225,500 gpd to 338,200 gpd, and the 6” sewer main is estimated to have a capacity of 507,300 gpd to 760,900 gpd. These capacities are well above the District’s plant’s permitted summer capacity of 34,000 gpd and the projected buildout flows even when the Eastshore South area is added to the District.

Currently influent flow to the WWTF varies from 11,000 pgd to 27,000 gpd. For this range of flows, the velocity in the 4” sewer to the WWTF varies from 0.19 ft/s to 0.48 ft/s. The flow velocity in the 4” sewer is much lower than the industry recognized minimum velocity of 2.0 ft/s. Therefore, it is advised that the District flushes the sewer periodically to clean out the settled solids.

Recommendations: No major improvements are needed at present for the collection system.

6.3 WASTEWATER TREATMENT PLANT

6.3.1 Plant History

P-6.1: FBSD Plant Overview

The FBSD plant was originally built in 1979 for a design capacity of 27,500 gpd. The original plant consisted of an influent flow metering unit, a single-cell aerated lagoon (L-1) and a chlorine disinfection unit. In 1995, the plant was expanded to a two-cell aerated lagoon system by adding a new aerated facultative lagoon (L-2) for meeting the growth needs in the area. The capacity of the plant was increased to 34,000 gpd and 56 lbs. BOD_5 /day for the summer months (April to November), and 23,000 gpd and 38 lbs. BOD_5 /day for the winter months (December to March). The two lagoons were operated in series. The L-2 lagoon was a primary treatment lagoon and was aerated by a 2-horsepower mechanical surface aerator. Effluent of the L-2 lagoon flowed by gravity to the L-1 lagoon that acted as a secondary treatment and settling lagoon prior to lagoon effluent discharging to the disinfection unit. The L-1 lagoon was also aerated by a 2-horsepower mechanical surface aerator. The 1995 expansion also included a new chlorine contact chamber, a new chlorine feed pump, and a new laboratory building. In 2003, the L-2 lagoon was modified, and separated into three (3) cells. A new influent flow tank and an anaerobic cell were also constructed. In April 2004, the L-1 lagoon was taken out of treatment service. In 2006, a subsurface flow constructed wetland was constructed for polishing the lagoon effluent before disinfection. Currently L-1 is used only occasionally for storage purpose during extreme heavy rain events. The District was now requested by the DOE to decommission the L-1 lagoon and appropriately dispose of the lagoon sludge. The District has received approval of the L-1 decommissioning plan and is scheduled to complete the decommissioning by the summer of 2008. The District is considering the potential uses of the L-1 lagoon area once the decommissioning is completed. But no detailed study has been done, so no decisions have been made at present.

6.3.2 General Process Descriptions

The Fisherman Bay Sewer District plant is a Class I plant. The District's existing plant consists of the following components in a downstream order: the influent metering system, the influent flow tank, the anaerobic pretreatment cell, the aerated lagoon L-2, the constructed wetland, the chlorine disinfection system, and the plant effluent metering system.

Liquid stream flow in plant is described as follows: Wastewater enters the plant through the 4" PVC sewer along the Lopez Road, which becomes a 6" line and meets the 4" PVC sewer from the Fisherman Bay Road. The flow then passes through a flume, where flow rate is measured and recorded by the battery powered Stevens flow meter. Influent composite samples are also taken at the flume location. Flow moves through the influent flow tank where grease is trapped, scum is formed, collected and pumped. From the influent flow tank, wastewater flows to the anaerobic pretreatment cell, where anaerobic bacteria removes some influent BOD and digest the settled sludge. Flow then moves to the L-2 lagoon which consists of three (3) cells separated by floating baffle curtains. The first cell is a constantly aerated cell, the second cell is generally aerated in the night time only, and the third is a non-aerated settling cell. Openings on the floating baffle curtains allow the flow to move from one cell to the next cell. Flow leaves the settling cell to the subsurface constructed wetland. The flow enters the wetland from one end, then goes through the wetland media, and exits from the opposite end of the wetland. Flow from the wetland then goes to the chlorine contact chamber where calcium hypochlorite tablets are added for disinfection. After leaving the contact chamber, flow moves through the effluent flume where plant effluent is measured by the same type of flow device as the influent. The flume is also the location where composite effluent samples and grab samples are taken. After the flume, plant effluent discharges to the San Juan Channel via a 4" outfall line, 2800 feet in length, with a single diffuser port.

The existing L-1 lagoon is currently not part of the treatment system, but occasionally used for emergency storage. Figure 6.2 is the plant site plan, and Figure 6.3 is the plant's process flow diagram and hydraulic profile. A detailed description and evaluation for each component of the plant are provided below.

6.3.3 Current Hydraulic and Organic Loadings

The permitted monthly average hydraulic loading for the plant is 34,000 gpd for the summer season (April to November) and 23,000 gpd for the winter season (December to March). The permitted organic loading for the plant is 56 lbs BOD_5/day for the summer season and 38 lbs

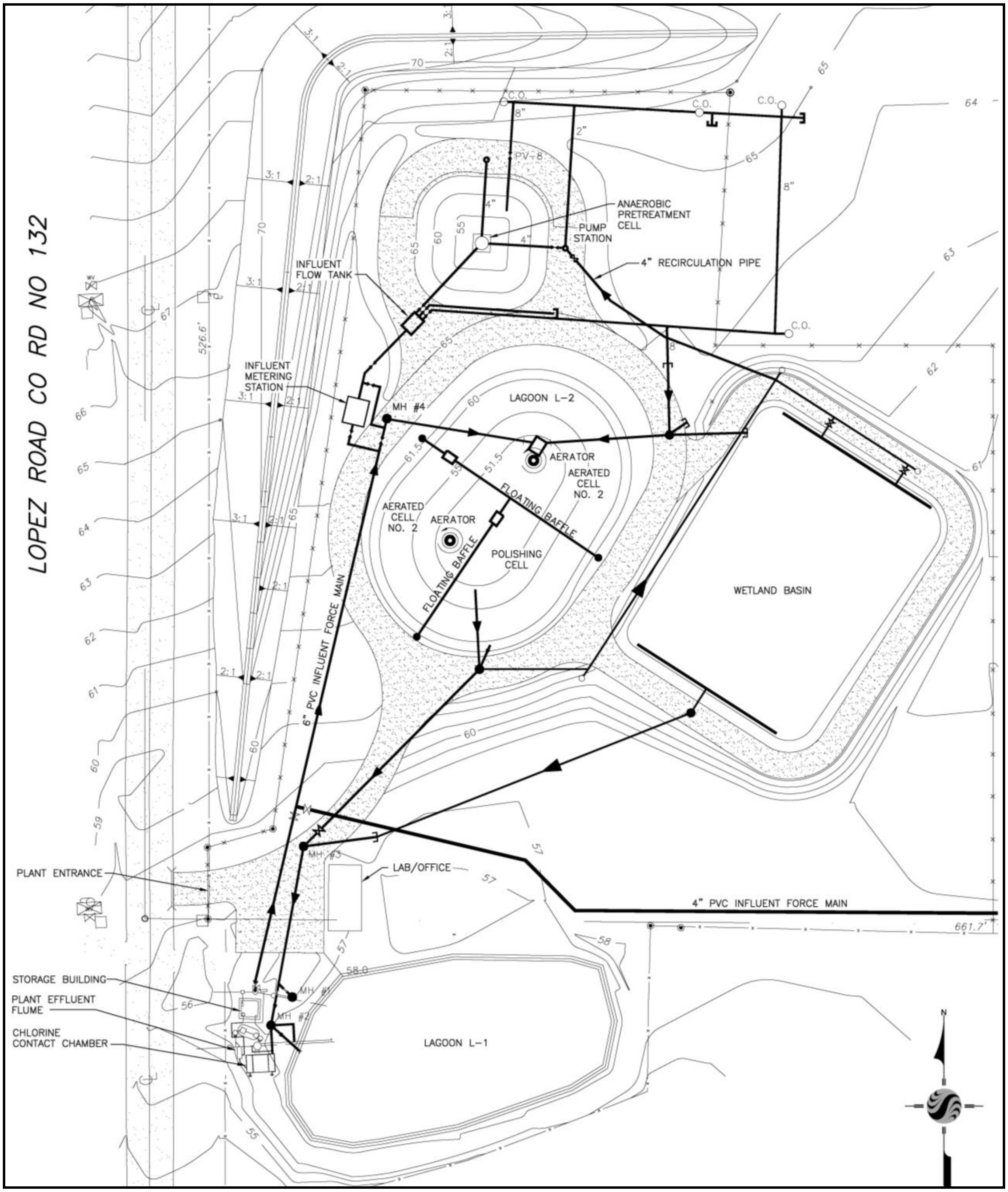


Figure 6.2 – FBSD Wastewater Treatment Plant Site Plan

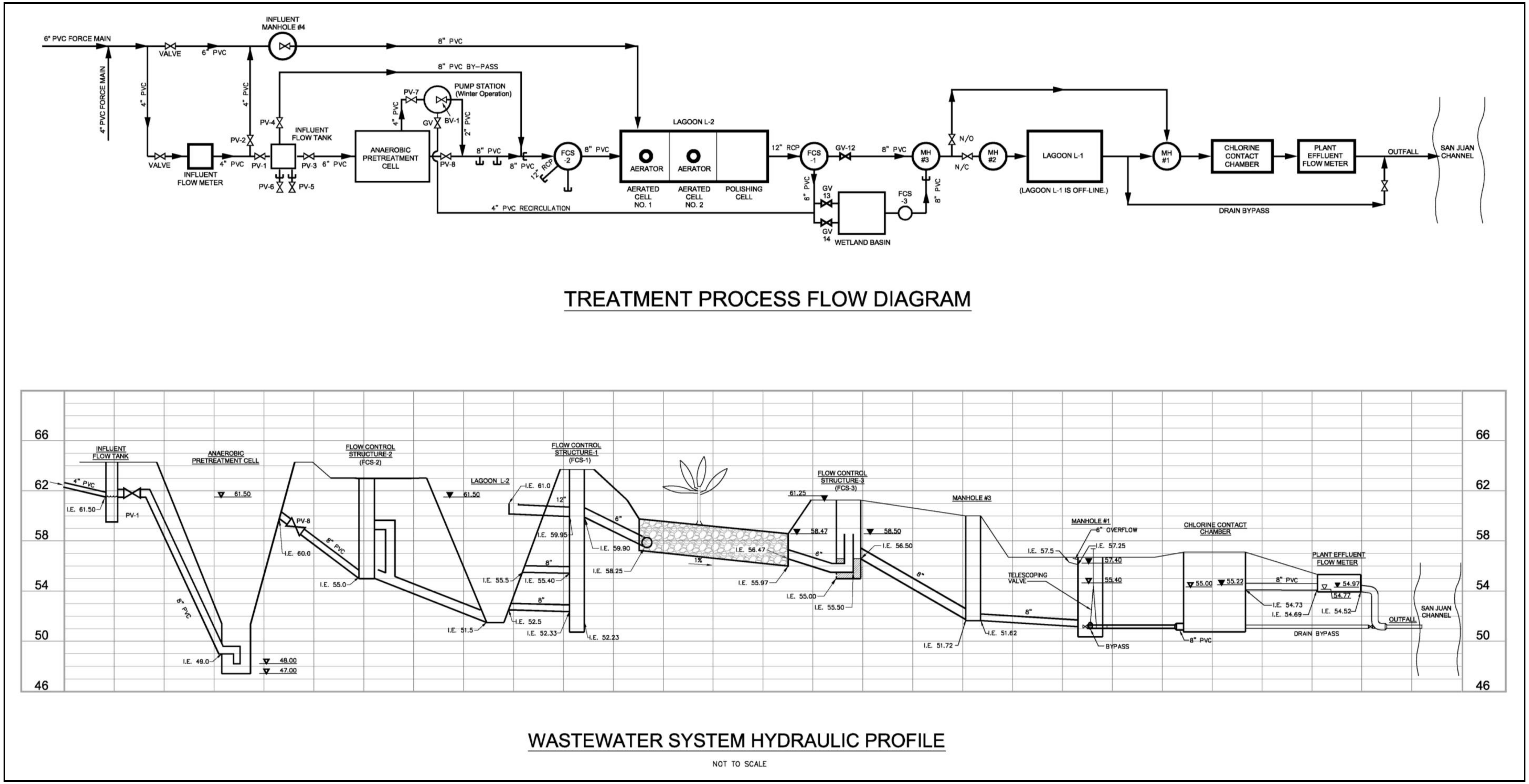


Figure 6.3 – FBSD Wastewater Treatment Plant Process Flow Diagram and Hydraulic Profile

BOD_5/day for the winter season. In the plant's permit, the Department of Ecology requires the District to submit a plan and a schedule whichever the following occurs first:

1. The actual flow or organic loading reaches 85% of any one of the permitted loading for three consecutive months; or
2. When the projected increase would reach the permitted capacity within five years.

Record data in Table 6.1, and Figure 6.4 and 6.5 shows that monthly average flows in the winter season have reached 85% or exceeded the permitted capacity in several occasions in the last 11 years. But there never have been any three consecutive monthly flows reaching 85% of the permitted capacity. The high flows were almost certainly caused by I/I contributions because of heavy rains. As the District progresses in rehabilitating the existing collection system, continuing reduction in I/I flow contribution is expected, and incidence of high flow may not occur again or very rarely. The permitted winter season capacity is much lower than the summer capacity. The basis for determining the winter capacity should be reviewed to see if a larger capacity can be granted. The highest summer flow was 76% of the permitted capacity. However, majority of the actual flows in the last 11 years were below 70% of the permitted capacities.

Table 6.1 – Record Flow Data Summary

Date	**Average Influent Flows** (gpd)	**Permitted Capacity** (gpd)	**Percentage of Permitted Capacity**
Jan-97	24000	23,000	104%
Feb-97	19000	23,000	83%
Mar-97	12000	23,000	52%
Apr-97	11000	34,000	32%
May-97	12000	34,000	35%
Jun-97	21000	34,000	62%
Jul-97	16000	34,000	47%
Aug-97	17000	34,000	50%
Sep-97	13000	34,000	38%
Oct-97	12000	34,000	35%
Nov-97	10000	34,000	29%
Dec-97	18000	23,000	78%
Jan-98	25000	23,000	109%
Feb-98	12000	23,000	52%
Mar-98	18000	23,000	78%
Apr-98	14000	34,000	41%
May-98	16000	34,000	47%
Jun-98	12000	34,000	35%
Jul-98	16000	34,000	47%
Aug-98	16000	34,000	47%
Sep-98	13000	34,000	38%
Oct-98	10000	34,000	29%
Nov-98	13000	34,000	38%
Dec-98	30000	23,000	130%

Jan-99	27000	23,000	117%
Feb-99	19000	23,000	83%
Mar-99	17000	23,000	74%
Apr-99	14000	34,000	41%
May-99	17000	34,000	50%
Jun-99	19000	34,000	56%
Jul-99	26000	34,000	76%
Aug-99	19000	34,000	56%
Sep-99	8000	34,000	24%
Oct-99	11000	34,000	32%
Nov-99	13000	34,000	38%
Dec-99	16000	23,000	70%
Jan-00	14000	23,000	61%
Feb-00	12000	23,000	52%
Mar-00	14000	23,000	61%
Apr-00	15000	34,000	44%
May-00	14000	34,000	41%
Jun-00	15000	34,000	44%
Jul-00	19000	34,000	56%
Aug-00	16500	34,000	49%
Sep-00	16900	34,000	50%
Oct-00	14500	34,000	43%
Nov-00	11000	34,000	32%
Dec-00	14600	23,000	63%
Jan-01	13200	23,000	57%
Feb-01	13100	23,000	57%
Mar-01	12400	23,000	54%
Apr-01	13900	34,000	41%
May-01	15700	34,000	46%
Jun-01	13600	34,000	40%
Jul-01	18500	34,000	54%
Aug-01	20800	34,000	61%
Sep-01	16300	34,000	48%
Oct-01	13400	34,000	39%
Nov-01	13200	34,000	39%
Dec-01	20200	23,000	88%
Jan-02	25000	23,000	109%
Feb-02	13000	23,000	57%
Mar-02	11000	23,000	48%

Apr-02	15000	34,000	44%
May-02	16000	34,000	47%
Jun-02	14000	34,000	41%
Jul-02	20000	34,000	59%
Aug-02	20000	34,000	59%
Sep-02	13000	34,000	38%
Oct-02	15000	34,000	44%
Nov-02	11000	34,000	32%
Dec-02	12000	23,000	52%
Jan-03	14000	23,000	61%
Feb-03	13000	23,000	57%
Mar-03	13000	23,000	57%
Apr-03	14000	34,000	41%
May-03	14000	34,000	41%
Jun-03	15000	34,000	44%
Jul-03	19000	34,000	56%
Aug-03	20000	34,000	59%
Sep-03	15000	34,000	44%
Oct-03	14000	34,000	41%
Nov-03	18000	34,000	53%
Dec-03	13000	23,000	57%
Jan-04	17000	23,000	74%
Feb-04	13000	23,000	57%
Mar-04	14000	23,000	61%
Apr-04	13000	34,000	38%
May-04	15000	34,000	44%
6/1/04	12000	34,000	35%
6/8/04	14000	34,000	41%
6/15/04	12000	34,000	35%
6/22/04	18000	34,000	53%
6/29/04	17000	34,000	50%
7/6/04	25000	34,000	74%
7/13/04	19000	34,000	56%
7/20/04	22000	34,000	65%
7/27/04	18000	34,000	53%
8/3/04	22000	34,000	65%

8/10/04	21000	34,000	62%
8/17/04	20000	34,000	59%
8/24/04	22000	34,000	65%
8/31/04	15000	34,000	44%
9/7/04	15000	34,000	44%
9/14/04	13000	34,000	38%
9/21/04	14000	34,000	41%
9/28/04	15000	34,000	44%
10/5/04	14000	34,000	41%
10/12/04	12000	34,000	35%
10/19/04	13000	34,000	38%
10/26/04	13000	34,000	38%
11/2/04	24000	34,000	71%
11/9/04	16000	34,000	47%
11/16/04	16000	34,000	47%
11/23/04	17000	34,000	50%
11/30/04	17000	34,000	50%
12/7/04	21000	23,000	91%
12/14/04	17000	23,000	74%
12/21/04	11000	23,000	48%
12/28/04	17000	23,000	74%
1/4/05	16000	23,000	70%
1/11/05	13000	23,000	57%
1/18/05	54000	23,000	235%
1/25/05	18000	23,000	78%
2/1/05	14000	23,000	61%
2/8/05	22000	23,000	96%
2/15/05	13000	23,000	57%
2/22/05	15000	23,000	65%
3/1/05	14000	23,000	61%
3/8/05	11000	23,000	48%
3/15/05	14000	23,000	61%
3/22/05	13000	23,000	57%
3/29/05	15000	23,000	65%
4/5/05	14000	34,000	41%
4/11/05	16000	34,000	47%
4/19/05	14000	34,000	41%

4/26/05	16000	34,000	47%
5/3/05	14000	34,000	41%
5/10/05	11000	34,000	32%
5/17/05	14000	34,000	41%
5/23/05	17000	34,000	50%
5/31/05	14000	34,000	41%
6/6/05	15000	34,000	44%
6/14/05	17000	34,000	50%
6/21/05	15000	34,000	44%
6/28/05	17000	34,000	50%
7/5/05	24000	34,000	71%
7/12/05	17000	34,000	50%
7/19/05	23000	34,000	68%
7/26/05	20000	34,000	59%
8/2/05	23000	34,000	68%
8/9/05	25000	34,000	74%
8/16/05	23000	34,000	68%
8/23/05	22000	34,000	65%
8/29/05	22000	34,000	65%
9/5/05	23000	34,000	68%
9/13/05	16000	34,000	47%
9/19/05	18000	34,000	53%
9/27/05	15000	34,000	44%
10/4/05	15000	34,000	44%
10/11/05	15000	34,000	44%
Oct-05	12000	34,000	35%
Nov-05	15000	34,000	44%
Dec-05	15000	23,000	65%
Jan-06	23000	23,000	100%
Feb-06	16000	23,000	70%
Mar-06	14000	23,000	61%
Apr-06	17000	34,000	50%
May-06	14000	34,000	41%
Jun-06	16000	34,000	47%
Jul-06	21000	34,000	62%
Aug-06	22000	34,000	65%
Sep-06	16000	34,000	47%

Oct-06	14000	34,000	41%
Nov-06	18000	34,000	53%
Dec-06	20000	23,000	87%
Jan-07	23000	23,000	100%
Feb-07	15000	23,000	65%
Mar-07	17000	23,000	74%
Apr-07	15000	34,000	44%
May-07	14000	34,000	41%
Jun-07	16000	34,000	47%
Jul-07	22000	34,000	65%
Aug-07	23000	34,000	68%
Sep-07	18000	34,000	53%
Oct-07	14000	34,000	41%
Nov-07	15000	34,000	44%
Dec-07	13000	23,000	57%
Jan-08	13000	23000	57%
Feb-08	15000	23000	65%
Mar-08	14000	23000	61%

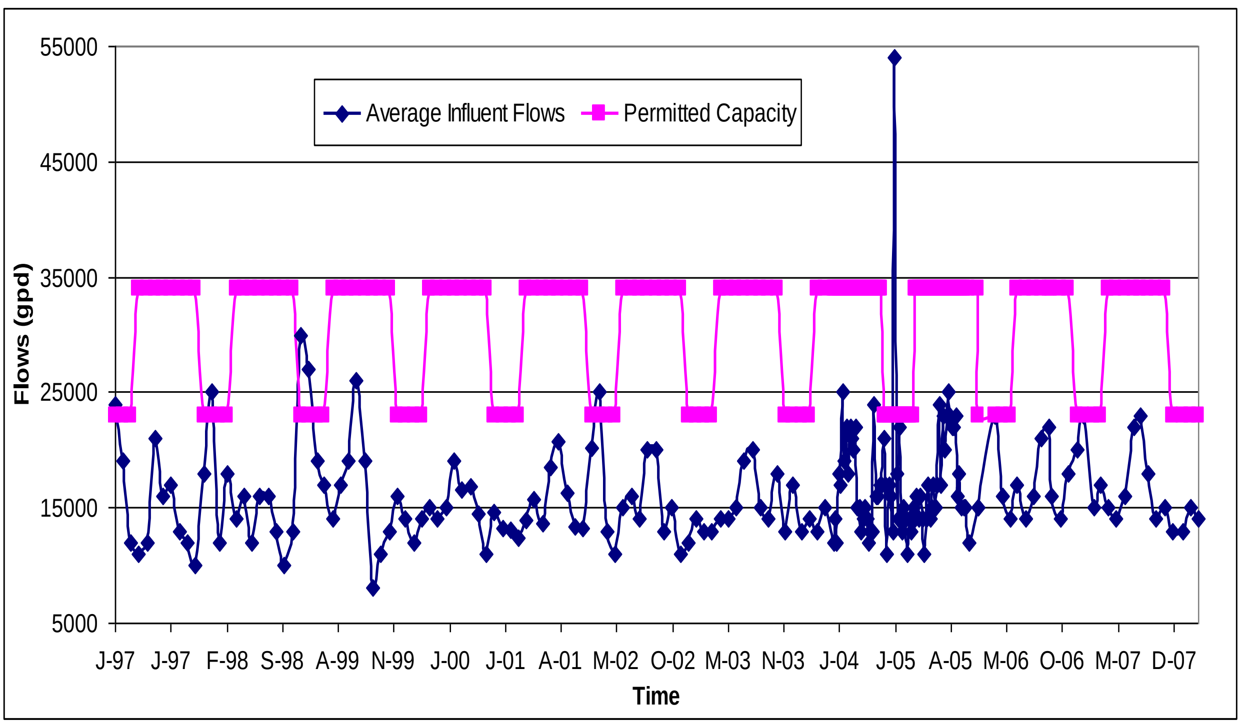


Figure 6.4 – Monthly Average Flows and the Permitted Flows

FISHERMAN BAY SEWER DISTRICT
WASTEWATER SYSTEM MASTER PLAN – DRAFT

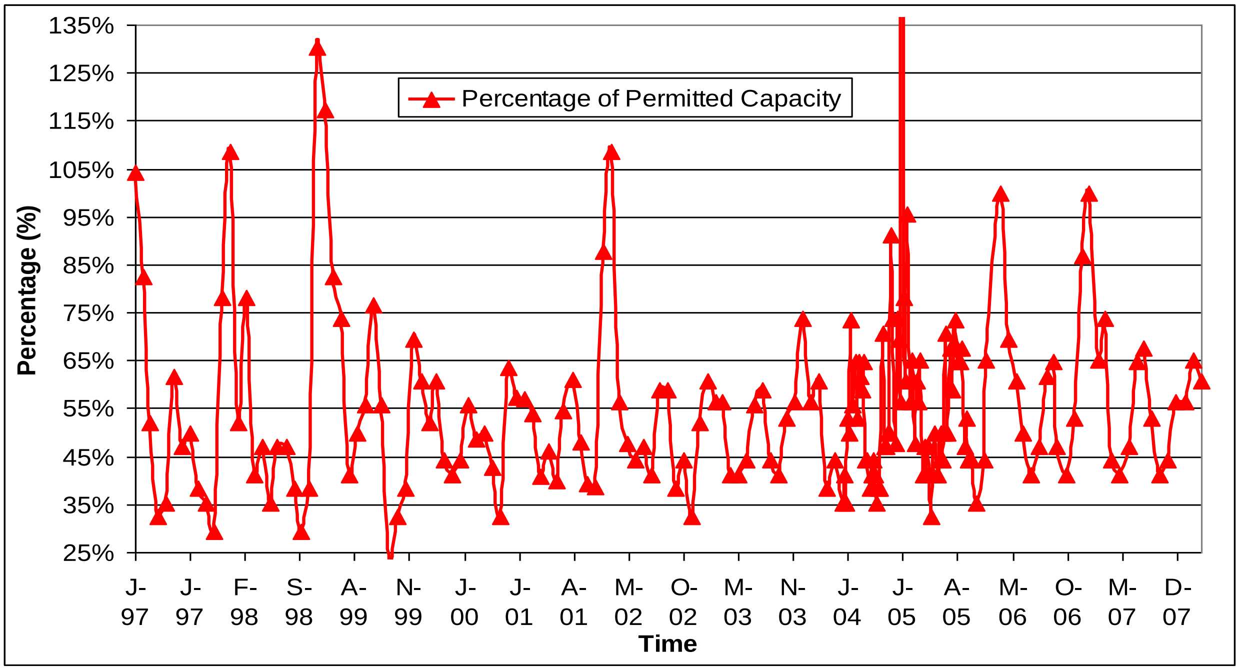


Figure 6.5 – Percentage of the Permitted Flows

Record data in Table 6.2, Figure 6.6 and Figure 6.7 show that BOD_5 loading had exceeded 85% of the permitted capacity on four (4) occasions, and was near 85% on two occasions in the last 11 years, . But there were no three consecutive occurring. Majority of the BOD_5 loadings were below 65%.

Table 6.2 – BOD_5 Loading Data

Date	Influent Flow [mgd]	Influent BOD5 mg/l	Influent BOD5 Loading (lbs/d)	Permitted Loading (lbs/d)	Percentage of Permitted Loading
Jan-97	0.024	47	9.4	38	25%
Feb-97	0.019	96	15.2	38	40%
Mar-97	0.012	110	11.0	38	29%
Apr-97	0.011	133	12.2	56	22%
May-97	0.012	172	17.2	56	31%
Jun-97	0.021	167	29.2	56	52%
Jul-97	0.016	194	25.9	56	46%
Aug-97	0.017	164	23.3	56	42%
Sep-97	0.013	188	20.4	56	36%
Oct-97	0.012	143	14.3	56	26%
Nov-97	0.01	205	17.1	56	31%
Dec-97	0.018	148	22.2	38	58%
Jan-98	0.025	107	22.3	38	59%
Feb-98	0.012	154	15.4	38	41%
Mar-98	0.018	150	22.5	38	59%

Apr-98	0.014	171	20.0	56	36%
May-98	0.016	165	22.0	56	39%
Jun-98	0.012	192	19.2	56	34%
Jul-98	0.016	193	25.8	56	46%
Aug-98	0.016	256	34.2	56	61%
Sep-98	0.013	193	20.9	56	37%
Oct-98	0.01	139	11.6	56	21%
Nov-98	0.013	129	14.0	56	25%
Dec-98	0.03	99	24.8	38	65%
Jan-99	0.027	114	25.7	38	68%
Feb-99	0.019	206	32.6	38	86%
Mar-99	0.017	149	21.1	38	56%
Apr-99	0.014	252	29.4	56	53%
May-99	0.017	331	46.9	56	84%
Jun-99	0.019	255	40.4	56	72%
Jul-99	0.026	283	61.4	56	110%
Aug-99	0.019	256	40.6	56	72%
Sep-99	0.008	290	19.3	56	35%
Oct-99	0.011	194	17.8	56	32%
Nov-99	0.013	160	17.3	56	31%
Dec-99	0.016	148	19.7	38	52%
Jan-00	0.014	120	14.0	38	37%
Feb-00	0.012	145	14.5	38	38%
Mar-00	0.014	130	15.2	38	40%
Apr-00	0.015	140	17.5	56	31%
May-00	0.014	196	22.9	56	41%
Jun-00	0.015	194	24.3	56	43%
Jul-00	0.019	215	34.1	56	61%
Aug-00	0.0165	195	26.8	56	48%
Sep-00	0.0169	222	31.3	56	56%
Oct-00	0.0145	190	23.0	56	41%
Nov-00	0.011	146	13.4	56	24%
Dec-00	0.0146	144	17.5	38	46%
Jan-01	0.0132	113	12.4	38	33%
Feb-01	0.0131	135	14.7	38	39%
Mar-01	0.0124	161	16.6	38	44%
Apr-01	0.0139	127	14.7	56	26%
May-01	0.0157	176	23.0	56	41%
Jun-01	0.0136	216	24.5	56	44%
Jul-01	0.0185	206	31.8	56	57%
Aug-01	0.0208	223	38.7	56	69%
Sep-01	0.0163	213	29.0	56	52%
Oct-01	0.0134	174	19.4	56	35%
Nov-01	0.0132	203	22.3	56	40%
Dec-01	0.0202	135	22.7	38	60%
Jan-02	0.025	141	29.4	38	77%

Feb-02	0.013	172	18.6	38	49%
Mar-02	0.011	175	16.1	38	42%
Apr-02	0.015	170	21.3	56	38%
May-02	0.016	172	23.0	56	41%
Jun-02	0.014	211	24.6	56	44%
Jul-02	0.02	247	41.2	56	74%
Aug-02	0.02	303	50.5	56	90%
Sep-02	0.013	198	21.5	56	38%
Oct-02	0.015	198	24.8	56	44%
Nov-02	0.011	155	14.2	56	25%
Dec-02	0.012	160	16.0	38	42%
Jan-03	0.014	173	20.2	38	53%
Feb-03	0.013	125	13.6	38	36%
Mar-03	0.013	152.5	16.5	38	44%
Apr-03	0.014	168	19.6	56	35%
May-03	0.014	179	20.9	56	37%
Jun-03	0.015	178.6	22.3	56	40%
Jul-03	0.019	203	32.2	56	57%
Aug-03	0.02	145	24.2	56	43%
Sep-03	0.015	248	31.0	56	55%
Oct-03	0.014	149.5	17.5	56	31%
Nov-03	0.018	139	20.9	56	37%
Dec-03	0.013	134.1	14.5	38	38%
Jan-04	0.017	122.6	17.4	38	46%
Feb-04	0.013	162.3	17.6	38	46%
Mar-04	0.014	154.9	18.1	38	48%
Apr-04	0.013	182.1	19.7	56	35%
May-04	0.015	193.9	24.3	56	43%
6/1/04	0.012	205.1	20.5	56	37%
6/8/04	0.014	172.2	20.1	56	36%
6/15/04	0.012	179.8	18.0	56	32%
6/22/04	0.018	205.8	30.9	56	55%
6/29/04	0.017	192.6	27.3	56	49%
7/6/04	0.025	201.5	42.0	56	75%
7/13/04	0.019	165	26.1	56	47%
7/20/04	0.022	181.4	33.3	56	59%
7/27/04	0.018	200.6	30.1	56	54%
8/3/04	0.022	212	38.9	56	69%
8/10/04	0.021	218.8	38.3	56	68%
8/17/04	0.02	184.4	30.8	56	55%
8/24/04	0.022	205.7	37.7	56	67%
8/31/04	0.015	221.7	27.7	56	50%
9/7/04	0.015	217.2	27.2	56	49%
9/14/04	0.013	222.1	24.1	56	43%
9/21/04	0.014	199.1	23.2	56	42%

9/28/04	0.015	184.2	23.0	56	41%
10/5/04	0.014	122.4	14.3	56	26%
10/12/04	0.012	178.1	17.8	56	32%
10/19/04	0.013	165.5	17.9	56	32%
10/26/04	0.013	143.5	15.6	56	28%
11/2/04	0.024	142.9	28.6	56	51%
11/9/04	0.016	145.7	19.4	56	35%
11/16/04	0.016	166.3	22.2	56	40%
11/23/04	0.017	143.6	20.4	56	36%
11/30/04	0.017	123.2	17.5	56	31%
12/7/04	0.021	109.6	19.2	38	51%
12/14/04	0.017	109.3	15.5	38	41%
12/21/04	0.011	102.1	9.4	38	25%
12/28/04	0.017	99.7	14.1	38	37%
1/4/05	0.016	118.3	15.8	38	42%
1/11/05	0.013	129.5	14.0	38	37%
1/18/05	0.054	100.2	45.1	38	119%
1/25/05	0.018	79	11.9	38	31%
2/1/05	0.014	118.3	13.8	38	36%
2/8/05	0.022	76	13.9	38	37%
2/15/05	0.013	131.4	14.2	38	37%
2/22/05	0.015	137.7	17.2	38	45%
3/1/05	0.014	139.4	16.3	38	43%
3/8/05	0.011	147.3	13.5	38	36%
3/15/05	0.014	158.8	18.5	38	49%
3/22/05	0.013	133.1	14.4	38	38%
3/29/05	0.015	117.6	14.7	38	39%
4/5/05	0.014	128.2	15.0	56	27%
4/11/05	0.016	174.6	23.3	56	42%
4/19/05	0.014	182.1	21.3	56	38%
4/26/05	0.016	162.8	21.7	56	39%
5/3/05	0.014	194.9	22.8	56	41%
5/10/05	0.011	192.7	17.7	56	32%
5/17/05	0.014	147.4	17.2	56	31%
5/23/05	0.017	168.5	23.9	56	43%
5/31/05	0.014	202.1	23.6	56	42%
6/6/05	0.015	160.3	20.1	56	36%
6/14/05	0.017	176.1	25.0	56	45%
6/21/05	0.015	193.8	24.2	56	43%
6/28/05	0.017	181.9	25.8	56	46%
7/5/05	0.024	236	47.2	56	84%
7/12/05	0.017	215.8	30.6	56	55%
7/19/05	0.023	164.3	31.5	56	56%

7/26/05	0.02	232.9	38.8	56	69%
8/2/05	0.023	214.8	41.2	56	74%
8/9/05	0.025	204.7	42.7	56	76%
8/16/05	0.023	177.9	34.1	56	61%
8/23/05	0.022	144	26.4	56	47%
8/29/05	0.022	159.3	29.2	56	52%
9/5/05	0.023	187.8	36.0	56	64%
9/13/05	0.016	153.9	20.5	56	37%
9/19/05	0.018	153.6	23.1	56	41%
9/27/05	0.015	158.7	19.9	56	35%
10/4/05	0.015	149.1	18.7	56	33%
10/11/05	0.015	164.9	20.6	56	37%
10/25/05	0.012	137.5	13.8	56	25%
Nov-05	0.015	140.5	17.6	56	31%
Dec-05	0.015	94.8	11.9	38	31%
Jan-06	0.023	116.9	22.4	38	59%
Feb-06	0.016	188.7	25.2	38	66%
Mar-06	0.014	211.3	24.7	38	65%
Apr-06	0.017	165	23.4	56	42%
May-06	0.014	193.2	22.6	56	40%
Jun-06	0.016	213.2	28.4	56	51%
Jul-06	0.021	178	31.2	56	56%
Aug-06	0.022	180.3	33.1	56	59%
Sep-06	0.016	168.2	22.4	56	40%
Oct-06	0.014	138.2	16.1	56	29%
Nov-06	0.018	126.6	19.0	56	34%
Dec-06	0.02	93.3	15.6	38	41%
Jan-07	0.023	97.9	18.8	38	49%
Feb-07	0.015	143	17.9	38	47%
Mar-07	0.017	106.2	15.1	38	40%
Apr-07	0.015	146.6	18.3	56	33%
May-07	0.014	187.5	21.9	56	39%
Jun-07	0.016	163.3	21.8	56	39%
Jul-07	0.022	141.7	26.0	56	46%
Aug-07	0.023	142.8	27.4	56	49%
Sep-07	0.018	144.9	21.8	56	39%
Oct-07	0.014	134.9	15.8	56	28%
Nov-07	0.015	117.7	14.7	56	26%
Dec-07	0.013	137.9	15.0	38	39%
Jan-08	0.013	138.1	15.0	38	39%
Feb-08	0.015	119.7	15.0	38	39%
Mar-08	0.014	102.9	12.0	38	32%
Average	**0.016**	**166.7**	**22.7**	**N/A**	**45**

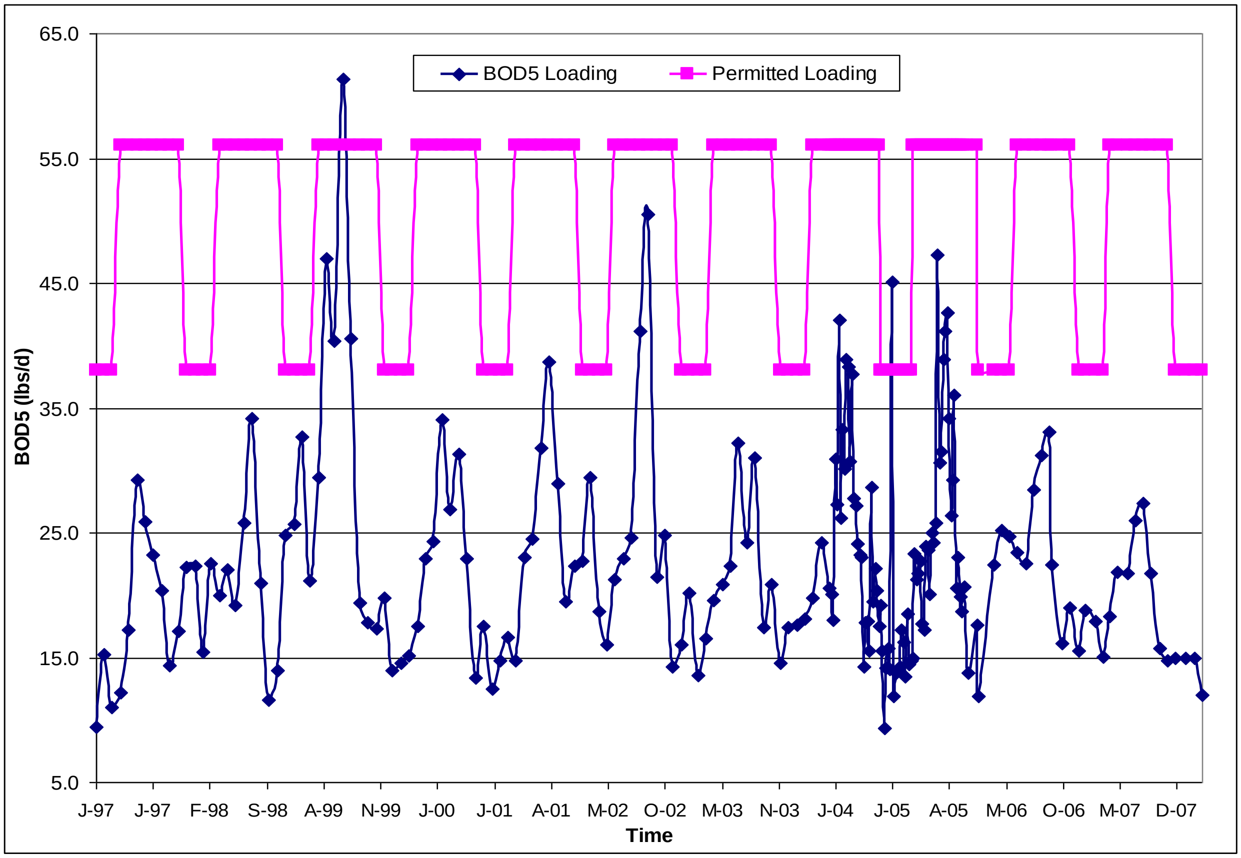


Figure 6.6 – BOD5 Loading Data

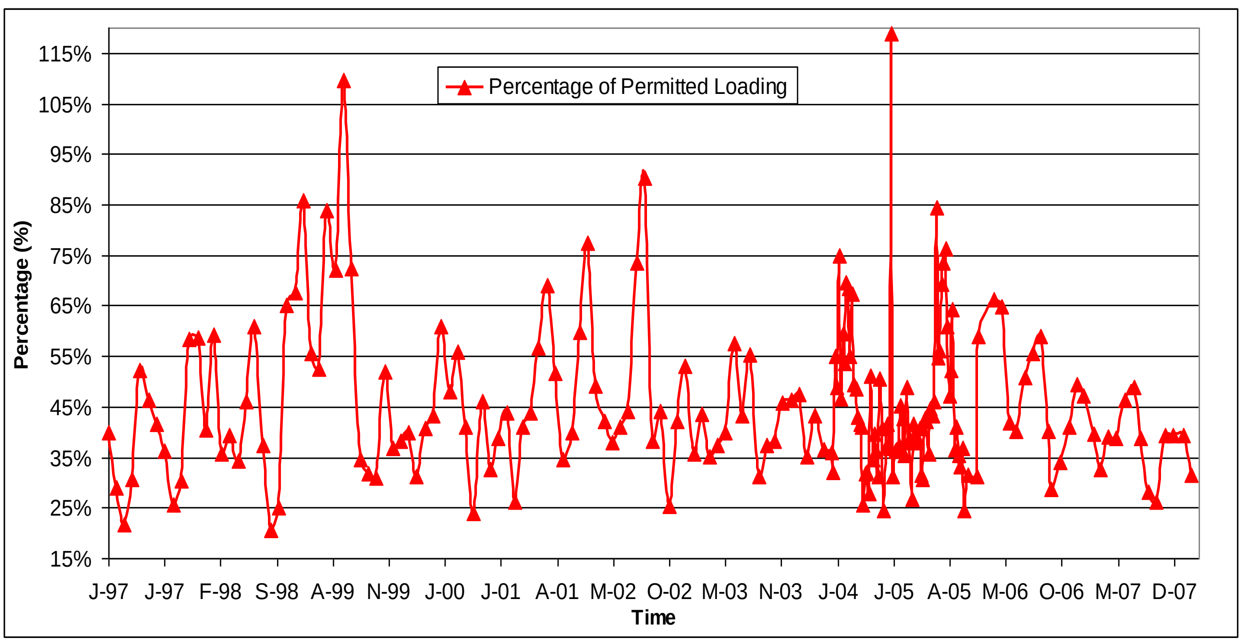


Figure 6.7 –Percentage of Permitted BOD_5 Loading

Plant effluent BOD_5, $CBOD_5$ data for those months or weeks that had hydraulic flows and/or organic loading approaching 85% or exceeding 85% of the permitted capacities were compiled and summarized in the following Table 6.3.

Table 6.3 – High Loading and Effluent Quality Data

Date	Influent Flow	Influent BOD_5	Permitted Hydraulic Capacity	Permitted Organic Capacity	Percentage of permitted Capacity		Effluent	
	[mgd]	mg/l	(gpd)	(Lbs BOD_5/d)	Flow Loading	Organic loading	BOD_5 (mg/l)	$CBOD_5$ (mg/l)
Jan-97	0.024	47	0.023	38	104%	25%	16.2	
Feb-97	0.019	96	0.023	38	83%	40%	12.3	
Jan-98	0.025	107	0.023	38	109%	59%	15.2	
Dec-98	0.03	99	0.023	38	130%	65%	17.2	
Jan-99	0.027	114	0.023	38	117%	68%	33	
Feb-99	0.019	206	0.023	38	83%	86%	25	
May-99	0.017	331	0.034	56	50%	84%	107	
Jul-99	0.026	283	0.034	56	76%	110%	50	
Dec-01	0.0202	135	0.023	38	88%	60%	9.5	
Jan-02	0.025	141	0.023	38	109%	77%	17	
Aug-02	0.02	303	0.034	56	59%	90%	32	
12/7/04	0.021	109.6	0.023	38	91%	51%	13.4	10.7
1/18/05	0.054	100.2	0.023	38	235%	119%	22.3	20.7
2/8/05	0.022	76	0.023	38	96%	37%	15.1	13.1
7/5/05	0.024	236	0.034	56	71%	84%	22.2	20.2
Jan-06	0.023	117	0.023	38	100%	59%	12.6	11.9
Dec-06	0.02	93.3	0.023	38	87%	41%		13.1
Jan-07	0.023	97.9	0.023	38	100%	49%		13.5

Data in Table 6.3 shows that high flow or organic loadings have not affected the plant performance and the effluent quality except for four occasions, which occurred prior to the 2003 upgrade. Lagoon system is known to have exceptional buffering capability for shock loadings. But it is also possible that actual capacity of the plant is larger than the permitted capacity, especially with the recent additions and upgrades for the plant.

6.3.4 Influent Metering

Description: The influent flow metering system is located inside a small building. The metering system consists of a pre-fabricated fiberglass flume and a Stevens float gage in an integrated stilling well. The flume is manufactured by Free Flow. The flume is connected to 4” pipes at both ends. The gage on the flume shows that the maximum measuring depth is 0.45 ft. The instantaneous totalized flow rate and totalized daily flow rate are measured by the Stevens A/F data logger.

The flume appears to be a large trapezoidal type of flume with a 60^{o} V-notch throat. The Owner's flow rate table shows a maximum measuring capacity of 214,100 gpd. Information on the manufacturer's website indicates this flume has a maximum capacity of 148 gpm or 213,120 gpd.

Evaluations: The 60º V flumes have a sharp V-throat section similar to a V-notch weir and produces superior resolution for accurate flow measurement down to 1 gpm. The trapezoidal flume has the following application advantages over other flumes and weirs.

P-6.2: Influent Flow Meter and Building

- The bottom is flat from entrance to exit for better head conservation.
- Trapezoidal flumes do not require a free-fall discharge to operate correctly.
- The natural shape of the flume mimics many earthen and concrete-lined ditches. Little or no transition is required in these situations.
- 60°V trapezoidal flumes provide a practical means of obtaining good flow data on low and intermittent flow streams. This flume produces more readable head under 10 gpm than any other flume or weir.

The flume's capacity appears adequate for the present flow conditions and the projected year 2020 conditions without the Eastshore South connections. But the operator has reported that flume was overflowed several times in the past during heavy rain events, and now he has to throttle down the valve on the influent pipe to the flume for preventing overflowing the flume during heavy rain events when several pumps in the collection system are running at the same time. The operator stated that the overflow was not caused by the limitation of the flume capacity; rather it was due to the limited capacity of the plant's 4" outfall pipe. The inadequate capacity of the outfall pipe caused water backing up in the lagoons and in the flume. More detailed discussions for the outfall will be provided later in this report.

Though the flume is located within the building, it was reported that odor has escaped from the flume in the past. Therefore, the flume must be covered, and two small compressors are used to take stinky air to the L-2 lagoon for odor control.

The existing Stevens flow meter is functional. Flow data is generally downloaded once a month. The flow meter offers instantaneous flow reading at the site, but not totalized flow reading.

Overall, the influent flow metering system appears adequate for meeting present and year 2020 flow measuring needs.

Recommendations: If financial resources are available now or in the future plant expansion, the District should consider the following improvements to the influent metering system:

- Replace the existing large flume with an X-large flume that offers a measuring range of 1 to 600 gpm or 1440 gpd to 864,000 gpd. The X-large flume will be able to meet the current and buildout flow measurement needs.
- Elevate and install the flume in a concrete channel for preventing overflowing from the flume. The invert elevation of the flume should be raised to at least the same level as the top berm of the L-2 lagoon. This invert elevation will prevent water level variations in the lagoon from affecting the operation of the flume.
- Cover the new channel with checkered plate for odor control.
- Replace the existing Stevens flow meter with an ultrasonic flow meter for instantaneous flow and totalized flow reading at the site.

6.3.5 Influent Flow Tank

Description: During the 2003 plant upgrade design, serious scum accumulation and corrosive problems were reported in the existing influent manhole #4 upstream of L-2. The operator had to clean the scum in the manhole occasionally. Therefore, for the convenience of cleaning potential scum, a concrete tank is constructed before the anaerobic cell. This tank is also designed for flow diverting and flow splitting purpose. Flow diverting is meant to direct flow directly to L-2 through the existing FSC-2 structure with bypass pipe. Flow splitting is meant to split flow evenly between the proposed new anaerobic cell and future second anaerobic cell. The design capacity of the tank is 1,000 gallons, which provides 0.7 hour detention time for the permitted 34,000 gpd flow and 1.0 hour for the 23,000 gpd flow.

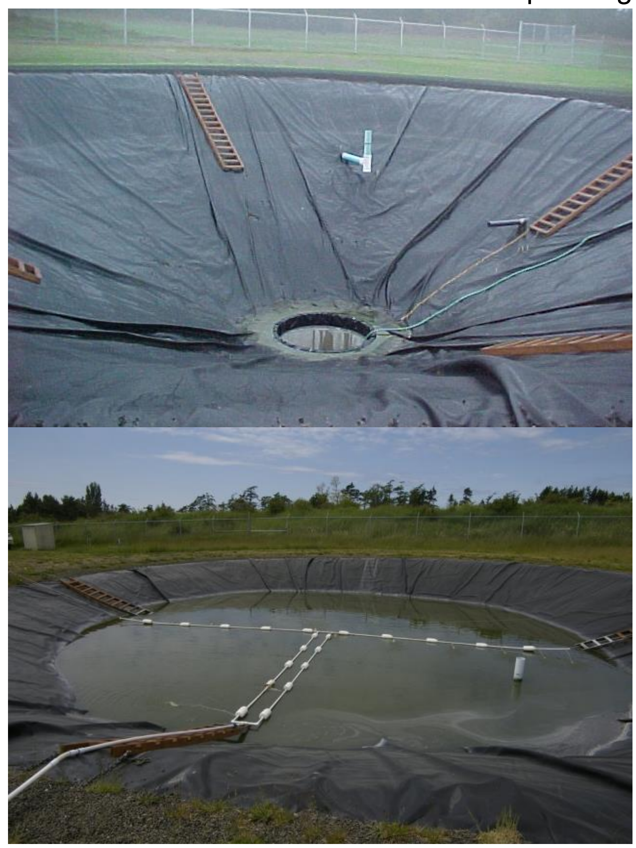
P-6.3: Influent Flow Tank

Evaluations: The Influent Flow Tank appears functional as the designed intended. Grease is trapped by the tank. The collected grease is pumped twice a year, and sent to Tenelco Inc. in Lake Stevens for final handling and disposal.

Recommendations: No improvements are needed at present.

6.3.6 Anaerobic Pretreatment

Description: The Anaerobic Pretreatment Cell consists of a HDPE lined earthen pond and a six (6) feet diameter, 5 feet high concrete manhole pit at the bottom. The cell has interior slope of 2:1. Operational water depth of the cell is 15 feet with 3 feet freeboard. The cell's operating volume is 83,000 gallons at the 15 feet water depth. Based on the engineer's experience, and as a rule of thumb, the anaerobic pretreatment cell is generally designed to maintain 2 days hydraulic retention time (HRT). Therefore, the cell has a hydraulic capacity of 41,500 gallons based on 2 days HRT.



P-6.4: Anaerobic Pretreatment Cell

Influent to the cell enters from the bottom of sump, and then flows upward through the sludge in the sump and the pond, which is similar to the upflow anaerobic sludge blanket (UASB) reactor. The sludge layer in the pit and in the pond is rich with anaerobic bacteria that remove influent BOD. The sludge layer also acts like a filter to entrap the influent solids.

The design goal for the cell was to remove 50% of influent BOD_5. The purpose is to reduce carbon source for controlling algae overgrowth in the L-2 lagoon and reducing solids accumulation in the downstream lagoon. BOD_5 removal in the cell with anaerobic process also reduces aeration energy requirement for the L-2 lagoon aeration.

To control the septic odor from the plant influent, L-2 effluent is pumped to the cell for providing an aerobic cap. The discharge manifolds in the cell are 3/4" diameter PVC pipes. The orifice size on the manifold pipes is equal to the 3/4" pipe section area. Recirculation rate for the L-2 effluent is maintained at approximately 5 to 6 gpm.

Evaluations: Hydrogen sulfide odor is often the concern for using anaerobic treatment process. But ponds undergoing active methane fermentation can accept heavy BOD loads without objectionable odor because of their neutral or alkaline pH buffer capacity and rapid conversion of organic acids to methane and CO_2 prevents formation of low pH conditions and emission of H_2S. Odor had occurred from the cell approximately one month after the startup in 2004. But after reviewing characteristics of the influent wastewater, it was determined that the odor was not generated by the cell, but was caused by the odorous intermediate products in the STEP influent wastewater because the odor was not hydrogen sulfide smell and the same odor was also noticeable at the influent flume. Initially, an existing algae mill was recommended for controlling the odor. For several months, the mill was effective for controlling the odor by providing an aerobic cap in the cell with gentle aeration. However, by late May of 2004, odor became noticeable again because of increasing degradation activities in the STEP system as the weather became warmer. At this time, it was recommended recirculating the oxygenated mixed liquor in the L-2 lagoon to place the aerobic cap in the cell for odor control. Little odor has been noticed since the recirculation started. Therefore, recirculation has generally controlled the influent odor at the plant.

Average removal rates of the anaerobic pretreatment cell were 27% for BOD_5 and $CBOD_5$ and 26% for soluble $CBOD_5$ (see Table 6.4 and Figure 6.8). These removal rates were short of the design goal of 50% removal rate. The low removal rates were caused by three unique factors of the plant. The first factor is weak influent organic strength due to the septic tanks. Septic tanks in the STEP system have removed majority of the easily settleable and biodegradable organic components in the wastewater. This limited the performance of the cell in comparison with cells receiving typical domestic wastewater. In fact, it's preferred that the anaerobic pretreatment cell receives high organic loading because of its passive process. The capacity of the anaerobic cell is usually limited by its hydraulic loading, not the organic loading. The second factor is generally low wastewater temperature due to I/I flows, especially in the winter months. Low water temperature reduces the activity of the bacteria, hence the performance of the cell. The third factor is the recirculation for odor control. Recirculation introduces oxygen to the cell, which is detrimental to anaerobic bacteria. Microscopic examinations showed that oxygen introduced by the recirculation has caused certain damage to the anaerobic bacteria in the cell.

In spite of these unfavorable factors, the cell appears to have achieved the design goal of reducing algae growth in the L-2 lagoon, improving L-2 performance and saving aeration energy requirement. As shown in the **Appendix E** of the report, it would need 2 days hydraulic retention time in the winter and 1.4 days hydraulic retention time in the summer to achieve the 26% $CBOD_5$ in an aerated cell. Therefore, energy saving with the anaerobic pretreatment is substantial.

As record data in this report has shown that influent TSS to the plant was very weak, therefore TSS removal in the anaerobic pretreatment cell was never a concern. Sludge accumulation in the cell increased rapidly in the first year of operation (6 feet measured in the summer of 2004), but has since decreased significantly because of anaerobic digestion. In May 2005, the sludge was measured at 24". In June 2006, the sludge was measured at 18" in the manhole pit and 12" at the bottom of the cell. These data shows that digestion has prevented the depth of accumulated sludge in the cell from increasing since the startup.

Recommendations: The anaerobic pretreatment cell has been performing satisfactorily. However, the District should consider installation of a floating cover for cell for odor control. The floating cover was originally recommended in the design, but was not provided with the cell construction because of the District's financial condition at that time. If the cover is installed, the existing recirculation system will not be needed. This will eliminate oxygen introduction to the cell and improve the BOD_5 removal performance of the cell.

Table 6.4 – Anaerobic Pretreatment Cell Performance Data Summary

Date	Plant Influent				Anaerobic Cell Effluent			Recirculation			Adjusted		Anaerobic Cell		
	Flow	BOD5	Filtered CBOD5	CBOD5	BOD5	Filtered CBOD5	CBOD5	Flow	CBOD5	Filtered CBOD5	Inf. CBOD5	Inf. Filtered CBOD5	BOD5 Removal	CBOD5 Removal	Filtered CBOD5 Removal
	(gpd)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(gpd)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(%)	(%)	(%)
10/28/03	13000	124.0			118								5%		
11/4/03	12000	160.2			185										
11/11/03	16000	159.5			166.4										
11/18/03	17000	165.8			142.8								14%		
11/25/03	18000	67.7			85.3										
12/2/03	15000	138.0			118								14%		
12/9/03	13000	106.9			67.6								37%		
12/16/03	15000	112.1			109.8								2%		
12/23/03	10000	128.7			139.1										
12/30/03	11000	184.5			152.3								17%		
1/6/04	18000	122.9			132.1										
1/13/04	15000	111.6			112.6										
1/20/04	13000	119.7			131.2										
1/27/04	17000	136.1			115.8								15%		
2/3/04	16000	79.9			104.3										
2/10/04	15000	149.8			152.5										
2/17/04	12000	204.6			190.3								7%		
2/24/04	13000	214.8			144.4								33%		
3/2/04	12000	148.3			166.6										
3/9/04	20000	120.6			104.4								13%		
3/16/04	14000	156.9			117								25%		
3/23/04	14000	183.5			167.6								9%		
3/30/04	12000	165.8			150.8								9%		
4/6/04	13000	149.1			151.6										
4/13/04	11000	180.0			169.4								6%		
4/20/04	12000	220.7			176.9								20%		
4/27/04	13000	178.6		141.0	173								3%		

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5/4/04	13000	197.3		164.3	147.3		118.2						25%	28%	
5/11/04	15000	199.6		169.1	151.2		126.1						24%	25%	
5/18/04	14000	188.1		167.7	156.2		127.8						17%	24%	
5/25/04	15000	179.4		152.9	157.6		133.6						12%	13%	
6/1/04	12000	205.1		179.2	137.2		32.9	17000					33%	82%	
6/8/04	14000	172.2		141.6	141.5		37.2	17000					18%	74%	
6/15/04	12000	179.8		125.1	122.7		50.4	9000					32%	60%	
6/22/04	18000	205.8		145.4	109.6		36.6	600					47%	75%	
6/29/04	17000	192.6		165.4	149.8		124.9	1200					22%	24%	
7/6/04	25000	201.5		171.9	171.4		133.7	1800					15%	22%	
7/13/04	19000	165.0		134.1	149.3		121.2	12250					10%	10%	
7/20/04	22000	181.4		134.9	166		78	14000					8%	42%	
7/27/04	18000	200.6		160.6	145		87.7	12000					28%	45%	
8/3/04	22000	212.0		188.7	127.4		95.6	12000					40%	49%	
8/10/04	21000	218.8		196.4	194.7		86.9	12000					11%	56%	
8/17/04	20000	184.4		157.1	140		93.4	12000					24%	41%	
8/24/04	22000	205.7		172.6	176.7		105.1	12000					14%	39%	
8/31/04	15000	221.7		187.9	122.7		69	11000	17.2		116		45%	40%	
9/7/04	15000	217.2		184.5	132.7		88.7	11000	12.3		112		39%	21%	
9/14/04	13000	222.1		172.4	148.3		101.7	11000	21.9		103		33%	2%	
9/21/04	14000	199.1		163.0	151.7		83.4	7000	31.5		119		24%	30%	
9/28/04	15000	184.2		151.0	140.3		76.2	6500	25.4		113		24%	33%	
10/5/04	14000	122.4		91.4	123.7			6400	21.5		69				
10/12/04	12000	178.1		131.7	126.5		58	17000	14.3		63		29%	8%	
10/19/04	13000	165.5		122.9	119.1		59.6	19000	18.5		61		28%	2%	
10/26/04	13000	143.5		121.8				17000			53				
11/2/04	24000	142.9		109.0	113.3		42.6	17000	15.4		70		21%	39%	
11/9/04	16000	145.7		107.4	90.6		51	17000	15.8		60		38%	15%	
11/16/04	16000	166.3		159.2	101.1		53.6	17000	16		85		39%	37%	
11/23/04	17000	143.6		110.3				16000			57				
11/30/04	17000	123.2		106.7	122.2		59.4	16000	20.8		65		1%	9%	
12/7/04	21000	109.6		92.1	98.2		56.9	16000	19.6		61		10%	6%	

12/14/04	17000	109.3		81.1				16000			42				
12/21/04	11000	102.1		96.9	74.8		67.9	16000	16.3		49		27%		
12/28/04	17000	99.7		95.6	76		73.1	16000	19.6		59		24%		
1/4/05	16000	118.3		110.9	88.7		77.4	15000	23		68		25%		
1/11/05	13000	129.5		110.4	95.7		75.2	15000	25.7		65		26%		
1/18/05	54000	100.2		84.8	67.9		55.8	15000	29		73		32%	23%	
1/25/05	18000	79.0		70.9	53.6		44.6	15000	14.4		45		32%	1%	
2/1/05	14000	118.3		107.8	75.3		69.3	15000	12.4		58		36%		
2/8/05	22000	76.0		66.0	66.5		55.1	15000	16		46		13%		
2/15/05	13000	131.4		116.4				15000			54				
2/22/05	15000	137.7		129.3				15000			65				
3/1/05	14000	139.4		133.1	85		80.4	15000	19.4		74		39%		
3/8/05	11000	147.3		132.3	86.9		67.9	8000	10.8		81		41%	16%	
3/15/05	14000	158.8		142.4	75.7		59.7	8000	17.8		97		52%	39%	
3/22/05	13000	133.1		129.4	76.7		65.6	11000	11.7		75		42%	13%	
3/29/05	15000	117.6		114.1	104.3		90.4	13000	11.7		67		11%		
4/5/05	14000	128.2		112.3	107		89.7	12000	21.9		71		17%		
4/11/05	16000	174.6		164.1			95.2	12000			94				
4/19/05	14000	182.1		168.0			62.9	12000			90			30%	
4/26/05	16000	162.8		148.6			116.2	6600			105				
5/3/05	14000	194.9		189.2	78.8		71	7200	14.7		130		60%	45%	
5/10/05	11000	192.7		181.4	157.5		130.1	3500	27.4		144		18%	10%	
5/17/05	14000	147.4		123.3	131.4		111.8	5400	16.5		94		11%		
5/23/05	17000	168.5		151.8	88.2		70.4	10000	22.5		104		48%	32%	
5/31/05	14000	202.1		177.1	110		88.3	10000	18.2		111		46%	20%	
6/6/05	15000	160.3		143.5	124.4		94.2	12000	26.5		92		22%		
6/14/05	17000	176.1		166.0	97.8		88.7	14000	29.3		104		44%	15%	
6/21/05	15000	193.8		164.8	96.3		49.9	14000	28.5		99		50%	50%	
6/28/05	17000	181.9		159.1	143		74.3	14000	31.4		101		21%	27%	
7/5/05	24000	236.0		228.3	124.8		77.2	15500	26.7		149		47%	48%	
7/12/05	17000	215.8		199.7	112.3		57.6	14000	22.9		120		48%	52%	
7/19/05	23000	164.3		160.5	124.8		60.2	14000	35		113		24%	47%	

7/26/05	20000	232.9		225.2	135.5		69.8	14000	32.1		146		42%	52%	
8/2/05	23000	214.8		200.7	115		79	14000	24.9		134		46%	41%	
8/9/05	25000	204.7		192.5	87.3		81.1	14000	33.7		135		57%	40%	
8/16/05	23000	177.9		173.6	149.3		84.6	17000	29.1		112		16%	25%	
8/23/05	22000	144.0		143.1	127.3		59.4	15500	26.7		95		12%	37%	
8/29/05	22000	159.3		155.9	119.5		80.7	17000	22.4		98		25%	17%	
9/5/05	23000	187.8		180.3	151.8		96.7	17000	26.2		115		19%	16%	
9/13/05	16000	153.9		143.9	84		71.2	15500	20.9		83		45%	15%	
9/19/05	18000	153.6		148.2	117		58.5	14500	21		91		24%	36%	
9/27/05	15000	158.7		158.3	95.1		62.5	14000	18.8		91		40%	31%	
10/5/05	18000	149.0		145.6	98.3		77.3	14000	18.3		90		34%	14%	
10/10/05	15000	164.5		151.4	102		85.7	13000	21.5		91		38%	6%	
10/17/05	19000	155.4		140.4											
10/25/05	14000	137.5		131.6	96		76.7	13000	19.2		77		30%	1%	
11/1/05	17000	141.8		139.3											
11/7/05	15000	106.8		108.0											
11/14/05	14000	131.3		128.5											
11/21/05	15000	146.3		156.4											
11/28/05	18000	140.5		136.5	96.5		89.7	12350	19.9		89				
12/5/05	16000	142.6		135.1											
12/12/05	12000	151.6		136.6											
12/19/05	12000	169.5		160.7											
12/26/05	17000	94.8		87.7	77.3		65.2	11500	16.6		59				
1/206	16000	137.6		124.4											
1/9/06	22000	121.6		110.4											
1/16/06	29000	106.0		95.5											
1/23/06	15000	100.9		93.4											
1/30/06	50000	116.9		100.1	73.8		65.3	11500	19.6		85			23%	
2/6/06	17000	95.1		81.2											
2/13/06	12000	151.0		139.0											
2/20/06	13000	170.0		149.6											
2/27/06	13000	188.7		162.2	120		97.7	11500	23.9		97				

3/6/06	13000	164.2		157.4											
3/13/06	15000	153.2		146.5											
3/20/06	16000	147.5		130.2											
3/27/06	15000	211.3		190.8	78.8		71.7	12300	24.9		116			38%	
4/3/06	15441	159.5		143.8											
4/10/06	14590	149.1		134.9											
4/17/06	17182	186.4		177.3											
4/24/06	16848	165.0		151.0	77		66.8	12300	21.7		96			31%	
5/1/06	11064	220.4		203.2											
5/8/06	13113	207.1		179.2											
5/15/06	14165	210.0		203.3											
5/22/06	14452	171.1		159.2											
5/29/06	13922	193.2		161.8	153.8		70.8	11500	21.3		98			28%	
6/5/06	13086	190.3		167.6											
6/12/06	14463	160.8		146.0											
6/19/06	15299	186.7		167.2											
6/26/06	16168	213.2		189.6	121.8		96.2	8600	32.5		135			29%	
7/3/06	28042	234.8		221.4											
7/10/06	20047	194.3		183.0											
7/17/06	21766	166.5		166.5											
7/24/06	16993	178.0		149.1	92.2		67.6	9600	19.5		102			34%	
7/31/06	18056	190.7		170.4											
8/7/06	24125	170.9		159.1											
8/14/06	22348	175.6		143.6											
8/21/06	21172	174.0		151.9											
8/28/06	17419	180.3		152.8	103		72.3	12300	19.1		97			26%	
9/4/06	19722	191.7		185.7											
9/11/06	15003	157.1		132.8											
9/18/06	13484	177.9		155.8											
9/26/06	14871	146.0		133.4											
10/2/06	13474	134.1		114.4											
10/9/06	14147	117.1		94.9											

10/16/06	13301	148.0		124.0											
10/23/06	13933	142.4		119.3			59.3	8640	19.2	4	81			27%	
10/30/06	13232	149.3		131.6											
11/6/06	27740	135.8		125.1			60.1	8640	16.9	3.5	99			40%	
11/13/06	30282	129.5		108.5			69.3	8640	18.7	2.8	89			22%	
11/20/06	12654	125.7		108.5			57.8	8640	17.6	2.6	72			19%	
11/27/06	25252	115.3		110.6				8640	22.6	4.5	88				
12/4/06	23607	90.8		75.0			59.4	8640	21	7	61				
12/11/06	15360	113.9		93.6			85.3	8640	16.6	4.2	66				
12/18/06	14958	95.9		80.5			64.2	8640	13.7	2.8	56				
12/25/06	19894	72.7		52.2											
1/1/07	20156	113.5		101.1			76.4	8640	15.7	3.8	75				
1/8/07	26807	65.6		52.6			48.9	8640	13.7	3.8	43				
1/15/07	14076	89.4		77.5			79.1	8640	15.3	2.8	54				
1/22/07	18244	90.6		73.0			64.5	8640	13	2.7	54				
1/29/07	13228	130.3		120.6				8640	15		79				
2/5/07	11517	154.7		131.9		62.9	97.1	8640	17.8	4.7	83				
2/12/07	14837	134.1	72.4	116.2		40.2	75.5	8640	15.5	4.1	79	47		5%	15%
2/19/07	16989	136.2	86.3	120.1		52	72	8640	14.7	4.7	85	59		15%	12%
2/26/07	12834	147.1	76.5	127.1		49.2	74.8	8640	14.8	4.4	82	47		9%	0%
3/5/07	11473	147.1	103.3	131.7		26.8	49.9	8640	18.4	2.6	83	60		40%	55%
3/12/07	31305	114.5	52.3	103.4		34.7	53.3	8640	15.3	3.2	84	42		37%	17%
3/19/07	18674	89.4	52.7	76.6		37	57	8640	18.3	4.2	58	37		2%	1%
3/26/07	15668	73.8	40.8	63.8		26.5	47.5	8640	11.8	3.8	45	28			4%
4/2/07	12962	93.9	50.5	80.6		36.8	52.5	8640	12.5	3.5	53	32		2%	
4/9/07	12218	138.9	99.3	125.0		30.4	42.2	8640	8.7	2.8	77	59		45%	49%
4/16/07	13204	168.8	103.7	164.3		72.4	92.5	8640	16.7	4.3	106	64		13%	0%
4/23/07	18033	153.5	87.2	136.6		58.8	93.2	8640	19	4.5	99	60		5%	3%
4/30/07	16621	153.0	86.3	144.6		31.1	63.5	8640	25.1	4.2	104	58		39%	47%
5/1/07	14358														

5/7/07	13971	185.7	113.6	181.4		67.4	96.9	8640	24.3	3.4	121	71		20%	6%
5/14/07	10864	199.0	128.6	200.1		69.3	109.1	8640	23.5	2.4	122	73		10%	5%
5/21/07	12393	155.1	93.2	146.9		23	41.2	8640	19	2.5	94	56		56%	59%
5/28/07	18883	210.1	125.4	196.2		97.1	152.4	8640	24.9	3.1	142	87			
6/4/07	18821	161.1	87.6	150.6		91.5	135	8640	17.4	1.5	109	61			
6/11/07	13122	152.4	88.5	134.3		75.5	117.5	8640	17.8	2.1	88	54			
6/18/07	14598	160.3	100.5	155.2		43.2	86	8640	19.5	2.2	105	64		18%	32%
6/25/07	18226	179.3	101.6	173.5		76.8	109	8640	27.4	2.4	127	70		14%	
7/2/07	23806	143.5	93.0	140.2		77.2	116.3	8640	19.1	1.5	108	69			
7/9/07	16220	147.4	85.5	140.7		67.9	121.5	8640	27.2	3.7	101	57			
7/16/07	18776	143.6	103.1	138.5		66.8	131.5	8640	26.3	3.2	103	72			7%
7/23/07	20534	145.2	92.4	138.6		34.5	73.5	8640	15.3	6.2	102	67		28%	48%
7/30/07	25136	128.9	73.9	118.0		49.9	86.3	8640	15.5	5	92	56		6%	11%
8/6/07	23275	160.5	102.2	153.8		47.9	74.8	8640	20.2	4.2	118	76		36%	37%
8/13/07	25391	134.1	70.3	122.0		26.6	60.3	8640	15.4	3.9	95	53		36%	50%
8/20/07	20552	137.3	71.8	119.5		41.8	73.8	8640	17.3	5.5	89	52		17%	20%
8/27/07	19870	139.4	87.6	125.0		26.5	48.5	8640	18	2	93	62		48%	57%
9/3/07	23322	167.4	98.8	165.2		48.1	67.3	8640	16.1	2.9	125	73		46%	34%
9/10/07	20990	129.3	73.5	126.9		19	53.3	8640	14.3	3	94	53		43%	64%
9/17/07	16861	118.6	63.9	111.6		28.5	67	8640	12.7	2.7	78	43		14%	34%
9/24/07	14934	164.1	94.5	154.5		39.6	67.3	8640	22.3	2.3	106	61		37%	35%
10/1/07	14789	114.0		110.9											
10/8/07	13676	140.5	79.7	128.8		66.1	100	8640	17.3	2.2	86	50			
10/15/07	13976	152.3	0.0	139.9											
10/22/07	13962	130.0	74.0	124.6		23.1	49	8640	10.2	1.9	81	46		39%	50%
10/29/07	13859	137.5	74.4	124.5		30	58.7	8640	9.2	1.8	80	47		27%	36%
11/5/07	11633	106.1	55.0	99.0		27.5	60.4	8640	7.6	1.7	60	32			15%
11/12/07	17310	134.4	65.6	129.1		34.9	59.1	8640	10.8	2.2	90	44		34%	22%
11/19/07	17092	105.3	62.2	104.1		43.4	69	8640	13.8	1.7	74	42		6%	
11/26/07	14102	125.1	68.6	115.1		48.7	75.4	8640	17.2	2.8	78	44		3%	

12/3/07	21456	129.2	69.8	115.7		51.1	82								
12/10/07	13934	119.8		110.1			84.2	8640	20.1	5.1	76	2			
12/17/07	13946	140.1	81.4	128.9		45.8	80.6	8640	19.3		87	50		7%	9%
12/24/07	10369	149.5	86.4	137.7		57.6	90.4	8640	23.2	4.7	86	49			
12/31/07	12095	150.8	91.2	136.5		54.4	86.6	8640	20.8	5.8	88	56		2%	2%
1/1/08	8538							8640	19.7	5.5	10	3			
1/7/08	10251	182.8	107.8	164.2		61.5	91	8640	22.1	4.7	99	61		8%	
1/14/08	12483	138.4	0.0	122.2											
1/21/08	14044	129.6	69.2	115.6		50.3	79.2	8640	20.9	3	80	44			
1/28/08	15768	106.6	50.4	79.3		58.3	92	8640	22.7	6.4	59	35			
2/4/08	20910	127.4	72.2	110.1		57.2	86	8640	21.9	4.8	84	52			
2/11/08	18722	99.0	52.4	84.5		43.3	62.6	8640	16.1	3	63	37			
2/18/08	13338	118.1	60.8	96.9		49.3	75.8	8640	14.2	4.4	64	39			
2/25/08	11737	134.4	76.6	120.9		44.9	72	8640	15.2	4.1	76	46		5%	2%
3/4/08	17649	106.8		96.9											
3/10/08	14429	115.3	73.6	103.0		27.8	66.3	8640	11.2	2.4	69	47		3%	41%
3/17/08	12006	98.4	60.0	88.5		45.4	61.2	8640	8.8	1.5	55	36			
3/24/08	15184	127.1	78.2	119.2		52.7	74.4	8640	18.2	2.4	83	51		10%	
3/31/08	17724	67.0	28.6	58.8		36.3	54.8	8640	15.9	3.4	45	20			
Average	16638	152	77	137	121	48	78	10769	19	3	87	51	27%	27%	26%

Note: The removal percentage data didn't include those that have negative calculated removal efficiency.

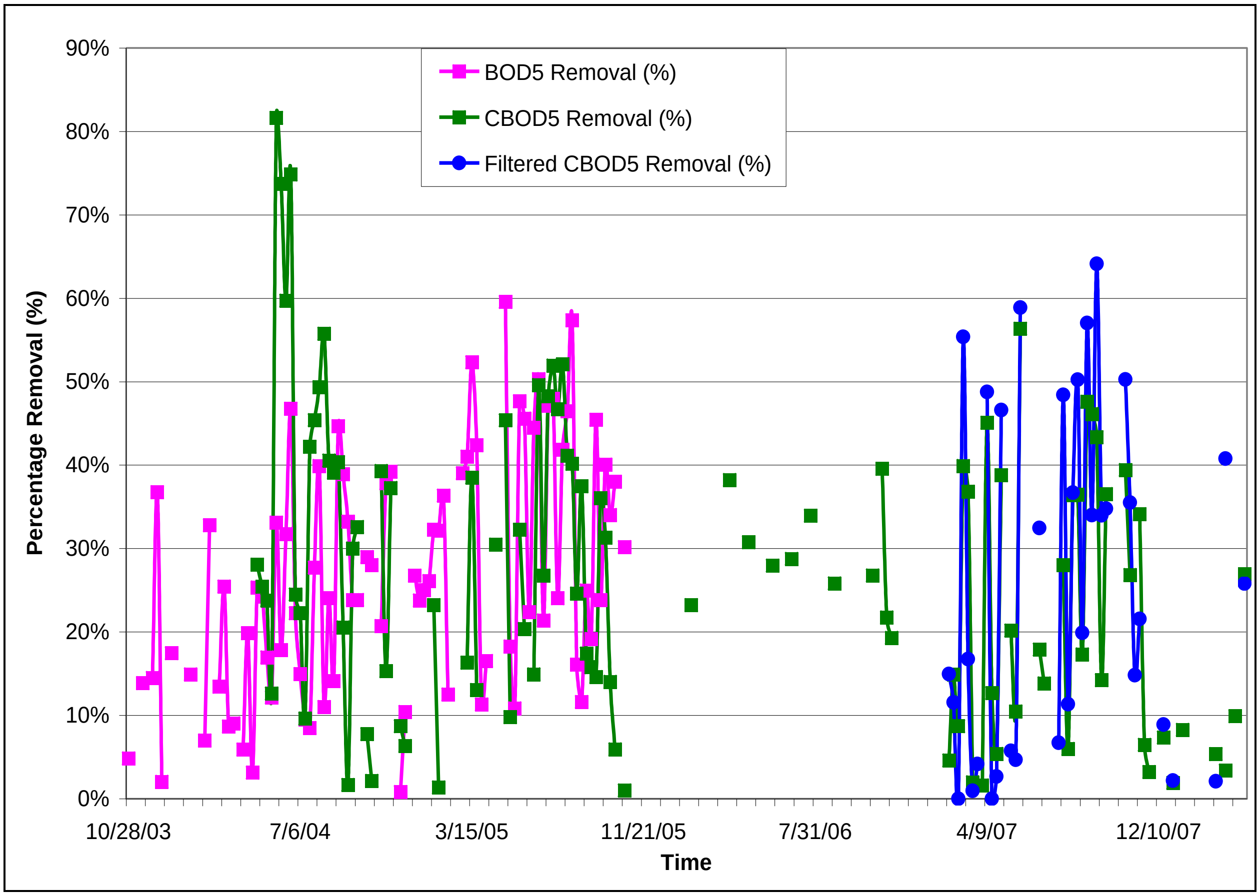

Figure 6.8 – Anaerobic Pretreatment Cell BOD_5, $CBOD_5$ and Filtered $CBOD_5$ Removals

6.3.7 Lagoon L-2

P-6.5: L-2 lagoon

Descriptions: The existing L-2 lagoon was constructed in 1995 and is lined with 60 mil HDPE liner. The L-2 lagoon is approximately 10 feet deep with 3 feet freeboard, has a bottom area of 2,410 square feet and a water surface area of 11,373 and a 3 to 1 side slope. Estimated water volume of L-2 is 515,000 gallons. In 2003, the lagoon was separated into three (3) cells for reducing short circuiting through the lagoon. The lagoon was divided into three cells using a

36 mil UV resistant Hypalon™ floating baffle. The first two cells are aerated cells. The third cell is used for settlement and polishing. The aerated cell #1 has an operating volume of approximately 257,500 gallons. The aerated cell #2 and the polishing cell each has an operating volume of approximately 128,750 gallons.

The aerated cell #1 is aerated by a 3 hp Aqua turbo surface aerator, Mode lAER0150-30. This cell is aerated constantly. The aerated cell #2 is aerated during night time only by a 2hp Aqua turbo surface aerator. The required oxygen for aerobic degradation in the day time is provided by the algae growing in the cell. The operation of the aerator is controlled by a timer.

Mechanical surface aerators are rated 2.5 to 3.5 lbs O_2/hp-hour [13]. Assuming the two Aqua aerators (5 hp total) are capable of providing minimum 2.0 lbs oxygen per horsepower per hour, the two aerators are able to provide minimum 240 lbs O_2/day. This equates to a 109 lbs BOD_5 /day organic loading capacity using 2.2 lbs O_2/lbs BOD_5 /day design criteria to account for nitrification and benthic demand from sludge.

<u>Evaluations:</u> The permitted organic loading for the plant is 56 lbs BOD_5 /day for the summer season and 38 lbs BOD_5 /day for the winter season. The permitted organic loadings are well below the estimated capacity of the existing two aerators even without any BOD removal by the anaerobic pretreatment cell.

The projected summer BOD_5 loadings for the UGA and the FBSD service area are 79 lbs/day for year 2020, 103 lbs/day for year 2028 and 135 lbs/day for the buildout condition. If the anaerobic pretreatment cell removes at least 25% of the influent organic loading, the existing two aerators will be able to meet the buildout aeration needs, but with no safety margin. In order to provide adequate safety factor, additional aerators will be required for the buildout conditions.

In addition to provide adequate oxygen for aerobic treatment needs, aerators must also supply enough energy to mix the contents of the lagoon. Depending on the depth and configuration of the lagoon, partially mixed facultative lagoon requires about 1 to 6.5 horsepower per million gallons water, and partially mixed aerobic flow through lagoon requires 25 to 40 hp/million gallons [12, 13, 14]. The threshold energy input value for the suspension of the solids is about 7.5 to 8.75 hp/million gallon[14]. Based on the mixing criteria in the literatures, the aerated cell # 1 requires an energy input of 2.25 hp and the aerated cell #2 requires an energy input of 1.13 hp for the suspension of solids. Since the required energy inputs for both cells for mixing are less than the rated horsepower of the aerators, the two cells have adequate mixing.

Since the anaerobic pretreatment cell addition to the treatment process, algae growth in the L-2 lagoon has decreased. Algal counts above approximately1-3x10^5 per milliliter generally contribute BOD above 30 mg/l effluent limit (Richard, 1994). Algae level in the lagoons varies throughout the year. Generally algae level is low in the winter months because of cold temperature and short daylight time, and blooms in the spring when weather gets warm and high in summer months due to long sunlight time. Microscopic examinations performed by Dr.

Michael Richard observed low level of algae in the order of magnitude of 10^4/ml or lower in the second year of operation (see Figure 6.9).

In addition to algae level reduction, oxygen generated by the algae was utilized for beneficial use of providing oxygen needs for aerobic activity in the lagoon. The use of algae oxygen achieved at least 25% energy saving because the aerator in the cell #2 was operated in nighttime only in comparison with previous operations.

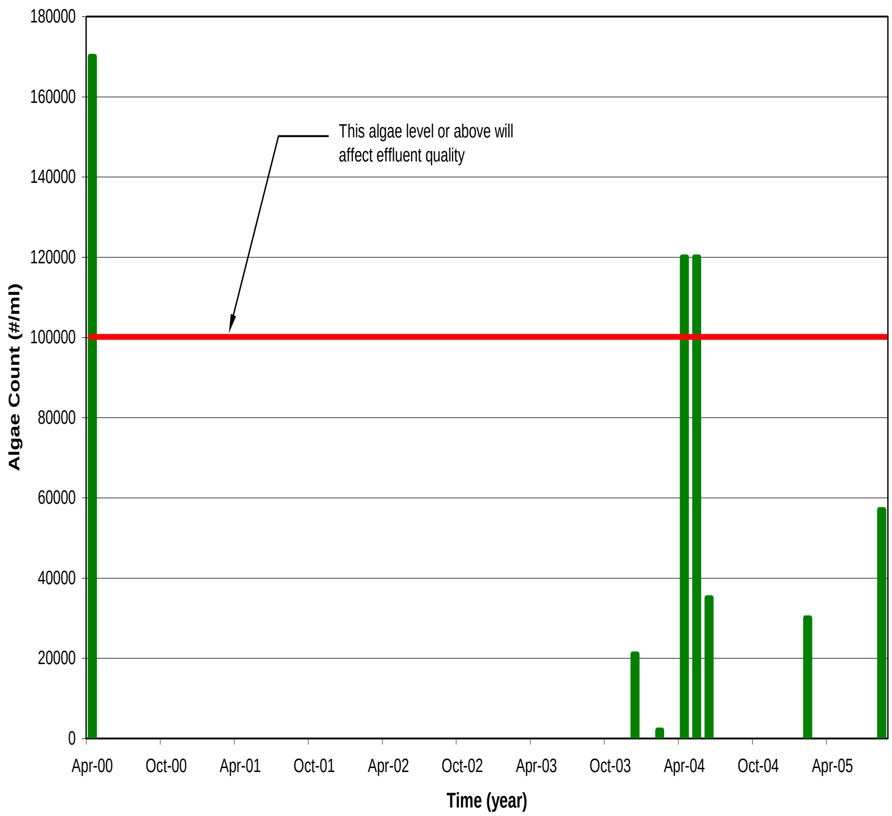

Figure 6.9 – L-2 Effluent Algae Levels

The influence of the algae was also reflected by the L-2 lagoon effluent TSS and BOD_5 values as shown on Figure 6.10. The winter effluent TSS and BOD_5 values were generally lower than the summer because algae growth in the winter is slow. Figure 6.10 also shows that the BOD_5 trend generally parallels the TSS trend.

Figure 6.11 shows that effluent CBOD is trending down below 25 mg/l since the summer of 2006, and SCBOD (filtered soluble CBOD) is generally below 5 mg/l. when soluble CBOD is below 5mg/l, it is generally considered that CBOD removal is essentially completed. The remaining 5 mg/l is considered to be the non-biodegradable refractory organics. It should be pointed out that the particulate CBOD in the lagoon effluent is usually not the residual of the plant influent CBOD unless the plant is overloaded organically. In fact, almost all of the particulate CBOD in the effluent are bio floc and algae. The high proportional particulate CBOD in the lagoon effluent is an indication of the polishing cell's poor efficiency for separating the solids from the liquid. This is one of the reasons that the CBOD or BOD monitoring data often can not validate the calculated values based on the first-order kinetics equation.

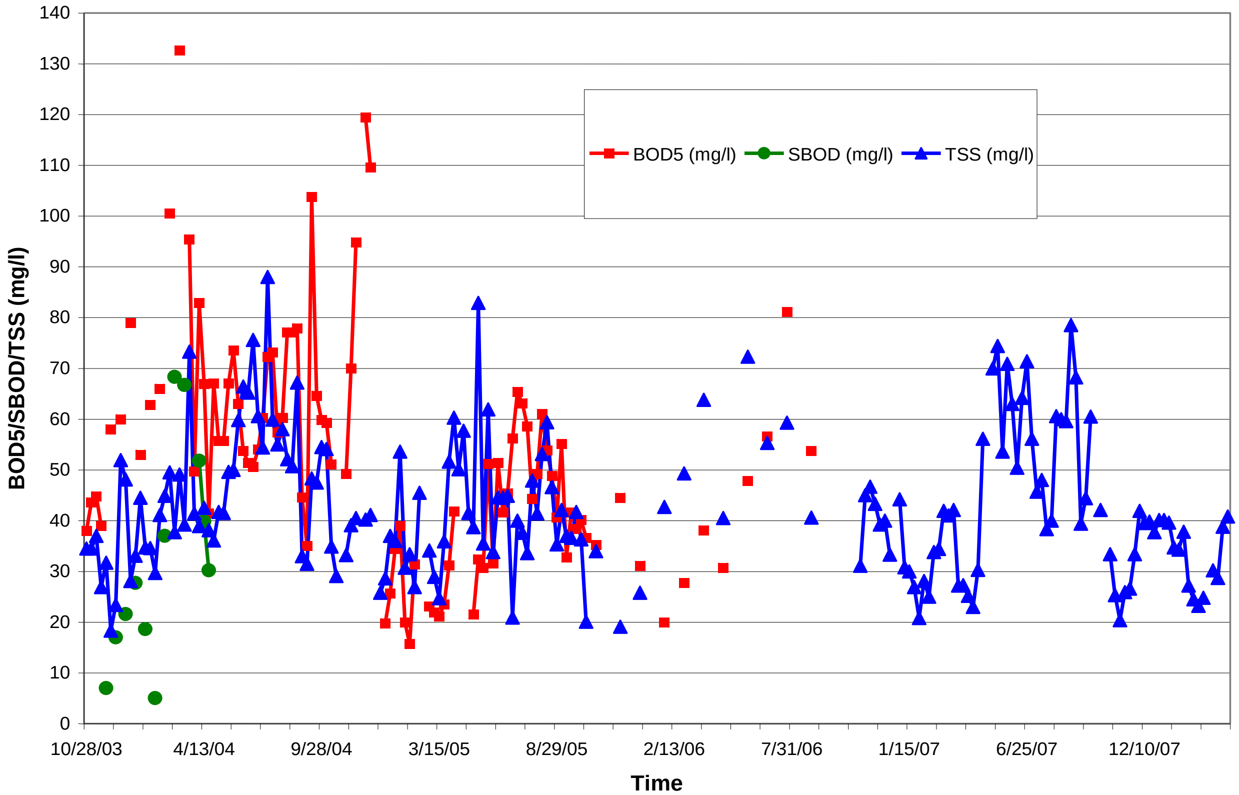

Figure 6.10 – L-2 Lagoon Effluent BOD5, SBOD and TSS

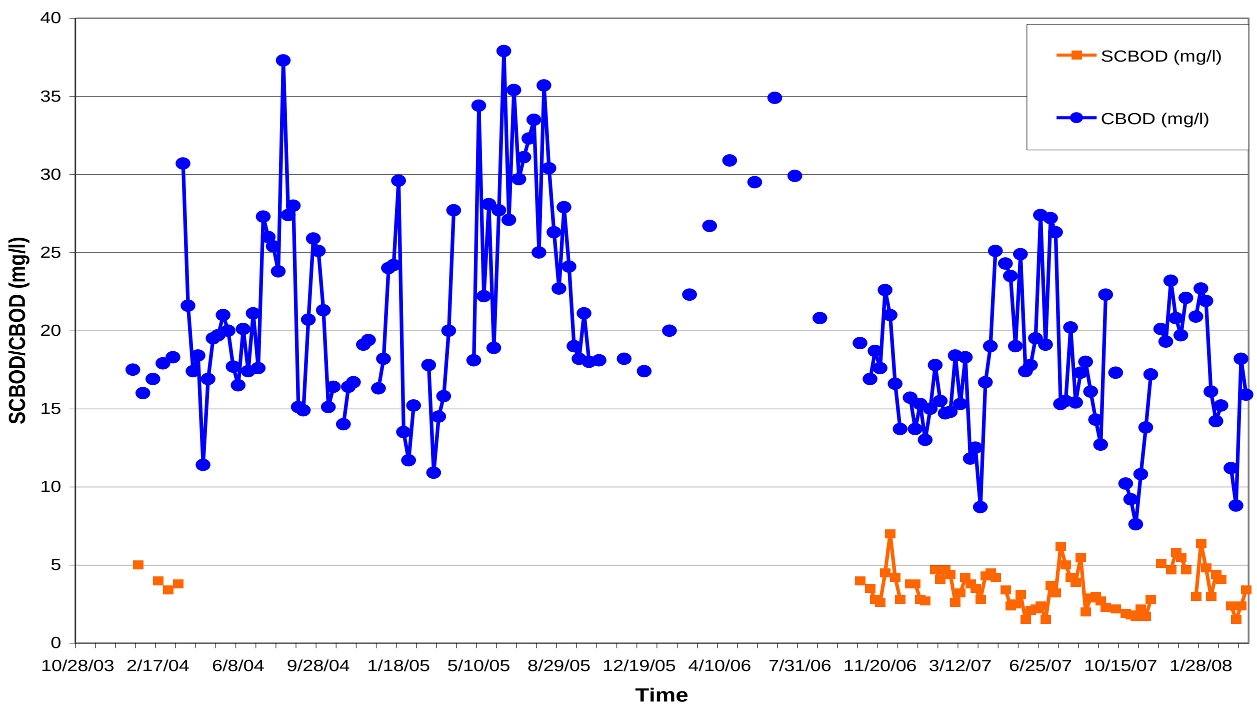

Figure 6.11 – L-2 Lagoon Effluent SCBOD and CBOD

Table 6.5 – L-2 Influent and Effluent data

Date	Plant Influent Flows	L-2 Influents (Anaerobic Pretreatment Cell Effluents)			L-2 Effluents				
		BOD5	Filtered CBOD5	CBOD5	BOD5	SBOD	SCBOD	CBOD	TSS
	(gpd)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
10/28/03	13000	118			38				34.5
11/4/03	12000	185			43.6				34.5
11/11/03	16000	166.4			44.8				37
11/18/03	17000	142.8			38.9				26.9
11/25/03	18000	85.3				7			31.7
12/2/03	15000	118			58				18.3
12/9/03	13000	67.6				17			23.4
12/16/03	15000	109.8			60				51.9
12/23/03	10000	139.1				21.6			48.1
12/30/03	11000	152.3			78.9				28.1
1/6/04	18000	132.1				27.7			33.1
1/13/04	15000	112.6			53			17.5	44.5
1/20/04	13000	131.2				18.6	5		34.7
1/27/04	17000	115.8			62.8			16	34.6
2/3/04	16000	104.3				5			29.7
2/10/04	15000	152.5			66			16.9	41.1
2/17/04	12000	190.3				37	4		44.9
2/24/04	13000	144.4			100.5			17.9	49.5
3/2/04	12000	166.6				68.3	3.4		37.7
3/9/04	20000	104.4			132.6			18.3	49.1
3/16/04	14000	117				66.7	3.8		39.2
3/23/04	14000	167.6			95.4			30.7	73.3
3/30/04	12000	150.8			49.7			21.6	41.4
4/6/04	13000	151.6			82.9	51.8		17.4	38.9
4/13/04	11000	169.4			66.9	39.8		18.4	42.5
4/20/04	12000	176.9			41.4	30.2		11.4	38.1
4/27/04	13000	173			67			16.9	36.1
5/4/04	13000	147.3		118.2	55.7			19.5	41.7
5/11/04	15000	151.2		126.1	55.7			19.7	41.5
5/18/04	14000	156.2		127.8	67			21	49.6
5/25/04	15000	157.6		133.6	73.5			20	50
6/1/04	12000	137.2		32.9	63			17.7	59.8
6/8/04	14000	141.5		37.2	53.7			16.5	66.4
6/15/04	12000	122.7		50.4	51.4			20.1	65.2
6/22/04	18000	109.6		36.6	50.6			17.4	75.6
6/29/04	17000	149.8		124.9	54			21.1	60.6
7/6/04	25000	171.4		133.7	60.2			17.6	54.4
7/13/04	19000	149.3		121.2	72.3			27.3	88
7/20/04	22000	166		78	73.1			26	59.9

7/27/04	18000	145		87.7	57.4			25.4	55
8/3/04	22000	127.4		95.6	60.3			23.8	58
8/10/04	21000	194.7		86.9	77.1			37.3	52.1
8/17/04	20000	140		93.4	77.1			27.4	50.7
8/24/04	22000	176.7		105.1	77.9			28	67.2
8/31/04	15000	122.7		69	44.6			15.1	33
9/7/04	15000	132.7		88.7	35			14.9	31.5
9/14/04	13000	148.3		101.7	103.8			20.7	48.3
9/21/04	14000	151.7		83.4	64.6			25.9	47.5
9/28/04	15000	140.3		76.2	59.8			25.1	54.5
10/5/04	14000	123.7			59.3			21.3	54.1
10/12/04	12000	126.5		58	51.1			15.1	34.9
10/19/04	13000	119.1		59.6				16.4	29.1
11/2/04	24000	113.3		42.6	49.2			14	33.2
11/9/04	16000	90.6		51	70			16.4	39.1
11/16/04	16000	101.1		53.6	94.8			16.7	40.5
11/30/04	17000	122.2		59.4	119.4			19.1	40.2
12/7/04	21000	98.2		56.9	109.6			19.4	41.1
12/21/04	11000	74.8		67.9				16.3	25.8
12/28/04	17000	76		73.1	19.8			18.2	28.6
1/4/05	16000	88.7		77.4	25.6			24	37
1/11/05	13000	95.7		75.2	34.4			24.2	36
1/18/05	54000	67.9		55.8	39			29.6	53.6
1/25/05	18000	53.6		44.6	19.9			13.5	30.7
2/1/05	14000	75.3		69.3	15.7			11.7	33.4
2/8/05	22000	66.5		55.1	31.4			15.2	26.9
2/15/05	13000								45.5
3/1/05	14000	85		80.4	23.1			17.8	34.1
3/8/05	11000	86.9		67.9	21.9			10.9	28.9
3/15/05	14000	75.7		59.7	21.1			14.5	24.7
3/22/05	13000	76.7		65.6	23.5			15.8	35.9
3/29/05	15000	104.3		90.4	31.2			20	51.6
4/5/05	14000	107		89.7	41.8			27.7	60.3
4/11/05	16000			95.2					50.1
4/19/05	14000			62.9					57.7
4/26/05	16000			116.2					41.5
5/3/05	14000	78.8		71	21.5			18.1	38.7
5/10/05	11000	157.5		130.1	32.4			34.4	82.9
5/17/05	14000	131.4		111.8	30.7			22.2	35.5
5/23/05	17000	88.2		70.4	51.2			28.1	61.9
5/31/05	14000	110		88.3	31.6			18.9	33.8
6/6/05	15000	124.4		94.2	51.4			27.7	44.6
6/14/05	17000	97.8		88.7	41.6			37.9	44.5
6/21/05	15000	96.3		49.9	45.4			27.1	44.9
6/28/05	17000	143		74.3	56.2			35.4	20.9
7/5/05	24000	124.8		77.2	65.4			29.7	40

7/12/05	17000	112.3		57.6	63.1			31.1	37.6
7/19/05	23000	124.8		60.2	58.6			32.3	33.6
7/26/05	20000	135.5		69.8	44.3			33.5	47.9
8/2/05	23000	115		79	49.2			25	41.4
8/9/05	25000	87.3		81.1	61			35.7	53.1
8/16/05	23000	149.3		84.6	53.8			30.4	59.4
8/23/05	22000	127.3		59.4	48.8			26.3	46.6
8/29/05	22000	119.5		80.7	40.6			22.7	35.3
9/5/05	23000	151.8		96.7	55.1			27.9	42.1
9/13/05	16000	84		71.2	32.8			24.1	37
9/19/05	18000	117		58.5	41.6			19	36.6
9/27/05	15000	95.1		62.5	38.3			18.2	41.7
10/5/05	18000	98.3		77.3	40.1			21.1	36.3
10/10/05	15000	102		85.7	36.6			18	20.1
10/25/05	14000	96		76.7	35.2			18.1	34
11/28/05	18000	96.5		89.7	44.5			18.2	19.1
12/26/05	17000	77.3		65.2	31.1			17.4	25.8
1/30/06	50000	73.8		65.3	19.9			20	42.7
2/27/06	13000	120		97.7	27.7			22.3	49.3
3/27/06	15000	78.8		71.7	38.1			26.7	63.8
4/24/06	16848	77		66.8	30.7			30.9	40.5
5/29/06	13922	153.8		70.8	47.8			29.5	72.3
6/26/06	16168	121.8		96.2	56.6			34.9	55.3
7/24/06	16993	92.2		67.6	81.1			29.9	59.3
8/28/06	17419	103		72.3	53.7			20.8	40.6
10/23/06	13933			59.3			4	19.2	
11/6/06	27740			60.1			3.5	16.9	31.1
11/13/06	30282			69.3			2.8	18.7	45
11/20/06	12654			57.8			2.6	17.6	46.7
11/27/06	25252						4.5	22.6	43.3
12/4/06	23607			59.4			7	21	39.2
12/11/06	15360			85.3			4.2	16.6	40
12/18/06	14958			64.2			2.8	13.7	33.3
1/1/07	20156			76.4			3.8	15.7	44.2
1/8/07	26807			48.9			3.8	13.7	30.8
1/15/07	14076			79.1			2.8	15.3	30
1/22/07	18244			64.5			2.7	13	26.9
1/29/07	13228							15	20.8
2/5/07	11517		62.9	97.1			4.7	17.8	28.1
2/12/07	14837		40.2	75.5			4.1	15.5	25
2/19/07	16989		52	72			4.7	14.7	33.8
2/26/07	12834		49.2	74.8			4.4	14.8	34.4
3/5/07	11473		26.8	49.9			2.6	18.4	41.9
3/12/07	31305		34.7	53.3			3.2	15.3	41
3/19/07	18674		37	57			4.2	18.3	42.1
3/26/07	15668		26.5	47.5			3.8	11.8	27.2

4/2/07	12962		36.8	52.5			3.5	12.5	27.3
4/9/07	12218		30.4	42.2			2.8	8.7	25.2
4/16/07	13204		72.4	92.5			4.3	16.7	23
4/23/07	18033		58.8	93.2			4.5	19	30.3
4/30/07	16621		31.1	63.5			4.2	25.1	56.1
5/7/07	13971		67.4	96.9			3.4	24.3	70
5/14/07	10864		69.3	109.1			2.4	23.5	74.4
5/21/07	12393		23	41.2			2.5	19	53.6
5/28/07	18883		97.1	152.4			3.1	24.9	70.9
6/4/07	18821		91.5	135			1.5	17.4	63
6/11/07	13122		75.5	117.5			2.1	17.8	50.4
6/18/07	14598		43.2	86			2.2	19.5	64.2
6/25/07	18226		76.8	109			2.4	27.4	71.4
7/2/07	23806		77.2	116.3			1.5	19.1	56.1
7/9/07	16220		67.9	121.5			3.7	27.2	45.7
7/16/07	18776		66.8	131.5			3.2	26.3	48
7/23/07	20534		34.5	73.5			6.2	15.3	38.3
7/30/07	25136		49.9	86.3			5	15.5	40
8/6/07	23275		47.9	74.8			4.2	20.2	60.6
8/13/07	25391		26.6	60.3			3.9	15.4	60
8/20/07	20552		41.8	73.8			5.5	17.3	59.6
8/27/07	19870		26.5	48.5			2	18	78.5
9/3/07	23322		48.1	67.3			2.9	16.1	68.2
9/10/07	20990		19	53.3			3	14.3	39.4
9/17/07	16861		28.5	67			2.7	12.7	44.4
9/24/07	14934		39.6	67.3			2.3	22.3	60.5
10/8/07	13676		66.1	100			2.2	17.3	42.1
10/22/07	13962		23.1	49			1.9	10.2	33.4
10/29/07	13859		30	58.7			1.8	9.2	25.3
11/5/07	11633		27.5	60.4			1.7	7.6	20.4
11/12/07	17310		34.9	59.1			2.2	10.8	25.9
11/19/07	17092		43.4	69			1.7	13.8	26.6
11/26/07	14102		48.7	75.4			2.8	17.2	33.4
12/3/07	21456		51.1	82					41.9
12/10/07	13934			84.2			5.1	20.1	39.5
12/17/07	13946		45.8	80.6				19.3	39.8
12/24/07	10369		57.6	90.4			4.7	23.2	37.7
12/31/07	12095		54.4	86.6			5.8	20.8	40.1
1/1/08	8538						5.5	19.7	40.1
1/7/08	10251		61.5	91			4.7	22.1	39.6
1/14/08	12483								34.7
1/21/08	14044		50.3	79.2			3	20.9	34.3
1/28/08	15768		58.3	92			6.4	22.7	37.8
2/4/08	20910		57.2	86			4.8	21.9	27.2
2/11/08	18722		43.3	62.6			3	16.1	24.5
2/18/08	13338		49.3	75.8			4.4	14.2	23.2

2/25/08	11737		44.9	72			4.1	15.2	24.8
3/10/08	14429		27.8	66.3			2.4	11.2	30.2
3/17/08	12006		45.4	61.2			1.5	8.8	28.7
3/24/08	15184		52.7	74.4			2.4	18.2	38.8
3/31/08	17724		36.3	54.8			3.4	15.9	40.8
Average	**16,638**	**121**	**48**	**78**	**53**	**33**	**4**	**20**	**43**

The design of aerated lagoons for BOD removal is based on first-order kinetics. The commonly used basic equation is:

$$C_e / C_o = 1/[1+K_T)*(t)/n]^n$$

Where: C_e = effluent BOD_5 or $CBOD_5$, mg/l
C_o = influent BOD_5 or $CBOD_5$, mg/l
K_T = temperature dependent overall first order removal rate constant, d^{-1}
t = V/Q, total hydraulic detention time in the system, days; and
n = number of equal sized cells in the system

The above equation assumed that the observed BOD or CBOD removal (either overall, including soluble and suspended solids contributions or soluble only) can be described by the first-order kinetics. The BOD or CBOD removal is measured between the lagoon influent and effluent outlets. The overall rate constant K_T values are calculated with the following equation:

$$K_T = K_{20}*\theta^{(T-20)}$$

Where: θ = 1.036(12, 13 and 15), 1.047(16), 1.06(14), temperature coefficient
K_{20} = 0.276 d^{-1} (12, 13 and 15), 0.20(16), rate constant at 20°C for domestic wastewater for observed BOD or CBOD. The rate constant for soluble BOD or CBOD would be higher. A value of 2.5 is used by the Metcalf & Eddy.

The above lagoon design equations are widely recognized by regulatory agencies and authoritative experts. The most important parameter in these equations is the rate constant. For a given temperature, the rate constant depends on the biodegradability of the wastewater. For a particular domestic wastewater, the rate constant can be determined using pilot-scale system. However, using the plant monitoring data to determine the rate constant is not appropriate because plants are generally operated significantly below their actual hydraulic and organic capacities. When plants are operated below their capacities, the hydraulic detention time is longer than needed, but the observed effluent BOD or CBOD values will not become proportionally smaller since significant portion of the effluent BOD or CBOD is attributable to algae and biosolids in the effluent. But the quantity of algae and biosolids in the effluent can not be described in the first-order removal function. In fact, longer hydraulic detention time generally increase the production of the algae. Therefore, it can be seen from the following equation that the calculated (K_T) removal rate constant will be much smaller than the its real value when the plant is operated below capacities.

$$K_T = (C_o - C_e)/C_e t$$

Using soluble effluent BOD or CBOD will also result in smaller K_T if the plant is operated under capacity. This is because once the biodegradable soluble BOD or CBOD removal is completed and only refractory soluble BOD or CBOD remains, the first-order kinetics is not applicable anymore. Therefore, additional hydraulic detention time will not decrease effluent soluble BOD or CBOD in accordance with the first-order kinetics, so the calculated K_T will also be smaller than its real value. In reality, the removal rate should be a constant value based on temperature and wastewater characteristics. But calculated K will vary based on the particular influent flow rate, influent and effluent BOD values.

Because effluent BOD, CBOD or soluble BOD or CBOD are either not the simple residuals of the influent or not biodegradable for plants operating under capacity, the calculated lagoon effluent values from the first-order equation generally cannot be validated by these monitored effluent values. Time delays due to large lagoon volume also present challenges for validating the calculated values with the monitored values because the effluent values do not correspond to the influent values. Table 6.6 is a comparison between the monitored data and calculated values. Figure 6.12, 6.13 and 6.14 are graphical presentations.

Table 6.6 – Monitored Values and Calculated Values

Date	Plant Influent Flows	**L-2 Influents (Anaerobic Pretreatment Cell Effluents)** BOD$_5$	SC BOD$_5$	C BOD$_5$	WW Temp		Cell #1 HRT	Cell #2 HRT	**L-2 Effluents** Monit. BOD$_5$	Cal. BOD$_5$	Monit. SC BOD$_5$	Cal. SC BOD$_5$ K_{20} = 0.276	Cal. SC BOD$_5$ K_{20} = 2.5	Monit. C BOD$_5$	Cal. C BOD$_5$
	(gpd)	(mg/l)	(mg/l)	(mg/l)	(°F)	(°C)	(d)	(d)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
10/28/03	13000	118			58	14.4	19.8	9.9	38	6.6					
11/4/03	12000	185			52	11.1	21.5	10.7	43.6	11.0					
11/11/03	16000	166.4			51	10.6	16.1	8.0	44.8	15.4					
11/18/03	17000	142.8			48	8.9	15.1	7.6	38.9	15.5					
12/2/03	15000	118			52	11.1	17.2	8.6	58	9.7					
12/16/03	15000	109.8			47	8.3	17.2	8.6	60	10.3					
12/30/03	11000	152.3			45	7.2	23.4	11.7	78.9	9.7					
1/13/04	15000	112.6			47	8.3	17.2	8.6	53	10.6				17.5	
1/27/04	17000	115.8			48	8.9	15.1	7.6	62.8	12.6				16	
2/10/04	15000	152.5			47	8.3	17.2	8.6	66	14.4				16.9	
2/24/04	13000	144.4			48	8.9	19.8	9.9	100.5	10.8				17.9	
3/9/04	20000	104.4			51	10.6	12.9	6.4	132.6	13.0				18.3	
3/23/04	14000	167.6			52	11.1	18.4	9.2	95.4	12.5				30.7	
3/30/04	12000	150.8			53	11.7	21.5	10.7	49.7	8.7				21.6	

4/6/04	13000	151.6			53	11.7	19.8	9.9	82.9	9.8				17.4	
4/13/04	11000	169.4			55	12.8	23.4	11.7	66.9	8.1				18.4	
4/20/04	12000	176.9			57	13.9	21.5	10.7	41.4	9.1				11.4	
4/27/04	13000	173			57	13.9	19.8	9.9	67	10.0				16.9	
5/4/04	13000	147.3		118.2	59	15.0	19.8	9.9	55.7	8.0				19.5	6.4
5/11/04	15000	151.2		126.1	60	15.6	17.2	8.6	55.7	9.9				19.7	8.3
5/18/04	14000	156.2		127.8	61	16.1	18.4	9.2	67	9.0				21	7.3
5/25/04	15000	157.6		133.6	62	16.7	17.2	8.6	73.5	9.7				20	8.3
6/1/04	12000	137.2		32.9	62	16.7	21.5	10.7	63	6.0				17.7	1.4
6/8/04	14000	141.5		37.2	63	17.2	18.4	9.2	53.7	7.7				16.5	2.0
6/15/04	12000	122.7		50.4	64	17.8	21.5	10.7	51.4	5.1				20.1	2.1
6/22/04	18000	109.6		36.6	65	18.3	14.3	7.2	50.6	8.1				17.4	2.7
6/29/04	17000	149.8		124.9	68	20.0	15.1	7.6	54	9.4				21.1	7.8
7/6/04	25000	171.4		133.7	68	20.0	10.3	5.2	60.2	18.4				17.6	14.4
7/13/04	19000	149.3		121.2	70	21.1	13.6	6.8	72.3	10.4				27.3	8.4
7/20/04	22000	166		78	70	21.1	11.7	5.9	73.1	14.2				26	6.7
7/27/04	18000	145		87.7	70	21.1	14.3	7.2	57.4	9.3				25.4	5.6
8/3/04	22000	127.4		95.6	71	21.7	11.7	5.9	60.3	10.6				23.8	8.0
8/10/04	21000	194.7		86.9	70	21.1	12.3	6.1	77.1	15.6				37.3	7.0
8/17/04	20000	140		93.4	72	22.2	12.9	6.4	77.1	9.9				27.4	6.6
8/24/04	22000	176.7		105.1	70	21.1	11.7	5.9	77.9	15.1				28	9.0
8/31/04	15000	122.7		69	68	20.0	17.2	8.6	44.6	6.3				15.1	3.6
9/7/04	15000	132.7		88.7	68	20.0	17.2	8.6	35	6.9				14.9	4.6
9/14/04	13000	148.3		101.7	66	18.9	19.8	9.9	103.8	6.5				20.7	4.5
9/21/04	14000	151.7		83.4	64	17.8	18.4	9.2	64.6	8.0				25.9	4.4
9/28/04	15000	140.3		76.2	65	18.3	17.2	8.6	59.8	7.9				25.1	4.3
10/5/04	14000	123.7			63	17.2	18.4	9.2	59.3	6.7				21.3	
10/12/04	12000	126.5		58	62	16.7	21.5	10.7	51.1	5.6				15.1	2.5
10/19/04	13000	119.1		59.6	60	15.6	19.8	9.9						16.4	3.2
11/2/04	24000	113.3		42.6	58	14.4	10.7	5.4	49.2	14.9				14	5.6
11/9/04	16000	90.6		51	56	13.3	16.1	8.0	70	7.3				16.4	4.1
11/16/04	16000	101.1		53.6	56	13.3	16.1	8.0	94.8	8.1				16.7	4.3
11/30/04	17000	122.2		59.4	53	11.7	15.1	7.6	119.4	11.6				19.1	5.6
12/7/04	21000	98.2		56.9	51	10.6	12.3	6.1	109.6	13.0				19.4	7.5
12/21/04	11000	74.8		67.9	52	11.1	23.4	11.7						16.3	3.5
12/28/04	17000	76		73.1	48	8.9	15.1	7.6	19.8	8.2				18.2	7.9
1/4/05	16000	88.7		77.4	50	10.0	16.1	8.0	25.6	8.4				24	7.3
1/11/05	13000	95.7		75.2	46	7.8	19.8	9.9	34.4	7.6				24.2	6.0
1/18/05	54000	67.9		55.8	46	7.8	4.8	2.4	39	25.7				29.6	21.1
1/25/05	18000	53.6		44.6	50	10.0	14.3	7.2	19.9	6.0				13.5	5.0
2/1/05	14000	75.3		69.3	51	10.6	18.4	9.2	15.7	5.8				11.7	5.3
2/8/05	22000	66.5		55.1	50	10.0	11.7	5.9	31.4	9.5				15.2	7.9
3/1/05	14000	85		80.4	49	9.4	18.4	9.2	23.1	6.9				17.8	6.5
3/8/05	11000	86.9		67.9	52	11.1	23.4	11.7	21.9	4.5				10.9	3.5
3/15/05	14000	75.7		59.7	53	11.7	18.4	9.2	21.1	5.5				14.5	4.3
3/22/05	13000	76.7		65.6	53	11.7	19.8	9.9	23.5	5.0				15.8	4.3

3/29/05	15000	104.3		90.4	53	11.7	17.2	8.6	31.2	8.3				20	7.2
4/5/05	14000	107		89.7	54	12.2	18.4	9.2	41.8	7.5				27.7	6.3
5/3/05	14000	78.8		71	60	15.6	18.4	9.2	21.5	4.7				18.1	4.2
5/10/05	11000	157.5		130.1	61	16.1	23.4	11.7	32.4	6.2				34.4	5.1
5/17/05	14000	131.4		111.8	62	16.7	18.4	9.2	30.7	7.3				22.2	6.2
5/23/05	17000	88.2		70.4	63	17.2	15.1	7.6	51.2	6.4				28.1	5.1
5/31/05	14000	110		88.3	65	18.3	18.4	9.2	31.6	5.6				18.9	4.5
6/6/05	15000	124.4		94.2	65	18.3	17.2	8.6	51.4	7.0				27.7	5.3
6/14/05	17000	97.8		88.7	66	18.9	15.1	7.6	41.6	6.5				37.9	5.9
6/21/05	15000	96.3		49.9	69	20.6	17.2	8.6	45.4	4.8				27.1	2.5
6/28/05	17000	143		74.3	68	20.0	15.1	7.6	56.2	8.9				35.4	4.6
7/5/05	24000	124.8		77.2	69	20.6	10.7	5.4	65.4	12.4				29.7	7.7
7/12/05	17000	112.3		57.6	62	16.7	15.1	7.6	63.1	8.3				31.1	4.3
7/19/05	23000	124.8		60.2	68	20.0	11.2	5.6	58.6	12.0				32.3	5.8
7/26/05	20000	135.5		69.8	71	21.7	12.9	6.4	44.3	9.8				33.5	5.1
8/2/05	23000	115		79	72	22.2	11.2	5.6	49.2	9.9				25	6.8
8/9/05	25000	87.3		81.1	72	22.2	10.3	5.2	61	8.4				35.7	7.8
8/16/05	23000	149.3		84.6	72	22.2	11.2	5.6	53.8	12.9				30.4	7.3
8/23/05	22000	127.3		59.4	71	21.7	11.7	5.9	48.8	10.6				26.3	4.9
8/29/05	22000	119.5		80.7	69	20.6	11.7	5.9	40.6	10.5				22.7	7.1
9/5/05	23000	151.8		96.7	68	20.0	11.2	5.6	55.1	14.6				27.9	9.3
9/13/05	16000	84		71.2	69	20.6	16.1	8.0	32.8	4.7				24.1	3.9
9/19/05	18000	117		58.5	67	19.4	14.3	7.2	41.6	8.2				19	4.1
9/27/05	15000	95.1		62.5	66	18.9	17.2	8.6	38.3	5.2				18.2	3.4
10/5/05	18000	98.3		77.3	63	17.2	14.3	7.2	40.1	7.7				21.1	6.1
10/10/05	15000	102		85.7	62	16.7	17.2	8.6	36.6	6.3				18	5.3
10/25/05	14000	96		76.7	61	16.1	18.4	9.2	35.2	5.5				18.1	4.4
11/28/05	18000	96.5		89.7	52	11.1	14.3	7.2	44.5	10.2				18.2	9.5
12/26/05	17000	77.3		65.2	49	9.4	15.1	7.6	31.1	8.2				17.4	6.9
1/30/06	50000	73.8		65.3	48	8.9	5.2	2.6	19.9	25.5				20	22.5
2/27/06	13000	120		97.7	46	7.8	19.8	9.9	27.7	9.5				22.3	7.7
3/27/06	15000	78.8		71.7	49	9.4	17.2	8.6	38.1	7.0				26.7	6.4
4/24/06	16848	77		66.8	54	12.2	15.3	7.6	30.7	7.0				30.9	6.1
5/29/06	13922	153.8		70.8	60	15.6	18.5	9.2	47.8	9.0				29.5	4.2
6/26/06	16168	121.8		96.2	65	18.3	15.9	8.0	56.6	7.7				34.9	6.1
7/24/06	16993	92.2		67.6	68	20.0	15.2	7.6	81.1	5.8				29.9	4.2
8/28/06	17419	103		72.3	67	19.4	14.8	7.4	53.7	6.9				20.8	4.8
10/23/06	13933			59.3	59	15.0	18.5	9.2			4			19.2	3.6
11/6/06	27740			60.1	56	13.3	9.3	4.6			3.5			16.9	9.9
11/13/06	30282			69.3	52	11.1	8.5	4.3			2.8			18.7	13.8
11/20/06	12654			57.8	52	11.1	20.3	10.2			2.6			17.6	3.7
12/4/06	23607			59.4	47	8.3	10.9	5.5			7			21	9.9
12/11/06	15360			85.3	48	8.9	16.8	8.4			4.2			16.6	8.1
12/18/06	14958			64.2	47	8.3	17.2	8.6			2.8			13.7	6.0
1/1/07	20156			76.4	47	8.3	12.8	6.4			3.8			15.7	10.6
1/8/07	26807			48.9	46	7.8	9.6	4.8			3.8			13.7	9.7

1/15/07	14076			79.1	44	6.7	18.3	9.1			2.8			15.3	7.4
1/22/07	18244			64.5	45	7.2	14.1	7.1			2.7			13	8.3
2/5/07	11517		62.9	97.1	45	7.2	22.4	11.2			4.7	4.3	0.1	17.8	6.6
2/12/07	14837		40.2	75.5	46	7.8	17.4	8.7			4.1	3.8	0.1	15.5	7.2
2/19/07	16989		52	72	47	8.3	15.2	7.6			4.7	5.8	0.1	14.7	8.0
2/26/07	12834		49.2	74.8	48	8.9	20.1	10.0			4.4	3.6	0.1	14.8	5.5
3/5/07	11473		26.8	49.9	46	7.8	22.4	11.2			2.6	1.8	0.0	18.4	3.3
3/12/07	31305		34.7	53.3	48	8.9	8.2	4.1			3.2	7.8	0.3	15.3	11.9
3/19/07	18674		37	57	49	9.4	13.8	6.9			4.2	4.4	0.1	18.3	6.8
3/26/07	15668		26.5	47.5	50	10.0	16.4	8.2			3.8	2.4	0.1	11.8	4.4
4/2/07	12962		36.8	52.5	50	10.0	19.9	9.9			3.5	2.6	0.1	12.5	3.7
4/9/07	12218		30.4	42.2	52	11.1	21.1	10.5			2.8	1.9	0.0	8.7	2.6
4/16/07	13204		72.4	92.5	53	11.7	19.5	9.8			4.3	4.8	0.1	16.7	6.1
4/23/07	18033		58.8	93.2	54	12.2	14.3	7.1			4.5	5.9	0.1	19	9.3
4/30/07	16621		31.1	63.5	54	12.2	15.5	7.7			4.2	2.8	0.1	25.1	5.7
5/7/07	13971		67.4	96.9	55	12.8	18.4	9.2			3.4	4.6	0.1	24.3	6.6
5/14/07	10864		69.3	109.1	56	13.3	23.7	11.9			2.4	3.1	0.1	23.5	4.9
5/21/07	12393		23	41.2	58	14.4	20.8	10.4			2.5	1.2	0.0	19	2.1
5/28/07	18883		97.1	152.4	60	15.6	13.6	6.8			3.1	8.8	0.2	24.9	13.9
6/4/07	18821		91.5	135	62	16.7	13.7	6.8			1.5	7.8	0.2	17.4	11.6
6/11/07	13122		75.5	117.5	63	17.2	19.6	9.8			2.1	3.7	0.1	17.8	5.8
6/18/07	14598		43.2	86	64	17.8	17.6	8.8			2.2	2.4	0.0	19.5	4.8
6/25/07	18226		76.8	109	65	18.3	14.1	7.1			2.4	5.8	0.1	27.4	8.2
7/2/07	23806		77.2	116.3	66	18.9	10.8	5.4			1.5	8.2	0.2	19.1	12.3
7/9/07	16220		67.9	121.5	67	19.4	15.9	7.9			3.7	4.1	0.1	27.2	7.3
7/16/07	18776		66.8	131.5	67	19.4	13.7	6.9			3.2	5.0	0.1	26.3	9.8
7/23/07	20534		34.5	73.5	67	19.4	12.5	6.3			6.2	2.9	0.1	15.3	6.2
7/30/07	25136		49.9	86.3	68	20.0	10.2	5.1			5	5.4	0.1	15.5	9.3
8/6/07	23275		47.9	74.8	68	20.0	11.1	5.5			4.2	4.7	0.1	20.2	7.3
8/13/07	25391		26.6	60.3	67	19.4	10.1	5.1			3.9	3.0	0.1	15.4	6.8
8/20/07	20552		41.8	73.8	67	19.4	12.5	6.3			5.5	3.5	0.1	17.3	6.2
8/27/07	19870		26.5	48.5	67	19.4	13.0	6.5			2	2.1	0.0	18	3.9
9/3/07	23322		48.1	67.3	67	19.4	11.0	5.5			2.9	4.8	0.1	16.1	6.8
9/10/07	20990		19	53.3	66	18.9	12.3	6.1			3	1.7	0.0	14.3	4.8
9/17/07	16861		28.5	67	66	18.9	15.3	7.6			2.7	1.9	0.0	12.7	4.4
9/24/07	14934		39.6	67.3	65	18.3	17.2	8.6			2.3	2.2	0.0	22.3	3.8
10/8/07	13676		66.1	100	63	17.2	18.8	9.4			2.2	3.4	0.1	17.3	5.2
10/22/07	13962		23.1	49	58	14.4	18.4	9.2			1.9	1.4	0.0	10.2	3.1
10/29/07	13859		30	58.7	56	13.3	18.6	9.3			1.8	2.0	0.0	9.2	3.8
11/5/07	11633		27.5	60.4	55	12.8	22.1	11.1			1.7	1.4	0.0	7.6	3.1
11/12/07	17310		34.9	59.1	54	12.2	14.9	7.4			2.2	3.3	0.1	10.8	5.6
11/19/07	17092		43.4	69	52	11.1	15.1	7.5			1.7	4.3	0.1	13.8	6.8
11/26/07	14102		48.7	75.4	50	10.0	18.3	9.1			2.8	3.9	0.1	17.2	6.0
12/10/07	13934			84.2	48	8.9	18.5	9.2			5.1			20.1	7.0
12/17/07	13946		45.8	80.6	47	8.3	18.5	9.2						19.3	6.9
12/24/07	10369		57.6	90.4	47	8.3	24.8	12.4			4.7	3.2	0.1	23.2	5.0

12/31/07	12095		54.4	86.6	46	7.8	21.3	10.6			5.8	3.9	0.1	20.8	6.2
1/7/08	10251		61.5	91	47	8.3	25.1	12.6			4.7	3.3	0.1	22.1	4.9
1/21/08	14044		50.3	79.2	45	7.2	18.3	9.2			3	4.6	0.1	20.9	7.2
1/28/08	15768		58.3	92	45	7.2	16.3	8.2			6.4	6.2	0.2	22.7	9.8
2/4/08	20910		57.2	86	45	7.2	12.3	6.2			4.8	8.7	0.3	21.9	13.1
2/11/08	18722		43.3	62.6	46	7.8	13.8	6.9			3	5.6	0.2	16.1	8.1
2/18/08	13338		49.3	75.8	47	8.3	19.3	9.7			4.4	3.9	0.1	14.2	6.1
2/25/08	11737		44.9	72	47	8.3	21.9	11.0			4.1	3.0	0.1	15.2	4.8
3/10/08	14429		27.8	66.3	48	8.9	17.8	8.9			2.4	2.4	0.1	11.2	5.8
3/17/08	12006		45.4	61.2	49	9.4	21.4	10.7			1.5	2.9	0.1	8.8	4.0
3/24/08	15184		52.7	74.4	50	10.0	17.0	8.5			2.4	4.7	0.1	18.2	6.6
3/31/08	17724		36.3	54.8	50	10.0	14.5	7.3			3.4	4.0	0.1	15.9	6.0
Ave.	**16,958**	**121**	**48**	**77**	**57**	**14**	**16**	**8**	**53**	**9**	**3**	**4**	**0.1**	**20**	**6**

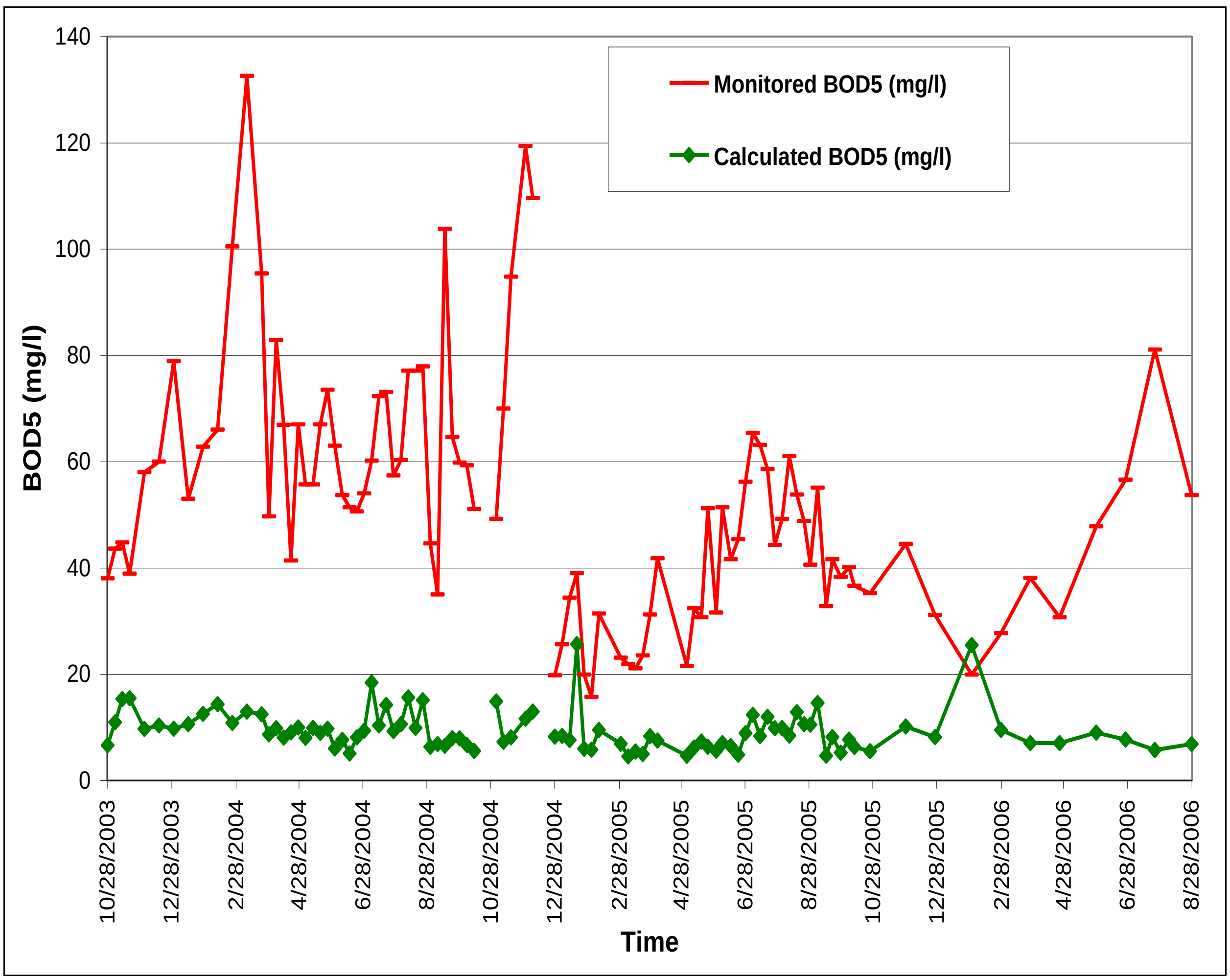

Figure 6.12 – Monitored and Calculated Effluent BOD_5

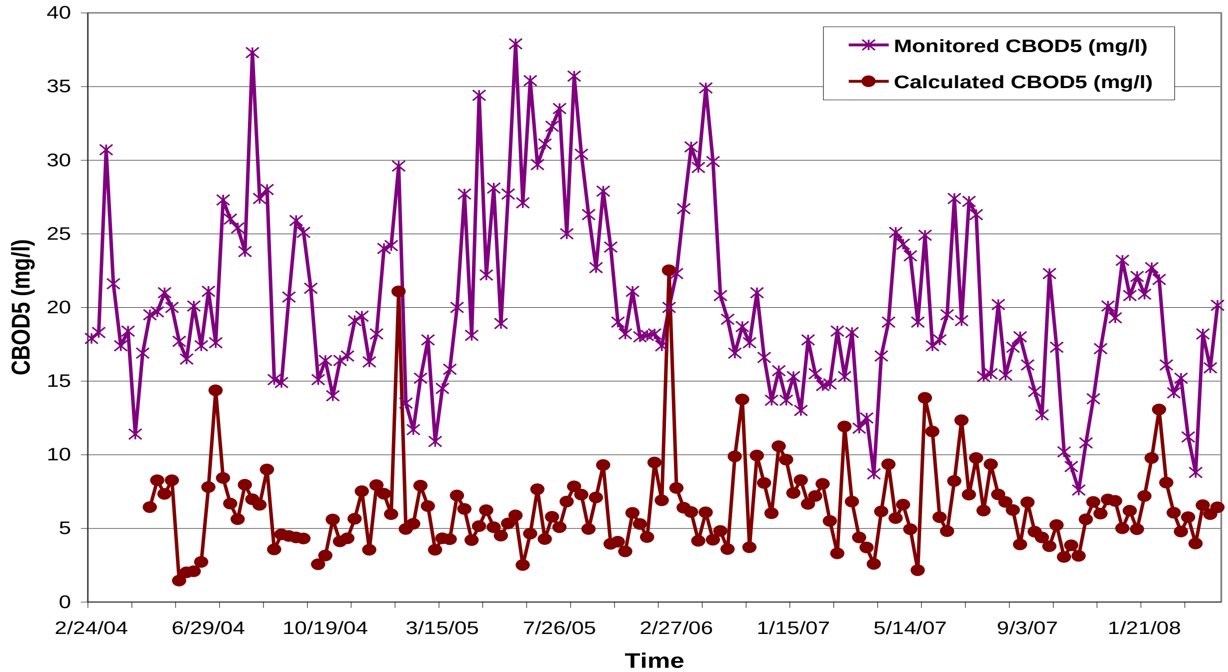

Figure 6.13 – Monitored and Calculated Effluent $CBOD_5$

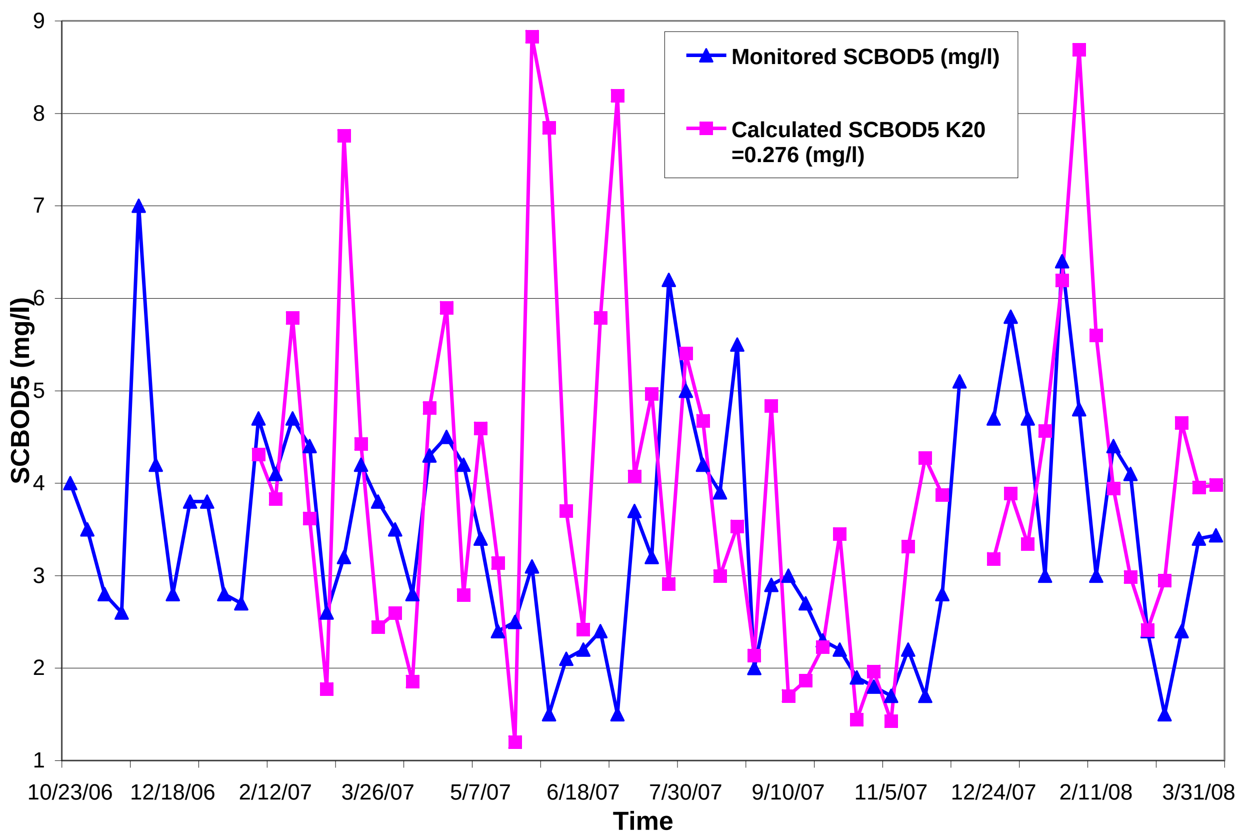

Figure 6.14 – Monitored and Calculated $SCBOD_5$

Figure 6.12 shows a large difference between the monitored BOD_5 and the calculated BOD_5. This is because that the monitored BOD_5 is not only influenced by algae and other particulate BOD_5, but also nitrification. The difference between the monitored $CBOD_5$ and the calculated $CBOD_5$ is smaller, due to the elimination of the nitrification influence, but still significant. The monitored and calculated $SCBOD_5$ based on the K_{20} of 0.276 is very close. However, when a large K_{20} of 2.5 is used for calculation as suggested by the literature (14), the difference between the monitored and calculated $SCBOD_5$ values becomes significant. This can be interpreted that the plant was operated significantly under capacity.

The above discussions concluded that the first-order equation is the recognized formula for estimating the aerated lagoon capacity, but the calculated results cannot be reasonably validated by the plant monitoring data.

Both the simple arithmetic average and the flow weighted average of the monitored influent $CBOD_5$ to the L-2 lagoon from 2004 to 2008 were 77 mg/l (see **Appendix E**). Because lagoon has excellent buffering capability and is very forgiving for shock loading, the simple arithmetic average influent $CBOD_5$ is generally appropriate as the design influent $CBOD_5$. For a conservative estimate of the lagoon capacity, 90 mg/l will be used as the design influent $CBOD_5$ to the L-2 lagoon. Using 0.276 for K_{20}, 7.7^oC for the winter temperature, 17.2^oC for the summer temperature, 1.036 for the temperature coefficient, 257,500 gallons for the aerated cell #1 volume, 125,760 gallons for the aerated cell #2 volume, and the first-order equation, 20 mg/l $CBOD_5$ for lagoon effluent, the hydraulic capacity of the L-2 is estimated to be 29,500 gpd for the winter season and 41,400 gpd for the summer season (see **Appendix E**).

Recommendations: The L-2 is performing well. No improvements are needed at present.

6.3.8 Constructed Wetland

Description: The constructed wetland was built in 2006. The wetland is a subsurface flow system (SFS) designed for 41,424 gpd flow. The wetland basin is lined with 36 mil HDPE liner. Bottom of the basin is sloped at 1% from inlet to outlet. The interior side slope of the basin is 2 to 1. The wetland has surface area of 12,348 square feet. The length to width aspect ratio of the basin is 2 to 1.

P-6.6: Constructed Wetland – May 2008

The wetland media consists of approximately 30% ¾" washed clean gravel and 70% of 2" minus shredded tire chips. The depth of the media varies from 30” to 45”. Total media volume is approximately 31,000 cubic feet. The tire chips media is located at the influent end of the wetland. The design porosity of the gavel is 0.39. But actual porosity of the gavel media is 0.41 based on field testing. The porosity of the tire chips is 0.57. The design hydraulic retention time in the wetland basin is 2 days.

P-6.7: Constructed Wetland – March 2008

Vegetation in the wetland was transplanted locally from the Lopez Island. Common reeds are the predominately plants in the wetland. Other vegetation in the wetland includes cattails and bulrushes. Wetland pictures show that plants in the wetland have grown significantly in one year.

P-6.8: Constructed Wetland – June 2007

Projected wetland effluent $CBOD_5$ 4.7 mg/l based on the influent $CBOD_5$ of 22 mg/l. Projected wetland effluent TSS was 4.7 mg/l based on influent TSS of 44 mg/l.

Evaluations: Table 6.7 shows the L-2 lagoon effluent data, the wetland effluent data and removal efficiencies for soluble $CBOD_5$, CBOD5 and TSS. Lagoon effluent data that were before wetland was in service is also included in the table. It is assumed that plant effluent TSS is same as the wetland effluent TSS.

Table 6.7 – Wetland Influent, Effluent and performance Data

Date	L-2 Effluent			Wetland			Removal Efficiency		
	SCBOD5	CBOD5	TSS	SCBOD5	CBOD5	Plant Eff. TSS	SCBOD5	CBOD5	TSS
	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(%)	(%)	(%)
10/28/03			34.5			21.7			37%
11/4/03			34.5			21.2			39%
11/11/03			37			29.1			21%

11/18/03			26.9			23				14%
11/25/03			31.7			29.3				8%
12/2/03			18.3			13				29%
12/9/03			23.4			19				19%
12/16/03			51.9			35				33%
12/23/03			48.1			35.6				26%
12/30/03			28.1			29.6				-5%
1/6/04			33.1			32.8				1%
1/13/04		17.5	44.5			33.9				24%
1/20/04	5		34.7			26.6				23%
1/27/04		16	34.6			28.9				16%
2/3/04			29.7			27.2				8%
2/10/04		16.9	41.1			33.1				19%
2/17/04	4		44.9			28.9				36%
2/24/04		17.9	49.5			33.9				32%
3/2/04	3.4		37.7			35.3				6%
3/9/04		18.3	49.1			33.1				33%
3/16/04	3.8		39.2			38.3				2%
3/23/04		30.7	73.3			33.2				55%
3/30/04		21.6	41.4			41.5				0%
4/6/04		17.4	38.9			27.2				30%
4/13/04		18.4	42.5			21.9				48%
4/20/04		11.4	38.1			21.6				43%
4/27/04		16.9	36.1			21.4				41%
5/4/04		19.5	41.7			26.8				36%
5/11/04		19.7	41.5			24.2				42%
5/18/04		21	49.6			30.8				38%
5/25/04		20	50			33				34%
6/1/04		17.7	59.8			33.3				44%
6/8/04		16.5	66.4			40.6				39%
6/15/04		20.1	65.2			31.7				51%
6/22/04		17.4	75.6			42				44%
6/29/04		21.1	60.6			43.6				28%
7/6/04		17.6	54.4			52.6				3%
7/13/04		27.3	88			57.7				34%
7/20/04		26	59.9			57.7				4%
7/27/04		25.4	55			31.8				42%
8/3/04		23.8	58			28.9				50%
8/10/04		37.3	52.1			28				46%
8/17/04		27.4	50.7			30.4				40%
8/24/04		28	67.2			44.9				33%
8/31/04		15.1	33			28.5				14%
9/7/04		14.9	31.5			21				33%
9/14/04		20.7	48.3			30				38%
9/21/04		25.9	47.5			35.3				26%
9/28/04		25.1	54.5			28				49%

10/5/04		21.3	54.1			34.2			37%
10/12/04		15.1	34.9			16.7			52%
10/19/04		16.4	29.1			14.9			49%
10/26/04						18.6			
11/2/04		14	33.2			23.6			29%
11/9/04		16.4	39.1			27.9			29%
11/16/04		16.7	40.5			25.7			37%
11/23/04						28			
11/30/04		19.1	40.2			27.3			32%
12/7/04		19.4	41.1			32.6			21%
12/14/04						22.7			
12/21/04		16.3	25.8			21.2			18%
12/28/04		18.2	28.6			22.4			22%
1/4/05		24	37			29.6			20%
1/11/05		24.2	36			33.7			6%
1/18/05		29.6	53.6			37.9			29%
1/25/05		13.5	30.7			22.3			27%
2/1/05		11.7	33.4			24.7			26%
2/8/05		15.2	26.9			18.6			31%
2/15/05			45.5			27.5			40%
2/22/05						22.6			
3/1/05		17.8	34.1			25.8			24%
3/8/05		10.9	28.9			17.8			38%
3/15/05		14.5	24.7			15.6			37%
3/22/05		15.8	35.9			15.1			58%
3/29/05		20	51.6			25.5			51%
4/5/05		27.7	60.3			35.7			41%
4/11/05			50.1			32.6			35%
4/19/05			57.7			20.2			65%
4/26/05			41.5			23.3			44%
5/3/05		18.1	38.7			16.1			58%
5/10/05		34.4	82.9			33.3			60%
5/17/05		22.2	35.5			18.3			48%
5/23/05		28.1	61.9			46.8			24%
5/31/05		18.9	33.8			25			26%
6/6/05		27.7	44.6			18			60%
6/14/05		37.9	44.5			27.5			38%
6/21/05		27.1	44.9			26.7			41%
6/28/05		35.4	20.9			21.7			-4%
7/5/05		29.7	40			28.3			29%
7/12/05		31.1	37.6			25			34%
7/19/05		32.3	33.6			27.5			18%
7/26/05		33.5	47.9			41.7			13%
8/2/05		25	41.4			36.7			11%
8/9/05		35.7	53.1			42.5			20%
8/16/05		30.4	59.4			35			41%

8/23/05		26.3	46.6			46.7			0%
8/29/05		22.7	35.3			22.5			36%
9/5/05		27.9	42.1			30			29%
9/13/05		24.1	37			24.2			35%
9/19/05		19	36.6			28.3			23%
9/27/05		18.2	41.7			27.5			34%
10/5/05		21.1	36.3			23.3			36%
10/10/05		18	20.1			15.8			21%
10/17/05						21.7			
10/25/05		18.1	34			20.8			39%
11/1/05						16.7			
11/7/05						10			
11/14/05						17.5			
11/21/05						20.8			
11/28/05		18.2	19.1			19.2			
12/5/05						22.5			
12/12/05						20.8			
12/19/05						19.2			
12/26/05		17.4	25.8			21.7			16%
1/206						27.5			
1/9/06						31.7			
1/16/06						26.7			
1/23/06						20			
1/30/06		20	42.7			23.3			45%
2/6/06						21.7			
2/13/06						24.2			
2/20/06						28.3			
2/27/06		22.3	49.3			30.8			38%
3/6/06						38.3			
3/13/06						29.2			
3/20/06						26.7			
3/27/06		26.7	63.8			30			53%
4/3/06						36.7			
4/10/06						22.5			
4/17/06						19.2			
4/24/06		30.9	40.5			19.2			53%
5/1/06						15			
5/8/06						18.3			
5/15/06						26.7			
5/22/06						35.8			
5/29/06		29.5	72.3			48.3			33%
6/5/06						25.8			
6/12/06						20.8			
6/19/06						35			
6/26/06		34.9	55.3			38.3			31%
7/3/06						42.5			

7/10/06						15			
7/17/06						26.7			
7/24/06		29.9	59.3			26.7			55%
7/31/06						35			
8/7/06						45			
8/14/06						43.3			
8/21/06						20.8			
8/28/06		20.8	40.6			26.7			34%
9/4/06						5.5			
9/11/06						29.2			
9/18/06						19.2			
9/26/06						5.8			
10/2/06						6.7			
10/9/06						30			
10/16/06						68.3			
10/23/06	4	19.2				47.5			
10/30/06						40			
11/6/06	3.5	16.9	31.1			19.2			38%
11/13/06	2.8	18.7	45			15			67%
11/20/06	2.6	17.6	46.7			15			68%
11/27/06	4.5	22.6	43.3		13.7	17.5		39%	60%
12/4/06	7	21	39.2		12.2	16.7		42%	57%
12/11/06	4.2	16.6	40		18.9	15		-14%	63%
12/18/06	2.8	13.7	33.3		17.2	16.7		-26%	50%
12/25/06						12.5			
1/1/07	3.8	15.7	44.2		17.4	20.8		-11%	53%
1/8/07	3.8	13.7	30.8		9.9	14.2		28%	54%
1/15/07	2.8	15.3	30		11.3	15.8		26%	47%
1/22/07	2.7	13	26.9		10.9	15		16%	44%
1/29/07		15	20.8		20.6	15		-37%	28%
2/5/07	4.7	17.8	28.1	13.4	18.1	20.6	-185%	-2%	27%
2/12/07	4.1	15.5	25	16.6	17.2	15.6	-305%	-11%	38%
2/19/07	4.7	14.7	33.8	17.2	20	15	-266%	-36%	56%
2/26/07	4.4	14.8	34.4	21.4	21.1	12.5	-386%	-43%	64%
3/5/07	2.6	18.4	41.9	17.2	18.7	12.5	-562%	-2%	70%
3/12/07	3.2	15.3	41	8.6	10.2	13.1	-169%	33%	68%
3/19/07	4.2	18.3	42.1	12	12.7	13.1	-186%	31%	69%
3/26/07	3.8	11.8	27.2	12	13.1	4.4	-216%	-11%	84%
4/2/07	3.5	12.5	27.3	25	27.6	11.3	-614%	-121%	59%
4/9/07	2.8	8.7	25.2	24.5	27.4	11.25	-775%	-215%	55%
4/16/07	4.3	16.7	23	42.8	39.3	17.5	-895%	-135%	24%
4/23/07	4.5	19	30.3	51.1	49.8	20.6	-1036%	-162%	32%
4/30/07	4.2	25.1	56.1	59.2	66.6	45.6	-1310%	-165%	19%
5/7/07	3.4	24.3	70	73.4	76.7	38.8	-2059%	-216%	45%
5/14/07	2.4	23.5	74.4	60.5	68.4	51.9	-2421%	-191%	30%
5/21/07	2.5	19	53.6	88.1	99.2	43.1	-3424%	-422%	20%

5/28/07	3.1	24.9	70.9	57.8	51.3	56.3	-1765%	-106%	21%
6/4/07	1.5	17.4	63	24.5	30.3	47.5	-1533%	-74%	25%
6/11/07	2.1	17.8	50.4	19.7	21	36.3	-838%	-18%	28%
6/18/07	2.2	19.5	64.2	19.1	18.9	5	-768%	3%	92%
6/25/07	2.4	27.4	71.4	20.4	19.2	6.9	-750%	30%	90%
7/2/07	1.5	19.1	56.1	17.8	17.6	6.3	-1087%	8%	89%
7/9/07	3.7	27.2	45.7	22.1	23	6.3	-497%	15%	86%
7/16/07	3.2	26.3	48	25.3	28.1	4	-691%	-7%	92%
7/23/07	6.2	15.3	38.3	12.8	14.4	6.5	-106%	6%	83%
7/30/07	5	15.5	40	13.4	14.8	4.5	-168%	5%	89%
8/6/07	4.2	20.2	60.6	12.3	13.5	5	-193%	33%	92%
8/13/07	3.9	15.4	60	9.1	9.8	7	-133%	36%	88%
8/20/07	5.5	17.3	59.6	9.4	9.8	5.5	-71%	43%	91%
8/27/07	2	18	78.5	7.8	8.9	5.5	-290%	51%	93%
9/3/07	2.9	16.1	68.2	5.5	6	9	-90%	63%	87%
9/10/07	3	14.3	39.4	8.4	8.7	6.5	-180%	39%	84%
9/17/07	2.7	12.7	44.4	5.8	6.3	7	-115%	50%	84%
9/24/07	2.3	22.3	60.5	5.5	6.2	6	-139%	72%	90%
10/1/07						5			
10/8/07	2.2	17.3	42.1	4.3	5	2.5	-95%	71%	94%
10/15/07						4			
10/22/07	1.9	10.2	33.4	4	4	5	-111%	61%	85%
10/29/07	1.8	9.2	25.3	2.9	3.2	3	-61%	65%	88%
11/5/07	1.7	7.6	20.4	2.5	2.8	3.5	-47%	63%	83%
11/12/07	2.2	10.8	25.9	1.9	2.3	4.5	14%	79%	83%
11/19/07	1.7	13.8	26.6	1.9	2.7	2.8	-12%	80%	89%
11/26/07	2.8	17.2	33.4	2.7	3.8	3.5	4%	78%	90%
12/3/07			41.9	1.7	3.2	8.5			80%
12/10/07	5.1	20.1	39.5		2.3	4.5		89%	89%
12/17/07		19.3	39.8	3.8	3.2	4		83%	90%
12/24/07	4.7	23.2	37.7	2.5	2.9	3.3	47%	88%	91%
12/31/07	5.8	20.8	40.1	2.2	2.9	3.5	62%	86%	91%
1/1/08	5.5	19.7	40.1			3.5			91%
1/7/08	4.7	22.1	39.6	2.8	4.7	4.3	40%	79%	89%
1/14/08			34.7			4			88%
1/21/08	3	20.9	34.3	2	2.9	3.8	33%	86%	89%
1/28/08	6.4	22.7	37.8	2.9	3.3	6	55%	85%	84%
2/4/08	4.8	21.9	27.2	2.2	5.6	4.5	54%	74%	83%
2/11/08	3	16.1	24.5	3.3	5.5	3.5	-10%	66%	86%
2/18/08	4.4	14.2	23.2	1.8	3	2.3	59%	79%	90%
2/25/08	4.1	15.2	24.8	3.3	5.4	3.5	20%	64%	86%
3/4/08						2.5			
3/10/08	2.4	11.2	30.2	3.6	4.3	3.5	-50%	62%	88%
3/17/08	1.5	8.8	28.7	4.1	4.2	4	-173%	52%	86%
3/24/08	2.4	18.2	38.8	3.9	4	4	-63%	78%	90%
3/31/08	3.4	15.9	40.8	2.9	6.1	5	15%	62%	88%

Average	**4**	**20**	**43**	**16**	**17**	**23**			
Average since 6/18/06	**3**	**18**	**42**	**7.2**	**7.9**	**5.1**		**56%**	**88%**

Notes:
1. 4/9/07 results were from a composite sample of 37% wetland effluent and 63% L-2 effluent.
2. 4/17/07 results were from a composite sample of 20% wetland effluent and 80% L-2 effluent.
3. 4/24/07 results were from a composite sample of 29% wetland effluent and 71% L-2 effluent.
4. 5/7/07 results were from a composite sample of 20% wetland effluent and 80% L-2 effluent.
5. 5/14/07 results were from a composite sample of 35% wetland effluent and 65% L-2 effluent.
6. 5/21/07 results were from a composite sample of 42% wetland effluent and 58% L-2 effluent.
7. 5/28/07 results were from a composite sample of 11% wetland effluent and 89% L-2 effluent.
8. 6/4/07 results were from a composite sample of 23% wetland effluent and 77% L-2 effluent.

TSS data in Table 6.7 that were before the wetland startup shows that chlorine disinfection system removed substantial TSS in the L-2 effluent. The TSS removal was due to the killing of algae by the chlorine. But the TSS removal was not consistent, and plant effluent TSS had the same trend as the L-2 effluent TSS (see Figure 6.15 and 6.16).

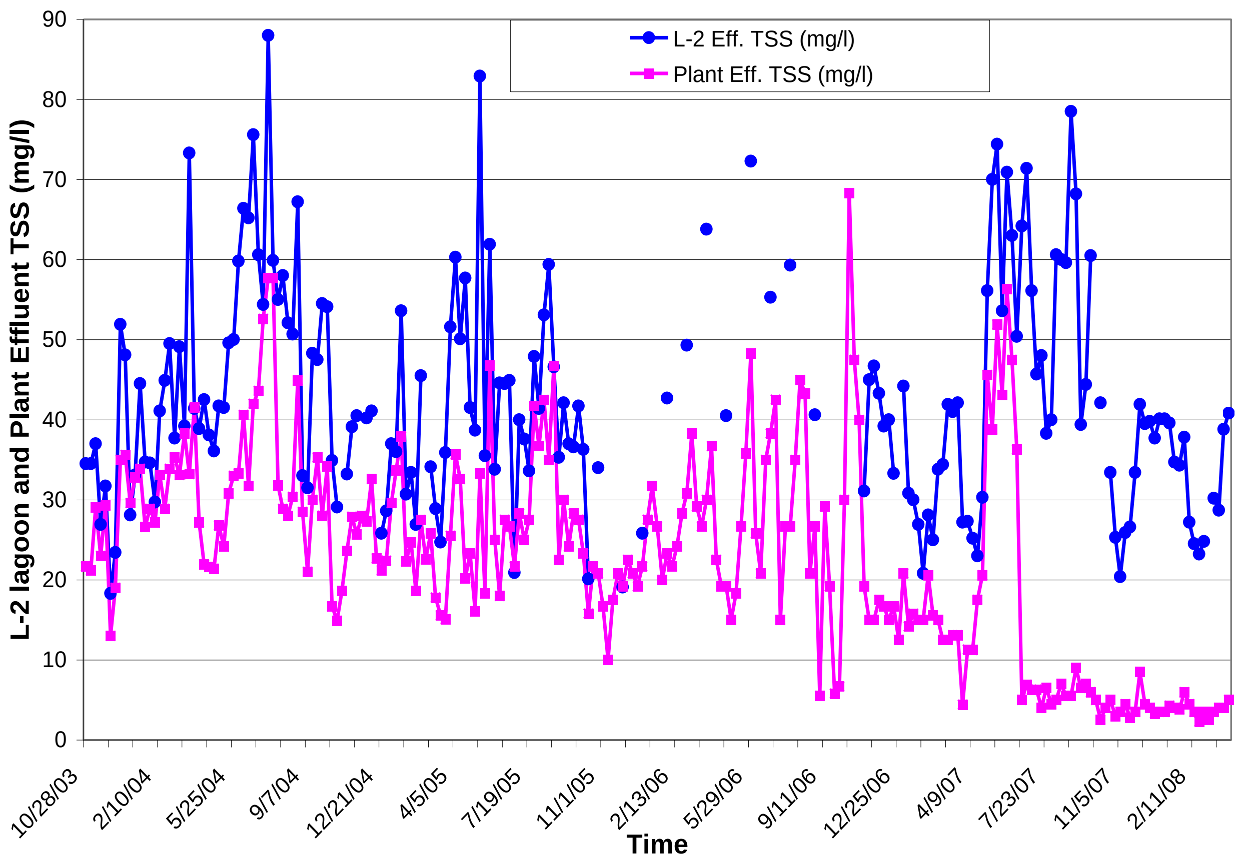

Figure 6.15 – L-2 Lagoon and Plant Effluent TSS

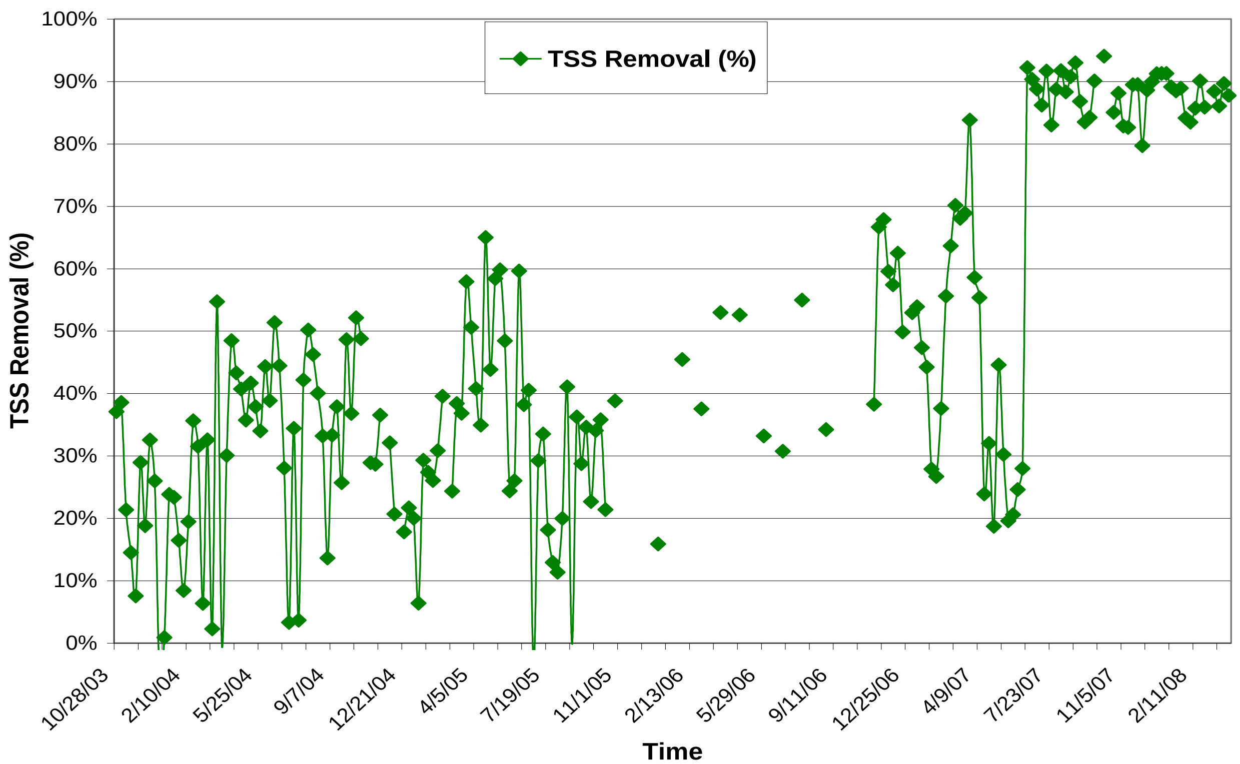

Figure 6.16 – TSS Removal (%)

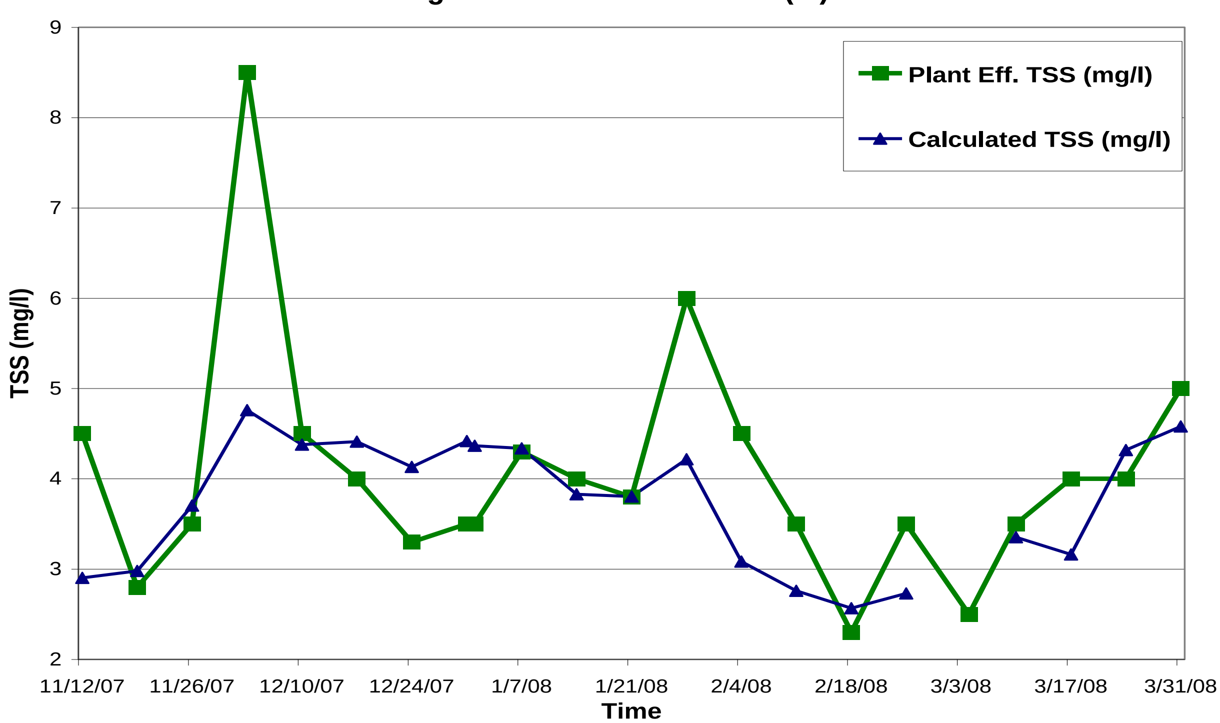

Figure 6.17 – Monitored and Calculated TSS Comparison

The wetland began service in November 2006. In the initial several months of operation, debris in the wetland media, primarily from the tire chip media, was washed out and cause erratic TSS variation in the wetland effluent as shown in the Figure 6.15 and 6.16. Another reason for the initial TSS erratic change was mixing the wetland effluent with L-2 lagoon effluent. However, the wetland has consistently removed TSS to below 5 mg/l for an average efficiency of 88% since June 18, 2007. The "2005 Addendum to the 1994 Engineering Report" for the wetland design has predicted a 5.3 mg/l of TSS for the wetland effluent based on 44 mg/l influent TSS. The average data since June 18, 2007 in Table 6.7 is generally in line with the design influent TSS and predicted effluent TSS. A validation analysis was performed for the monitoring data from November 12, 2007 to March 31, 2008 (see **Appendix F**). The monitored TSS data and the calculated TSS values generally correlate well as shown on the Figure 6.17.

Limited data in Table 6.7 and on Figure 6.15 also show that the wetland can handle high influent TSS without affecting effluent TSS.

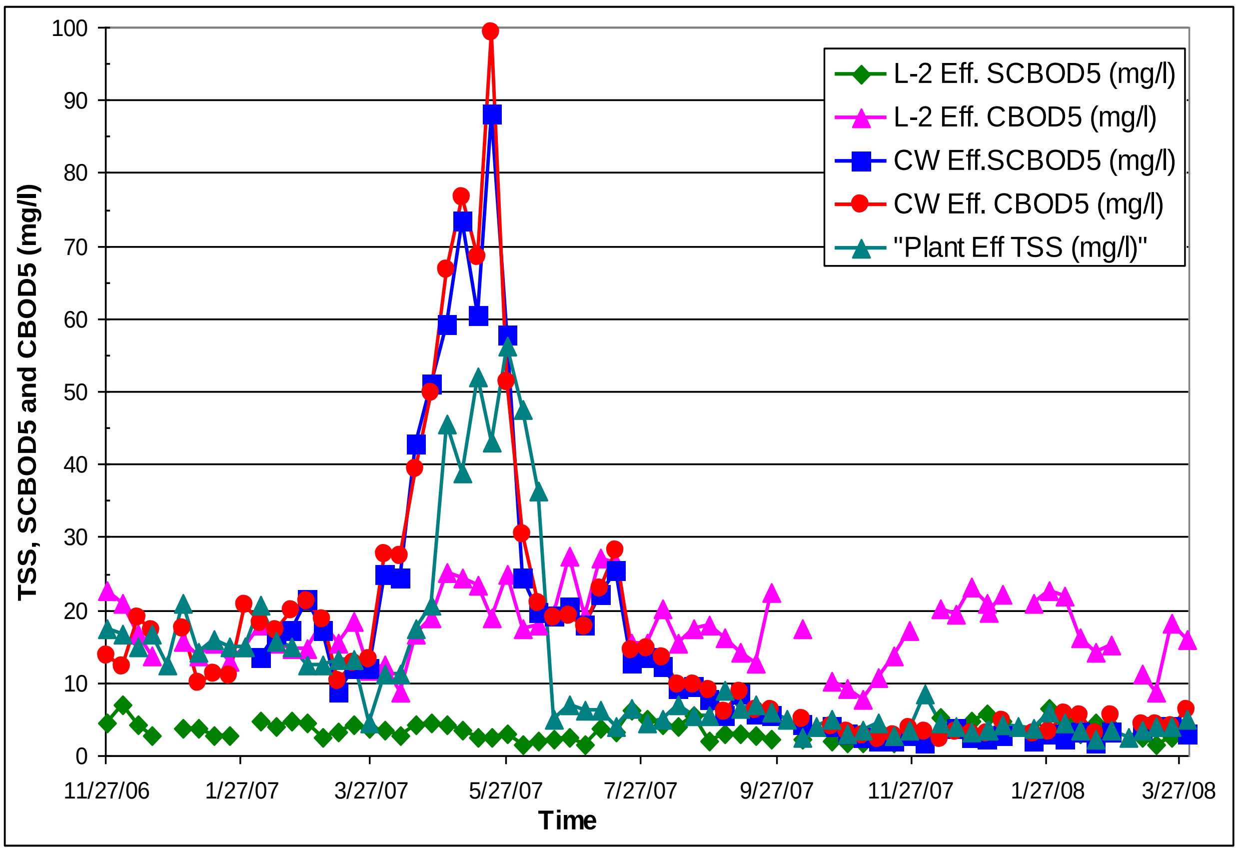

Figure 6.18 – Wetland Influent and Effluent $SCBOD_5$, $CBOD_5$ and Plant Effluent TSS

Figure 6.18 indicates several facts or phenomena. First of all, it verified that L-2 lagoon has removed soluble $CBOD_5$ to such a degree that the remaining soluble $CBOD_5$ can be considered as non-biodegradable. Second, wetland media had contributed both $CBOD_5$ and soluble $CBOD_5$ in the initial several months of operation. It is nearly certain that the $CBOD_5$ contributions were attributable to the steel wires (ferrous iron) in the tire chips. It appears that the wetland media stopped leaching out and contributing $SCBOD_5$ around November 12, 2007 based on the comparison of the L-2 lagoon effluent $SCBOD_5$ and the wetland effluent $SCBOD_5$ in Table 6.7. Third, wetland effluent $CBOD_5$ and $SCBOD_5$ had the same trends that were independent of the influent $CBOD_5$ and $SCBOD_5$ to the wetland. This is a further confirmation that wetland media were responsible for the initial variations of the wetland effluent $SCBOD_5$ and $CBOD_5$. However, once the wetland media stopped $SCBOD_5$ and $CBOD_5$ contributions, the wetland effluent $CBOD_5$ and $SCBOD_5$ is also stabilized. Fourth, wetland effluent $CBOD_5$ correlated well with the reduction of the TSS by the wetland after the debris in the wetland media was washed out. This is a confirmation of the particulate $CBOD_5$ contribution by algae and biosolids. Finally, average wetland effluent $CBOD_5$ is slightly higher than the average effluent $SCBOD_5$. This indicates that majority of the L-2 CBOD5 is particulate in nature, and particulate $CBOD_5$ in the wetland effluent is almost non-existent, and the subsurface wetland is very effective for particulate $CBOD_5$ removal due to excellent the TSS removal efficiency.

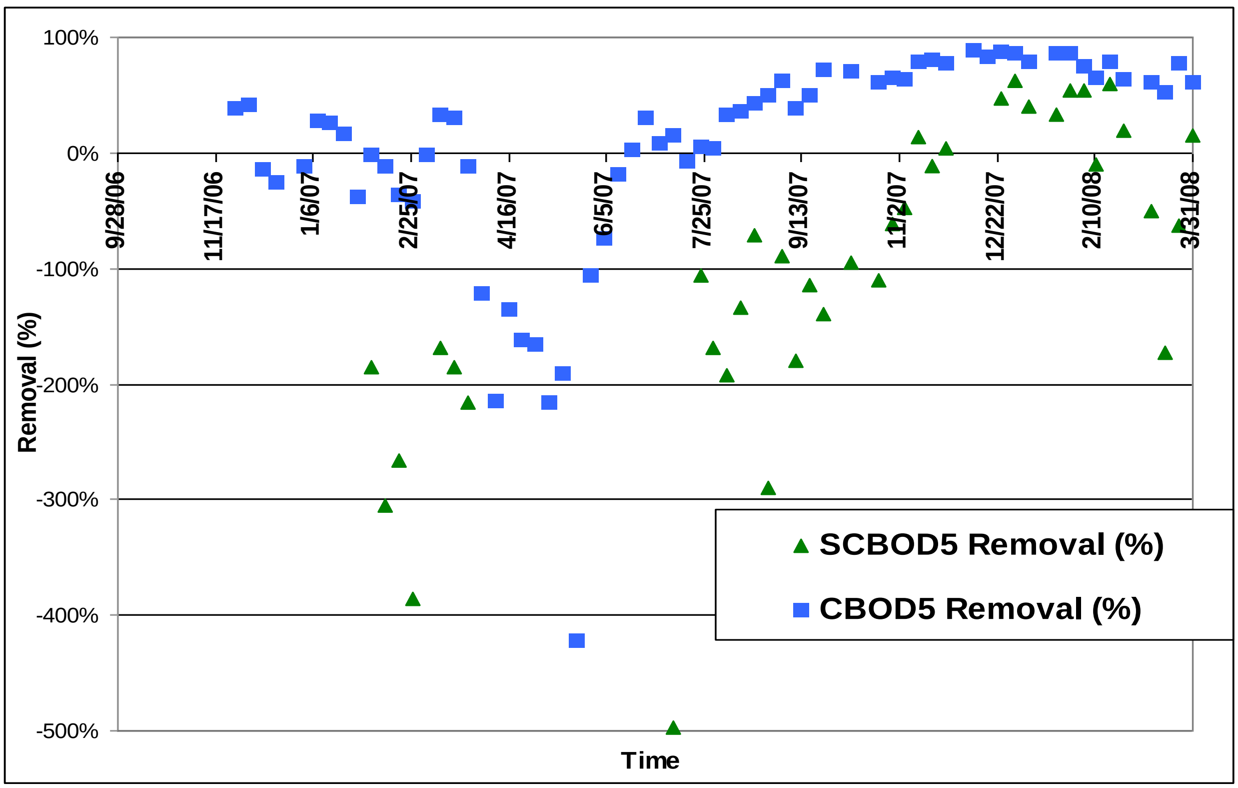

Figure 6.19 – Wetland $SCBOD_5$ and $CBOD_5$ Removal Efficiencies

Figure 6.19 shows the $SCBOD_5$ and $CBOD_5$ removal efficiencies of the wetland. Negative removal efficiencies are generally due to the contributions by the dissolved compounds from the wetland media. The most recent $SCBOD_5$ removal efficiencies shown on the figure varied erratically, but they were meaningless because the differences between the influent and effluent wetland were very small, they were well within the allowable errors of sampling, testing, etc.

$CBOD_5$ removal efficiencies shown on the figure were consistently higher than 50% after September 2007.

The “2005 Addendum to the 1994 Engineering Report” for the wetland design has predicted a 4.7 mg/l of $CBOD_5$ for the wetland effluent based on 22 mg/l influent $CBOD_5$ and the wetland design flow of 41,424 gpd. The average influent $CBOD_5$ since June 18, 2007 in Table 6.7 was 18 mg/l, which is lower than the design influent $CBOD_5$. The predicted effluent $CBOD_5$ was 4.7 mg/l, which is lower than the average wetland effluent $CBOD_5$ of 7.9 mg/l. It must be pointed out that the predication was based on biodegradable $CBOD_5$ with fully established and matured vegetation. The average wetland effluent $CBOD_5$ contained approximately 4 mg/l non-biodegradable $CBOD_5$. If the 4 mg/l non-biodegradable $CBOD_5$ is to be excluded from the wetland effluent, then the remaining biodegradable effluent $CBOD_5$ is fairly close to predicated value.

A validation analysis was also conducted for the wetland effluent $CBOD_5$ and included in the **Appendix F**. The validation analysis shows that the monitored $CBOD_5$ and the calculated $CBOD_5$ correlated reasonably well (see Figure 6.20).

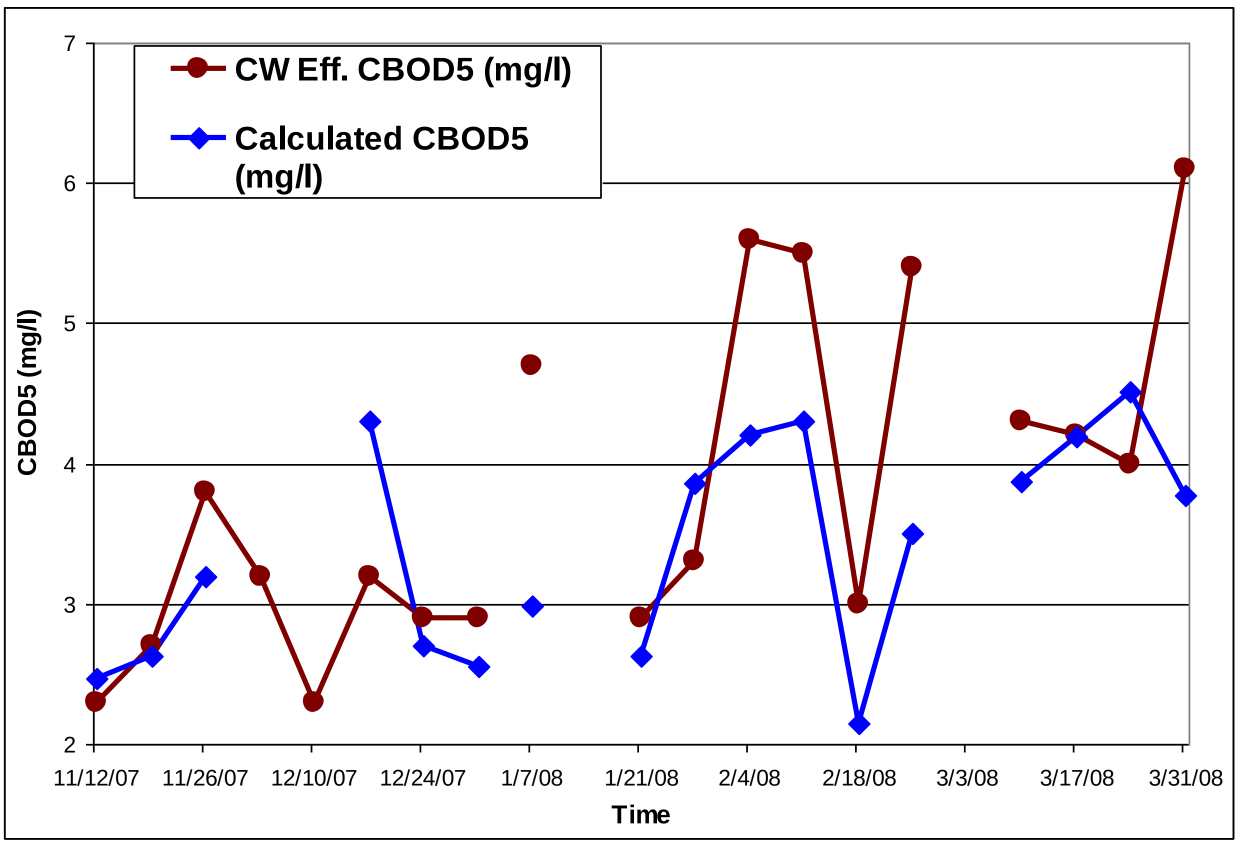

Figure 6.20 – Monitored and Calculated Wetland Effluent $CBOD_5$

In addition to the particulate $CBOD_5$ and TSS removal, other observed benefits of the wetland includes reduction of fecal coliform, less chlorine dosage requirement and easy control of chlorine residual for the plant effluent.

Picture 6.6 is the most recent picture taken at the end of May, 2008. The purpose of the vegetation in the wetland is to take up nutrients in the lagoon effluent and transmit oxygen to the wetland media for bacteria aerobic digestion use. Plant operator has reported that wetland effluent has very low DO. In fact, the effluent has to be aerated with a small pump in an existing manhole upstream of the chlorine contact chamber for preventing denitrification occurring in the chamber. But the vegetation propagates in the wetland, DO in the effluent should increase.

In conclusion, it appears that debris in the wetland media has been washed out, and $CBOD_5$ contributing compound leaching from the tire chips has either stopped or been consumed to insignificant level. Wetland effluent quality is consistently very good. The monitored TSS and $CBOD_5$ values correlated well with the calculated values.

Recommendations: No improvements are needed at present. Once vegetation in the wetland fully matures and establishes, better effluent quality is expected.

6.3.9 Final Effluent Disinfection

Description: The disinfection system consists of a calcium hypochlorite tablet feeding device and a contact chamber. The tablet feeding device was fabricated by the plant operator. Chlorine dosage is manually adjusted by varying the stream flowing through the tablet feed device.

P-6.9: Chlorine Feed Device

Shown on Figure 6.21 and Figure 6.22 are the as-built drawings of the existing chlorine contact chamber. The chorine contact chamber is 8' wide, 10'-3" long and 7'-6" deep pre-cast concrete tank. The chamber has 3" wide and 5' tall concrete baffles. The contact chamber has a volume of 3,000 gallons at 5 feet water depth. At minimum 30 minutes contact time, this volume is equal to 144,000 gpd flow capacity.

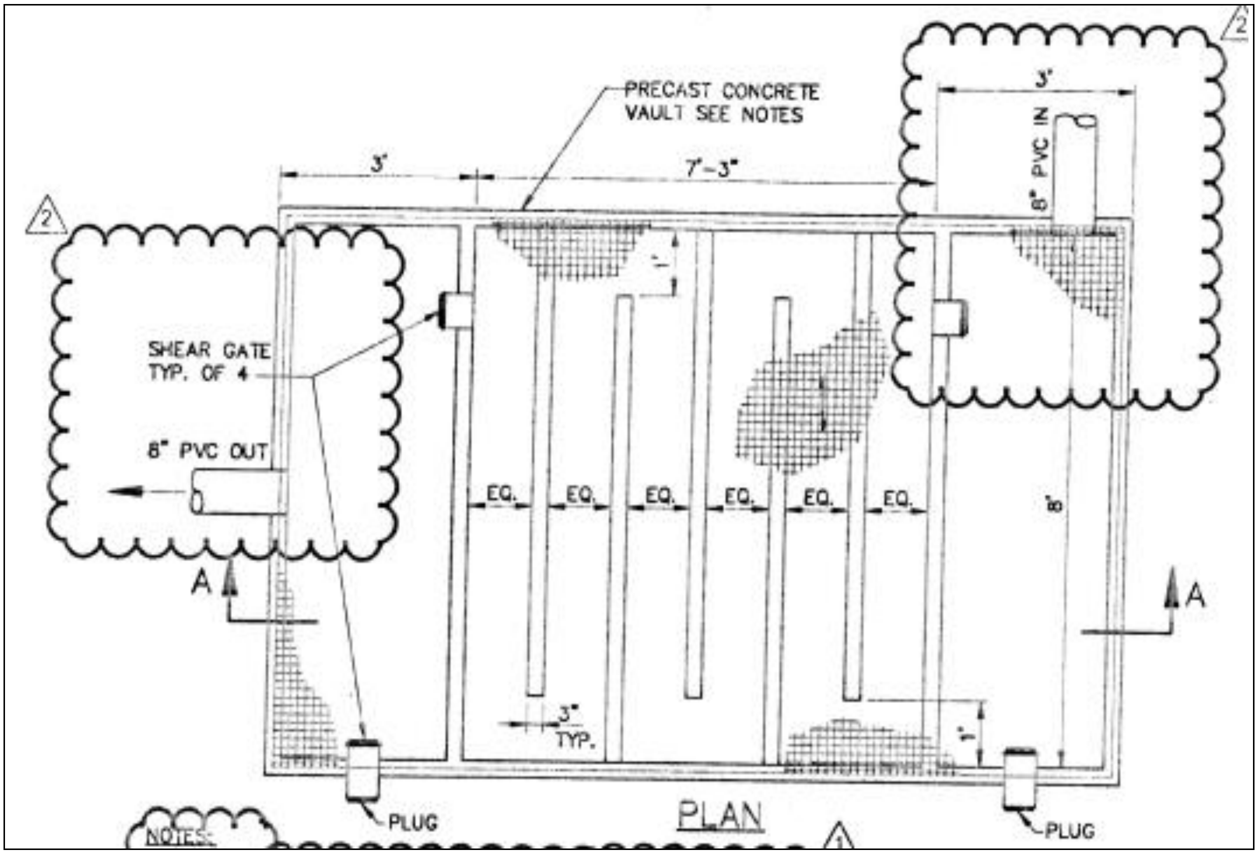

Figure 6.21 – Chlorine Contact Chamber Design Plan

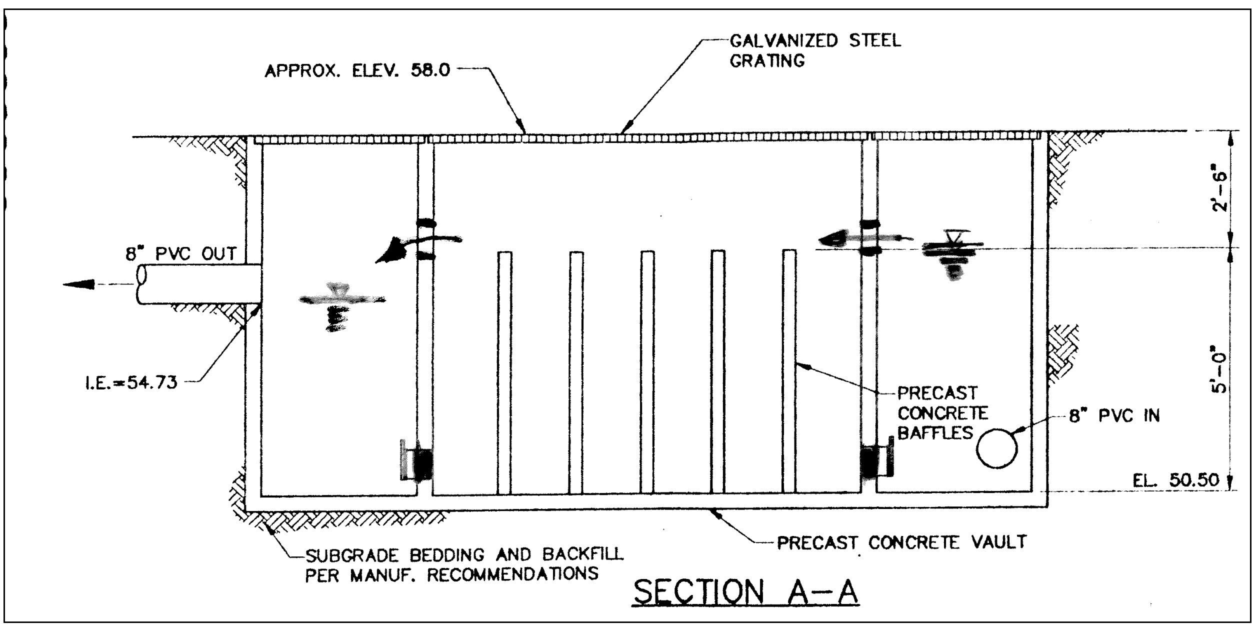

Figure 6.22 – Chlorine Contact Chamber Design Section

FISHERMAN BAY SEWER DISTRICT
WASTEWATER SYSTEM MASTER PLAN – DRAFT

Evaluations: Since the tablet feed device is an improvised system by the plant operator, thus there is no capacity limitation because the operator can fabricate a new large system if needed. The capacity of the contact chamber is sufficient for meeting currently permitted plant capacity. But it is not large enough to meet the projected year 2020 peak flow disinfection needs. Therefore, the District should prepare to expand the disinfection system for meeting the future flow needs. Potential alternatives for expanding the existing disinfection include expansion of the existing chlorine contact chamber and replacing the existing system with an ultraviolet disinfection system. These alternatives will be further discussed later in the report.

The District's current permit limits for fecal coliform are 200/100 ml for monthly average and 400/100 ml for weekly average. The District was in compliance with the monthly average permit requirements with occasional weekly permit violations based on data shown on Figure 6.23. The difficulty of fully compliance with the weekly fecal coliform permit requirement was primarily due to high algae in the effluent and nitrification in the lagoon. Algae in the effluent provide protective cover for the bacteria and reduce the efficiency of the disinfection. Nitrification in the lagoon produces nitrite that consumes chlorine, thus reduce the amount of chlorine that can be used for disinfection. High algae and nitrite often occur at the same time, which presents difficulty of providing adequate chlorine dosage for disinfection within the required residual chlorine limit.

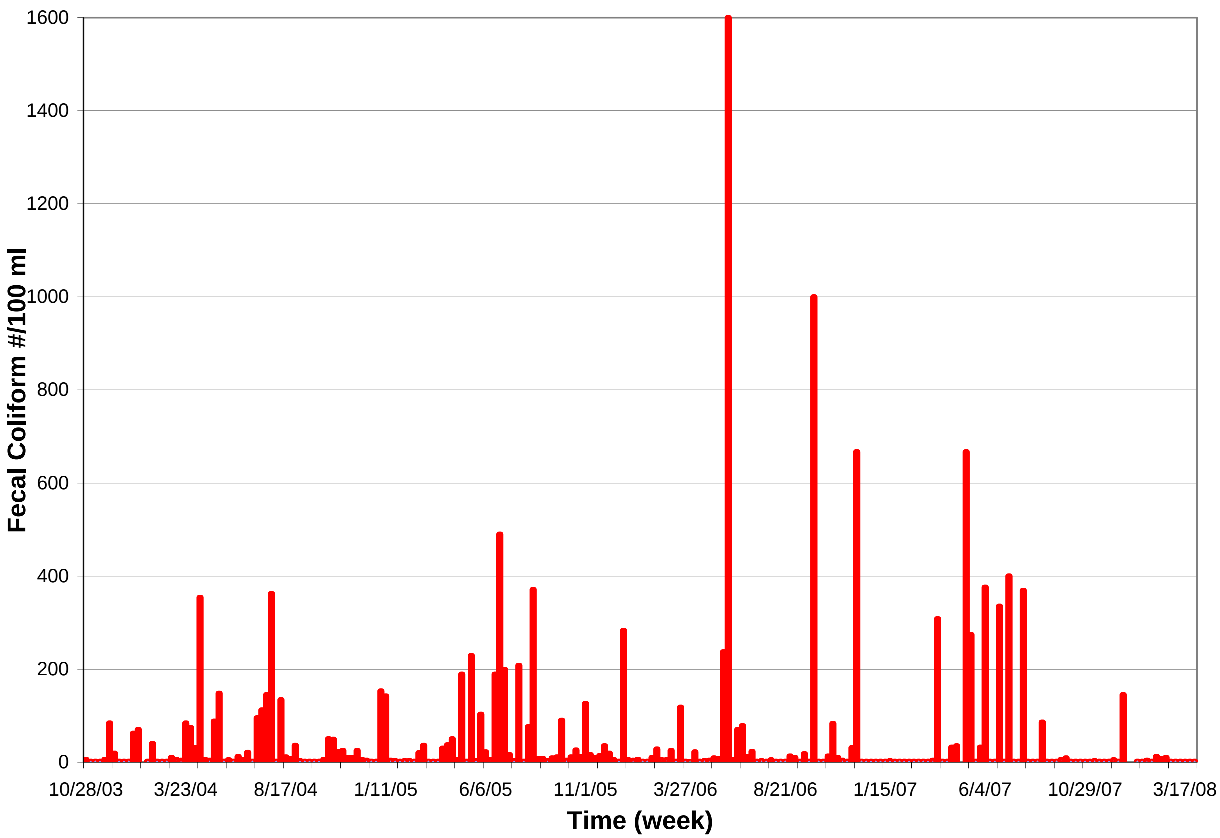

Figure 6.23 – Weekly Effluent Fecal Coliform

Performance of the disinfection system has improved since the performance of the wetland stabilized in recent months. The operator recently reported that the wetland has removed significant fecal coliform, and the effluent contains less 100 to 500 fecal counts/100 ml based on testing. At the same time, the required chlorine dosage has also reduced. The operator was able to consistently maintain a chlorine residual of less than 0.1 mg/l, which is well below the permit requirement of 0.5 mg/l.

The District's current permit for total residual chlorine (TRC) limit is 0.5mg/l for monthly average and 0.75 mg/l for weekly average. Additionally, the permit also has an interim limit of 0.75 mg/l for monthly average and 1.0 mg/l for weekly average. The interim limit expired on November 26, 2007. The District was generally in compliance with the monthly limit, with occasional weekly permit violations.

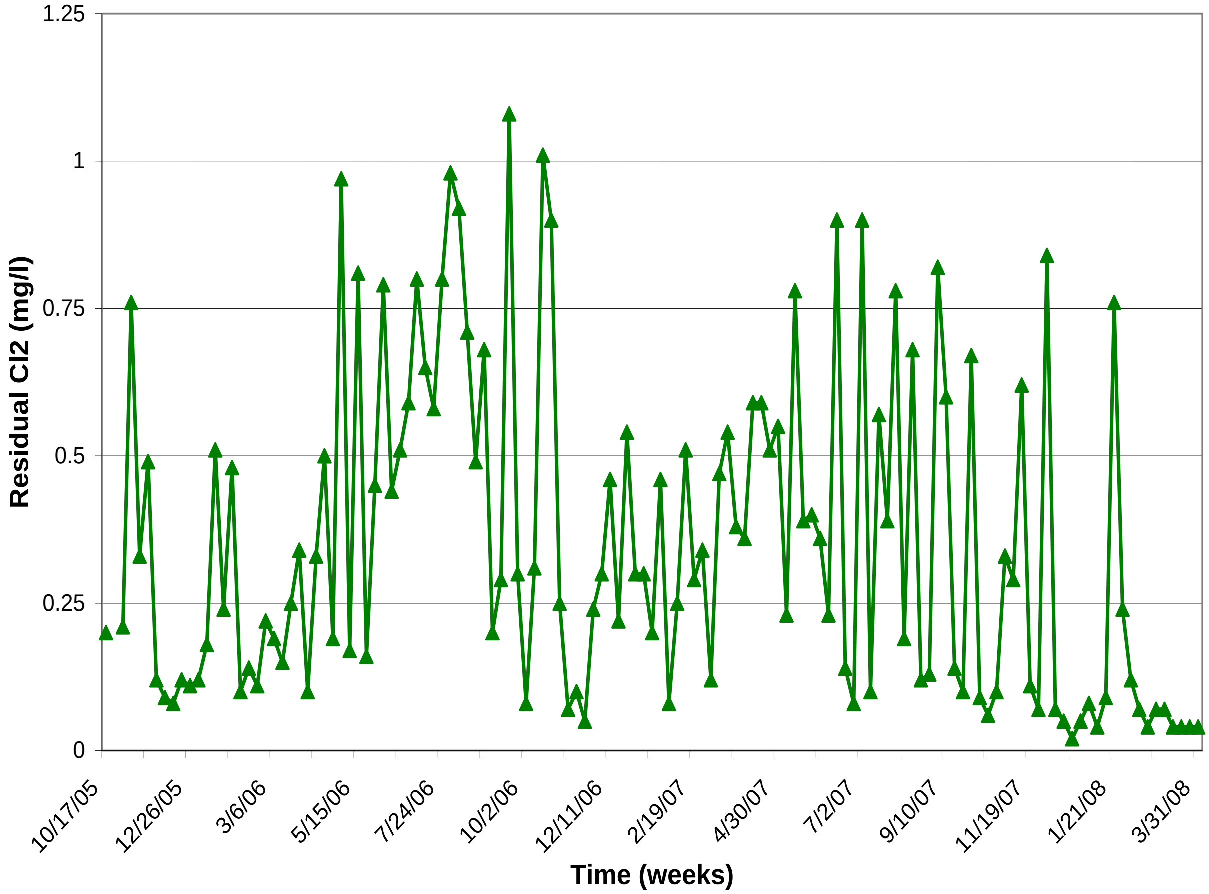

Figure 6.24 – Weekly Effluent TRC

Recommendations: The District should consider preparing an implementation plan and schedule for expanding the existing disinfection system for meeting the projected future flow needs.

6.3.10 Plant Effluent Metering

Description: The effluent flow metering system is located outdoor, enclosed by a wooden box, and in the vicinity of the chlorine contact chamber. The effluent metering system is almost identical to the influent metering system. The metering system consists of a large pre-fabricated fiberglass trapezoidal type of flume with a 60^o V-notch throat and a Stevens flow meter. The flume is manufactured by Plasti-Fab. The flume is connected to 4" pipes at both ends. The gage on the flume shows that the maximum measuring depth is 0.6 ft. The instantaneous totalized flow rate and totalized daily flow rate are measured by the Stevens A/F data logger.

P-6.10: Plant Effluent Flume

Evaluations: Information on the manufacturer's website indicates this flume has measuring range of 1 to 120 gpm or 1440 gpd to 172,800 gpd. The flume's capacity appears adequate for the present flow conditions, but very close to the projected year 2020 peak flow conditions.

The existing Stevens flow meter is functional. Flow data is generally downloaded once a month. The flow meter offers instantaneous flow reading at the site, but not totalized flow reading.

Recommendations: The District should consider the following improvements to the influent metering system in the future plant expansions:

- Replace the existing large flume with an x-large flume that offers a measuring range of 1 to 600 gpm or or 1440 gpd to 864,000 gpd. But if an effluent pump station is installed as recommended later in this report, then a magnetic flow meter is recommended with the pump station for effluent metering.
- Install the flume in a concrete channel with checkered plate for better protection of the flume.
- Replace the existing Stevens flow meter with an ultrasonic flow meter for instantaneous flow and totalized flow reading at the site.

6.3.11 Plant Effluent Outfall and Discharge

Description: After effluent metering, plant effluent is discharged into San Juan Channel via a 4-inch diameter outfall, 2,800 feet in length, with a single 2-inch diameter diffuser port. The outfall was repaired and anchored in 1994 and the missing 2-inch diffuser on the end of the pipe was replaced. In 2004, an outfall inspection was performed and the outfall was again re-anchored and another 2-inch diffuser was re-attached.

Evaluations: The outfall is a gravity pipe with a submerged discharge in the San Juan Channel. As-built information for the outfall is incomplete. The capacity of the outfall is limited by the slope of the fall and the sea level in the San Juan Channel. Under normal conditions, only the portion of the pipe that lies above the sea level flows by gravity at partially full. The rest of the pipe is flowing full under pressure. Presumably, the full flowing pipe is last portion of the outfall prior to the discharge. The operator has reported that water backs up in the plant's lagoon during heavy rain events due to the limited capacity of the outfall. Therefore, during the extreme rain events, the whole length of the outfall is flowing full under pressure. The capacity of the outfall during full flowing condition is determined by the level differential between the sea level and the water level in the effluent flume. The limited capacity of the outfall has not only caused water backing up, but also has limited the amount of flow the plant can accept due to concerns of overflowing the influent flume. Restricting flow entering the plant during rain days can potentially cause sewage backup in the collection system or even overflowing at some low areas. Therefore, the capacity of the outfall should be addressed as early as possible.

There are several potential alternatives for addressing the outfall capacity problem. These alternatives include construction of a storage pond at the plant site, replacing the existing 4" outfall with a large pipe, construction of a parallel new outfall, or construction of a new effluent pump station. The effluent pump station appears to be a cost effective alternative for addressing outfall capacity problem in comparison with the other alternatives. This alternative can potentially eliminate the need for upgrading the existing effluent metering system by using a magnetic flow meter instead. Detailed evaluations of these alternatives are provided in Section 7 of this report.

Recommendations: The recommended alternative is to construct a new duplex effluent pump station. The operation of the pump station will be automatically controlled by levels in the wetwell.

The effluent pump station alternative requires upgrading the existing the generator for emergency uses and checking the pressure rating of the outfall pipe. The new generator shall include an automatic switch for turning on/off in the event of power outage.

P-6.11: L-1 Lagoon

6.3.12 L-1 Lagoon

Description: The L-1 lagoon was built in the 1980 and operated as the primary aerated lagoon. After the 1995 plant expansion, this lagoon was operated as an aerated polishing/settling cell. But after the 2003 plant upgrade was completed, this lagoon was used primarily for emergency storage during heavy rain events since it was taken off line in April 2004. The L-1 lagoon was lined with PVC liner which is covered by 6" of backfill for the protection of the liner. The lagoon is 7 ft deep according to the as-built drawings. The water surface area at full depth is approximately 8,500 square feet. Sludge measurement by the District in May 2007 shows that sludge accumulation in the lagoon varies from 6 inches to 36 inches. Estimated average sludge depth was 24 inches. Estimated sludge quantity was 89,000 gallons at 3 to 6% solids. Preliminary test results show that sludge from this lagoon met all Class B biosolids criteria.

The Department of Ecology (DOE) has notified the District that the L-1 lagoon must be decommissioned and biosolids in the lagoon have to be appropriately disposed of. The DOE has approved the District's solids sampling and testing plan, and solids removal and disposal plan for completing the requested decommission in the summer of 2008. The District is considering potential options of using the L-1 area, but no formal study or decision has been done or made.

The removal and land application of the biosolids will be conducted by a licensed contractor. All prospective contractors will be required to submit documentations to show that they are permitted to conduct biosolids disposal. In addition to cost, the District will require the contractors to include a detailed biosolids removal and disposal schedule, location of the land application, land application plan in their proposal.

Evaluations: Based on past experiences with heavy rain events, it is wise to consider re-building the L-1 lagoon into a dedicated emergency storage pond. However construction of a duplex pump station for pumping plant effluent to the San Juan Channel is generally less expensive, but more effective for resolving then plant outfall capacity limitation problem. This alternative also requires less land area.

Recommendations: We do not recommend re-building the existing L-1 lagoon for a storage pond at this time. The District should consider other potential future uses for the L-1 lagoon area other than storage. A formal study should be done to determine the best option of using the L-1 area.

6.3.13 Solids Treatment and Disposal

Description: Solids in the wastewater are either collected by the septic tanks in the District's STEP system, or are settled in the anaerobic pretreatment cell or the L-2 lagoon at the plant. The septage collected by the septic tanks are pumped and sent to Anacortes by a contractor for further treatment and final disposal. Typical quantity of the septage is approximately 40,000 gallons/year. The scum collected by the influent flow tank and grease trap contents in the STEP system are pumped and sent to Tenelco for treatment and disposal. The District conducts a sludge depth survey annually for the anaerobic pretreatment cell and L-2 lagoon. When sludge removal from the two ponds is required, a professional contractor will be used for the removal, handling and final disposal.

Evaluations: Data in Table 4.9, Figure 4.7 and Figure 4.8 show that the plant influent TSS varied from low teens to approximately 70 mg/l with a simple average value of 37 mg/l. This influent TSS is very low in comparison with the typical value of 220 mg/l for domestic wastewater. This means that the septic tanks in the District's STEP system are very efficient in TSS removal.

Recommendations: The current practices of solids handling appears adequate, no improvements are required at present.

6.3.14 Electrical and Control System

Description: According to 1996 record drawings, Opalco Utility is the power provider for the plant. Primary power supply to the plant is 120/240 V, single phase. The plant also has a 5KW (6.7 hp) standby generator as the alternative power sources in case of power outage. The generator provides 120/240V and single phase power. The generator is able to run 6 hours continuously before the fuel tank must be refilled. The plant's motor control center (MCC) has a 200A circuit breaker. There are spare spaces for four (4) additional breakers on the MCC. Shown on Figure 6.25 through 6.26 are electrical and control record drawings.

Current power uses at the plant include lighting, lab instruments, ventilations, aerators and recirculation pumps. The constant running aerator in the L-2 lagoon is rated 3.0 hp. The timer controlled aerator is rated 2.0 hp. The recirculation pump is rated ¼ hp and the aeration pump prior to the chlorine contact chamber is rated 0.5 hp.

The control system consists of an auto dialer and a timer. The auto dialer will alert the operator in the event of power outage and aerator failure. The timer is recently added to control the operation of the aerator in the Cell #2 of the L-2 lagoon.

Evaluations: It is estimated that 200A at 240V is approximately 64 hp. The 200A circuit breaker appears to be adequate for present and foreseeable future power needs. There are also enough spare breaker spaces the MCC for additional equipment connections because only two aerators are used at present. The single phase power supply is functional, but generally 3-phase power is recommended for motors that are larger than 1 hp. The control system is simple, and adequate for the plant's alerting/warning system.

The 5 KW generator must be manually turned on and off in the event of power outage. Though the generator appears to be able to meet the present plant's needs, it is not used for powering the aerators according to the operator because in the event of power outage, the pumps in the collection system are also down, so the plant receives little influent during power outage.

But the operator also reported that some of residents installed their own generators in recent years, so some of the pumps in the collection system can pump wastewater to the plant during power outage.

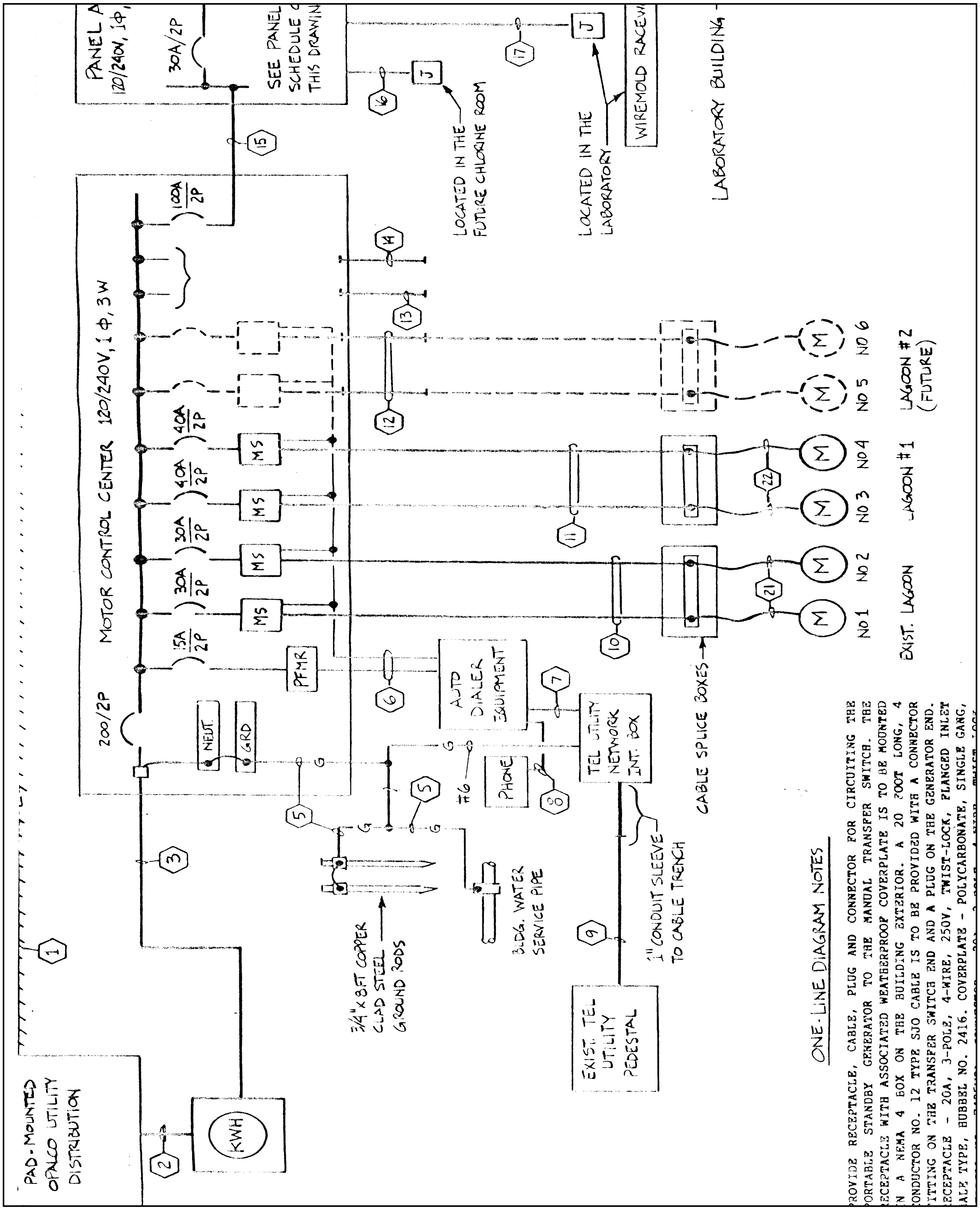

Figure 6.25 – Existing MCC Diagram

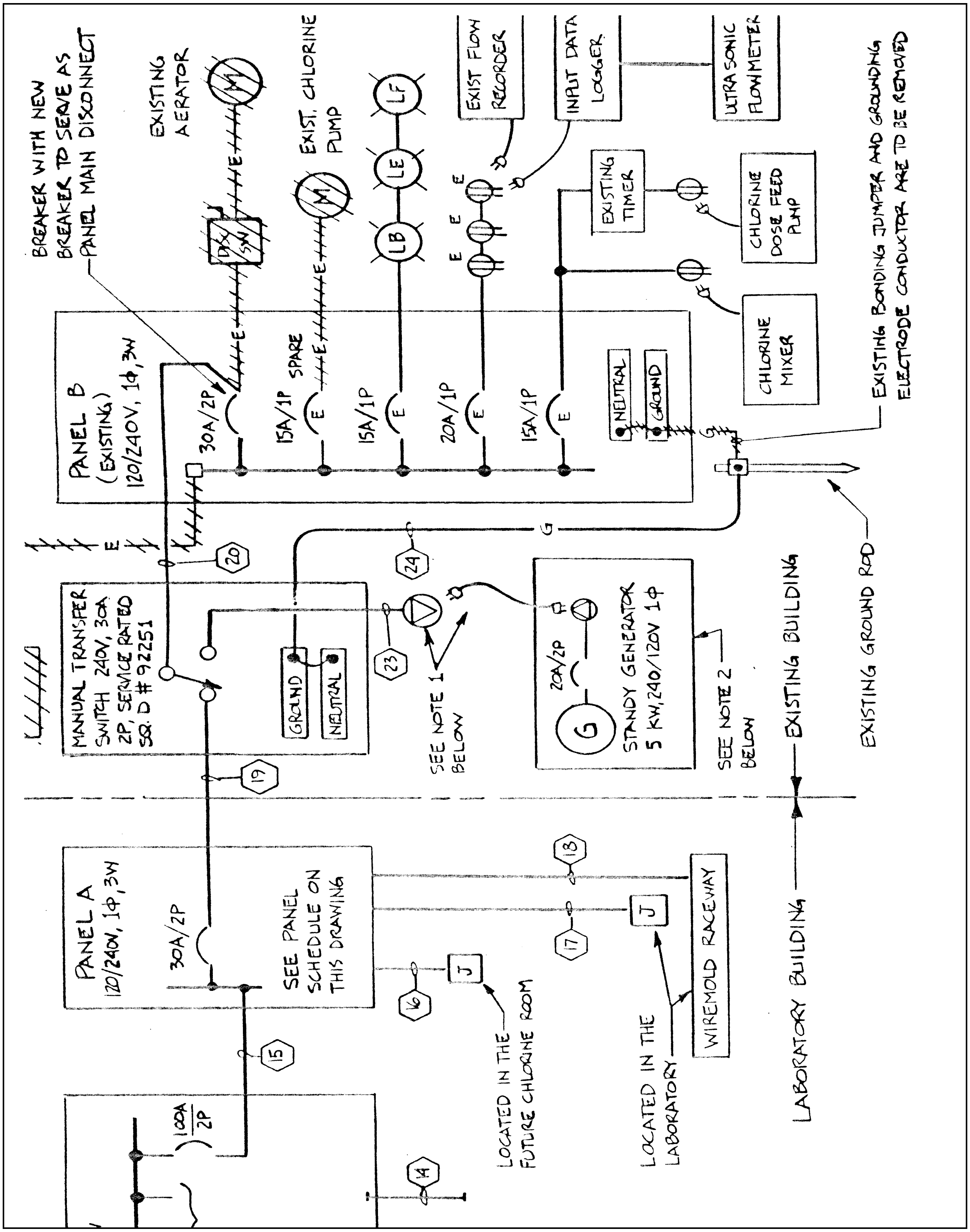

Figure 6.26 – Generator Connection Diagram

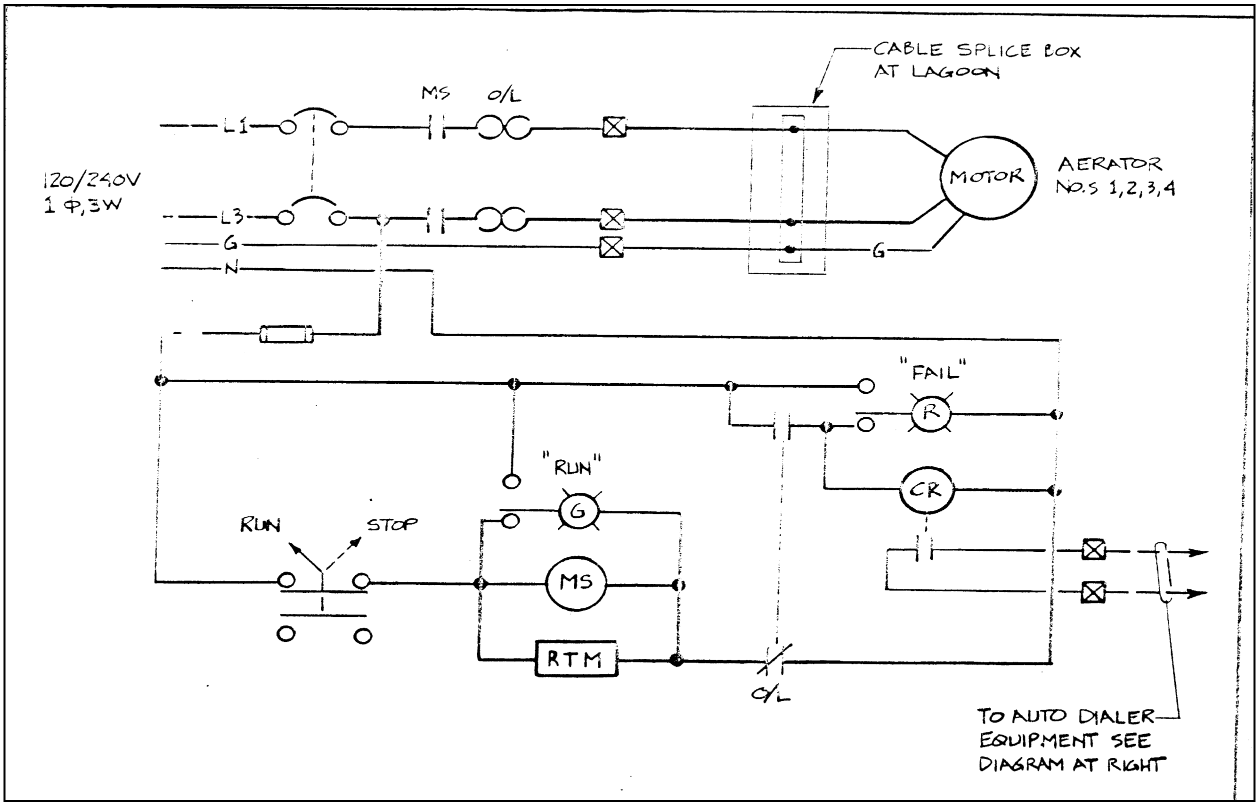

Figure 6.27 – MCC Control Diagram

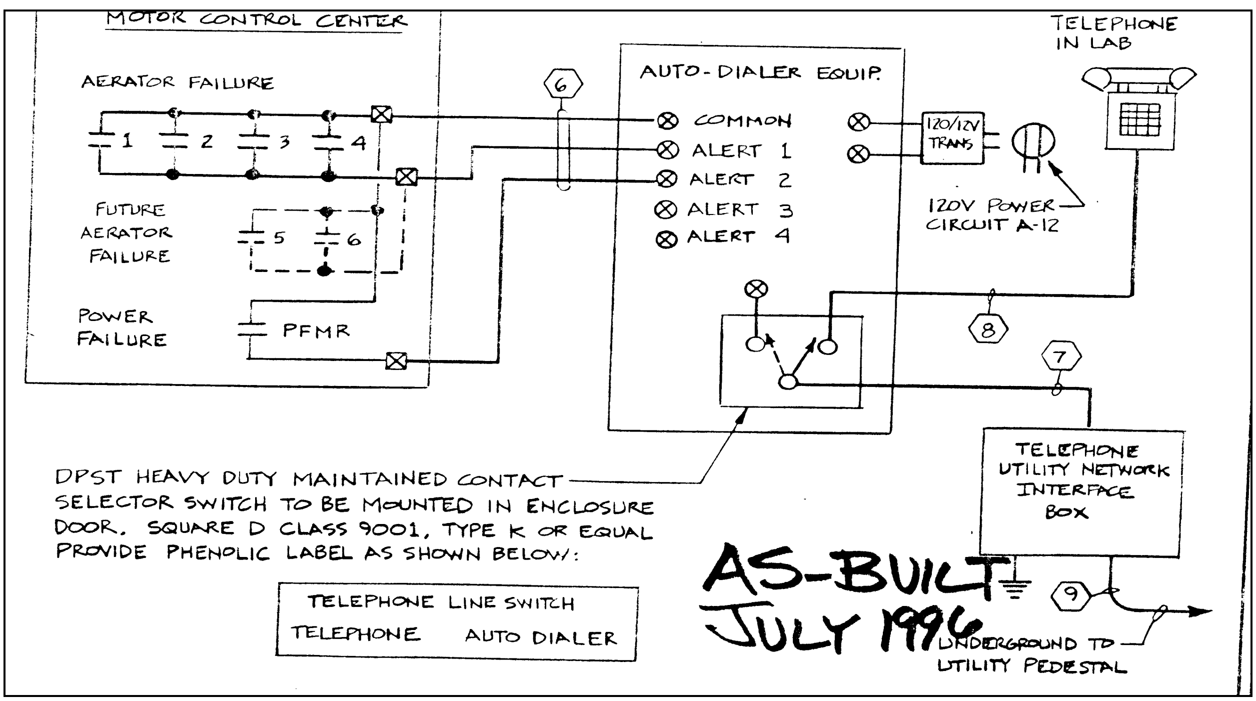

Figure 6.28 – Aerator Control Diagram

Generally, the generator is required to provide power for all critical equipment in the plant. For the District's plant, the critical equipment includes aerators and the effluent pumps if installed in the future. Typically, the generator should be equipped with an automatic switch for turning on/off the generator.

Recommendations: The District should consider upgrading the existing electrical system to 3-phase power supply if feasible and replacing the existing generator with a larger generator with an automatic switch in the future plant expansion.

6.3.15 Administration, Operator, and Lab

Description: The District's organization consists of commissioners, clerk and plant operating personnel. The Commissioners are elected officials responsible for the District's finance, ordinances establishment, revision and enforcement, regulatory compliance and personnel management, etc. The District has one part time clerk that is responsible for bookkeeping, billing, fee collection and general office management. The plant and the collection system are currently managed and operated by Mr. Geoffrey Holmes. Mr. Holmes is a Group I certified operator. He splits his duties between the plant, the laboratory and the collection system. He spends approximately 2/3 time at the plant, 1/3 time on the collection system. His duties include collection and plant operation and maintenance, repair works, new construction inspections, and lab work, etc. Mr. Holmes has an assistant working about 24 hours per month. Mr. Holmes is training the assistant so that he can be the plant operator when Mr. Holmes retires in the future. Mr. Holmes also has a substitute. The substitute is Ms. Stephanie Hylton who is a level I certified operator and an accredited laboratory technician. Ms. Hylton will work at the plant and the lab when Mr. Holmes is on leave or need help.

The plant has one time-proportional composite sampler. This sampler is used for influent sampling one day and effluent sampling on another day. The sampler typically takes 500 ml every hour for 24 hours. Sampler is iced during use.

The lab at the plant is accredited by the DOE's Laboratory Accreditation program (Lab #M385) for testing BOD/CBOD, chlorine residual, pH, TSS and fecal coliform. The District uses Edge Analytical in Burlington for other needed tests.

Evaluations: The District has adequate skilled personnel for managing and operating the office, the collection system, the plant and the lab.

Recommendations: The District appears well managed. There are no recommendations at this time.

6.3.16 Capacity Summary of the Plant's Major Units

Listed in Table 6.8 is a summary of the estimated capacities for the major units in the existing plant. The table also included the projected future flow and organic loading conditions. The flow loading data for the year 2020 and 2028 didn't include the Eastshore South area. However, the build-out data included the Eastshore South area. For the influent flow metering, disinfection system and the plant effluent metering system, the listed data are projected peak summer flow values that have been rounded-up. The comparisons between the estimated capacities and the projected future conditions should help the District to plan ahead for improvements, upgrades and expansions for meeting present, near-term and long-term needs.

It should be pointed out that the estimated L-2 lagoon and wetland capacities in the Table 6.8 were based on a low plant effluent $CBOD_5$ limit of 12 mg/l. If the limit is increased to 17 mg/l, then the hydraulic capacities of the units will be considerably higher (see estimates in the **Appendix E**).

Table 6.8 – Capacity of Major Units and Projected Future Needs

Item description	Estimated Capacity	Current Permits (winter/Summer)	Year 2020 Loadings[1]	Year 2028 Loadings[1]	Build-out Loadings[1]	Notes
Influent Flow Metering	213,120 gpd	23,000 gpd/ 34,000 gpd	180,000 gpd	235,000 gpd	361,000 gpd	Summer peak flows
1000-gallon Influent Flow Tank	n/a		49,000gpd/ 53,000 gpd	63,000 gpd/ 68,000 gpd	97,000 gpd 104,000 gpd	Split flow and remove grease, scum/floatables
Anaerobic Pretreatment Cell	41,424 gpd					Based on 2 days HRT
Aerated Cell #1 and Cell #2	33,200 gpd/ 41,4001 gpd					Based on 20 mg/l $CBOD_5$ effluent
Polishing Cell #3	62,880 gpd					Based on 2 days HRT
Constructed Wetland	41,424 gpd					Design capacity
Chlorine Disinfection System	144,000 gpd		181,000 gpd	236,000 gpd	362,000 gpd	Based on 30 minutes HRT for summer peak flows
Plant Effluent Metering System	172,800 gpd		181,000 gpd	236,000 gpd	362,000 gpd	Summer peak flows
Aerators	109 lbs BOD_5/d	38 lbs BOD_5/d 56 lbs BOD_5/d	63 lbs BOD_5/d 73 lbs BOD_5/d	80 lbs BOD_5/d 107 lbs BOD_5/d	119 lbs BOD_5/d 161 lbs BOD_5/d	2.2 lbs O_2/lbs BOD_5 /d

(1) Projected flows in Table 5.7 were rounded up to 1000s.
(2) 1,000 gallons was added to the projected flow and 6 lbs was added to the projected BOD loading for the septage supernatant contributions.

6.3.17 Performance of the Plant and Potential Reuse of Plant Effluent

A. Performance of the plant

The plant's current permit requires the plant effluent to meet the following limits:
CBOD5: 25 mg/l, average monthly; 40 mg/l, average weekly
TSS: 75 mg/l, average monthly; 110 mg/l, average weekly
Fecal coliform: 200 #/100 ml, average monthly; 400 #/100 ml, average weekly
Total residual chlorine: 0.5 mg/l, average monthly; 0.75 mg/l, average weekly

pH: 6.0 to 9.0, daily.

Plant effluent data from October 2003 to April 2008 were compiled and summarized in Table 6.9. Since effluent fecal coliform and total residual chlorine have been discussed in the previous section of the report, no further discussions will be provided herein.

Effluent pH as listed in Table 6.9 and shown on Figure 6.29 were always in compliance with the effluent limit of 6.0 to 9.0. Effluent TSS were also always in compliance with the permit limit. Monthly effluent $CBOD_5$ and percentage removal were also always in compliance with the permit limits except one month because of wetland media leaching.

B. Potential reuse of the plant effluent

The State of Washington agreed that encouraging the use of reclaimed water, while still assuring the health and safety of public and the protection of the environment, could enable the State to use its water resources in the best interest of present and future generations. In 1992, the State legislature approved the Reclaimed Water Act and codified as Chapter 90.46 RCW. This act encourages using reclaimed water for land applications and industrial and commercial uses and treating wastewater as a potential resource. The basic premise for reclamation is that the water must be used for direct, beneficial purposes. Chapter 90.46 RCW was amended by the legislature in 1995 to provide for non-consumptive uses of reclaimed water. This legislation provided for the reuse of reclaimed water through surface percolation (infiltration) or direct injection. This legislation established that reclaimed water is no longer considered wastewater.

The State of Washington has four classes of reclaimed water: A, B, C, and D, with Class A being the highest. Class A water has the most reuse potential and the least restrictions on its use. The major difference between Class A reclaimed water and the other classes is that Class A water is filtered and water in the other classes is not.

Class A reclaimed water means reclaimed water that, at a minimum, is at all times an oxidized, coagulated, filtered, disinfected wastewater. The wastewater shall be considered adequately disinfected if the median number of total coliform organisms in the wastewater after disinfection does not exceed 2.2 per 100 milliliters, as determined from the bacteriological results of the last seven days for which analyses have been completed, and the number of total coliform organisms does not exceed 23 per100 milliliters in any sample.

Class B reclaimed water means reclaimed water that, at a minimum, is at all times an oxidized, disinfected wastewater. The wastewater shall be considered adequately disinfected if the median number of total coliform organisms in the wastewater after disinfection does not exceed 2.2 per 100 milliliters, as determined from the bacteriological results of the last seven days for which analyses have been completed, and the number of total coliform organisms does not exceed 23 per 100 milliliters in any sample.

Class C reclaimed water means reclaimed water that, at a minimum, is at all times an oxidized, disinfected wastewater. The wastewater shall be considered adequately disinfected if the median number of total coliform organisms in the wastewater after disinfection does not exceed

Table 6.9 – FBSD WWTP Effluent Data

Date	Plant Influents			Plant Effluents								Removal Percentages		
	BOD5	Filtered CBOD5	CBOD5	BOD5	CBOD5	Filtered CBOD5	Grab BOD5	TSS	PH	Fecal	Cl2 Residual	BOD5 Removal	Filtered CBOD5 Removal	CBOD5 Removal
	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	s.u.	(#/100ml)	(mg/l)	(%)	(%)	(%)
10/28/03	124.0			5.3				21.7	8.03	6		96%		
11/4/03	160.2			9.1				21.2	8.39	2		94%		
11/11/03	159.5			10.4				29.1	8.25	2		93%		
11/18/03	165.8			13.5				23	8.26	2		92%		
11/25/03	67.7			10.4				29.3	8.32	6		85%		
12/2/03	138.0			11.4				13	8.2	84		92%		
12/9/03	106.9			10.7				19	8.27	19		90%		
12/16/03	112.1			8.5				35	8.21	2		92%		
12/23/03	128.7			7.3				35.6	8.33	2		94%		
12/30/03	184.5			11.4				29.6	8.37	2		94%		
1/6/04	122.9			14.1				32.8	8.42	62		89%		
1/13/04	111.6			9.6	7			33.9	8.43	70		91%		
1/20/04	119.7			9.8	8.2			26.6	8.33			92%		
1/27/04	136.1			11.3	8.4			28.9	8.38	2		92%		
2/3/04	79.9			12.1				27.2	8.37	40		85%		
2/10/04	149.8			11.9	8.9			33.1	8.22	2		92%		
2/17/04	204.6			19.6	10.6			28.9	8.08	2		90%		
2/24/04	214.8			20	14.6			33.9	8.29	2		91%		
3/2/04	148.3			22.7	18.1			35.3	8.31	10		85%		
3/9/04	120.6			21.7	15			33.1	8.22	6		82%		
3/16/04	156.9			22.7	18.5			38.3	8.04	4		86%		
3/23/04	183.5			41.4	20.4			33.2	7.73	84		77%		
3/30/04	165.8			49.5	24.6			41.5	8.87	74		70%		
4/6/04	149.1			17.4	14.3			27.2	7.98	31		88%		
4/13/04	180			25.7	9.9			21.9	7.92	354		86%		

4/20/04	220.7			8	8			21.6	7.95	6		96%		
4/27/04	178.6		141	15.8	15.1			21.4	7.82	4		91%		
5/4/04	197.3		164.3	54.9	17.4			26.8	7.74	88		72%		
5/11/04	199.6		169.1	14.5	13.9			24.2	8.08	148		93%		
5/18/04	188.1		167.7	28	16.5			30.8	7.65	2		85%		
5/25/04	179.4		152.9	15.2	14.9			33	7.72	5		92%		
6/1/04	205.1		179.2	18.6	15.6			33.3	7.85	2		91%		
6/8/04	172.2		141.6	22.4	13.1			40.6	7.89	12		87%		
6/15/04	179.8		125.1	18.5	10.9			31.7	7.97	5		90%		
6/22/04	205.8		145.4	19.6	8.2			42	7.94	21		90%		
6/29/04	192.6		165.4	33.8	16.1			43.6	7.79	2		82%		
7/6/04	201.5		171.9	59.9	13.4			52.6	7.86	95		70%		
7/13/04	165		134.1	52	25			57.7	7.75	112		68%		
7/20/04	181.4		134.9	49.4	19.5			57.7	7.62	145		73%		
7/27/04	200.6		160.6	46.4	19.9			31.8	7.57	362		77%		
8/3/04	212		188.7	12.8	12.2			28.9	7.69	2		94%		
8/10/04	218.8		196.4	70.5	25.9			28	7.58	134		68%		
8/17/04	184.4		157.1	30.6	17.7			30.4	7.64	11		83%		
8/24/04	205.7		172.6	25.6	21.4			44.9	7.61	7		88%		
8/31/04	221.7		187.9	15.3	11.6			28.5	7.69	36		93%		
9/7/04	217.2		184.5	5.4	4			21	7.88	3		98%		
9/14/04	222.1		172.4	18	5.3			30	7.67	2		92%		
9/21/04	199.1		163	25.1	23.3			35.3	7.6	2		87%		
9/28/04	184.2		151	58.8	12.1			28	7.72	2		68%		
10/5/04	122.4		91.4	15.6	12			34.2	7.75	2		87%		
10/12/04	178.1		131.7	14.9	8.6			16.7	7.63	6		92%		
10/19/04	165.5		122.9	11.1	10.1			14.9	7.78	50		93%		
10/26/04	143.5		122		4.9			18.6	7.71	49				
11/2/04	142.9		109	14.5	14			23.6	7.87	23		90%		
11/9/04	145.7		107.4	8.8	11.5			27.9	8	25		94%		
11/16/04	166.3		159.2	17.4	14.6			25.7	8.03	10		90%		
11/23/04	143.6		110.3	12	11.7			28	7.95	10		92%		

11/30/04	123.2		106.7	16.9	15			27.3	7.9	25		86%		
12/7/04	109.6		92.1	13.4	10.7			32.6	7.94	6		88%		
12/14/04	109.3		81.1	19.1	11.8			22.7	7.98	4		83%		
12/21/04	102.1		96.9	20.6	15.1			21.2	7.96	2		80%		
12/28/04	99.7		95.6	21.9	15.2			22.4	7.97	2		78%		
1/4/05	118.3		110.9	24.4	18.7			29.6	8.06	153		79%		
1/11/05	129.5		110.4	29.4	20.3			33.7	8.13	142		77%		
1/18/05	100.2		84.8	22.3	20.7			37.9	7.95	4		78%		
1/25/05	79		70.9	15	11.2			22.3	7.87	3		81%		
2/1/05	118.3		107.8	13.1	8.7			24.7	7.9	2		89%		
2/8/05	76		66	15.1	13.1			18.6	7.78	3		80%		
2/15/05	131.4		116.4	15.5	13.1			27.5	7.98	3		88%		
2/22/05	137.7		129.3	20.1	14.7			22.6	7.95	2		85%		
3/1/05	139.4		133.1	13.9	11.4			25.8	7.95	20		90%		
3/8/05	147.3		132.3	16	12.2			17.8	7.97	36		89%		
3/15/05	158.8		142.4	10.1	8.7			15.6	7.94	2		94%		
3/22/05	133.1		129.4	16.2	8.5			15.1	8.01	2		88%		
3/29/05	117.6		114.1	13.2	10.7			25.5	8.1	2		89%		
4/5/05	128.2		112.3	13	10.2			35.7	8.11	30		90%		
4/11/05	174.6		164.1	22.6	18			32.6	7.96	37		87%		
4/19/05	182.1		168	20.5	17.8			20.2	7.91	50		89%		
4/26/05	162.8		148.6	26.6	25.4			23.3	7.81	6		84%		
5/3/05	194.9		189.2	25.7	23.1			16.1	7.87	189		87%		
5/10/05	192.7		181.4	23.8	18.9			33.3	7.88	2		88%		
5/17/05	147.4		123.3	21.5	18.8			18.3	7.9	229		85%		
5/23/05	168.5		151.8	30.5	28.9			46.8	7.82	3		82%		
5/31/05	202.1		177.1	20.6	16.2			25	7.76	103		90%		
6/6/05	160.3		143.5	27.9	19.7			18	7.79	22		83%		
6/14/05	176.1		166	28.8	23.9			27.5	7.73	5		84%		
6/21/05	193.8		164.8	45	22.9			26.7	7.66	189		77%		
6/28/05	181.9		159.1	47.4	22.5			21.7	7.77	490		74%		
7/5/05	236		228.3	22.2	20.2			28.3	7.83	199		91%		

7/12/05	215.8		199.7	30.6	20.4			25	7.75	16		86%		
7/19/05	164.3		160.5	39.6	27.2			27.5	7.72	3		76%		
7/26/05	232.9		225.2	25.2	21.9			41.7	7.74	208		89%		
8/2/05	214.8		200.7	22.3	21.4			36.7	7.78	2		90%		
8/9/05	204.7		192.5	24.9	22.6			42.5	7.72	76		88%		
8/16/05	177.9		173.6	21.7	21.6			35	7.72	371		88%		
8/23/05	144		143.1	43.5	24.7			46.7	7.61	8		70%		
8/29/05	159.3		155.9	14.8	13			22.5	7.69	8		91%		
9/5/05	187.8		180.3	14.4	13.5			30	7.71	3		92%		
9/13/05	153.9		143.9	11.4	11.2			24.2	7.69	9		93%		
9/19/05	153.6		148.2	13.7	12.5			28.3	7.59	11		91%		
9/27/05	158.7		158.3	10.4	10.9			27.5	7.55	90		93%		
10/5/05	149		145.6	12.1	11.9			23.3	7.59	4		92%		
10/10/05	164.5		151.4	12.1	11.7			15.8	7.61	11		93%		
10/17/05	155.4		140.4		8.7			21.7	7.56	26	0.2			
10/25/05	137.5		131.6	25.7	13.8			20.8	7.55	12		81%		
11/1/05	141.8		139.3		9.9			16.7	7.58	126	0.21			
11/7/05	106.8		108		11.4			10	7.64	16	0.76			
11/14/05	131.3		128.5		12.5			17.5	7.61	10	0.33			
11/21/05	146.3		156.4		11.6			20.8	7.79	14	0.49			
11/28/05	140.5		136.5	13.3	13.3			19.2	7.75	35	0.12	91%		
12/5/05	142.6		135.1		15			22.5	7.79	19	0.09			
12/12/05	151.6		136.6		15.6			20.8	7.88	5	0.08			
12/19/05	169.5		160.7		14			19.2	7.99	2	0.12			
12/26/05	94.8		87.7	19.5	11.7			21.7	7.92	283	0.11	79%		
1/206	137.6		124.4		10.1			27.5	7.76	5	0.12			
1/9/06	121.6		110.4		11.7			31.7	7.81	4	0.18			
1/16/06	106		95.5		13.8			26.7	7.61	6	0.51			
1/23/06	100.9		93.4		11.8			20	7.78	2	0.24			
1/30/06	116.9		100.1	12.6	11.9			23.3	7.69	2	0.48	89%		
2/6/06	95.1		81.2		10.2			21.7	7.72	10	0.1			
2/13/06	151		139		11.8			24.2	7.65	28	0.14			

2/20/06	170		149.6		15			28.3	7.71	5	0.11			
2/27/06	188.7		162.2	15.7	14.7			30.8	7.69	5	0.22	92%		
3/6/06	164.2		157.4		16.3			38.3	7.9	25	0.19			
3/13/06	153.2		146.5		15.5			29.2	7.8	2	0.15			
3/20/06	147.5		130.2		18.6			26.7	8.05	118	0.25			
3/27/06	211.3		190.8	21.7	18.8			30	8.08	2	0.34	90%		
4/3/06	159.5		143.8		23.6			36.7	7.9	1	0.1			
4/10/06	149.1		134.9		18.1			22.5	7.8	22	0.33			
4/17/06	186.4		177.3		24.8			19.2	7.9	2	0.5			
4/24/06	165		151	22.1	19			19.2	7.8	3	0.19	87%		
5/1/06	220.4		203.2		17.9			15	7.8	4	0.97			
5/8/06	207.1		179.2		18.8			18.3	7.8	9	0.17			
5/15/06	210		203.3		24.4			26.7	7.8	8	0.81			
5/22/06	171.1		159.2		22			35.8	7.6	237	0.16			
5/29/06	193.2		161.8	45.9	22.1			48.3	7.55	1600	0.45	76%		
6/5/06	190.3		167.6		18.6			25.8	7.5	5	0.79			
6/12/06	160.8		146		14.6			20.8	7.5	70	0.44			
6/19/06	186.7		167.2		20.6			35	7.8	78	0.51			
6/26/06	213.2		189.6	35.6	22.8			38.3	7.5	12	0.59	83%		
7/3/06	234.8		221.4		22.6			42.5	7.6	23	0.8			
7/10/06	194.3		183		12.8			15	7.6	2	0.65			
7/17/06	166.5		166.5		12.4			26.7	7.6	3	0.58			
7/24/06	178		149.1		14.4			26.7	7.7	2	0.8			
7/31/06	190.7		170.4		11.1			35	7.7	5	0.98			
8/7/06	170.9		159.1		9.8			45	7.80	2	0.92			
8/14/06	175.6		143.6		11.8			43.3	7.80	2	0.71			
8/21/06	174		151.9		8.1			20.8	7.70	2	0.49			
8/28/06	180.3		152.8	17.1	12.7			26.7	7.75	13	0.68	91%		
9/4/06	191.7		185.7		16.4			5.5	7.60	10	0.2			
9/11/06	157.1		132.8		10.6			29.2	7.60	2	0.29			
9/18/06	177.9		155.8		7.1			19.2	7.70	18	1.08			
9/26/06	146		133.4		37.1			5.8	7.40	2	0.3			

10/2/06	134.1		114.4		27.1			6.7	6.90	1000	0.08			
10/9/06	117.1		94.9		71			30	7.10	2	0.31			
10/16/06	148		124		57.8			68.3	7.30	2	1.01			
10/23/06	142.4		119.3		31.2			47.5	7.30	13	0.9			
10/30/06	149.3		131.6		21.1			40	7.70	83	0.25			
11/6/06	135.8		125.1		9.7			19.2	7.70	10	0.07			
11/13/06	129.5		108.5		18.3			15	7.70	4	0.1			
11/20/06	125.7		108.5		24.2			15	8.00	2	0.05			
11/27/06	115.3		110.6		11.3			17.5	7.80	31	0.24			
12/4/06	90.8		75		9.8			16.7	8.00	667	0.3			
12/11/06	113.9		93.6		17.2			15	8.00	2	0.46			
12/18/06	95.9		80.5		14.9			16.7	8.00	2	0.22			
12/25/06	72.7		52.2		10.6			12.5	7.80	2	0.54			
1/1/07	113.5		101.1		18.1			20.8	8.00	2	0.3			
1/8/07	65.6		52.6		7.9			14.2	7.70	2	0.3			
1/15/07	89.4		77.5		12			15.8	7.80	2	0.2			
1/22/07	90.6		73		10.4			15	7.80	3	0.46			
1/29/07	130.3		120.6		19.2			15	7.90	2	0.08			
2/5/07	154.7		131.9		17			20.6	7.80	2	0.25			
2/12/07	134.1	72.4	116.2		17	17.2		15.6	8.00	2	0.51		77%	85%
2/19/07	136.2	86.3	120.1		17.9	18.8		15	7.90	2	0.29		79%	84%
2/26/07	147.1	76.5	127.1		25	24.8		12.5	7.90	2	0.34		67%	80%
3/5/07	147.1	103.3	131.7		19.9	20.3		12.5	7.90	2	0.12		81%	85%
3/12/07	114.5	52.3	103.4		10.4	9.4	9.9	13.1	8.00	2	0.47		80%	91%
3/19/07	89.4	52.7	76.6		10.4	11.8	11.5	13.1	8.10	2	0.54		80%	85%
3/26/07	73.8	40.8	63.8		10.2	12.3	10.5	4.4	8.20	4	0.38		75%	81%
4/2/07	93.9	50.5	80.6		22.2	25.3	26.8	11.3	8.10	308	0.36		56%	69%
4/9/07	138.9	99.3	125		10.4	9.7	12.6	11.25	8.20	2	0.59		90%	92%
4/16/07	168.8	103.7	164.3		29.3	26.9	35.4	17.5	8.10	2	0.59		72%	84%
4/23/07	153.5	87.2	136.6		15.2	10.9	7.65	20.6	8.20	32	0.51		83%	92%
4/30/07	153	86.3	144.6		15.9	8.9	21.9	45.6	8.30	35	0.55		82%	94%
5/1/07					15.9	8.9	21.9		8.20		0.23			

5/7/07	185.7	113.6	181.4		16.2	9.4	20.9	38.8	8.00	667	0.78		86%	95%
5/14/07	199	128.6	200.1		16.8	8.8	21.8	51.9	7.90	274	0.39		87%	96%
5/21/07	155.1	93.2	146.9		37.7	24.6	26.5	43.1	7.90	2	0.4		60%	83%
5/28/07	210.1	125.4	196.2		22.9	11.5	25.4	56.3	7.90	32	0.36		82%	94%
6/4/07	161.1	87.6	150.6		19.7	13.6	19.1	47.5	8.10	376	0.23		78%	91%
6/11/07	152.4	88.5	134.3		14.5	6.9	10.7	36.3	8.00	2	0.9		84%	95%
6/18/07	160.3	100.5	155.2		13.3	12.1	17.1	5	8.30	2	0.14		87%	92%
6/25/07	179.3	101.6	173.5		14.8	14	16.2	6.9	8.40	335	0.08		85%	92%
7/2/07	143.5	93	140.2		13.9	15.1	6.9	6.3	8.30	2	0.9		85%	89%
7/9/07	147.4	85.5	140.7		15	15	20.1	6.3	8.40	400	0.1		82%	89%
7/16/07	143.6	103.1	138.5		28.8	24.2	31.7	4	8.30	2	0.57		72%	83%
7/23/07	145.2	92.4	138.6		14.3	19.7	14.9	6.5	8.30	2	0.39		85%	86%
7/30/07	128.9	73.9	118		11.8	12.8	11	4.5	8.30	369	0.78		84%	89%
8/6/07	160.5	102.2	153.8		10.2	10.7	10.3	5	8.20	2	0.19		90%	93%
8/13/07	134.1	70.3	122		5.3	4.6	7.9	7	8.30	2	0.68		92%	96%
8/20/07	137.3	71.8	119.5		10.7	9.1	9.5	5.5	8.20	2	0.12		85%	92%
8/27/07	139.4	87.6	125		6.8	7.2	8.4	5.5	8.20	86	0.13		92%	94%
9/3/07	167.4	98.8	165.2		4.6	5.4	5	9	8.20	2	0.82		95%	97%
9/10/07	129.3	73.5	126.9		6.1	7.2	5.4	6.5	8.10	2	0.6		92%	94%
9/17/07	118.6	63.9	111.6		6.7	7.3	3.2	7	8.10	2	0.14		90%	93%
9/24/07	164.1	94.5	154.5		6.6	6.7	6.9	6	8.20	6	0.1		93%	96%
10/1/07	114		110.9		3.5			5	8.20	9	0.67			
10/8/07	140.5	79.7	128.8		4	4.2	4.4	2.5	8.10	2	0.09		95%	97%
10/15/07	152.3		139.9		5.4			4	8.20	2	0.06			
10/22/07	130	74	124.6		4.7	5.2	3.9	5	8.10	2	0.1		94%	96%
10/29/07	137.5	74.4	124.5		3.5	4.1	2.3	3	8.20	2	0.33		95%	97%
11/5/07	106.1	55	99		2.8	3.1	2.7	3.5	8.00	2	0.29		95%	97%
11/12/07	134.4	65.6	129.1		3.7	3.7	2.4	4.5	8.10	3	0.62		94%	97%
11/19/07	105.3	62.2	104.1		4.1	4.1	3	2.8	8.10	2	0.11		93%	96%
11/26/07	125.1	68.6	115.1		2.8	2.9	2.4	3.5	8.00	2	0.07		96%	97%
12/3/07	129.2	69.8	115.7		5.8	5.6	3.7	8.5	8.00	2	0.84		92%	95%
12/10/07	119.8		110.1		5.3		1.9	4.5	8.20	5	0.07			

12/17/07	140.1	81.4	128.9		3.3	4.3	1.7	4	8.10	2	0.05		96%	97%
12/24/07	149.5	86.4	137.7		3.8	4	2.9	3.3	8.10	145	0.02		96%	97%
12/31/07	150.8	91.2	136.5		4.9	5.5	3.2	3.5	8.00		0.05		95%	96%
1/1/08					4.9	5.5	3.2	3.5			0.08			
1/7/08	182.8	107.8	164.2		7.1	5.9	3.2	4.3	8.1	2	0.04		93%	96%
1/14/08	138.4		122.2		4.5			4	8.1	2	0.09			
1/21/08	129.6	69.2	115.6		5.7	7.1	2.6	3.8	8	4	0.76		92%	94%
1/28/08	106.6	50.4	79.3		4.8	4.5	1.9	6	8	2	0.24		90%	94%
2/4/08	127.4	72.2	110.1		4	4	1	4.5	8.1	12	0.12		94%	96%
2/11/08	99	52.4	84.5		3.8	3.5	1.3	3.5	8.1	7	0.07		93%	96%
2/18/08	118.1	60.8	96.9		5.1	5.4	4.1	2.3	8.1	10	0.04		92%	94%
2/25/08	134.4	76.6	120.9		4	4	3.4	3.5	8.1	2	0.07		95%	97%
3/4/08	106.8		96.9					2.5	8	2	0.07			
3/10/08	115.3	73.6	103		4.9	6.3	2.7	3.5	8	2	0.04		93%	94%
3/17/08	98.4	60	88.5		3.1	3.7	3.3	4	8	2	0.04		95%	96%
3/24/08	127.1	78.2	119.2		2.1	2.1	2.9	4	8	2	0.04		97%	98%
3/31/08	67	28.6	58.8		6.5	3.8	3.1	5	7.9	2	0.04		77%	94%
4/7/08	144	67.2	121.3		5.3	6.4	4.9	4					92%	95%
4/14/08	167.8	87.6	146.9		5.5	5.4	5.1	3.3					94%	96%
4/21/08	175.7	89.4	152.5		4.2	4.1	5.8	6					95%	97%
4/28/08	187.5	99.8	163.5		7	7.3	4.5	4.8					93%	96%
Average	**152**	**80**	**137**	**22**	**14**	**9**	**9**	**23**	**8**	**56**	**0.35**	86%	82%	93%

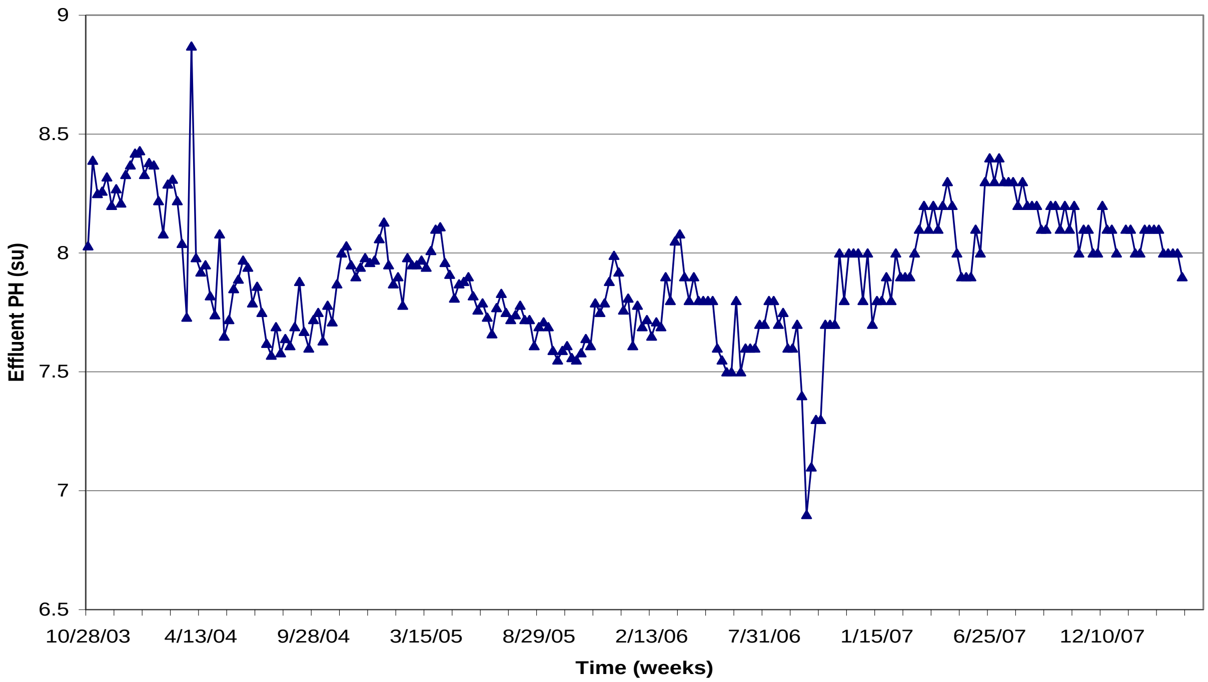

Figure 6.29 – Effluent pH

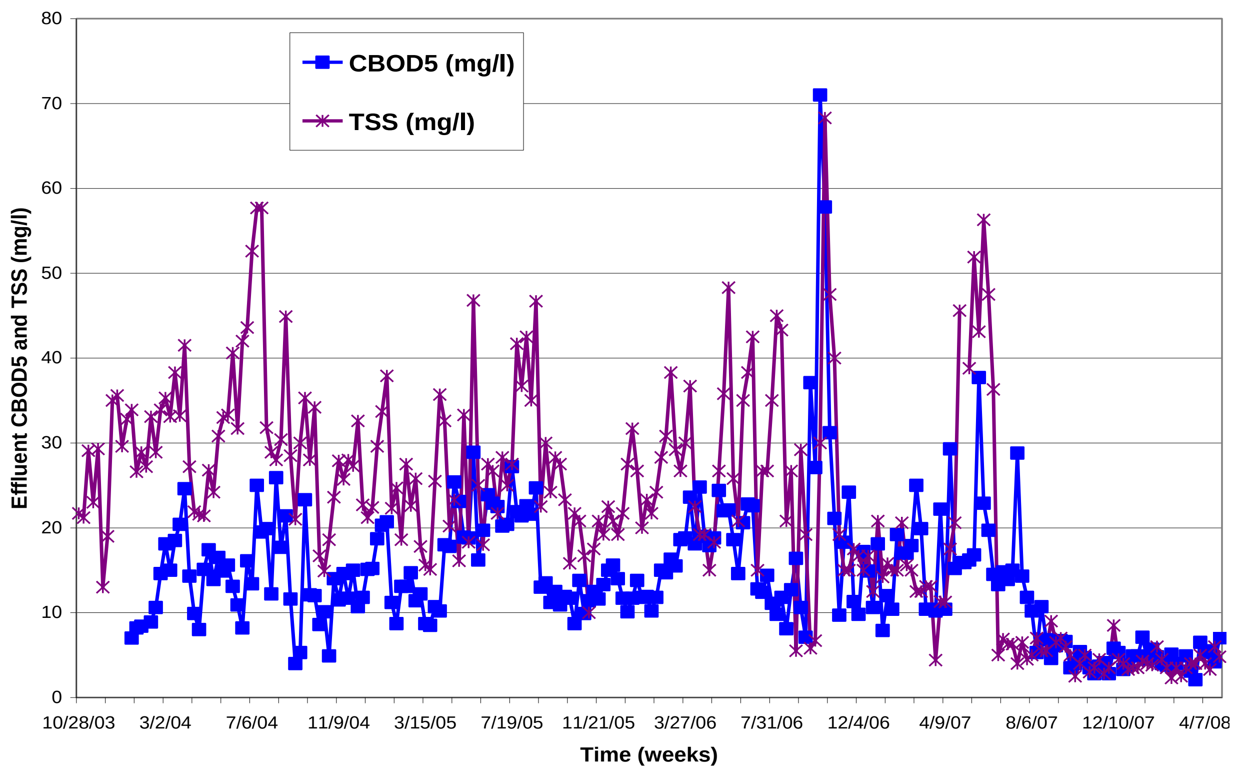

Figure 6.30 – Effluent CBDO5 and TSS

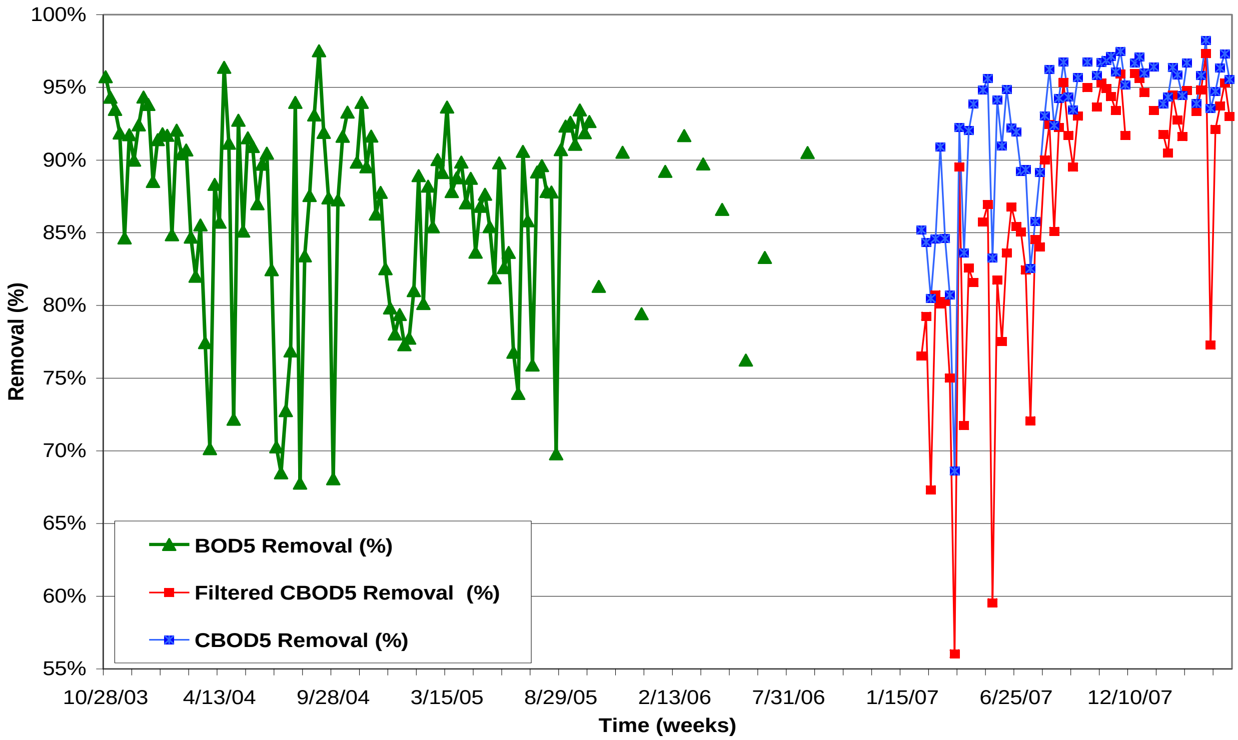

Figure 6.31 – Removal Percentage

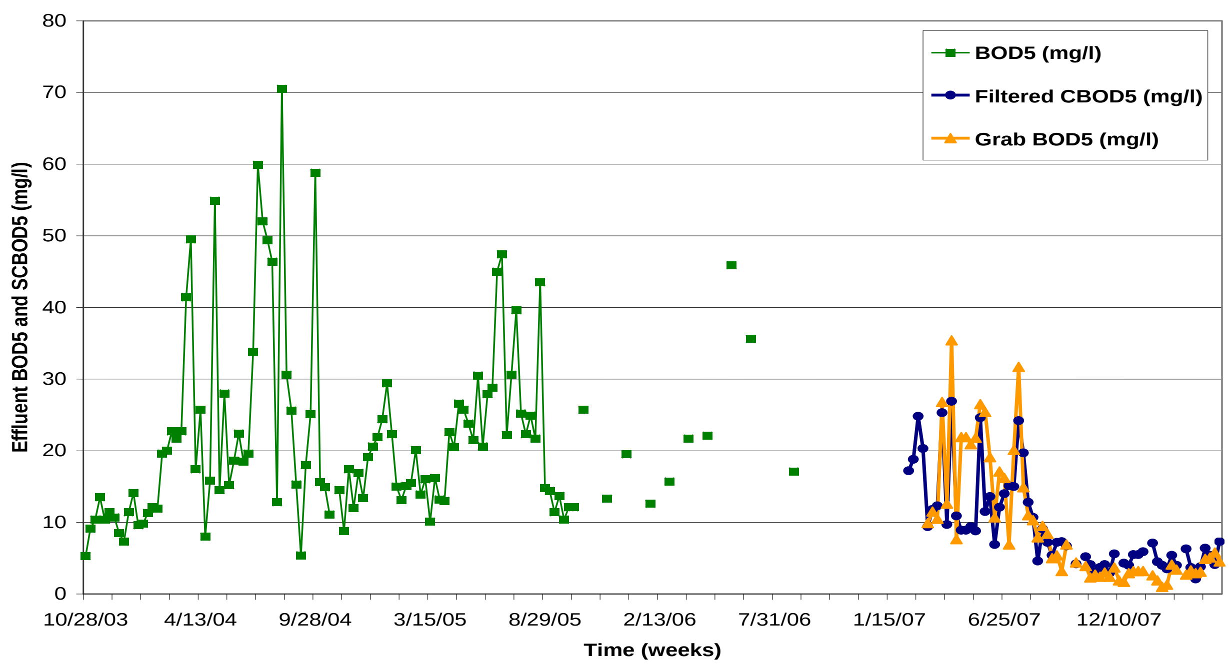

Figure 6.32 – Effluent BOD5 and SCBOD5

23 per 100 milliliters, as determined from the bacteriological results of the last seven days for which analyses have been completed, and the number of total coliform organisms does not exceed 240 per 100 milliliters in any sample.

Class D reclaimed water means reclaimed water that, at a minimum, is at all times an oxidized, disinfected wastewater. The wastewater shall be considered adequately disinfected if the median number of total coliform organisms in the wastewater after disinfection does not exceed 240 per 100 milliliters, as determined from the bacteriological results of the last seven days for which analyses have been completed.

In order to meet the requirements for all classes of reclaimed water, the wastewater must be fully oxidized. Fully oxidized wastewater is a wastewater in which organic matter has been stabilized such that the biochemical oxygen demand (BOD) does not exceed 30 mg/L and the total suspended solids (TSS) do not exceed 30 mg/L, is non-putrescible, and contains dissolved oxygen.

What differentiates a water reclamation facility from a wastewater treatment facility is the reclamation facility is required to have additional reliability and redundancy features. These features ensure that the water is being adequately and reliably treated so that, as a result of that treatment, it is suitable for a direct beneficial use.

The District's plant produced exceptionally good quality of effluent in the recent several months. It appears that the current effluent can meet Class D reclaimed water standards. However, the beneficial uses of the Class D reclaimed water are very limited. The permitted uses of the Class D reclaimed water include irrigation of trees, selective food crops, flushing sanitary sewer and discharge to wetland. To increase the uses of the plant effluent, it must at least meet Class C standards. The Class C reclaimed water can be used for non-food crops irrigation, selected food crops, orchards and vineyards, limited landscape irrigation, dust control, soil dampening, etc. It seems that the plant effluent is able to meet the Class C standards if the performance of the wetland can consistently maintain at the present level. To achieve Class B standards, the plant's existing disinfection system must be replaced with an UV disinfection system for reliable and consistent performance. To achieve Class A standards, a filtration system such as a packaged sand filter with continuous backwashing or a prefabricated cloth media filter is needed.

The Lopez Island's main fresh water resource is groundwater. The main source of recharge to the groundwater is rain which is only 20 to 30 inches per year because the island is shielded by the rain shadow of the Olympic Mountains. Additionally, the U.S. Geological Survey (USGS) in cooperation with the County Conservation District studied the possibilities of seawater intrusion in 1992 and found that 46% of 185 well water samples had chloride concentrations indicating seawater intrusion. Therefore, pumping more groundwater will reduce its availability and deteriorate its quality. To support continuing growth on the island, other water resources must be developed to supplement the groundwater resource, and the plant effluent should be considered as one of the supplement water resources.

Reclaimed water can be used for a variety of purposes including agriculture irrigation, impoundments, landscaping, ground water recharge, and various commercial and industrial uses. Based on the conditions on the island, the most feasible reuse of the reclaimed water is probably agriculture irrigation and commercial uses, such as nursery and construction water uses. Almost all these uses are seasonal with varying quantity demands. Therefore, effluent discharge to the San Juan Channel will continue.

In light of the limited potable water resources on the island, the District should coordinate with other relevant entities or organizations to explore the potential uses, users, quantity demands and quality requirements for the reclaimed water, then develop plans for upgrading the plant for meeting the reuse needs if there are reasonable demands. Once the required quantity and quality are known for the reclaimed water, then appropriate improvement needs for the plant can be evaluated and determined. The use of plant effluent will not only supplement the fresh water resources on the island, but also will bring additional revenues for the District. Therefore, this is win-win issue for the region.

6.4 RECEIVING WATER BODY AND POTENTIAL FUTURE EFFLUENT QUALITY REQUIREMENTS

Plant effluent is discharged to the San Juan Channel via a single 2" diffuser at latitude 48^{o}31'59"N and longitude 122^{o}55'04"W. The San Juan Channel has a designated water body ID #WA-02-0010, which is designated as a Class AA (extraordinary) marine receiving water. Water quality of this class shall markedly and uniformly exceed the requirements of all or substantially all uses.

The effluent limits set forth in the District's current permit were technology based limits because the technology based limits were more stringent than the water quality based limits. This means that plant effluent is not causing any concern about deteriorating the receiving water body quality. However, future effluent limits are generally expected to become more stringent. Potential likely future new limits could include ammonia, phosphorus, and disinfection by-products (DBP), such as THMs. But it's impossible to predict if and when these potential limitations will be required. Potential options for meeting these limits include upgrading the existing lagoon plant to a mechanical plant for meeting all potential new limits, adding coagulation for phosphorus removal, replacing the existing chlorine disinfection with UV for eliminating DBP production. Upgrading the plant to a mechanical plant will be a huge undertaking financially for the District. Mechanical plants generally produce good quality effluent, but also require very skilled operator for operation and maintenance, and high O&M costs. Frequent sludge handling and processing is typically associated with the mechanical plants.

6.5 MIXING ZONE STUDY FOR THE OUTFALL

The San Juan Channel is a vast water body in comparison with the District plant effluent flow. But adverse impact of the plant effluent on the receiving water body is required to be limited to the immediate vicinity of the discharge diffuser port, defined by acute and chronic mixing zones. In other words, the water quality criteria within the mixing zones may be exceeded. The regulatory chronic mixing zone in the District's permit is 315 feet horizontal radius around the discharge diffuser port. The mixing zone extends vertically from the diffuser to an upper boundary at the water surface. The regulatory acute mixing zone is 31.5 feet, in spherical shape and with the water surface as the upper boundary and the sea bottom as the lower boundary.

To meet the water quality standards, there must have adequate dilution at the edge of the regulatory mixing zones. A dilution factor is used to measure the amount of mixing of effluent and the receiving water that occurs at the boundary of the mixing zones. The actual dilution factors at the edge of the mixing zones are determined by the use of the UM mixing model within the US EPA Visual PLUMES model interface. Factors that affect the dilution factors include ambient water temperature, pH, ammonia, salinity, density, current speed, diffuser port characteristics, depth of the discharge point, effluent flows, effluent temperature and salinity etc. Apparently, the better the effluent quality, the smaller the dilution factor is required.

A mixing zone study was performed in 1993 by Beak Consultants In June 1993 based on a 4" single diffused port (see **Appendix G**) for the District. But several factors used by the Beak Consultants were not in conformity with DOE's current guidance. Therefore, the Department of Ecology re-evaluated the study using updated ambient temperature, salinity, density and current speed data for the 2" single diffuser port (see **Appendix G**). The UM3 interface within Visual PLUMES was used to estimate the required dilution factors of the mixing zone under varying conditions. Maximum daily flow of 72,300 gpd was used in the study for acute condition, and average monthly 29,000 gpd was used for chronic condition modeling. The critical dilution factors at the edge of the mixing zones were determined to be 61 for acute mixing zones and 423 for chronic mixing zones based on the models run on October 10, 2005. But the listed dilution factors in the permit were 180 for the acute mixing zone and 557 for the chronic mixing zone.

It appears that DOE's main concern in evaluating the impact of the plant effluent on the San Juan Channel water quality is fecal coliform, ammonia and total residual chlorine. But at the current level of effluent quality, there is no reasonable potential for these parameters to exceed the current water quality criteria.

6.6 PRETREATMENT

In addition to the septic tanks, the District also requires restaurants businesses to have grease traps for collecting oil and grease in their wastewater. The 1994 Engineering Report (3) indicated that the District investigated the septic tank sediments from a dentist's office and a printing shop regarding mercury and silver. But effluent samples have shown that mercury was below the chronic level, and silver is non-detectable.

6.7 SEPTAGE, SIGHT, SMELL AND NOISE

6.7.1 Septage

Septage is generally defined as the liquid and solid material pumped from a septic tank or cesspool during cleaning. Septage is usually characterized by large quantities of grit and grease, highly offensive odor, great capacity to foam upon agitation, poor settling and dewatering characteristics, and high solids and organic contents (BOD5, NH_3 and TKN). Reported septage generation rates in the literature vary widely, but on average it is approximately 55 gallons per capita per year. The 2000 US census reported a population of 2177 people on the island. Assuming population growth in the past 7 years is 2.5% per year, and then current population on the island is approximately 2,588 people. Therefore, there are approximately 2,588 people served by septic system on the island. This equates to about 142,340 gallons of septage per year or 390 gallons septage per day.

Since there is no septage treatment or disposal facility on the island, septage from the island is hauled by truck using ferry to Anacortes wastewater treatment plant for treatment and disposal. This is a significant financial burden for the residents on the island in addition to potential environmental risk for the marine water. To reduce hauling cost, septage hauling contractors have approached the District and asked the District to accept supernatant of the septage. The District wanted to help and agreed to accept septage supernatant starting in June 2005. The District's plant typically receives one (1) to three (3) supernatant per week. The quantity of the supernatant ranges from 150 gallons to 1,500 gallons each time, with an average of 850 gallons. BOD_5 of the supernatant is approximately 820 mg/l based on test results in June, July, and August 2005. Included in the **Appendix H** is the record of the supernatant acceptance.

The supernatant is pumped from the hauling truck's tank at approximately 7 gpm flow rate and discharges to the plant influent immediately after the influent flume. Therefore, the plant influent data in this report didn't include the supernatant flow or the organic loading. The plant's removal efficiency data also didn't take the supernatant loading into account. While the supernatant flow quantity is generally insignificant in comparison with the plant influent flow, the organic loading is about 5.8 lbs BOD_5 for 850 gallons and can be as high as 10 lbs BOD_5 for 1,500 gallons at 820 mg/l concentration. These amounts of BOD_5 loading are significant in comparison with the permitted loading or the current loading in as shown in the following Table 6.10.

Table 6.10 – Septage Supernatant BOD5 Loading and Plant Loadings

	Plant's Current Average conditions	Permitted Winter Conditions	Permitted Summer Conditions	Notes
Flows (gpd)	16,000	23,000	34,000	Table 6.2

BOD_5 Loading (lbs/d)	22.7	38	56	Table 6.2
BOD_5 Influent Concentrations (mg/l)	167	198	197	Table 6.2. The permitted values were calculated from flow and loading.
Average Septage BOD_5 loading (lbs/d)	5.8	5.8	5.8	
High Septage BOD_5 loading (lbs/d)	10	10	10	
Percentage of plant BOD_5 loading	26%	15%	10%	At average septage loading condition
Percentage of plant BOD_5 loading	44%	26%	18%	At High septage loading condition
BOD_5 Concentration increase (mg/l)	41	30	20	At average septage loading condition
BOD_5 Concentration increase (mg/l)	69	52	35	At High septage loading condition

Additionally, since septage is generally very high with TKN, the supernatant also contributes TKN organic loading to the plant, which has significant oxygen demand.

Although the septage supernatant has high organic loading, plant effluent data has not shown any adverse effect because of accepting the supernatant. This is because the supernatant was not discharged to the plant on daily basis, and both the anaerobic pretreatment cell and the aerated lagoon have excellent capability of handling shock organic loading due to their large volumes and long detention times. However, it is recommended that the supernatant be released to the plant influent at a controlled small flow rate for better treatment. This is especially important for large volume of supernatant since large volume of supernatant without controlled release can potentially cause odor problem for the currently uncovered anaerobic pretreatment cell.

The District wanted to accept the septage supernatant in a regular basis. This not only helps the local residents and business, but also brings in revenues to the District. Based on the existing plant condition, the main challenges of accepting septage are odor control, prevent grease and grit from entering the plant and reduce shock loading. These challenges can be resolved by constructing a septage receiving station in conjunction with the plant influent metering system upgrade. The septage receiving station should be a completely enclosed structure with a screen for removing solids and a pinch valve for controlled release of the supernatant to the plant influent. A perforated pipe can be used as part of the suction pipe for pumping supernatant from the truck to the station.

Because plant influent is generally weak in organic loading, no adverse impacts on the plant performance are expected by continuing acceptance of septage supernatant on a regular basis.

6.7.2 Sight, Smell and Noise

Until recently, properties surrounding the plant were farm lands with few resident units. As new development occurs on all surrounding properties, the issues of sight, smell and noise need to be considered. To have a good public relation and image is critical for the District to receive support for future plant expansion, upgrades, operations and planning.

To improve the aesthetic view of the plant site, landscaping along the property line can be used. The focus of the landscaping should be to provide a vegetation screen. In addition to enhancing the aesthetic view of the site, the vegetation screen will also provide a barrier for reducing smell and noise.

Odor is generally under control at the plant site. As recommended previously in this report, further improvements that should be done for better odor control include installation of a floating cover for the anaerobic pretreatment cell, upgrade the existing plant influent flow metering system and construction of septage receiving station.

The most significant mechanical equipment at the plant is the surface aerator. The type of aerator with 3 hp motor does not produce noticeable noise under normal conditions. If a new generator is installed on the plant site as recommended, the generator should be provided with noise attenuation enclosure and be located inside a building. This should limit the noise of the generator to an acceptable level.

7.0 Alternatives Development and Evaluation

7.1 GENERAL

This section discusses improvements needs and alternatives for meeting the present, and the projected year 2020, year 2028 and buildout condition needs. The alternatives were developed and evaluated based on current effluent limit requirements. Considerations in the alternatives developments and evaluations include foot print requirement, operator's skill requirement, expansion flexibility, capital cost, O&M cost, process reliability, current and future potential new or stringent effluent limits and environmental impacts for the vicinity area.

7.2 ALTERNATIVES FOR PRESENT CONDITION NEEDS

As data shown in section 6 of this report, the plant is currently performing well. Effluent quality is on the same level of quality from a typical mechanical plant of secondary level of treatment. Therefore, we do not see any present needs for replacing the existing aerated lagoon treatment process with other processes.

Data in Table 6.1 and 6.2 also showed that flows and organic loadings in some months and days have exceeded the 85% of permitted capacity, even exceeded the permitted capacity occasionally, though the flow and organic loading were much lower than the permitted capacities in the most recent year. Preliminary estimates shown in Table 6.8 and in the **Appendix E** indicate that actual capacity of the existing plant is probably much higher than the permitted capacity. The existing permitted capacity of the plant was based on the plant's 1994 treatment system that consisted of the L-2 lagoon and the L-1 lagoon. But since the 1994 plant expansion, several improvements and change have occurred to the plant: The L-1 lagoon was taken out of service and will be decommissioned soon; the L-2 lagoon was separated into three (3) cells by baffle curtains for reducing short circuiting; the berm of the L-2 lagoon was raised in 2003 and the total volume of the L-2 was increased; the anaerobic pretreatment cell was added in 2003; and the constructed wetland was added in 2006. Therefore, it is apparent that the capacity of current plant is different from the permitted capacity and the plant capacity needs to be re-rated based on the current treatment system.

Plant influent flow has occasionally exceeded 85% of the permitted capacity. Therefore, the District should request plant capacity re-rating as soon as adequate data is available to support the request. Re-rating the plant capacity will need extensive operational data to demonstrate and prove the capability of the plant, to validate the calculation model. The District has extensive data for plant influent and effluent, anaerobic pretreatment cell and L-2 lagoon, but limited data for the constructed wetland. Approximately one more year's data is needed for appropriately evaluate the performance and capacity of the wetland.

The other major concern at present is how to handle high flows during heavy rains. In the past, the operator was able to handle the high flows by throttling valve on the plant influent line upstream of the influent metering system and use the L-1 lagoon for temporary storage. The high flow problem is caused by I/I contributions to the collection system and limited by the outfall capacity. There are three (3) additional alternatives for resolving this problem. The first alternative is to rehabilitate the collection system for eliminating the I/I flows. As discussed previously in the report, the District has been rehabilitating the existing collection system in the past several years. But collection system rehabilitation is time-consuming, and financially and technically challenging. Therefore, this alternative cannot meet present urgent needs. The second alternative is to reconfigure and re-line the existing L-1 lagoon after the decommissioning is completed, and then use the pond as a temporary storage pond during high flows. Estimated cost for this alternative is $155,000 (see **Appendix I**). Drawbacks of the alternative include high capital cost and ineffective use of the land area and the pond. The third alternative is to construct a duplex effluent pump station for pumping the plant effluent to the outfall. This alternative requires evaluation of the outfall pipe pressure rating and installation of new emergency generator with an automatic switch. If this alternative is implemented, the existing plant effluent metering system can be replaced with a magnetic flow meter, and the whole plant will have back up power for operation. It's not clear what type of PVC pipe is used for the outfall. If a regular SDR 35 PVC is used, the pipe can withstand approximately 46 psi pressure based on manufacturer's literature. This pressure rating should be adequate to be used as a low pressure force main based on preliminary review of the site condition. Estimated cost for this alternative is $90,000 (see **Appendix I**). Comparing the three alternatives, it is recommended that construction of a duplex effluent pump station be used to address high flow needs. The pump station should consist of two identical submersible pumps, driven by variable frequency drives (VFD) for saving energy. Each pump should be designed to handle the projected year 2028 flows. The pump station will be operated alternately as duty pump and standby pump. Provisions should be provided for replacing the design pumps with large pumps for meeting the projected build-out conditions in the future. In addition to addressing the high flow issue, this alternative can be used for providing plant effluent reuse.

Since the District wanted to receive the septage supernatant on a regular basis, we recommend the District to build a septage receiving station in conjunction with the plant influent metering system upgrade. This will address several issues: septage receiving, overflow due to high flows during rain events and odor and flume capacity. Estimated cost for constructing the septage receiving station and the existing influent flow meter system upgrade is included in the **Appendix I**.

Even though recirculation appears effective for control septage odor for the anaerobic pretreatment cell in the last few years, occasionally minor odor still occurred. Therefore, we recommend installation of a floating cover for the cell for odor control, especially the District wanted to receive septage supernatant on a regular basis. This will also improve the performance of the cell by eliminating oxygen introduction to the cell. Estimated cost for installing the floating cover is included in the **Appendix I**.

Total estimated cost for the recommended improvements for the present condition is $245,000 as shown in the **Appendix I**.

7.3 ALTERNATIVES FOR YEAR 2020 CONDITION NEEDS

Data in Table 6.8 shows that the existing anaerobic pretreatment cell, the L-2 aerated cells, the wetland and the existing chlorine contact chamber needs expansion for meeting the projected year 2020 flows. As stated previously, the estimated capacities for the L-2 lagoon and the wetland in the Table 6.8 were based on a very conservative plant effluent $CBOD_5$ value of 5 mg/l. However, if the plant can be re-rated at higher capacities (see **Appendix E** for preliminary capacity estimates), the only required expansion will be the disinfection system for meeting the year 2020 projected loadings assuming that the effluent pump station will be built as recommended previously. This alternative is definitely less expensive than expanding the almost all plant units physically and structurally.

The previously discussed alternatives for expanding the existing disinfection system include chlorine contact chamber expansion and UV disinfection. Estimated costs in the **Appendix I** show that chlorine contact chamber expansion will be more expensive than the UV disinfection alternative. Other disadvantages of the chlorine contact chamber expansion include potential stringent chlorine residual requirement, disinfection by-products limitation in the future and chemical storage and handling. On the contrary, the UV system disinfection does not produce DBPs and does not add any chemicals to the plant effluent. The UV system will be an “off shelf” packaged low pressure low output system enclosed by a stainless steel channel with inlet and outlet connections and 120 Volt plug-in power supply. Therefore, UV is recommended for replacing the existing disinfection.

It appears that the existing constructed wetland can be re-rated at much higher capacity based on the limited preliminary effluent data and validation test. Therefore, wetland expansion is not likely required, thus it is not included in the cost estimate.

If the re-rated capacity of the existing plant is lower than needed, there are two options for meeting the projected year 2020 flow and other future flow needs: The first option is to continue using the current aerated lagoon system. The second option is to expand the plant with a different treatment process and decommission the existing lagoon system. If the plant effluent limits remain the same, the best scenario for continuing use of the lagoon system is to build a new train for meeting the projected buildout conditions, and the worst scenario is to build the second train of lagoon for meeting the projected year 2020 and 2028 conditions, then build a third train for meeting the projected buildout conditions. Based on present available information, we do not expect significant changes for the plant effluent quality requirements. Therefore, it is our opinion that the continuing the use of the lagoon system is the most cost effective solution for meeting the projected future needs based on the District’s existing conditions. Assuming the second train will be identical to the existing system, including an anaerobic pretreatment cell, aerated cells and a polishing cell. Estimated conceptual cost for this alternative is approximately

$827,000 as shown in the **Appendix I**. it would be approximately $861,000 if the disinfection system expansion is included.

However, if the final approved capacity of the current plant is much lower (for example, close to the current permitted capacity) than expected or the District desires to produce higher quality effluent for reuse purpose, or a nutrient removal process must be employed for meeting the regulatory effluent limits, then the existing lagoon system will not be the appropriate solution. This is because total trains of lagoons would be needed for meeting the projected buildout conditions, but the present plant site cannot accommodate these many trains of lagoons. Additionally, lagoon system is not the appropriate process for nutrients removal.

It can be seen from the above discussions that the final approved capacity of the current plant and the future required effluent limits are the most critical two factors for selecting the treatment process for expansion for meeting the projected future needs. But none of the two factors are known at present. We feel that the most critical time for selecting the treatment process for expansion is when the influent loading is approaching 85% of the final approved capacity for the existing plant. The District should have decided at that time if higher quality of effluent is needed for reuse purpose, detailed price quotes can be obtained from equipment vendors for capital cost and O&M cost comparisons, inquiries can be made regarding future effluent limit requirements, more data will be available for evaluating the performance of the wetland. Generally effluent limit is the driving force for the process selection. Other factors considered in the selection include capital cost, O&M cost, foot print requirement, operational flexibility, expansion flexibility, process reliability, environmental impacts, operator's classification requirements, sludge handling and disposal requirements, etc.

Depending on the future effluent quality requirements and based on the existing conditions, potential treatment processes that should be evaluated include membrane bioreactor (MBR) system, sequence batch reactor (SBR) system, packaged modular activated sludge plant and biological aerated biofilter (BAF) system. Main advantages of these systems are ease of installation and expansion because these systems are pre-assembled modular plants.

MBR systems have been used since 1980 for municipal and industrial wastewater treatment for discharge and reuse applications. Submerged in each MBR are membranes that physically reject pathogens and suspended solids. However, it is the biological process that removes contaminants such as BOD and nitrogen. If necessary, phosphorus removal can be achieved with simple chemical addition. MBR plant offers extremely compact footprint. Small MBR system is often pre-fabricated package system. MBR system produces exceptional quality of effluent. Typical MBR effluent is less than 2 mg/l for BOD and TSS, less than 3 mg/l for total nitrogen, and less than 0.05 mg/l for phosphorus. But MBR system generally requires screening and grit removal pre-treatments for the protection of the membranes. Capital cost for the MBR plant is very high. Typical cost for a MBR plant is approximately $22/gallon for the capital cost. For the projected year 2020 flow of 53,000 gpd, it would cost approximately $1.17 million. Annual O&M cost for the MBR plant is approximately $4/gallon. This equates to $212,000/ year O&M for a 53,000 gpd MBR plant. MBR system generally requires sophisticated control system and on-going sludge wasting and handling. Though MBR plant is typically PLC controlled operation and requires little intervention from the operator, troubleshooting and repairs of the system generally need the manufacturer's technician.

SBR system is a fill-and draw activated sludge system for wastewater treatment. In this system, wastewater is added to a single "batch" reactor, treated to remove undesirable components, and then discharged. Equalization, aeration, and clarification can all be achieved using a single batch reactor. To optimize the performance of the system, two or more batch reactors are used in a predetermined sequence of operations. SBR systems have been successfully used to treat both municipal and industrial wastewater. They are uniquely suited for wastewater treatment applications characterized by low or intermittent flow conditions. SBR system can be design with biological nutrient removal (BNR) capability and produces superior effluent quality. Less than 10 mg/l for BOD and TSS, less than 5 mg/l for total nitrogen and less than 1 mg/l for phosphorus can generally be achieved with the SBR plant. Most of SBR system requires screening and grit removal pretreatments, but some of systems do not need the pretreatment. Since the District's plant influent has very low TSS, screening and grit removal will not be needed for a SBR plant. Most of the SBR systems also required on-going sludge wasting and handling, but some of the systems only need several times a year, even once for several years depending on the influent conditions. Typical capital cost for the SBR plant is approximately $15/gallon. It would cost $795,000 for the projected 53,000 gpd year 2020 flow. O&M cost is also higher than a typical lagoon plant, but much lower than the MBR plant. Small SBR system can be prefabricated by the manufacturers. But generally owner procures SBR equipment and the control system, and builds cast-in-place concrete tanks on the plant site. SBR plants are also typically PLC controlled operation and need little attention under normal operating condition, but require relatively complicated control system and higher level of maintenance than typical lagoon plant. SBR plant

Packaged activated sludge plants such as FAST system from Smith and Loveless and AeroMod package plants are typical activated sludge wastewater treatment systems, providing secondary level or higher level of treatments depending on effluent requirements. This type of system is generally more complicated than the lagoon system or the SBR system because they have separate aeration unit, clarification unit and filtration unit for higher level of treatment, even digestion unit for sludge handling. On-going sludge wasting and handling is typically required for this type of plants.

BAF is a European developed wastewater treatment technology. This process incorporates a filtration system into a typical aeration reactor. Biostyr™ and Biofor™ are main brand systems for the BAF technology. BAF system can achieve a wide spectrum of effluent performance ranging from BOD reduction to full nitrification and de-nitrification. All of these occurring with suspended solids minimization. In addition, the required footprint is significantly smaller than typical activated sludge system. But application of the BAF process in US is not as popular as either the MBR or the SBR. Therefore, no further discussions will be provided herein.

Based on the above discussions and the District's conditions, we would recommend a SBR system in case the existing lagoon system cannot meet the District's projected future loading needs or the District simply desires to produce higher quality of effluent for reuse purpose. The SBR system can have modular design for ease of expansion, requires small foot print, have relatively simple treatment components. Figure 7.1 is the ISAM SBR layout from Fluidyne Corp. This SBR system consists of an anaerobic chamber for trash trap and sludge digestion, a SAM chamber for denitrification for nitrogen removal and a SBR reactor for biological removal of organic loading and nitrification, pumps for lifting sewage from the SAM chamber to the SBR tank and also used as a motive pump for jet aeration, a recycle system for directing mixed liquor from the SBR tank to the SAM chamber, and a decant device at the end of the SBR tank for effluent discharge.

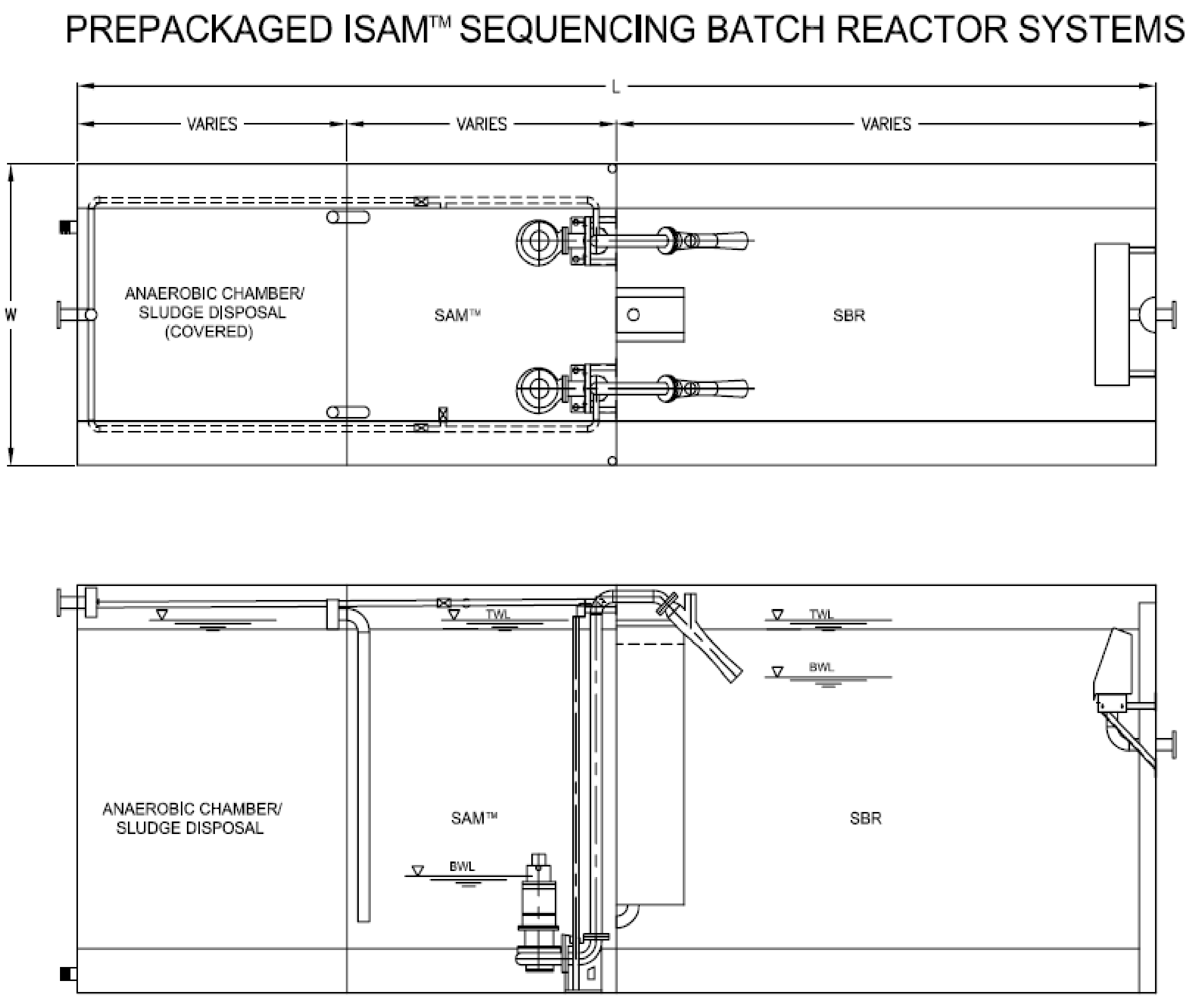

Figure 7.1 – SBR System

If the SBR system is used, total two trains of treatment process are recommended for meeting the projected buildout conditions. Each train will be designed for 53,000 gpd. The first train will be able to meet the needs of the projected year 2020 conditions.

7.4 ALTERNATIVES FOR YEAR 2028 CONDITION NEEDS

If the final approved capacity of the existing lagoon system is as high as estimated in the Appendix E, then only two trains of lagoon systems will be required for meeting the buildout condition, and the 2nd train of the lagoon system will be needed for meeting the projected year 2028 conditions. However, if the approved capacity of the existing lagoon system is near the capacity showing in Table 6.8, then the 2nd train of lagoon system should have been constructed in year 2020, and the 3rd train of the lagoon will not be required until the buildout condition approaches. Therefore, a lagoon system may and may not be needed in 2028 depending on the final approved capacity of the existing lagoon plant. But the plant effluent pumps must be upgraded to 370,000 gpd for meeting the projected 2028 and the build-out conditions. The existing wetland appears able to meet the projected year 2028 conditions based on current performance and effluent data.

However, if a SBR plant is selected, the second train of the SBR is required at this time for meeting the projected year 2028 conditions and the buildout conditions.

7.5 ALTERNATIVES FOR THE BUILD-OUT CONDITION NEEDS

The alternatives for meeting the projected build-out conditions also depend on the outcome of the re-rating the existing plant and the required effluent quality. If the plant can be rated at the capacity as estimated in the **Appendix E** and effluent limits remain the same as the current limits, then the addition of the second train of UV disinfection, anaerobic pretreatment cell, aerated cells and polishing cell will be sufficient for the plant to meet the projected build-out conditions, which includes the Eastshore South area. However, if the re-rated capacity is lower than the estimated capacity, a third of train of anaerobic cell, aerated cells and polishing cell will be required for meeting the build-out conditions. The estimated cost for building the third train will be similar to the cost for the second train. Similarly, the existing wetland appears able to meeting the projected buildout conditions based on current performance and limited effluent data.

But in the worst case scenario, if the final approved capacity of the current plant is close to the existing permitted capacity, a fourth train of lagoon system would be required for meeting the buildout condition. In this case, the SBR system should be used because the existing plant site cannot accommodate four trains of lagoons.

The above discussions show that plant capacity re-rating and effluent quality requirements are very critical for the District. They will have a profound financial consequence for the District depending on the final results of these two factors.

8.0 Summary

8.1 SUMMARY OF THE RECOMMENDATIONS

Table 8.1 is a summary of the recommended alternatives for various projected conditions based on discussions in Section 7 of this report. Scenario I recommendations are based on that the re-rated plant capacity can meet the projected year 2020 conditions. Scenario II recommendations are based on that the re-rated plant capacity is lower than the projected year 2020 conditions and a third train of treatment system will be required for meeting the projected buildout conditions. . Scenario III recommendations are based on that the existing lagoon cannot meet the projected future needs and a SBR system is required for meeting the future conditions.

Table 8.1 – Summary of Recommendations and Costs

Conditions	Present	Year 2020	Year 2028	Buildout
Scenario I Recommendations	• Re-rating the plant's capacity • Construction of a septage receiving station • Upgrading the existing plant influent flow metering system. • Installation of floating cover for the anaerobic pretreatment cell • Construction of an effluent pump station • Upgrading the emergency gen. set • Replace the existing plant effluent meter with a magnetic flow meter	• Replace the existing chlorine disinfection with UV disinfection • Re-evaluate the plant capacity	• Upgrade the effluent pumps to large pumps • Construct the 2nd train of anaerobic pretreatment cell, aerated cell and polishing cell if the rated capacity is as large as estimated in the Appendix E.	• Add a new train of UV system
Scenario II Recommendations	• Re-rating the plant's capacity • Construction of a septage receiving station • Upgrading the existing plant influent flow	• Replace the existing chlorine disinfection with UV disinfection • Construct the 2nd train of anaerobic pretreatment cell, aerated cell and	• Upgrade the effluent pumps to large pumps	• If the rated capacity is less than the estimated maximum capacity construct the 3rd train of anaerobic

	metering system. • Installation of floating cover for the anaerobic pretreatment cell • Construction of an effluent pump station • Upgrading the emergency gen. set • Replace the existing plant effluent meter with a magnetic flow meter	polishing cell if the rated capacity is less than the estimated maximum capacity.		pretreatment cell, aerated cell and polishing cell • Add a new train of UV system
Scenario III Recommendations	• Re-rating the plant's capacity • Construction of a septage receiving station • Upgrading the existing plant influent flow metering system. • Construction of an effluent pump station • Upgrading the emergency gen. set • Replace the existing plant effluent meter with a magnetic flow meter	• Build the first train of SBR system • Replace the existing chlorine disinfection with UV disinfection	• Build the 2nd train of SBR system • Upgrade the effluent pumps to large pumps	• Add a 2nd train of UV
Scenario I Cost	$245,000	$34,000	$847,000	$34,000
Scenario II Cost	$245,000	$861,000	$20,000	$861,000
Scenario III Cost	$194,000	$988,000	$974,000	$34,000

The above recommendations for scenario I and II are based on the following conditions:

- Performance of the wetland can maintain at the current level.
- Performance of the wetland can be successfully validated with the operational data.
- Plant effluent quality requirements are the same as the current limits.

8.2 DETAILED DECRIPTIONS OF THE RECOMEMNDED ALTERNATIVES

8.2.1 Present Condition

The plant effluent pump station shall consist of two identical pumps. Each pump shall be sized for 185,000 gpd or 130 gpm. Variable frequency drives should be used for saving energy and reducing wetwell size requirement. The two pumps should be alternated for operation based on operating time for equal wear. The operation of the pump should be controlled by a level system. In the event of duty pump fails, the standby pump shall be turned on automatically. Alarms shall be equipped for the pump station to alert the operator in the event of pump failure, power outage and high water level. A magnetic flow meter should be used to measure and record instant and totalized effluent flows. The flow meter should be installed on the discharge pipe of the pump station. If effluent is to be used, the reuse water should be taken off the discharge pipe of the pump station. Shown on Figure 8.1 is a conceptual site layout for the pump station. Preliminary pump station cut sheets are included in **Appendix J**.

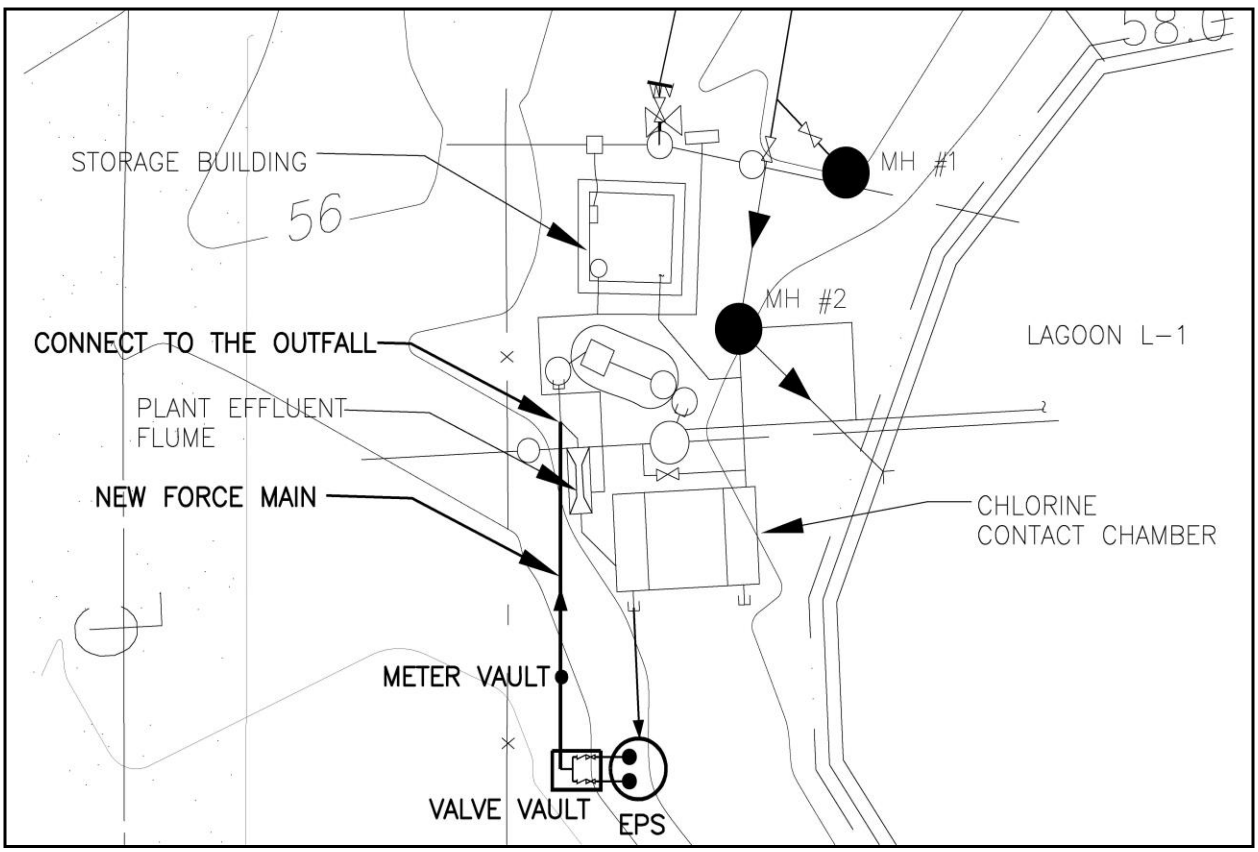

Figure 8.1 –Effluent Pump Station Conceptual Layout

The new generator set shall be a diesel type of generator with double walled fuel tank. The fuel tank shall be sized based on historic power outage time to ensure adequate operating time. The generator shall be sized for the build-out condition power needs for the whole plant. It is estimated that a 40 KW (54 hp) generator will have enough capacity for meeting the buildout condition power needs. The generator shall be equipped with an automatic switch for turning and off automatically in the event of power outage. Cut sheets for Cummins generator are included in the **Appendix J**.

The plant influent metering upgrade will include installation of an X-large trapezoidal flume and an ultrasonic flow meter. The flume will be installed within a concrete channel for protection. The channel will be covered with checkered plates for odor control. The flow meter will be NEMA 4X rated for rail-mounted installation. Preliminary cut sheets for the flume and flow meter are included in the **Appendix J**. The flume will be located near the existing flow meter site. But there will be no need for enclosing the system with a building.

The septage receiving station should be a concrete tank including an access hatch and a bar screen. Septage supernatant release from the station to the plant influent should be controlled by a pinch valve. Septage supernatant should be released to the upstream of the plant influent flow metering system. A small portable pump should be used to pump the supernatant to the station. The end of the pump suction pipe should be perforated pipe for preventing grit and grease from entering the plant.

The floating cover for the anaerobic pretreatment cell should be UV resistant membrane cover with one access hatch. The cover should be designed with the capability of about 2 feet up or down level variations. However if the SBR is selected for future expansion, the floating cover will not be needed since the existing recirculation appears effective for odor control for majority of the time.

Available plant data looks promising for re-rating the existing plant at a much higher capacity. However, available wetland performance data is limited, thus additional data is needed for the validating wetland design and performance evaluation. Once adequate data is available, then a plant capacity re-rating request should be prepared as soon as possible for DOE's review and approval.

8.2.2 Year 2020 Condition

The recommended UV disinfection is a low pressure low output packaged system with inlet and outlet connections for easy installation. The capacity of the UV system will be 200,000 gpd. The UV system will be powered by120 volt single phase power source. The UV system will consist of eight (8) lamps with a guaranteed life of 120,000 operating hours. Except for periodical lamp cleaning requirement, little attention is needed for the UV system operation. Cut sheets for the Trojan UV system is included in the **Appendix J**. A conceptual site layout is shown on Figure 8.2.

Re-evaluate the plant capacity based on the available monitoring data at that time. However, if the approved capacity is lower than the estimated, then a second train of anaerobic pretreatment cell, aerated cells and polishing cell will have to be built for meeting the projected year 2020 conditions. Figure 8.3 is a conceptual layout of the second train treatment cells.

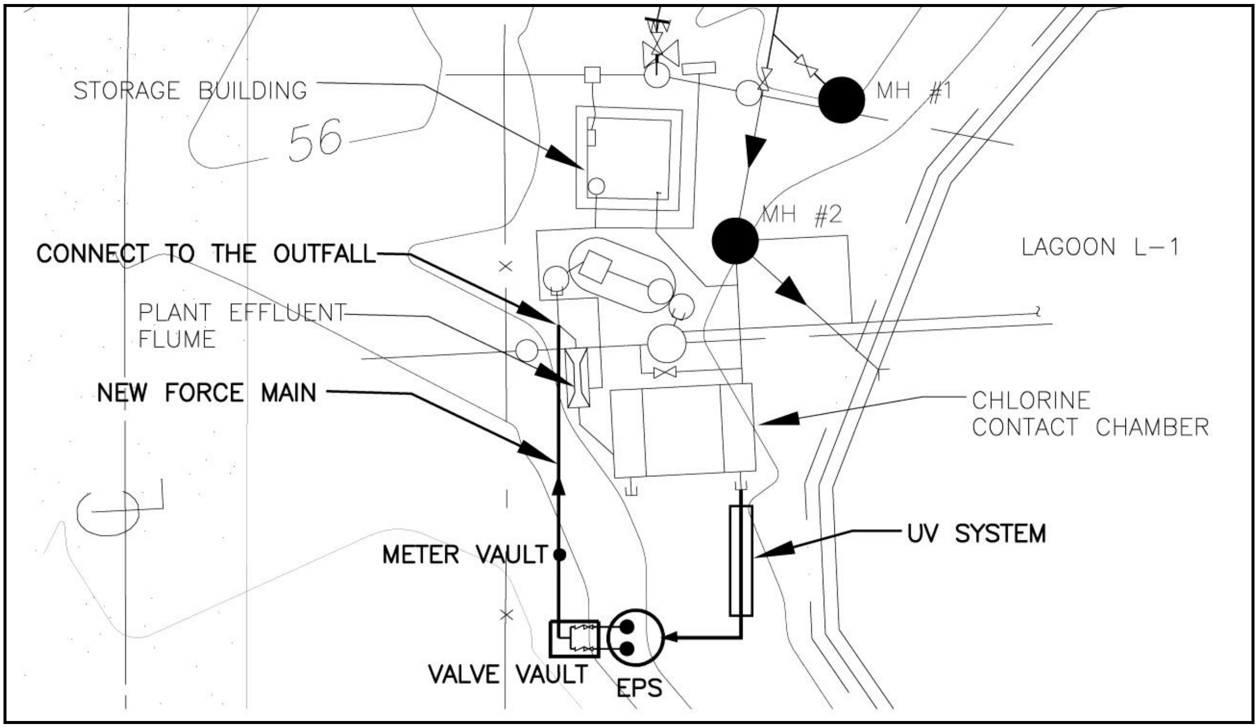

Figure 8.2 – Conceptual UV System Layout

The second train of the cells will be identical to the existing train of cells in size. Liner and aerators will also be same or similar to the existing ones.

However, if the lagoon system cannot meet the required effluent quality requirement or a total four trains of lagoons are requirement for meeting the projected buildout conditions, the existing lagoon system is recommended to be replaced with a SBR system. The first train of SBR system should be constructed. The existing anaerobic pretreatment cell is recommended to stay as an emergency storage pond and also function as an equalization pond for the SBR system. The SBR system is shown on Figure 7.1.

8.2.3 Year 2028 Condition

The plant effluent pumps will need to be replaced with 255 gpm flow capacity pumps for meeting the year 2028 and the build-out condition.

If the re-rated plant capacity re-rating is high as estimated based on current preliminary estimate, and the second train of the anaerobic pretreatment cell, the aerated cells and the polishing cell was not built for the year 2020 condition, then the second train of units will need to be built for meeting the year 2028 condition. The sizes, aerators and liners will be same as the existing train treatment system.

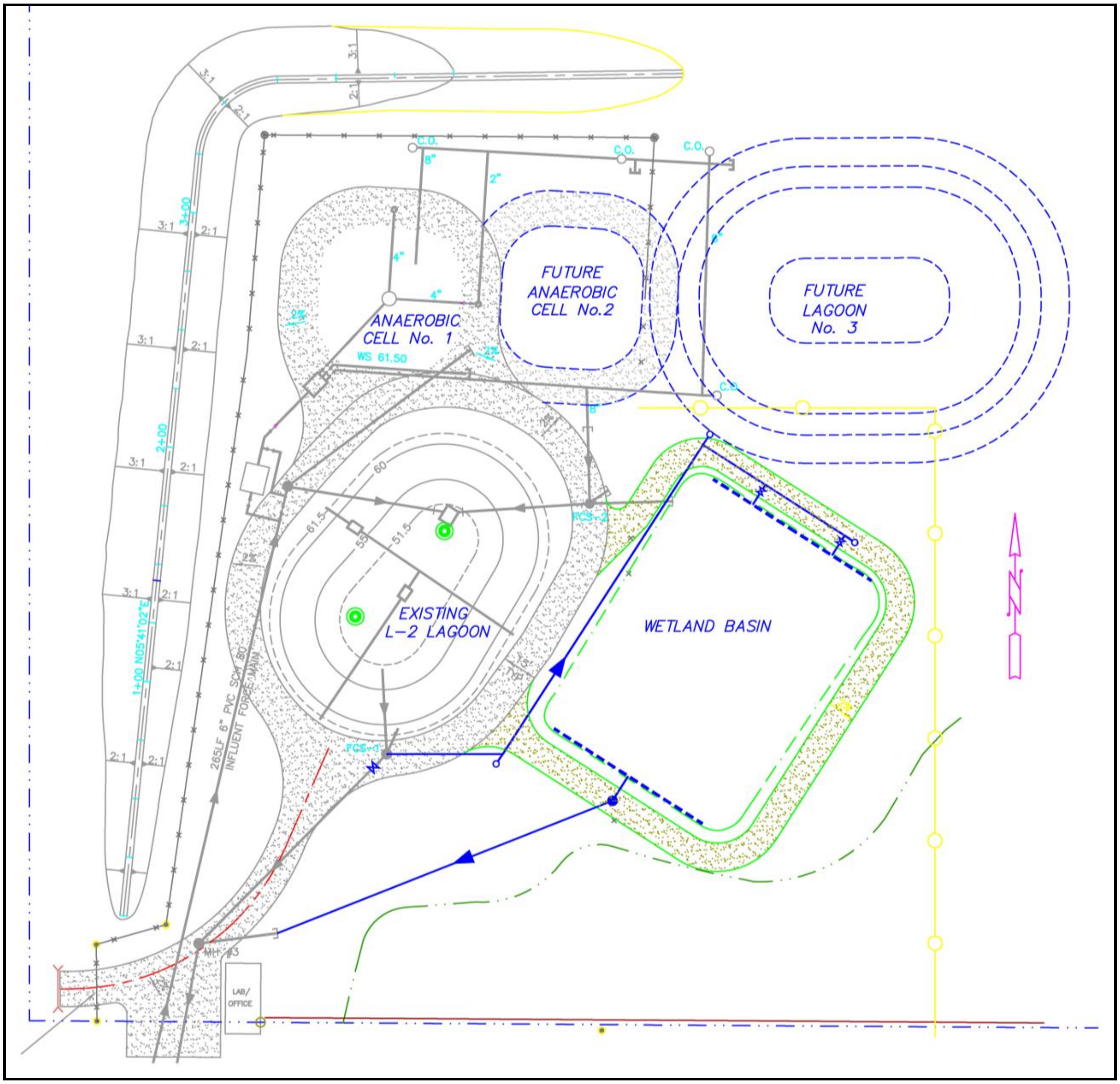

Figure 8.3 – Second Train of Treatment Cells Conceptual Layout

If the SBR system is selected and built for meeting the year 2020 condition, the second train of the SBR system will be required to be constructed for meeting the projected year 2028 conditions. The two trains of SBR should be able to meet the projected buildout condition too.

8.2.4 Build-out Condition

A second identical UV system will be required for meeting the projected buildout condition. Depending on the outcome of plant capacity re-rating, a third train of treatment cells may and may not be needed. If the third train is required, the sizes, aerators and liners will be same as the existing two train treatment systems.

In addition to the plant expansion, the collection system will also require extension to the Eastshore south area for servicing if this area is to be annexed by the District. Residents in this area are expected to be responsible for the cost of extension.

8.3 SUGGESTED IMPLEMENTATION SCHEDULE

Regulatory agencies require that planning and design should begin when the plant reaches 85% of the capacity and expansion construction starts when the plant reaches 90% of the capacity. Therefore, implementation schedules for the future expansions are entirely determined by the actual growth rate. The assumed growth rates for this study are 5.6% up to 2020, 3.8% after within the UGA area and 2.5% for other areas all time. Based on these growth rates, and assuming that the Eastshore South area will not be serviced until after 2028, the projected flows and loadings in the future years are listed in Table 8.1. The flows and BOD_5 loadings were projected based on the previous established criteria of 100 gpd/ERU and 0.15 lbs BOD_5/ERU for the summer season, 93 gpd/ERU and 0.14 lbs BOD_5/ERU for the winter season. The projected flows and BOD_5 loadings appear very conservative in comparison with the most recent two years data in Table 8.2. This is because unit ERU flow loadings used in the projections were flow values based on 90 percentile and 98 percentile analysis of the historical flow data, respectively for the winter season and the summer season (see Section 4 of this report), not the average values of the historical flows. The unit ERU BOD_5 loadings criteria were also established based on higher than flow weighted historical averages.

Table 8.1 – Projected Future Years Loadings

Year	UGA ERU	UGA and FBSD ERU	ESS ERU	Total Service Area ERU	Projected Flows		Projected BOD5 Loading	
					Winter	Summer	Winter	Summer
					(gpd)		(lbs/d)	
2008	173	309		309	28732	30895	34	46
2009	183	322		322	29950	32204	35	48
2010	193	336		336	31225	33576	37	50
2011	204	350		350	32563	35014	39	53
2012	215	365		365	33964	36521	40	55
2013	227	381		381	35434	38101	42	57
2014	240	398		398	36975	39758	44	60
2015	253	415		415	38592	41496	46	62
2016	268	433		433	40287	43320	48	65
2017	283	452		452	42066	45232	50	68
2018	298	472		472	43933	47239	52	71
2019	315	493		493	45892	49346	54	74
2020	333	516		516	47948	51557	57	77

2021	346	533		533	49549	53278	59	80
2022	359	551		551	51205	55059	61	83
2023	372	569		569	52919	56902	63	85
2024	386	588		588	54692	58808	65	88
2025	401	608		608	56526	60781	67	91
2026	416	628		628	58424	62822	69	94
2027	432	649		649	60388	64934	71	97
2028	449	671		671	62421	67119	74	101
2029	466	694	142	836	77729	83580	92	125
2030	483	717		859	79905	85920	95	129
2031	502	741		883	82157	88341	97	133
2032	521	766		908	84488	90847	100	136
2033	541	792		934	86899	93440	103	140
2034	561	819		961	89395	96124	106	144
2035	582	847		989	91978	98901	109	148
2036	588	859		1001	93114	100122	110	150
2037	588	866		1008	93744	100800	111	151
2038	588	873		1015	94391	101495	112	152
2039	588	880		1022	95053	102208	112	153
2040	588	887		1029	95732	102938	113	154
2041	**588**	**890**		**1032**	**95976**	**103200**	**114**	**155**

Table 8.2 – Most Recent Two Years Loading Data

Month and Year	Summer Flows	Winter Flows	Plant Influent BOD5	Summer BOD5 Loading	Winter BOD5 Loading
	(mgd)	(mgd)	(mg/l)	(lbs/d)	(lbs/d)
Apr-06	0.017		165	23.4	
May-06	0.014		193.2	22.6	
Jun-06	0.016		213.2	28.4	
Jul-06	0.021		178	31.2	
Aug-06	0.022		180.3	33.1	
Sep-06	0.016		168.2	22.4	
Oct-06	0.014		138.2	16.1	
Nov-06	0.018		126.6	19.0	
Dec-06		0.02	93.3		15.6
Jan-07		0.023	97.9		18.8
Feb-07		0.015	143		17.9
Mar-07		0.017	106.2		15.1
Annual Average	**0.017**	**0.019**	**150.3**	**24.5**	**16.8**
Apr-07	0.015		146.6	18.3	

May-07	0.014		187.5	21.9	
Jun-07	0.016		163.3	21.8	
Jul-07	0.022		141.7	26.0	
Aug-07	0.023		142.8	27.4	
Sep-07	0.018		144.9	21.8	
Oct-07	0.014		134.9	15.8	
Nov-07	0.015		117.7	14.7	
Dec-07		0.013	137.9		15.0
Jan-08		0.013	138.1		15.0
Feb-08		0.015	119.7		15.0
Mar-08		0.014	102.9		12.0
Annual Average	**0.017**	**0.014**	**139.8**	**21.0**	**14.2**
Total Average	**0.017**	**0.016**	**145.0**	**22.7**	**15.5**

But if the average loadings of the most recent two years and an aggressive 5.6% growth rate are used to project the future years flow and BOD_5 loading, winter flow will reach 85% of the currently permitted capacity by 2011, 90% by 2012 and 100% by 2013, while summer flow will reach 85% of the permitted capacity by 2016, 90% by 2018 and 100% by 2019. However it will not reach the 85% of the permitted organic loading capacity until 2020 as shown in Table 8.3. It can be seen that it is difficult to determine a meaningful implementation schedules at present for the future expansions. But it is clear that the winter flow appears to be approaching the currently permitted capacity. Therefore, the District needs to prepare the plant capacity re-rating as soon as adequate data is available. Depending on the final re-rated capacity of the current plant, expansion may not be required until after 2020 or as soon as few years from now.

Table 8.3 – Projected Future Flow and BOD5 Loading Based on Current Loadings

Year	**Projected Summer Flows**	**Projected Winter Flows**	**Projected Summer BOD_5 Loading**	**Projected Winter BOD_5 Loading**
	(mgd)	(mgd)	(lbs/d)	(lbs/d)
2008	0.018	0.017	24.0	16.4
2009	0.019	0.018	25.4	17.3
2010	0.020	0.019	26.8	18.3
2011	0.021	**0.020**	28.3	19.3
2012	0.023	**0.021**	29.9	20.4
2013	0.024	**0.023**	31.5	21.5
2014	0.025	0.024	33.3	22.7
2015	0.027	0.025	35.2	24.0
2016	**0.028**	0.027	37.1	25.4
2017	0.030	0.028	39.2	26.8
2018	**0.031**	0.030	41.4	28.3
2019	**0.033**	0.031	43.7	29.9
2020	0.035	0.033	**46.2**	**31.5**

2021	0.037	0.035	48.8	33.3
2022	0.039	0.037	51.5	35.2

8.4 FINANCIAL ANALYSIS

8.4.1 Current Financial Conditions

This financial analysis is intended to be a general overview of the District's financial structure and condition, not a user rate study. The District has several funds in its accounting system. These funds include the general fund, the reserve fund, the trust fund, the 1995 revenue bond fund, the1999 revenue bond fund, and the 2006 revenue bond fund (see **Appendix K**).
The District's incomes include connection fees, user fees, investment interests and miscellaneous charges and fees. The District currently charges $7993.00 per ERU for connecting to the District's collection system. The connection charges go to the District's reserve fund. The reserve fund is used for collection system and plant improvements and expansions. However, when it is needed, the District will use the reserve fund for general operating purpose. The current balance in the reserve fund is $261,519.34 as of May 2008.

The District charges $52.80 for ULID #1 residential users, $63.25 for ULID #1 commercial users, $53.84 for ULID #2 residential users and $64.29 for ULID #2 commercial users. These charges include operational & maintenance costs, 1995 revenue bond cost and 2006 revenue bond cost. The user fees and miscellaneous incomes go to the District's general fund. The general fund is used for operating and maintaining the collection system and the plant, general office supply, employee salary and benefits, insurance and bond payment, engineering and legal services, utilities and rents, etc, expenses. Total budgeted income for the 2008 fiscal year is $302,200, which includes $188,000 user fees income.

8.4.2 Future Capital Needs Forecast

Future capital financial needs for three scenarios were forecasted for various years and listed in the Table 8.4. Even though the construction cost index data from 1990 to 2008 complied by the Washington State Department of Transportation was about 4.5% annual increase, a conservative 6% was used to forecast future construction costs in light of the recent commodity price escalations.

Table 8.4 – Present and Future Capital Cost Needs

Project Needs	Estimated 2008 Dollar Cost	Estimated Year 2015 Dollar Cost	Estimated Year 2023 Dollar Cost	Estimated Year 2036 Dollar Cost
Scenario I (Total two trains of lagoon system)				
Present condition	$ 245,000			
Year 2020	$ 34,000	$ 51,123		
Year 2028	$ 847,000		$ 2,030,168	
Buildout	$ 34,000			$ 173,797

Scenario II (Total three trains of lagoon system)				
Present condition	$ 245,000			
Year 2020	$ 861,000	$ 1,294,803		
Year 2028	$ 20,000		$ 47,931	
Buildout	$ 861,000			$ 4,401,765
Scenario III (Two trains of SBR system)				
Present condition	$ 194,000			
Year 2020	$ 988,000	$ 1,485,587		
Year 2028	$ 974,000		$ 2,334,248	
Buildout	$ 34,000			$ 173,797
Note: Assuming construction will be completed 5 years prior to reaching the projected conditions.				

8.4.3 Future Revenues Forecast

The District has two main sources of revenues: the user rate fee and the connection fee. The user rate fee and miscellaneous other incomes in the District's general fund are used for office, collection system and the plant operations and routine maintenance and repairs. Currently the District has approximately 320 ERUs with a budgeted annual user fee income of $188,000, or approximately $49 per ERU per month on average. Assuming that the future user rates will be adjusted as necessary for general operation and maintenance expenses needs, then forecasting this source of revenues is not needed herein.

The connection fee in the District's reserve fund is used primarily for capital improvements and expansions. The reserve fund is invested in bank CDs with various maturities and earning approximately 3 to 4% interests. The connection fee varies according to the State's regulatory requirements. But generally the fee is expected to increases in the future. Based on the following assumptions, future available funds in 2015, 2023 and the buildout year 2036 were estimated and listed in the Table 8.5.

- The recommended improvements for the present condition will be completed in 2008
- There are no major capital improvements until 2015.
- No transfer to the general fund.
- The reserve fund earns 3.0% annual interest.
- The connection fee will remain at $7993.
- ERU increases at 5.6% within the UGA and 2.5% outside of the UGA.
- The Eastshore South area will not be connected until after 2028.
- Debt is assumed to grow at 6% annual rate.

Table 8.5 – Projected Available Funds in the Future

Year	Total ERUs in Services	ERU Increases	Connection Fee Per ERU	Connection Fee Revenues	Projected Capital Expense Scenario I	Projected Capital Expense Scenario II	Projected Capital Expense Scenario III	Projected Available Funds Under Scenario I	Projected Available Funds Under Scenario II	Projected Available Funds Under Scenario III
2008	**309**		**$ 7,993**		**$ 245,000**	**$ 245,000**	**$ 194,000**	**$ 261,519**	**$ 261,519**	**$ 261,519**
2009	322	13	$ 7,993	$ 104,627				$ 16,519	$ 16,519	$ 67,519

2010	336	14	$ 7,993	$ 109,645						
2011	350	14	$ 7,993	$ 114,922						
2012	365	15	$ 7,993	$ 120,474						
2013	381	16	$ 7,993	$ 126,314						
2014	398	17	$ 7,993	$ 132,459						
2015	415	17	**$ 7,993**	$ 138,924	**$ 51,123**	**$ 1,294,803**	**$ 1,485,587**	**$ 891,586**	**$ (352,093)**	**$ (480,154)**
2016	433	18	$ 7,993	$ 145,728						
2017	452	19	$ 7,993	$ 152,889						
2018	472	20	$ 7,993	$ 160,425						
2019	493	21	$ 7,993	$ 168,358						
2020	**516**	**22**	$ 7,993	**$ 176,709**						
2021	533	17	$ 7,993	$ 137,610						
2022	551	18	$ 7,993	$ 142,365						
2023	**569**	**18**	**$ 7,993**	**$ 147,288**	**$2,030,168**	**$ 47,931**	**$ 2,334,248**	**$ 645,511**	**$ 937,129**	**$ (1,553,297)**
2024	588	19	$ 7,993	$ 152,386						
2025	608	20	$ 7,993	$ 157,666						
2026	628	20	$ 7,993	$ 163,133						
2027	649	21	$ 7,993	$ 168,795						
2028	671	22	$ 7,993	$ 174,659						
2029	836	165	$ 7,993	$1,315,738						
2030	859	23	$ 7,993	$ 187,022						
2031	883	24	$ 7,993	$ 193,536						
2032	908	25	$ 7,993	$ 200,283						
2033	934	26	$ 7,993	$ 207,271						
2034	961	27	$ 7,993	$ 214,509						
2035	989	28	$ 7,993	$ 222,006						

2036	**1001**	**12**	**$ 7,993**	**$ 97,604**	**$ 173,797**	**$ 4,401,765**	**$ 173,797**	**$ 4,942,020**	**$ 1,142,303**	**$ (937,197)**
2037	1008	7	$ 7,993	$ 54,197						
2038	1015	7	$ 7,993	$ 55,552						
2039	1022	7	$ 7,993	$ 56,941						
2040	1029	7	$ 7,993	$ 58,365						
2041	1032	3	$ 7,993	$ 20,939						

Data in Table 8.5 show that the District will have adequate financial capability to support the required capital improvements and expansions for meeting the future growth needs for scenario I and II situations. But if the SBR system is to be built, additional funding may be required depending on the when the SBR system is actually built.

It should be noted that requests for service will be served on the basis of capacity availability. Circumstances can occur which would require the District to issue an Emergency or Interim Moratorium on new service connections. The plant's NPDES permit requires that future sewer connections, extensions or additional waste loads be limited if flows or waste loads reach 85% of any one of the design criteria, under which the plant is operated. The Department of Ecology requires this so that compliance can be maintained during the planning and execution of the measures necessary to meet the service requests.

8.5 FUNDING OPTIONS

In addition to the District's reserve fund, the District can also apply grants and low interest loans from the County, the State and US EPA for funding the collection system, and plant improvements and expansions. The District had obtained grants from the County for the collection system and pant expansions in the past. Potential other funding sources, eligibility and contact information are summarized in the following Table 8.6. Please contact Cathi Read at cathir@cted.wa.gov at the Washington State Department of Community, Trade and Economic Development for updated program information.

Table 8.6 – Potential Funding Sources Summary

PROGRAMS	ELIGIBLE PROJECTS	ELIGIBLE APPLICANTS	FUNDING AVAILABLE	HOW TO APPLY
Planning Programs				
CDPG-POG Community Development Block Grant – Planning-Only	• Comprehensive plans • Infrastructure plans • Feasibility	Projects must principally benefit low- to moderate-income people in non-entitlement	Grant • Up to $35,000 for a single jurisdiction and $50,000 for	Applications accepted year-round, on a fund-available basis Contact: Sheila Lee-

Grant Program	studies • Community action plans • Low-income housing assessments	cities and counties. • Cities or towns with fewer than 50,000 people • Counties with fewer than 200,000 people	multiple jurisdictions • Upper limits available for priority public health planning	Johnston 360-725-3009 sheilal@cted.wa.gov
PWTF Planning Public Works Trust Fund – Capital Facilities Planning Program	• Single or multiple system plans covering eligible systems • Updates to existing capital facilities plans • Environmental studies	• Counties, cities, and special-purpose districts that meet certain requirements (contact the client service representative) • No school or port districts	Loan • Up to $100,000 per jurisdiction each biennium • 0 percent interest, 6-year term • No match required • Must complete plan in 18 months	Applications accepted year-round, on a fund-available basis Contact: Client Service Representative at 360-586-4122 or http://www.pwb.wa.gov
CERB Planning Community Economic Revitalization Board – Rural Project-Specific Planning Program	Project-specific feasibility and pre-development studies that advance community economic development goals for industrial sector business development.	Eligible in designated rural counties or rural natural resource areas: • Counties, cities, towns, port districts, special districts • Federally recognized tribes • Municipal corporations, quasi-municipal corporations with economic development purposes	Matching Grant • Up to $50,000 per application • Requires 50 percent matching funds	Applications accepted year-round. The Board meets six times a year. Contact: Kate Rothschild 360-725-4058 kater@cted.wa.gov
RD Pre-development U.S. Dept. of Agriculture Rural Development – Rural Utilities Service – Water and Waste	Water and/or sewer planning; environmental work; and other work to assist in developing an application for infrastructure improvements	Low-income, small communities and systems serving areas under 10,000 population.	Loans; Grants in some cases, depending on funding availability Maximum $15,000 grant Requires minimum 25% match	Applications accepted year-round, on a fund-available basis Contact: Gene Dobry 360-704-7733 Eugene.dobry@wa.usda.gov

Disposal Direct Loans and Grants				http://www.rurdev.usda.gov/wa
Pre-Construction Programs				
PWTF Public Works Trust Fund – Pre-Construction Program	Pre-construction activities such as preliminary engineering, design, bid-document preparation, right-of-way acquisition, environmental studies	• Counties, cities, and special purpose districts that meet certain requirements (contact the client service representative) • No school or port districts	Loan • $1 million per jurisdiction each biennium • 0.5 to 2 percent interest, depending on local match • 5 to 15 percent local match • 5-year term, or 20-years if construction funds are acquired before first loan principle payment	Applications accepted year-round, on a fund-available basis Contact: Client Service Representative at 360-586-4122 or http://www.pwb.wa.gov
Construction Programs				
CDPG – GP Community Development Block Grant – General Purpose Grant Program	Final design and construction of domestic wastewater, side sewer connections, drinking water, stormwater, roads, streets, and bridge projects.	Projects must principally benefit low- to moderate-income people in non-entitlement cities and counties. • Cities or towns with fewer than 50,000 people • Counties with fewer than 200,000 people	Grant • Up to $1 million • No match required, but local contribution and gap financing preferred	Applications due in November, notification in March Contact: Bill Prentice 360-725-3015 billp@cted.wa.gov
CDBG-CIF Community Development Block Grant – Community Investment Fund	Top priority projects from county list of prioritized projects	Projects must principally benefit low- to moderate-income people in non-entitlement cities and counties. • Cities or towns with fewer than 50,000 people • Counties with fewer than 200,000 people	Grant • Up to $1 million • Need for grant must be clearly identified • Project must be ready to go • Must be a local priority project	Applications accepted year-round, on a fund-available basis Contact: Dan Riebli 360-725-3017 danr@cted.wa.gov

PWTF Public Works Trust Fund – Construction Program	New construction, replacement, and repair of existing infrastructure for domestic water, sanitary sewer, storm sewer, solid waste, road or bridge projects, and reasonable growth	• Counties, cities and special purpose districts that meet certain requirements (contact the client service representative) • No school or port districts	Loan • $7 million per jurisdiction each biennium • 0.5 to 2 percent interest, depends on local match • 5 to 15 percent local match • 20-year term maximum	Applications due in May (May 8, 2006) Funds available the next spring Contact: Client Service Representative at 360-586-4122 or http://www.pwb.wa.gov
DW SRF Drinking Water State Revolving Fund	Drinking water system infrastructure projects aimed at increasing public health protection	Community and non-community water systems (includes for-profit and non-profit systems, but not federal or state-owned systems); both privately- and publicly-owned systems are eligible	Loan • 1 percent loan fee • $3 million per jurisdiction a year • $6 million for jointly-owned projects • 0 to 1.5 percent interest rate • 20-year term; 30 for extremely disadvantaged communities • No local match required	Applications due in May (May 8, 2006) Funds available the next spring Contact: Chris Gagnon 360-236-3095 Chris.Gagnon@doh.wa.gov http://www.doh.wa.gov/ehp/dw/our_main_pages/dwsrf.htm
RD U.S. Dept. of Agriculture Rural Development - Rural Utilities Service - Water and Waste Disposal Direct Loans and Grants	Pre-construction and construction associated with building, repairing, or improving drinking water, solid waste facilities and wastewater facilities	• Cities or towns with fewer than 10,000 population • Counties, special purpose districts, non-profit corporations or tribes unable to get funds from other sources at reasonable rates and terms	Loans; Grants in some cases • Interest rates vary (currently ~4.5%) • Up to 40-year loan term • No pre-payment penalty	Applications accepted year-round on a fund-available basis Contact: Gene Dobry 360-704-7733 Eugene.dobry@wa.usda.gov http://www.rurdev.usda.gov/wa
DOE Ecology, Washington State Water Pollution Control Revolving Loan Fund	Planning, design, and construction projects associated with publicly-owned wastewater treatment facilities	Counties, cities, towns, conservation districts, or other political subdivision, municipal or quasi-municipal corporations, and tribes	Loan, either: • 2.6% interest for 6-20 year term, or • 1.3% interest for 5 year term • Hardship assistance for water pollution control facilities (existing	Applications accepted ~September 1 through ~October 31 for next fiscal year funding (check with staff for exact dates) Contact: Brian Howard 360-407-6510 brho461@ecy.wa.gov

			residential need only) may be available in the form of a reduced interest rate or extended term	
CCWF Ecology, Centennial Clean Water Fund	Planning, design, and construction projects associated with publicly-owned wastewater treatment facilities	Counties, cities, towns, conservation districts, or other political subdivision, municipal or quasi-municipal corporations, and tribes	Loan; Grants in some cases Hardship assistance for water pollution control facilities (existing residential need only) may be available in the form of a reduced interest rate or extended term, or a combination loan and grant if sewer user fees are in excess of 1.5% of the median household income	Applications accepted ~September 1 through ~October 31 for next fiscal year funding (check with staff for exact dates) Contact: Jeff Nejedly 360-407-6566 jnej461@ecy.wa.gov
CERB Community Economic Revitalization Board - Construction Program	Projects must support industrial sector business growth and job creation or retention in the state. • Bridges, roads and railroad spurs, domestic and industrial water, sanitary and storm sewers • Electricity, natural gas and telecommunications • General purpose industrial buildings, port facilities	• Counties, cities, towns, port districts, special districts • Federally-recognized tribes • Municipal and quasi-municipal corporations with economic development purposes.	Loans; grants in unique cases • Public facility projects required by private sector expansion and job creation • $1 million maximum per project • Interest rates vary • 20-year term maximum • Requires 25% minimum match • Applicants must demonstrate gap in public project funding and need for CERB assistance • CERB is authority for funding approvals	Applications accepted year-round. The Board meets six times a year. Contact: Kate Rothschild 360-725-4058 kater@cted.wa.gov
EPA STAG Multimedia State and Tribal Assistance Grants	STAG Grant funds are used to build and enhance the capacity of states and tribes to carry out compliance	State agencies, U.S. territories, federally recognized Indian Tribes, the District of Columbia,	Each year EPA's Office of Enforcement and Compliance Assurance announces the STAG grant focus	Information about the Grant Projects selected for funding can be found in the following links. The Office of Grants and

	assurance activities within their respective jurisdictions. The projects selected cover a wide range of activities that have and will continue to enable states and tribes to demonstrate compliance assurance and enforcement outcomes from their activities while serving as models for other states and tribes. These capacity building activities include training, studies, surveys and investigations.	Intertribal Consortia, state universities and multi-jurisdictional state organizations with enforcement and compliance assurance responsibilities or responsibilities that support enforcement and compliance assurance including but not limited to data management or research are eligible to apply for and receive funds. In addition, state universities with expertise in compliance assurance and enforcement issues are also eligible grant applicants	areas, application requirements, due dates and amount of money available through a Solicitation Notice. These notices are published at the government-wide Grants.gov Web site and at the EPA STAG Funding Opportunities Web page. This page also provides Frequently asked questions, the STAG Fact Sheet, and Definitions. Other Offices in EPA also provide STAG funds to states and tribes. Common STAG programs address water treatment, wastewater treatment, targeted watershed grants, and state revolving funds for water projects. Information on these programs is found at Water Funding In addition there are Environmental Justice Grants, the Tribal grant program and grants programs for the Federal Insecticide, Fungicide and Rodenticide Act and the Toxic Substances Control Act.	Debarment now maintains information on all current grants awarded by EPA, including an abstract and contacts. This database can be accessed at Grant Awards Database. http://www.epa.gov/oecaerth/state/grants/stag/index.html
Emergency Programs				
PWTF Public Works Trust Fund – Emergency Program	Projects necessary due to natural disaster, or immediate/emergent threat to public health and safety For domestic water systems, sanitary and	• Counties, cities, and special purpose districts that meet certain requirements (contact the client service representative)	Loan; pending availability of funds • 3 percent interest rate • No local match required • 20-year maximum term • $500,000 limit	Applications accepted year-round. Contact: Client Service Representative at 360-586-4122 or http://www.pwb.wa.gov

	storm sewers, solid waste, roads and bridges	• No school or port districts		
CDBG-IT Community Development Block Grant – Imminent Threat Grant Program	Repair water, sewer and drainage facility damages that pose an immediate, urgent threat to public health and safety • A formal disaster must be declared • Project must be ineligible for emergency funds from the Public Works Trust Fund	• Non-entitlement cities or towns with fewer than 50,000 people • Non-entitlement counties with fewer than 200,000 people	Grant; pending availability of funds Only eligible costs incurred after an emergency is formally declared can be reimbursed	Applications accepted year-round. Contact: Bill Prentice 360-725-3015 billp@cted.wa.gov

9.0 References

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20. "Draft Wastewater Facilities Plan, Fisherman Bay, Washington", ARC Engineers, July 19, 1976.
21. EPA Septage Treatment and Disposal Handbook, October 1984.

22. Wastewater Technology Fact Sheet – Sequencing Batch Reactor, EPA, September 1999.
23. Optimization of Various MBR Systems for Water Reclamation – Phase III, the City of San Diego Water Department and Montgomery Watson Harza, April 2004.

APPENDIX A

FBSD WWTP NPDES Permit

APPENDIX B

ERU Flow Percentile Analysis

APPENDIX C

Flow Weighted BOD5 and Ammonia Analysis

APPENDIX D

Influent Wastewater Temperature Percentile Analysis

APPENDIX E

L-2 Influent $CBOD_5$ Analysis, HRT and L-2 and Wetland Capacity Estimates

APPENDIX F

Wetland Effluent TSS and $CBOD_5$ Validation Calculations

APPENDIX G

Mixing Zone Studies

APPENDIX H

Septage Supernatant Receiving Record

APPENDIX I

Opinion of Probable Construction Cost Estimates

APPENDIX J

Preliminary Equipment Cut Sheets

APPENDIX K

The District's Finanacial Data