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City of West Sacramento - Wastewater Master Plan and Connection to the Lower Northwest Interceptor

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SECTION 1

Introduction

1.1 BACKGROUND

The City of West Sacramento (City) maintains a sewage collection system which serves all commercial, residential, and industrial development within its city limits. The sewer system is comprised of a series of gravity sewers, seven major pump stations, 3 smaller lift stations, and a forcemain network conveying wastewater flows to the City's wastewater treatment plant. The system has been expanded and modified as the City has grown.

The last citywide sewer master plan was conducted in 1987 and reflected City growth planning at that time. The 1987 Master Plan identified facilities associated with ultimate development of the City's boundary at that time. The study recommended a number of projects which have been completed over the last 15 years, including the elimination of several lift stations within the City, construction of the Industrial and Northport regional pump stations, and associated sewer and forcemain improvements. Since then, the City has adopted a new General Plan (last revision June 14, 2000), retired several pump stations, experienced significant growth in the Southport Area, initiated redevelopment of the vacant industrial areas along its waterfront, and is planning for the connection to the Sacramento Regional Sanitation District Lower Northwest Interceptor. In addition, the United States Environmental Protection Agency will require the City to develop a Capacity, Management, Operations, and Management Program (CMOM) for its sewer system. This new regulatory initiative will require the City to increase maintenance and sewer rehabilitation activities to prevent sewage spills.

Given these various changes and issues, the City has initiated this sewer master planning effort. The specific objectives of this sewer master plan are to:

- Update the 1987 Sewerage Master Plan to be consistent with its current General Plan, redevelopment plans, and recent City growth
- Assess condition of existing sewer system
- Measure existing wastewater flows, project future flows, and identify hydraulic bottlenecks
- Determine future regulatory requirements related to the management, operation, and maintenance of the sewer collection system
- Inspect known problem areas within the system and provide a framework for near-term and long-term sewer rehabilitation activities
- Describe system modifications required as part of the City's connection to the Lower Northwest Interceptor
- Develop a phased capital improvement plan for the recommended projects

The Southport Area development and future connection to the Lower Northwest Interceptor is detailed in the Southport Sanitary Sewer Master Plan dated April 2003.

1.2 GENERAL DESCRIPTION OF THE STUDY AREA

West Sacramento's city limits are defined by the Sacramento on the north, the Sacramento River on the east, Shangri-La Slough on the south, and the east levee of the Yolo Bypass on the west. This service area is shown on Figure 1-1. As shown, the City is divided into two general areas- mostly developed areas above the Port of Sacramento Deep Water Ship Channel and a partially developed area south of the shipping channel, called "Southport". A detailed view of the northern area of the City is shown on Figure 1-2.

1.3 EXISTING CITY WASTEWATER SYSTEM

The existing City wastewater collection system consists of gravity sewers ranging in size from 6-inch to 42-inch diameter pipe, 7 dry pit type pump stations, 3 lift stations, and a series of forcemains ranging in size from 12-inch to 30-inch diameter pipe. The wastewater is collected through the gravity sewers, conveyed to pump stations, and pumped through the forcemains to the City's wastewater treatment plant (WWTP) on South River Road north of the Ship Channel.

The northern section of the city is divided into five tributary areas, each served by one pump station. These tributary areas are named by their respective pump stations: Bryte, Jefferson, Industrial, Northport, and South. There are two smaller lift stations: Coke and Triangle Lift Stations. Southport is currently served by the Southport Pump Station, Bridgeway Island Pump Station, and the Allen Lift Station.

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Figure 1-1 City of West Sacramento Service Area and Land Use Zoning Designations

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Figure 1-2 Sewer Basins and Land Use North of Ship Channel

SECTION 2

Existing and Future Land Use

In this section, land use information developed within the City's current General Plan Update (2000) is reviewed. The City's population has increased from 26,164 people in 1986 (Master Sewerage Plan, 1987) to 31,615 in 2000 (Census, 2000). In the future the City projects a population of 77,100 people at the complete buildout of the City. Most of the new development will occur in Southport (south of the Ship Channel), however several redevelopment projects along the City's existing waterfront area are planned.

In this section, City planned land uses are separated into tributary areas for each of the major pump stations, which are then used to determine wastewater flows and sewer infrastructure needs. This section also provides a summary of development assumptions contained within the 1987 Master Plan as well the 2000 General Plan. A separate master plan has been developed for the Southport area. The Southport Sanitary Sewer Master Plan April 2003 provides detailed land use estimates for areas south of the Ship Channel.

2.1 PREVIOUS SEWER MASTER PLAN ASSESSMENT

As discussed in Section 1, the last citywide master sewerage system plan was conducted in 1987 by URS Corporation. The 1987 Master Plan identified facilities associated with ultimate development of the City's boundary at that time. The study recommended a number of projects which have been completed over the last 15 years, including the elimination of several lift stations within the City, construction of the Industrial and Northport regional pump stations, and associated sewer and forcemain improvements. Since 1987 there have also been significant changes to how development has progressed within the City; and with the City's eventual connection to the Lower Northwest Interceptor, the 1987 Master Plan is now inconsistent with City planning objectives.

Many of the pump stations north of the Ship Channel were originally sized to be consistent with the buildout of their tributary areas; this information has been reviewed and summarized. Table 2-1 provides original design assumptions for the Northport, Industrial, South, and Jefferson Pump Stations. With the exception of the Bryte Pump Station, these pump stations have not been expanded since the 1987 study. Bryte was modified in 1995 to receive flows from areas previously served by the Michigan Pump Station.

TABLE 2-1
ORIGINAL DESIGN ASSUMPTIONS FOR PUMP STATIONS NORTH OF THE SHIP CHANNEL

Pump Station	Residential Acres [a]	Commercial Acres [b]	Industrial Acres [b]	Other Acres [b]	Total WW Producing Acres
Bryte [c]	530	77	54	260	921
Jefferson [c]	137	107	146	54	444
Northport	57	105	158	783	1,103
Industrial	28	0	280	273	581
South	220	47	328	101	696
Total North of Ship Channel	972	336	966	1,471	3,745

a Areas are from Table 4-7 of 1987 Master Plan. Residential includes the following categories from the master plan: single family home, duplex, triplex, fourplex homes, apartments, mobile homes.

b Commercial includes the following categories from the 1987 Master Plan: commercial, motels. Industrial includes the following categories from the master plan: industrial and warehouse. The "Other Acres" category includes: churches, schools, parks. The total area does not include the right of way area or un-developable areas.

c The Jefferson pump station was formerly known as Capital Inn pump station. Bryte land uses and flows include Michigan Pump Station.

Source: Adapted from 1987 City Master Plan, Table 4-7

2.2 2000 GENERAL PLAN LAND USE INFORMATION

Land uses were obtained from the current City General Plan. Specific redevelopment projects were also included in the analysis. These planned projects are described in Figure 2-1 and include the Lighthouse Development, One Riverfront Plaza, and Raley's Landing. The land use information for areas North of the ship channel are presented in Table 2-2, organized by pump station tributary area.

TABLE 2-2
CURRENT PLANNED LAND USES FOR NORTH OF THE SHIP CHANNEL

Pump Station	Land Use[a] (acres)				
	Residential	Commercial	Industrial	Public	Total [b]
Bryte	1,349	129	106	110	1,694
Jefferson	518	100	72	13	703
Northport	58	358	465	523	1,404
Industrial	29	74	656	139	898
South	472	69	364	75	980
Total North of Ship Channel	2,173	730	1,663	860	5,426

a Land use calculated from City of West Sacramento General Plan, 2000 and City planned developments along waterfront.

b Total also includes public, park and school land areas.

Comparing Table 2-1 (1987 land use assumptions) and Table 2-2 (current General Plan land use assumptions), there is an overall increase in acres generating wastewater. As shown, the developable acreage increases from 3,745 acres in 1987 to 5,426 acres currently. This increase could be a

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Figure 2-1 Redevelopment Projects

combination of rezoning and different methodologies for calculating areas that could be developed. As a result of these changes, an evaluation of each tributary area has been conducted to confirm sufficient sewer and pump station capacity exists for buildout of the City's current General Plan.

Table 2-3 describes current land use zoning designations for the City of West Sacramento. This information is organized by pump station tributary area. The Southport Sanitary Sewer Master Plan provides a separate analysis for the newer Southport Area.

2.3 FUTURE DEVELOPMENT PROJECTS

The existing and future development projects are described below for the five northern tributary areas. The Southport Sanitary Sewer Master Plan describes land use planning information for the Southport area.

BRYTE TRIBUTARY AREA

Bryte is a mostly residential area with some commercial and industrial land use to the south. Bryte is still developing and currently has two development projects including the Lighthouse development and Riverpoint. The Lighthouse development includes 265 acres of mixed-use development, 110 acres of residential use, 763 single-family and multi-family units, 246,000 sf of retail commercial, 50,000 sf of marine commercial, 200,000 sf of business professional office, an 18-hole golf course and 29 acres of riverfront parkway, public access and landscape corridors.

JEFFERSON TRIBUTARY AREA

Jefferson is significantly different from the 1987 assumptions due to rezoning occurring in the sub areas of One Riverfront Plaza, Raley's Landing, and the Triangle. Land areas were rezoned from waterfront mixed uses, to a variety of office space, retail space, and housing. Redevelopment in the Triangle Area will convert the mostly abandoned industrial areas into offices, highrise apartments, and other commercial enterprises.

Several development projects are under construction in the Jefferson tributary area. East Riverfront property includes 43 acres of riverfront property that can be used for mixed-use development. The Washington Specific Plan involves 190 acres for redevelopment. One Riverfront Plaza adds 530,000 sf of office, 27,000 sf of retail, 25,000 sf of restaurants, and 170 apartments. Raley's landing is 25.2 acres of mixed used planning including 945,000 sf of office space, 46,000 sf of retail, 428-room hotel with convention and recreation facilities and 218 apartment units. Raley field added a 11,000 seat Triple A baseball stadium. The Triangle specific plan redevelops 180 acres on the riverfront including up to 7,0000,000 sf of office and commercial, and up to 5,000 high-density residential units.

SOUTH TRIBUTARY AREA

South is mostly residential and industrial with some commercial. The South tributary area is well developed. No major development projects are currently proposed.

Insert

TABLE 2-3 CURRENT LAND USE DESIGNATIONS

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TABLE 2-3
CURRENT LAND USE DESIGNATIONS

Land Use	Pump Station Acre Totals					Number of Dwelling Units	Dwelling Units per Acre[b]	Persons per Dwelling Unit[a]	Total People
	Bryte	Industrial	South	Jefferson	Northport				
RRA Rural Residential	0	0	0	0	0	0	0.80	3.00	0
R1-A Residential – One Family (A)	851	0	349	0	18	4,875	4.00	3.00	14,624
R1-B Residential – One Family (B)	0	0	0	0	0	0	4.00	3.00	0
R-2 Residential - One Family or Multi Family	156	29	1	46	0	1,619	7.00	2.50	4,049
RE Rural Estate	0	0	0	0	0	0	0.00	3.00	0
R-3 Multiple Family Residential	75	0	0	39	39	2,755	18.00	2.50	6,888
R-4 Apartment	0	0	0	0	0	0	18.00	2.25	0
WF/MU Waterfront/Mixed Use	14	0	121	433	0	2,388	4.20	2.25	5,372
Total Residential	**1,096**	**29**	**472**	**518**	**58**				**30,993**
C-1 Commercial - Neighborhood	5	0	5	1	0	N/A	N/A	N/A	N/A
C-2 Commercial - Community	57	0	12	7	52	N/A	N/A	N/A	N/A
CH Commercial - Highway	0	27	10	0	29	N/A	N/A	N/A	N/A
CW Commercial - Water Related	0	0	0	0	0	N/A	N/A	N/A	N/A
C-3 Commercial - General	29	0	7	14	135	N/A	N/A	N/A	N/A
PO Professional Office	0	0	35	0	61	N/A	N/A	N/A	N/A
BP Business Park	0	46	0	0	80	N/A	N/A	N/A	N/A
CBD Central Business District	38	0	0	77	0	N/A	N/A	N/A	N/A

TABLE 2-3
CURRENT LAND USE DESIGNATIONS

Land Use	Pump Station Acre Totals					Number of Dwelling Units	Dwelling Units per Acre[b]	Persons per Dwelling Unit[a]	Total People
	Bryte	Industrial	South	Jefferson	Northport				
Total Commercial	**129**	**74**	**69**	**100**	**358**				
ML Limited Industrial	0	0	0	0	124	N/A	N/A	N/A	N/A
M-1 Industrial - Light	106	0	39	72	148	N/A	N/A	N/A	N/A
M-2 Industrial - Heavy	0	424	147	0	193	N/A	N/A	N/A	N/A
M-3 Industrial Waterfront	0	231	178	0	0	N/A	N/A	N/A	N/A
Total Industrial	**106**	**656**	**364**	**72**	**465**				**N/A**
PQP Public/Quasi Public [c]	110	0	43	0	0	N/A	N/A	N/A	N/A
RP Recreation - Parks	17	0	9	13	4	N/A	N/A	N/A	N/A
POS Public Open Space	57	139	23	0	59	N/A	N/A	N/A	N/A
Total Public/Park/School	**110**	**139**	**75**	**13**	**523**				
A-1 Agricultural	0	0	0	0	137	N/A	N/A	N/A	N/A
CHP Academy	0	0	0	0	460	N/A	N/A	N/A	N/A
Total Other	**0**	**0**	**0**	**0**	**137**				
Grand Totals	**1,440**	**897**	**980**	**702**	**1,404**				**33,933**

a Source: Southport Sanitary Sewer Master Plan, July 1999, pg.2-4
b Source: Southport Sanitary Sewer Master Plan, July 1999, pg. 2-3
c Source: 90% of Parks/Other value from General Plan, June 2000, pg VI-4

Page 2 of Table 2-3

NORTHPORT TRIBUTARY AREA

Northport's land use is split between commercial, industrial and public land use. In Northport, the Riverside Centre is under development. The Riverside Centre includes 60.6 acres of professional office, 26-acre business park, 76 acre of light industrial zoning, and 10.7 acres of community commercial zoning.

INDUSTRIAL TRIBUTARY AREA

Industrial is well developed and is mostly a "dry" warehousing type industrial use. No major development projects are currently under construction in the Industrial Tributary Area. City staff estimate the area is probably over 80 percent built out.

SECTION 3
Study Methodology

This section addresses the methodology used to analyze the City's land use, estimate wastewater flows, and assess system capacity.

3.1 LAND USES

Land uses within the City of West Sacramento are divided into four main categories of residential, commercial, industrial and public space. Residential zoning designations and densities established within the City's General Plan and are listed in Table 3-1.

TABLE 3-1
SUMMARY OF RESIDENTIAL ZONING DESIGNATIONS AND DENSITIES

Zoning Designation	Description	Density (dwelling units/acre)
RE	Rural Estate	N/A
RRA	Rural Residential	0.8
R-1	Residential- One Family	4.0
R-2	Residential – One Family or Multi Family	7.0
R-3	Multi Family Residential	18
R-4	Apartment	18
MU	Mixed Use	4.2

N/A: Not applicable because RE was eliminated from consideration for the development of flows.

Source: City of West Sacramento General Plan

Commercial zoning includes commercial, professional office, business park, and central business district areas. Industrial zoning includes light, medium, heavy, and waterfront industrial. The City also classifies public space, which includes parks, open spaces, public land, and schools.

3.2 FLOW ESTIMATION

The land use information is used to estimate wastewater flows throughout the collection system. Wastewater flows are comprised of sanitary flow, infiltration, and inflow which are added together to determine the peak flow through the sewer. The methods used to compute these flows are described below.

3.3 SANITARY FLOW

Sanitary flow is wastewater generated from residences, businesses and industry. Average Sanitary Flow is determined by applying wastewater generation rates to different types of land uses. The wastewater generation rates from the City's Planning Department Standards are summarized in

Table 3-2. As shown, residential land uses sanitary flows are expressed on a per dwelling unit basis; commercial and industrial flow are expressed on a per acre basis. If specific development information is available which would tend to produce higher sanitary flows than the rates shown in Table 3-2, more conservative site-specific factors are used. The City has plans to redevelop its waterfront areas with high-density residential and commercial properties. For these areas, specific factors have been developed within this Master Plan.

TABLE 3-2
SUMMARY OF UNIT FLOW RATES

Zoning	Flow / Unit
Commercial	1,500 gallons per day per acre
Industrial	2,000 gallons per day per acre
Residential	
Rural Estate (RE)	N/A
Rural Residential (RR)	300 gallons per day per dwelling unit
R-1 (3 people per dwelling unit)	300 gallons per day per dwelling unit
R-2 (2.5 people per dwelling unit)	250 gallons per day per dwelling unit
R-3 (2.5 people per dwelling unit)	250 gallons per day per dwelling unit
R-4 (2.25 people per dwelling unit)	225 gallons per day per dwelling unit
Mixed Use (MU)	225 gallons per day per dwelling unit

Source: City of West Sacramento Planning Standards

3.4 INFILTRATION AND INFLOW

Infiltration and inflow (commonly referred to as I/I) is the extraneous water that enters a sewer system through lateral and pipeline defects such as open joints, offset joints, holes, cracks, holes in manhole covers, defects in manholes, or illegal area drains. Infiltration is generally caused from groundwater leaking though cracks or defects in pipes and manholes. In the case of West Sacramento, infiltration levels tend to increase with the water level of the Sacramento River. Inflow is rainwater entering the sewer through manholes, pipes, or through cross connections with area drains (such as rain gutters). Inflow typically occurs during rain events and is characterized by high, short duration spikes in flow.

To estimate peak wet weather flows (sanitary flows plus I/I), a peaking factor is applied to the average sanitary flow. The peaking factor is developed by considering historical peak to average flows within the City. For areas north of Ship Channel, the peaking factors are expected to remain at current levels due to the fact that the area is mostly developed and no significant new sewer systems would be required. Existing development within the City currently produce peaking factors between 3 and 3.5 at the WWTP. This level of leakage is generally consistent with leak rates experienced by other communities, including the SRCSD.

The City has initiated an infiltration and inflow reduction program. Initial studies have been completed which recommended several activities over the next few years, including:

1. Installation of a flow monitoring SCADA system at each pump station to determine peak flows in each basin
2. A pilot lateral repair program in Jefferson tributary area to determine level of I&I reduction.
3. On-going sewer rehabilitation of known problem areas, with focus on the RCP sewers.

These items are addressed in more detail in subsequent sections of this report. For the purposes of this study it has been assumed that the rates of infiltration and inflow would be maintained at current levels as a result of proactive maintenance activities by the City.

In Southport, which is currently mostly undeveloped, limited historical data exists to estimate peaking factors. As a result, peaking factors for Southport are developed by typical peaking curves observed by several municipalities. The peaking factors for Southport are listed in Table 3-3. As shown, the peaking factor decreases as the sanitary flow increases due to attenuation of peaks as flows combine into larger sewers.

TABLE 3-3
SUMMARY OF PEAKING FACTORS USED FOR SOUTHPORT

Average Sanitary Flow (mgd)	Peaking Factor
< 0.75	3.0
0.75 – 1.20	2.9
1.20 – 1.75	2.8
1.75 – 2.50	2.7
2.50 – 3.75	2.6
> 3.75	2.5

Note: Peaking factors are based on current engineering practices.

3.5 PIPE DESIGN STANDARDS

The selection of a pipe diameter to adequately convey peak flows is based on the pipe slope. Minimum slopes were calculated from a comparison of the City's actual construction slopes, the City's recommended minimum slopes, and published recommended minimum slopes. A slope of 0.0008 is considered the minimum practical slope for construction. Flatter slopes are difficult to accurately construct. Table 3-4 presents the minimum slopes that are recommended for any new sewer construction. Construction at these slopes allows for scour velocities of 2 feet per second within the pipe. Table 3-5 provides a summary of the allowable flows for each pipe diameter based on a d/D ratio of 0.5, and construction at minimum pipe slopes.

A minimum pipe size of 8 inches in diameter is assumed for any new collector sewers. Six-inch pipes are allowed by City Standards at the extreme upper ends of the systems.

TABLE 3-4
RECOMMENDED MINIMUM PIPE SLOPES

Pipe Diameter (inches)	Minimum Slope (feet/feet)
8	0.0035
10	0.0030
12	0.0022
15	0.0015
18	0.0012
21	0.0010
24	0.0008
27	0.0008
30	0.0008
33	0.0008
36	0.0008
39	0.0008
42	0.0008

Note: Recommended pipe slopes are based on current engineering practices.

TABLE 3-5
SUMMARY OF MAXIMUM PEAK FLOWS BY PIPE DIAMETER AT A MINIMUM SLOPE

Pipe Diameter (inches)	Minimum Slope (feet/feet)	Peak Flow [a] 50% Full (mgd)	Peak Velocity [b] 50% Full (feet/second)
8	0.0035	0.231	2.05
10	0.003	0.389	2.19
12	0.0022	0.541	2.13
15	0.0015	0.810	2.04
18	0.0012	1.178	2.06
21	0.001	1.622	2.08
24	0.0008	2.071	2.16
27	0.0008	2.836	2.20
30	0.0008	3.756	2.36
33	0.0008	4.843	2.52
36	0.0008	6.107	2.67
39	0.0008	7.561	2.82
42	0.0008	9.213	2.96

Peak flow (Q_{PEAK}) computed from Manning's equation, assuming a roughness coefficient "n" = 0.013 and d/D = 0.5.

Peak velocity (V_{PEAK}) computed from $V_{PEAK} = Q_{PEAK}/a$ where d/D = 0.5, a = cross-sectional area of the pipe.

3.6 PIPE MATERIALS

Several pipe materials are acceptable for new gravity sewers and forcemains.

GRAVITY SEWERS

Gravity sewer options generally include PVC, RCP, VCP (clay). The City has used all of these pipe types within the system, although the older RCP sewers have shown the most deterioration. PVC pipe should meet the requirements of ASTM D 3034 for pipe and fittings up to 15 inches in diameter. The recommended standard dimension ratio (SDR) of the PVC pipe up to 15-inch-diameter is either 35 or 26, depending on the depth of bury. SDR 35 is recommended for PVC pipe with up to a 12-foot depth of cover; SDR 26 is recommended for pipe with greater than a 12-foot depth of cover. The SDR is a measure of the thickness of the pipe compared to the pipe diameter and indicates the ability of the pipe to resist forces from static and live loads. Reinforced concrete pipe, ASTM C-76, with a PVC lining for sulfide corrosion resistance is recommended for pipes larger than 24 inches in diameter. VCP or large-diameter PVC pipe (AWWA C-900) could also be considered. VCP has long-term integrity, but is susceptible to leaking joints and root intrusion, so should be considered on a case-by-case basis. Allowable materials will be dictated by the most current version of the City Design Standards.

SEWER FORCEMAINS

Pressure pipe options include PVC, ductile iron pipe (DIP), high-density polyethylene (HDPE). HPDE should be considered primarily for directional drilling installations. Similar to gravity sewers, allowable materials and pipe ratings will be dictated by the most current version of the City Design Standards.

3.7 ROUGHNESS COEFFICIENT

The roughness coefficient, or Manning's "n" value, used to calculate pipe capacity, was n equal to 0.013. This value is somewhat conservative if PVC pipe is used. An "n" value of 0.011 may be more appropriate for PVC. An "n" value of 0.013 is a commonly used value that assumes a buildup of a slime layer in any pipe material after many years of service and is consistent with City standards. By using this value, pipe sizes selected are not restricted to one material type.

SECTION 4

Existing and Projected Flows

This section describes estimated average and peak flows for existing and future levels of development. The flow estimates are used to determine if pump stations and sewers are sized appropriately.

4.1 EXISTING AVERAGE AND PEAK FLOW

Existing average and peak flows were estimated using previous master plan information and flows measured at the pump stations. The flow recorders at several of the pump stations are not currently operational. As a result, flow information is pieced together from various studies over the last several years, including a flow study conducted as part of this project in 2002. Pump station capacity, historical average flows, and peak flow rates from 1986-1997 are presented in Table 4-1.

TABLE 4-1
MEASURED AVERAGE AND PEAK FLOW FOR 1986, 1997, AND 2002

Pump Station	Reliable Capacity (mgd) [g]	1986 Measured Average Flow (mgd) [e]	1997 ADWF [a] (mgd)	1997 Peak WWF [a] (mgd)	2002 Average (mgd)	2002 Peak (mgd)
Bryte	4.5	1.41	1.7	6.3[b]	1.5	3.3
Jefferson	5.6	0.56	0.5	3.5	0.8	3.2
Northport	3.6	[f]	1.0	1.7	0.5	1.4
Industrial	2.2	[f]	0.4	1.4	[d]	[d]
South	1.6	0.76	0.4	1.2	[d]	[d]
Bridgeway Island	2.3	[c]	[c]	[c]	[d]	[d]
Southport	5.2	0.39	0.6	1.2	0.9	0.8
Total	25	3.12	4.6	15.3+	5.5[h]	

a From City of West Sacramento Preliminary Infiltration/Inflow Analysis, June 1997.
b Maximum weekly average flow during large flow events.
c Bridgeway Island Pump Station not yet constructed.
d Flow data not available.
e Flows from Table 5-8 of 1986 master plan
f New pump station in 1987
g Two out of three pumps in service, except Bridgeway Island P.S. which has 1 out of 2 pumps in service
h Recorded flow at the WWTP

As shown, the average wastewater flows have increased as the City has developed from 3.12 mgd in 1986, to 4.6 mgd in 1997, and 5.5 mgd in 2002. Historical peak wet weather flows around the system are perhaps best described by the 1997 flow study where peak flows were measured during a series of January "El Nino" type wet weather events. During this period, system flows increased 3.5 times the average flows. Hydrographs at each pump station during the 1997 event are shown as Figure 4-1.

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Figure 4-1 Peak Wet Weather Flows Measured in 1997

4.2 2002 FLOW MONITORING STUDY RESULTS

A flow monitoring study was conducted during the winter of 2002 to update the 1997 peak flow information and describe the effectiveness of recent sewer repairs around the collection system. In the 2002 flow study eleven flow monitors were deployed in the area North of the Ship Channel and in Southport. The locations of the monitors are shown on Figure 4-2. The measured average and peak flows as well as pipe capacity are listed in Table 4-2. As shown, peak flows were observed below the capacity of the sewers; in most cases peak flows remained below half full pipe conditions. Unfortunately, the winter of 2002 was a relatively mild, dry winter and it is difficult to determine if peak flows have actually reduced since the 1997 wet season.

TABLE 4-2
2002 FLOW MONITORING PROGRAM RESULTS

Monitor	Location	Street Name	Nodes	Average Flow (mgd)	Maximum Flow (mgd)	Half Full Pipe Capacity (mgd)	Full Pipe Capacity (mgd)
1	Southport	Linden	5 - 4	0.47	0.71	1.62	3.25
2	South	Stone Boulevard	1206-1207	0.19	0.33	0.72	1.45
3	Jefferson	West Capitol Ave	1033-1032	0.02	0.04	0.39	0.78
4	Jefferson	West Capitol Ave	1047-1037	0.15	0.46	1.18	2.36
5	Jefferson	7th Street	1025-1024	0.13	0.33	1.62	3.25
6	Jefferson	8th Street	1016-1017	0.15	0.25	0.54	1.08
7	Bryte	Michigan Boulevard	1321-1322	0.16	0.28	2.23	4.46
8	Bryte	Sand Circle	1319-1318	0.02	0.08	1.7	3.4
9	Bryte	Along RD 900 Channel	1323-1300	0.92	1.44	1.92	3.85
10	Northport	West Capitol Avenue	1424-1400	0.21	0.85	0.78	1.57
11	Industrial	Industrial Boulevard	1121-1122	0.06	0.17	0.53	1.06

4.3 PROJECTED AVERAGE AND PEAK FLOWS

Future average flows can be estimated using the land use information described in the City's current General Plan (Table 2-3) and City Standard wastewater generation rates (Table 3-2). This approach was used to project flows in the mostly undeveloped Southport Area (consult Southport Sanitary Sewer Master Plan) and provides a relatively conservative (i.e. high) estimate of the wastewater generation potential for a specific area. If this approach is used for areas north of the Ship Channel, however, significantly higher flows than existing are estimated - in spite of the northern area being mostly developed. As shown in Table 4-3, using City Standard wastewater generation rates by land use, flows are projected to be near double that currently produced (8.7 mgd of average flow projected compared to approximately 5 mgd currently being generated).

Insert

Figure 4-2 Location of Flow Monitors Deployed in February/March 2002

Insert

TABLE 4-3 FLOW PROJECTIONS BY LAND USE

11 x 17 table

TABLE 4-3
FLOW PROJECTIONS BY LAND USE

Land Use	Pump Station Acre Totals					Number of Dwelling Units	Dwelling Units per Acre[b]	Persons per Dwelling Unit[a]	Total People	Number of Dwelling Units	Gallons per Person	Gallons per Acre[a]	Total Gallons per Day	Pump Station Gallon Totals				
	Bryte	Industrial	South	Jefferson	Northport									Bryte	Industrial	South	Jefferson	Northport
RRA Rural Residential	0	0	0	0	0	0	0.80	3.00	0	0	100	N/A	0	0	0	0	0	0
R1-A Residential - One Family (A)	851	0	349	0	18	4,875	4.00	3.00	14,624	4,436	100	N/A	1,330,745	1,021,200	0	419,061	0	22,097
R1-B Residential - One Family (B)	0	0	0	0	0	0	4.00	3.00	0	0	100	N/A	0	0	0	0	0	0
R-2 Residential- One Family or Multi Family	156	29	1	46	0	1,619	7.00	2.50	4,049	1,619	100	N/A	404,868	272,259	50,347	2,030	80,232	0
RE Rural Estate	0	0	0	0	0	0	0.00	3.00	0	0	100	N/A	0	0	0	0	0	0
R-3 Multiple Family Residential	75	0	0	39	39	2,755	18.00	2.50	6,888	2,755	100	N/A	688,832	336,759	0	0	174,885	177,188
R-4 Apartment	0	0	0	0	0	0	18.00	2.25	0	0	100	N/A	0	0	0	0	0	0
WF/MU Waterfront/Mixed Use	14	0	121	433	0	2,388	4.20	2.25	5,372	3,914	100	N/A	880,684	13,230	0	114,804	409,179	0
Total Residential	**1,096**	**29**	**472**	**518**	**58**				**30,953**				**3,305,128**	**1,643,448**	**50,347**	**535,895**	**1,317,469**	**199,285**
C-1 Commercial - Neighborhood	5	0	5	1	0	N/A	N/A	N/A	N/A	N/A	N/A	1,500	16,751	7,335	0	7,460	1,956	0
C-2 Commercial - Community	57	0	12	7	52	N/A	N/A	N/A	N/A	N/A	N/A	1,500	191,674	85,172	0	18,145	10,087	78,270
CH Commercial - Highway	0	27	10	0	29	N/A	N/A	N/A	N/A	N/A	N/A	1,500	100,196	0	41,060	15,008	0	44,129
CW Commercial - Water Related	0	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	1,500	0	0	0	0	0	0
C-3 Commercial - General	29	0	7	14	135	N/A	N/A	N/A	N/A	N/A	N/A	1,500	276,895	43,004	0	9,849	21,478	202,565
PO Professional Office	0	0	35	0	61	N/A	N/A	N/A	N/A	N/A	N/A	1,500	144,977	0	0	53,057	0	91,919
BP Business Park	0	46	0	0	80	N/A	N/A	N/A	N/A	N/A	N/A	1,500	189,501	0	69,228	0	0	120,273
CBD Central Business District	38	0	0	77	0	N/A	N/A	N/A	N/A	N/A	N/A	1,500	173,686	57,468	0	0	116,218	0
Total Commercial	**129**	**74**	**69**	**100**	**358**								**1,093,680**	**192,980**	**110,288**	**103,519**	**704,413**	**537,155**
ML Limited Industrial	0	0	0	0	124	N/A	N/A	N/A	N/A	N/A	N/A	2,000	248,797	0	0	0	0	248,797
M-1 Industrial - Light	106	0	39	72	148	N/A	N/A	N/A	N/A	N/A	N/A	2,000	729,755	212,722	0	78,064	143,202	295,766
M-2 Industrial - Heavy	0	424	147	0	193	N/A	N/A	N/A	N/A	N/A	N/A	2,000	1,527,034	0	848,632	293,231	0	385,171
M-3 Industrial Waterfront	0	231	178	0	0	N/A	N/A	N/A	N/A	N/A	N/A	2,000	819,702	0	462,833	356,869	0	0
Total Industrial	**106**	**656**	**364**	**72**	**465**				**N/A**				**3,325,288**	**212,722**	**1,311,465**	**728,164**	**143,202**	**929,734**
PQP Public/Quasi Public[c]	110	0	43	0	0	N/A	N/A	N/A	N/A	N/A	N/A	1,620	992,997	178,303	0	69,303	0	745,391
RP Recreation - Parks	17	0	9	13	4	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	0	0	0	0
POS Public Open Space	57	139	23	0	59	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	0	0	0	0
Total Public/Park/School	**110**	**139**	**75**	**13**	**523**								**992,997**	**178,303**	**0**	**69,303**	**0**	**745,391**
A-1 Agricultural	0	0	0	0	137	N/A	N/A	N/A	0	N/A	N/A	N/A	0	0	0	0	0	0
CHP Academy					460				408		100		40,800	0	0	0	0	40,800
Raley Field Baseball Stadium[4]	0	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	300	0	0	0	300	0
West Sacramento WTP Sludge Flows	0	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	600	0	0	0	0	600
Total Other	**0**	**0**	**0**	**0**	**137**								**900**	**0**	**0**	**0**	**300**	**600**
Grand Totals	**1,440**	**898**	**980**	**703**	**1,541**				**31,341**				**8,717,994**	**2,227,453**	**1,472,099**	**1,436,881**	**1,707,574**	**2,412,165**

a Source: Southport Sanitary Sewer Master Plan, July 1999, pg.2-4
b Source: Southport Sanitary Sewer Master Plan, July 1999, pg. 2-3
c Source: 90% of Parks/Other value from General Plan, June 2000, pg VI-4

Recognizing most of the future City development north of the Ship Channel is redevelopment of existing areas an alternative method to project future flows is utilized. This alternative method estimates the average flows to be the sum of the existing flows plus the projected flow from specific redevelopment projects. To be conservative, the existing flows are assumed to be the highest value observed at the pump stations from the 1986, 1997 and 2002 monitoring. These flows are listed in Table 4-7. Infiltration and inflow is assumed to be unchanged from current (1997 basis) levels, as no additional areas are being sewered.

Flows from future developments were estimated from City redevelopment information described in Figure 2-1. The new development projects were assigned flows from the City Standards and other adopted City specific planning information. Only Bryte, Jefferson, and Northport will experience a noticeable increase in flows in the future. South and Industrial have no additional development projects planned. Potential incremental flows for Northport are shown in Table 4-4. Potential incremental flows for Jefferson are shown in Table 4-5. Potential incremental flows for Bryte are shown in Table 4-6.

TABLE 4-4
NORTHPORT ADDITIONAL FUTURE FLOW

Land Use		Land Area (Acres)	Flow Per Acre Gallons	Total Flow Gallons	Estimated Development (%)	Total Additional Flow (mgd)
Riverpoint Plaza						
Commercial Highway	CH	8	1,500	12,000	0	0.012
Riverpoint Retail						
Commercial	C-3	92	1,500	138,000	0	0.138
Riverside Centre						
Professional Office	PO	60.6	1,500	90,900	80	0.0182
Business Park	BP	26	1,500	39,000	80	0.0078
Light Industrial	M-1	76	2,000	152,000	80	0.0304
Community Commercial	C-2	10.7	1,500	16,050	80	0.0032
TOTAL				**447,950**		**0.2096**

Insert

TABLE 4-5 JEFFERSON ADDITIONAL FUTURE FLOW

Insert

TABLE 4-6 BRYTE ADDITIONAL FUTURE FLOW

TABLE 4-7
PROJECTED FLOW ESTIMATE USING CURRENT FLOWS AND EXPECTED DEVELOPMENT

	Current Average mgd	Future Average mgd	Total Average mgd	I/I mgd	Total Peak mgd	Total Capacity mgd	Reliable Capacity mgd	Current Flow Sources[a]
Bryte	1.7	0.23	1.93	4.60	6.5	6.75	4.5	1997
Industrial	0.4	0.00	0.40	1.00	1.4	3.3	2.2	1997
Jefferson	1	1.64	2.64	3.00	5.6	8.4	5.6	2002
Northport	1	0.21	1.21	2.39	3.6	5.4	3.6	1997
South	0.7	0.00	0.70	0.40	1.1	2.4	1.6	1986
TOTAL	**4.8**	**2.1**	**6.9**	**11.4**	**18.2**	**26.3**	**17.5**	

a Current average flow data from the 1986, 1997, or 2002 flow monitoring study

b Significant infiltration problems within Northport along West Capitol were found in 1999. As a result a peaking factor of 3 was used to estimate the peak flows.

As shown, an additional 2.1 mgd of flow is estimated north of the Ship Channel after redevelopment of the various waterfront areas and infill properties. A total of 6.9 mgd on average plus 11.4 mgd of I/I would result in a total projected peak wet weather flow of 18.2 mgd. With the exception of Bryte, these flows are below the reliable capacity of the pump stations. A different methodology is used for projecting peak flows in the Southport Area and are described in detail in the Southport Sanitary Sewer Master Plan.

SECTION 5

Existing Sewer System

This section provides a description of the existing gravity sewers, major pump stations, and forcemain systems.

5.1 EXISTING GRAVITY SEWER SYSTEM

The collection lines in residential and light industrial areas are predominantly 6-or 8-inch clay pipe gravity lines feeding into 10- to 12-inch concrete sewers. These gravity lines are generally shallow, averaging less than 8 feet in depth. This is based on the lack of topographic relief in the area and accounts for the large number of pump stations necessary to convey flows to the wastewater treatment plant. The gravity system is comprised of different pipe materials which tend to deteriorate and leak at different rates. As shown in Figure 5-1, the Jefferson and South areas have predominately reinforced concrete pipe (RCP) sewers. Northport is principally vitrified clay pipe (VCP). Bryte has a mixture of VCP in residential areas to the north and RCP in commercial areas to the south. New sewer replacement projects typically utilize PVC.

A summary of the pipe sizes for existing development north of the ship channel is provided in Table 5-1. As shown, the system predominately consists of 6- and 8-inch diameter pipes.

TABLE 5-1
SUMMARY OF PIPES IN SEWER TRIBUTARY AREA

		Pump Station				
		Bryte	**Industrial**	**Jefferson**	**Northport**	**South**
6" pipe	miles	15.5	0.3	0.2	2.3	0.6
8" pipe	miles	14.4	3	6.8	4.6	14.8
10" pipe	miles	0.8	1.4	1.1	2.1	1
12" pipe	miles	1.4	0.3	1.2	1.6	2.5
15" pipe	miles	1.2	0.5	0.4	1.3	0.4
18" pipe	miles	0.6	0.4	0	0.3	0
21" pipe	miles	0.3	0	0.4	0	0
24" pipe	miles	0.6	0	0	0	0
27" pipe	miles	0	0	0	0	0
30" pipe	miles	0	0	0	0	0
42" pipe	miles	0	0	0	0	0
Total	**miles**	**34.8**	**5.9**	**10.1**	**12.2**	**19.3**

Major gravity sewers within each tributary pumping area are shown in Figure 5-2. A more detailed inventory and maps of sewers north of the ship channel is provided in Appendix A. Gravity pipelines in the Southport Area are shown in Southport Sanitary Sewer Master Plan.

Insert

Figure 5-1 General Sewer Pipe Materials Utilized North of Ship Channel

Insert

Figure 5-2 Major Sewers North of Ship Channel

Insert

TABLE 5-2 EXISTING MAJOR PUMP STATION DESIGN CRITERIA

5.2 EXISTING PUMP STATIONS

Most of the City land area and all pump stations are located near a ground elevation of 10 feet above mean sea level (MSL) with upstream gravity sewers typically near or below zero MSL with the influent hydraulic grade at the headworks at about 50 feet above MSL. The City WWTP is located at the highest point in the service area, about 40 feet above MSL. Forcemain pressure conditions are sufficient to lift wastewater from the gravity sewer levels upstream of the pump stations to the WWTP elevation and overcome friction losses in the forcemain pipelines.

Current design conditions at the seven major City pump stations are presented in Table 5-2. The configuration of the pump stations and forcemains are shown in Figure 5-3.

5.3 EXISTING FORCEMAIN SYSTEM

Five of the seven major pump stations in the existing system convey wastewater generated north of the Ship Channel into pressure piping ranging in size up to 24 and 27-inch diameter piping generally situated on Sacramento-Yolo Port District property paralleling Stone Boulevard from Park Boulevard to the WWTP. Two 20-inch pressure pipelines constructed in the 1980's carry flow from the Bryte, South, Industrial and Northport pump stations to the upstream terminus of the 24-inch pipeline south of the intersection of Stone and Park Boulevards. The 24-inch pipeline increases to 27-inch size near Jefferson Boulevard, where lateral pipeline connections add flow from the Jefferson pump station from the north and from the Southport pump station. Table 5-3 lists components of the various forcemain piping.

TABLE 5-3
FORCEMAIN CONVEYANCE SYSTEM

Force Main	Length Size	Year Constructed	Pipeline Material
Jefferson P.S.	7,108' -18"	1988	Steel
	2,200' -12", 18"	1988	Steel, CCSP
Bridgeway Island P.S.	10,355' - 2-12"	2001	PVC
Bryte P.S.	2,350' -16"	1976	AC
	198' -16"		CCSP
	115' -14"		CCSP
	1,845' -16"	1986	CLCS
	2,210' -16"	1976	AC
	740' -16", 14"	1976, 1986	AC, CLCS
	10' -12"		
	300' -18"	1966	CLCS
	1,365' -12", 16"	1968, 1986	AC, CLCS
	2,600' -18"	1974	AC
Michigan P.S. to Bryte P.S.	2,300' -18"	1995	SDR-35 PVC
Northport P.S.	1,800' -16"	1987	CLCS
Industrial P.S.	3,100' -14"	1977	Steel

TABLE 5-3
FORCEMAIN CONVEYANCE SYSTEM

Force Main	Length Size	Year Constructed	Pipeline Material
Southport P.S.	5,000’ -12”	1972	AC
	5,000’ -16”		
	600’ -18”	1972	CLCS
	700’ -16”		
	700’ -12”		
Industrial/Northport	7,700’ -16”		Steel
	7,700’ -14”		Steel
	735’ -20”		Steel
	2,560’ -24”		CCSP
	1,827’ -27”		CCSP
	200’ -30”		Steel
South P.S.	50’ -12”		
	100’ -12”		ACP
	75’ -18”		ACP
	535’ -20”	1987	ACP
	3-4,200’-12”	1951	2-Steel, 1-AC

Insert

Figure 5-3 Sewer Pump Stations and Forcemains

SECTION 6

Regulatory Requirements and CMOM

The operation and maintenance of the City of West Sacramento's sewer collection system is currently regulated under the City's National Point Discharge Elimination System (NPDES) permit for its wastewater treatment plant discharge. The City's NPDES permit currently contains two standard conditions related to the sewer system:

- **Proper operation and maintenance requirements at 40 CFR 122.41(e).** This standard permit condition requires proper operation and maintenance of permitted wastewater systems and related facilities to achieve compliance with permit conditions; and,
- **Duty to mitigate at 40 CFR 122.41(d).** This standard condition requires the permittee to take all reasonable steps to minimize or prevent any discharge in violation of the permit that has a reasonable likelihood of adversely affecting human health or the environment.

These two standard conditions require the City to properly operate and maintain its collection system as well as take all reasonable steps to minimize or prevent sanitary sewer overflow (SSO) discharges to waters of the United States that have a reasonable likelihood of adversely affecting human health or the environment. These provisions, along with a prohibition on SSOs to waters of the U.S., are the basis for requiring the City to provide adequate sanitary sewer collection system capacity.

The United States Environmental Protection Agency (EPA) is in the process of clarifying and building upon these expectations with proposed new sewer system regulations. In the coming years, the EPA will require each municipality to develop a *Capacity, Management, Operation, and Maintenance* (CMOM) program for its sewer system. While the specific CMOM program requirements will not be finalized until 2003, it is expected that the general performance standards required by the City under CMOM will remain largely unchanged from their proposed form. These general performance standards focus on prevention and notification of SSOs and are shown in Table 6-1.

TABLE 6-1
GENERAL PERFORMANCE STANDARDS IN PROPOSED CMOM STANDARD PERMIT CONDITIONS

The City would need to:

1. properly manage, operate, and maintain, at all times, the parts of collection system that the City owns or over which it has operational control;
2. provide adequate capacity to convey base flows and peak flows;
3. take all feasible steps to stop, and mitigate the impact of, sanitary sewer overflows;
4. provide notification to parties with a reasonable potential for exposure to pollutants associated with the overflow event; and,
5. develop a written summary of their CMOM program and make it, and required program audits, available to the public upon request.

The third proposed performance standard would require that the City take all feasible steps to stop and mitigate the impacts of SSOs. This is similar to the existing “duty to mitigate” standard permit condition at 40 CFR 122.41(d), but would expand the duty to mitigate and address SSOs that did not result in a discharge to waters of the United States. EPA believes that this expansion is appropriate because of the health risks associated with SSOs that do not go to the waters of the U.S., as well as the difficulty at the start of a specific SSO event in determining whether the SSO would ultimately result in a discharge of pollutants to waters of the U.S. EPA is proposing use of the word “feasible” in describing the types of steps that must be taken as a way of limiting the response to a reasonable range of measures, within the practical capability of the City, resulting from the exercise of reasonable judgment in application of the overflow emergency response plan.

The EPA’s expectations from CMOM are that agencies develop and maintain their own CMOM programs and the programs are not subject to specific approvals unless the City has a history of preventable sewer spills. While the City of West Sacramento does not have a history of SSOs within the sewer system, the implications of CMOM for the City will include:

1. **The City will need to develop a formal maintenance management program to document how the system is being repaired, rehabilitated, and inspected.** If an overflow or spill were to occur in the future, the burden of proof that the sewer system was properly maintained will fall upon the City. The EPA’s expectations are that the City has on-going programs for sewer cleaning, CCTV inspection, grease source control, pump station maintenance, and short-term and long-term sewer repairs and rehabilitation.

2. **The City will need to develop a spill response plan**. Specific requirements of this plan would be available when the CMOM regulations are adopted, but it is expected that the plan would include a written standard operating procedure, a spill identification and dispatch system, provisions for adequate personnel and equipment, and a notification system to City services, regulatory agencies, and the impacted community. The City’s existing response plan would need to be reviewed and updated as necessary to conform to these requirements.

3. **The City would need to develop a system evaluation and capacity assurance plan**. This plan is essentially contained within this Master Plan Report. The assurance plan should describe pump station capacity and redundancy, sewer capacity calculations, population projections, and an I&I assessment. This plan would continue to be updated as the City grows and the sewer system is modified. Additionally, the pump station Supervisory Control and Data Acquisition System (SCADA) system for the City’s pump stations would be upgraded to monitor flows, pump operation, and sump water levels to confirm flows and proper operation of the facilities.

4. **The City would need to conduct and submit regular audits of its CMOM program to the regulatory agency**. The audits are intended to describe any CMOM program deficiencies, proposed corrective actions, and scheduled improvements.

5. **The City will need to prepare and submit reports of compliance to the regulatory agency.** After connection to the Sacramento Regional Community Sanitation District, the City will no longer operate its sewer system under its existing NPDES permit. Instead, the City will be permitted as a satellite system under CMOM. The reports of compliance would be required at least on an annual basis, and more frequently if spills occur. As the CMOM regulations are implemented over the next year, it is expected that the specific permitting requirements would be fully described. The EPA has yet to determine whether the State or Regional Water Quality Control Board should be the entity to implement these permits.

Item 1, the development of a formal maintenance management system for the sewer system, is potentially the most significant and costly effort for the City. As evidenced by the strong track record of the City for maintaining service and general avoidance of spills, the City's maintenance staff are actively maintaining pump stations and sewers. However, maintenance efforts on sewers are largely in response to observed problems in the field. CMOM recommends that the City develop a more rigorous system-wide condition assessment to anticipate potential problems and take preventive measures. This recommended sewer rehabilitation program for the City is described in Section 7.

SECTION 7

Recommended Sewer Maintenance And Rehabilitation Program

This section describes current City maintenance practices, recommends near-term rehabilitation and replacement projects based on recent CCTV inspection activities, and prioritizes long-term rehabilitation activities and annual budgeting.

7.1 INDUSTRY PERSPECTIVE ON SEWER SYSTEM OPERATION, MAINTENANCE, AND REHABILITATION

The City maintains an annual budget of approximately $709,000 per year for operations and maintenance (O&M) items such as power, new equipment, labor, and other necessary repairs. Figure 7-1 provides a perspective on level of O&M funding provided by the City compared to other communities. Annual O&M costs are organized differently for each municipality, so direct comparisons between systems are difficult to make other than the fact that West Sacramento appears to be consistent (if not higher) with funding for the industry. It is important to note that the EPA information are scaled from 1981 cost surveys and most of the costs were found to be related to personnel (60 percent of the total annual budget) and power (18 percent) and equipment replacement (18 percent). Historically, little or no annual budgets have been dedicated to replacement and rehabilitation of sewers. It is expected that as systems continue to deteriorate, these annual costs will increase to include required sewer rehabilitation and replacement activities.

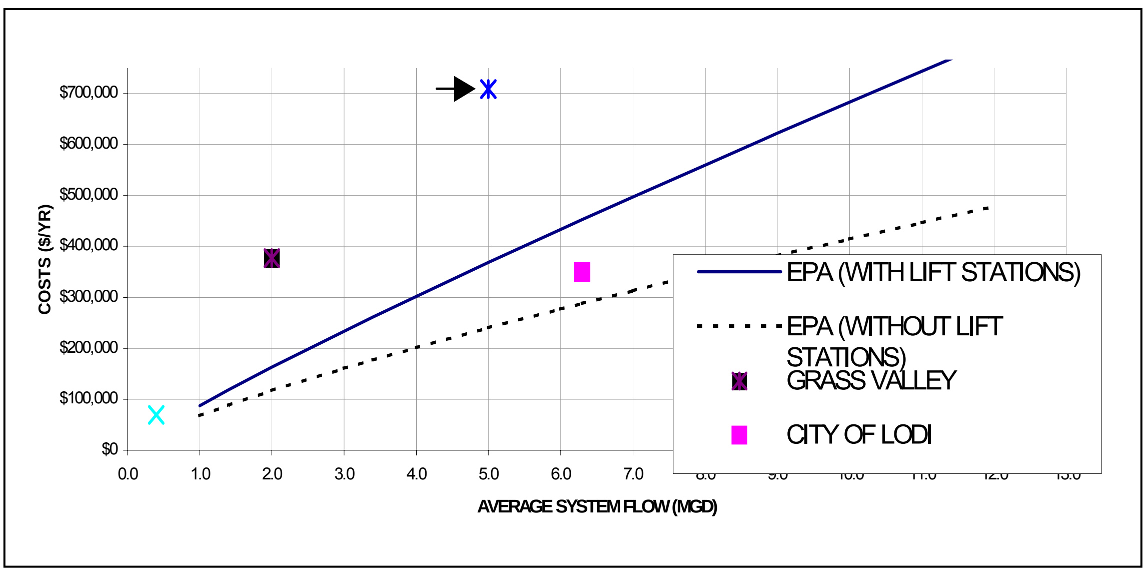

Figure 7-1
Comparison of Annual Collection System O&M Costs for Various Communities

The EPA's CMOM initiative has recognized that municipalities have historically not committed sufficient funds toward annual sewer rehabilitation and replacement projects, resulting in sewage spills and overflows that would otherwise be preventable. Based on EPA's surveys of systems across the country, Figure 7-2 provides a general distribution of the causes of sewage spills. As shown, the top three reasons for "preventable" spills involve excessive infiltration and inflow, line blockages (typically from root or grease accumulation within the pipe), or pipe breaks due to deterioration. It is important to note that the City of West Sacramento currently experiences all three of these problems, although to-date they have not resulted in chronic spills. The objective of future maintenance and rehabilitation efforts will be to minimize the potential for these sewer problems.

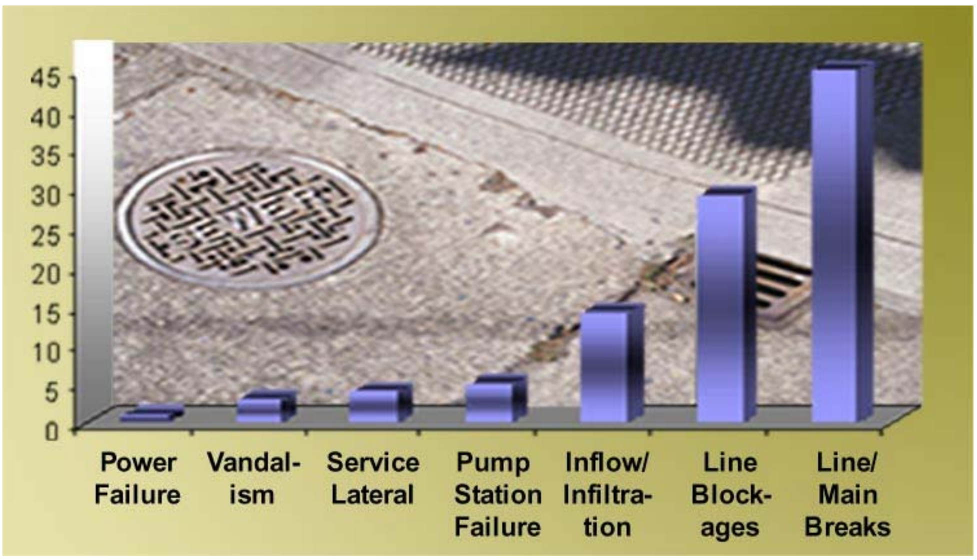

Figure 7-2
General Distribution of Causes for Preventable Sewer Spills
Source: EPA 2001 CMOM Survey

7.2 CURRENT CITY MAINTENANCE PRACTICES

The City's collection system maintenance program can be generally described within the following bulleted items:

- As-needed maintenance of pump stations including periodic cleaning and equipment replacement. Equipment replacement and repairs are in accordance with manufacturer recommendations.
- Periodic sewer inspection and cleaning, typically in response to observed problems within the pump station wet wells.
- Sewer repairs and rehabilitation in reaction to observed problems. Typical problems requiring repair include pipe corrosion and deterioration, cracked pipes, and offset joints.
- In emergency situations or larger projects the City will hire outside contractors to complete certain repairs.

- An independent maintenance budget from the City's "Sewer Fund" Capital Improvement Program. Limited budgets established toward preventative maintenance activities.

These activities have provided an effective and focused approach toward maintenance and the City has not historically experienced significant impacts to service or sewer spills. The approach, however, is largely "reactive" and does not allow the City to anticipate potential problems or take preventative measures prior to potentially significant problems occurring. The approach also does not allow the City to accurately budget for a long-term rehabilitation and replacement of facilities.

7.3 SYSTEM-WIDE CONDITION ASSESSMENT

Many municipalities have utilized a condition assessment approach toward long-term sewer maintenance and rehabilitation. The approach requires the City to assess the severity of sewer problems throughout the system and prioritizes repairs prior to significant problems occurring. The City has taken the first steps toward a more comprehensive evaluation and repair of its system. The assessment work completed to date includes:

- In 1997, the City commissioned a Preliminary Infiltration and Inflow Analysis (ECO:LOGIC Engineering, 1997) evaluation of the entire system. The study concluded that significant infiltration and inflow was occurring in the Jefferson tributary area and significant inflows were occurring in the Northport, Jefferson, and Industrial tributary areas. The results of this study are shown graphically in Figure 4-1, where the effect of storm events during January 1997 are described for each pump station.

- In 1999, the City completed a more detailed evaluation (Infiltration and Inflow Reduction Analysis- Phase 2, Bennett and Staheli Engineers, 1999) of the specific problem areas of the City. The study identified and prioritized cost effective I/I reduction projects in the Jefferson area and recommended a targeted infiltration repair of 25 percent of the leakiest laterals (approximately 75 out of 300 laterals) to determine how effectively infiltration can be removed. The City has not initiated this project until it can determine whether its immediate priorities should be repairing leaks or rehabilitating deteriorated sewers.

- In 2001-2002, the City commissioned this master planning effort to help develop a long-term funding plan; prioritize rehabilitation projects and to plan for the City's connection to the Lower Northwest Interceptor. This evaluation determined that while leaks are not impacting sewer and pump station capacity, a number of areas with high potential of deteriorating sewers exist. The study recommendations identify near-term (over the next 1 to 5 years) sewer and pump station modification projects, prioritize future assessments, and develop a basis for identifying and funding long-term rehabilitation projects.

7.4 CCTV INSPECTION PROGRAM RESULTS

In 2002, ECO:LOGIC performed sewer cleaning and CCTV inspection on specific sewers of concern within the City. Sewers inspected included portions of Park Blvd and Alabama Ave and sections along West Capitol Avenue. These sewers are all reinforced concrete pipes (RCP) constructed in the 1950s. Park Blvd (12-inch) and West Capitol Avenue (8-inch) are constructed at slight slopes and have had problems with debris accumulating within the pipe restricting flow and presumably increasing the rate of sewer corrosion by hydrogen sulfide. In the late 1990s, portions of Park Blvd were replaced with PVC after the sewer collapsed. In 2001, a portion of West Capitol Avenue was lined and the voids grouted after CCTV inspection noted significant (2-5 foot) voids within the pipe.

The 12-inch sewer along Alabama Ave is a major trunk for the South tributary area and was inspected to determine its overall condition.

The sewers given CCTV inspection are rated on their relative condition and need for repairs. Table 7-1 provides a general rating system used in the review of CCTV inspection tapes.

TABLE 7-1
SEWER CONDITION CATEGORIES USED FOR THE CCTV INSPECTION PROGRAM

Condition Category	Description
A	Pipe in sound condition. Inspect within several years.
B	Pipe in generally good condition. Perform routine inspection and cleaning on infrequent basis.
C	Point repairs or maintenance should be carried out to extend pipe life and reduce likelihood of problems. Perform routine maintenance.
D	Major repairs necessary to maintain service in structurally damaged pipes. Pipe replacement or relining should be considered. Enhanced maintenance required until repairs are made.
F	Imminent failure. Replace or rehabilitate pipe ASAP in order to maintain service. Extraordinary maintenance required until repairs are made.

Figures 7-3, 7-4, 7-5, and 7-6 provide a description of the sections CCTV'ed and major pipe defects observed. A complete log of the inspection is provided in Appendix C of this report. Important observations from the review of the CCTV inspection include:

- All pipes showed some level of deterioration. The tapes show noticeable pitting and exposed aggregate of the RCP. In fact, no sewer inspected would score above a "C" on the above condition rating system (Table 7-1). It was not possible to determine remaining pipe wall thickness or predict when actual failure might occur.
- Approximately 950 feet of sewer along West Capitol between Poplar Ave and Westacre Road is severely deteriorated and will require immediate repair (Rating "F", above). Large voids (2-3 feet in length) along the crown of the pipe were observed and the sewer is partially collapsed in certain areas. In 2001, the adjacent section of pipe west of Poplar Avenue showed similar level of deterioration and was successfully rehabilitated with a chemical formed-in-place HDPE liner. It is assumed the same rehabilitation method could be utilized for this section of pipe.
- In general, the sewers required significant cleaning and removal of debris prior to inspection. It is not known when these sewers were cleaned prior to this investigation, but it was apparent that the slopes and water velocities do not effectively flush material down the sewer to the pump station. It is believed that the accumulation of material increases hydrogen sulfide formation and eventual corrosion of the RCP. The sewers along West Capitol were plugged with grease. These sewers showed the most significant deterioration.
- The eastern end of West Capitol sewer is fed by a shallow 12-inch sewer along Merkley Avenue which was included in the inspection project. This sewer conveys most flows from the Triangle Area (including equalized flows from Raley's Ballpark). This line was observed to be flowing full during the inspection and the area it serves is relatively undeveloped (no games were being played). Where the sewer hits West Capitol Boulevard there exist several sharp 90 degree turns (including one tee without a manhole in front of Carols Restaurant) which may be a hydraulic constraint for this sewer.

7.5 RECOMMENDED PLAN

The preliminary CCTV inspection program identifies several priority rehabilitation projects and provides a perspective on where to focus future resources. The recommended sewer repair and inspection projects include the following listing:

1. Immediately repair the approximate 950-foot section of partially collapsed 8-inch sewer along West Capitol Avenue. Utilizing a formed-in-place HDPE liner is recommended. Considering this line was recently cleaned and inspected, a contractor's estimate for this job is approximately $35 per foot. Grout injection of the voids behind the pipe could also be conducted if the City believes this technique was, in fact, effective for the 2001 emergency repair project. Grout injection may cost an additional $10,000 to $15,000. Total project costs may be $50,000 for this repair.

2. Initiate additional CCTV inspection of the RCP sewers (larger, older pipes first) to determine if the level of pitting and deterioration is similar to the sewers inspected along Park, West Capitol, and Alabama. It is currently unknown whether the deterioration observed is typical, worse, or better than the remainder of the RCP sewers. Cleaning, CCTV inspection, and review costs are estimated at approximately $2.00 per foot. A prioritized list for additional RCP sewer cleaning and inspection are shown in Table 7-2. As shown, this initial inspection program would cost on the order of $115,000.

TABLE 7-2
RECOMMENDED CCTV INSPECTION AND CLEANING PROGRAM FOR LARGER RCP SEWERS

Area	Street	Pipe Size	Length (feet)	Unit Cost ($/lf)	Cost ($)
Bryte					
	Michigan Street	24	3,200	2	6,400
	Michigan Street	12	1,200	2	2,400
	Evergreen Avenue	10	1,800	2	3,600
	Glide Court	10	1,800	2	3,600
	Evergreen Avenue	8	5,000	2	10,000
	Proctor	8	1,200	2	2,400
	Willow	8	1,600	2	3,200
	Maple	8	2,800	2	5,600
	Walnut	8	2,000	2	4,000
	Pecan	8	2,000	2	4,000
	Glide Avenue	8	1,600	2	3,200
	Rice	8	600	2	1,200
Jefferson					
	West Street	15	1,100	2	2,200
	Triangle Area	12	3,000	2	6,000
	3rd Street	12	400	2	800
	8th Street	12	1,600	2	3,200
	8th Street	10	1,200	2	2,400
	Triangle Area	10	1,800	2	3,600
	2nd Street	8	1,600	2	3,200

TABLE 7-2
RECOMMENDED CCTV INSPECTION AND CLEANING PROGRAM FOR LARGER RCP SEWERS

Area	Street	Pipe Size	Length (feet)	Unit Cost ($/lf)	Cost ($)
Jefferson (con't)	3rd Street	8	800	2	1,600
	4th Street	8	2,200	2	4,400
	5th Street	8	1,600	2	3,200
	6th Street	8	1,200	2	2,400
	7th Street	8	600	2	1,200
	A Street	8	600	2	1,200
	B Street	8	1,600	2	3,200
	C Street	8	1,600	2	3,200
	E Street	8	2,400	2	4,800
	F Street	8	2,400	2	4,800
	Welland	8	800	2	1,600
	James	8	800	2	1,600
	Andrew	8	800	2	1,600
	William	8	800	2	1,600
	Elizabeth	8	600	2	1,200
	California	8	600	2	1,200
South					
	Stone	12	2,400	2	4,800
Subtotal, Larger RCP Sewer Inspection			**57.300**		**$114,600**

3. Line the remainder of the 8-inch sewer along West Capitol Avenue from Poplar to Merkley Streets. This sewer has slight slopes and a large amount of fast food type restaurants adding to its grease and septicity problem. The deterioration is expected to continue and the smooth liner may actually help prevent debris from accumulating. Lining projects such as this have significant economies of scale, and per foot prices for larger projects tend to drop considerably, potentially saving on the order of $10-15 per foot compared to similar smaller projects. After additional cleaning and inspection of other RCP sewers (Item 2 above), determine whether it would be possible to bundle similar rehabilitation projects together. It is estimated that in-situ lining of remaining sections of West Capitol Blvd would cost on the order of $150,000.

4. As the plans for the Triangle Area's redevelopment are finalized, the City should evaluate whether the 12-inch sewer along Merkley Ave would be abandoned for a new pump station, or whether this sewer would be modified (enlarged) to serve new development in this area. While some deterioration was evidenced in the pipe, it may be prudent to <u>not</u> repair the pipe until the near term future of this area is better understood. At a minimum, it is recommended to reconfigure the sewers in front of Carols Restaurant so that the 12-inch sewer along Merkley Ave. connects directly (by manhole) into the West Capitol Ave. sewer. Additionally, flow monitoring should continue within the Merkely sewer to confirm surcharging is not occurring. The estimated cost for re-plumbing the Merkely sewer into West Capitol is $15,000. It is probable that the Triangle Area will require a completely new sewer system and pump station to serve this area due to the larger buildings expected in this area. Given that this area is currently served by a shallow, gently sloped 12-inch pipe that is observed flowing full, preliminary recommendations for this area would be to build a separate pump station that serves all development in Triangle (including

the River Cats Stadium) and construct a new forcemain which connects to the existing 18-inch forcemain on South River Road. A more detailed assessment of these options would be warranted as re-development plans are finalized. Costs for these modifications would be responsibility of the assessment district and not included in the City's CIP (developed in this study).

5. The City should implement a formal program to appropriately clean, whether by hydraulic or mechanical methods, all sewer lines within the City. At least 10% of the collection system lines should be cleaned each year. Many communities elect to clean sewers once every 5 years, or as needed. The accumulation of material should be monitored each year and the cleaning frequency adjusted accordingly. While the City does actively clean its system, there does not appear to be a system in place for ensuring all lines are periodically flushed. The initial inspection program shown in Table 7-2 would provide cleaning for approximately one fifth of the larger sewers (larger than 6-inch) within the City.

6. The City should implement an inspection and enforcement program that encourages the proper operation and maintenance of all grease traps and a grease education program for commercial establishments and residential customers. A grease control ordinance may reduce the frequency of cleaning certain sewers in heavy commercial areas.

7. Implement the targeted I/I reduction project for the Jefferson tributary area described in the 1999 Bennett Staheli I/I Reduction Analysis Phase 2 Report. This plan involves a focused program of repairing 25 percent of the leakiest laterals (approximately 75 out of 300 laterals) within Jefferson to determine how effective infiltration can be removed within the laterals. The "leakiest" laterals can be identified in the next phase CCTV inspection work described above, assuming the work is completed during the winter. The 1999 Report had estimated a cost of $394,000 for this project and included inspection, open cut construction and repair of laterals, and follow up evaluation of effectiveness. This project should be deferred if the CCTV inspection work discovers areas similar to the significantly deteriorated pipes on West Capitol Avenue.

8. Establish an annual sewer replacement fund that assumes an average pipeline life of 50 to 75 years. This fund would be used to implement projects as they are identified and prioritized over the next several years. The basis of this replacement fund is developed in Section 9.

Insert

Figure 7-3 Detailed Inspection of Alabama and Park Boulevard Sewers

Insert

Figure 7-4 Detailed Inspection of Park Boulevard Sewers

Insert

Figure 7-5 Detailed Inspection of West Capitol Avenue Sewer

Insert

Figure 7-6 Detailed Inspection of West Capitol Avenue Sewer Pipe

SECTION 8

Recommended Wastewater Pump Station And Forcemain Modifications

The gravity sewers convey wastewater to one of seven major pump stations around the City. A series of interconnected forcemains convey wastewater under pressure to the City wastewater treatment plant (WWTP) on South River Road north of the Ship Channel. This pumping system will require improvements in the future for two principal reasons: (1) elements of the system need replacement due to age and, (2) the City's connection to the Sacramento Regional Community Sanitation District (SRCSD) will redirect the pumped flow into the Lower Northwest Interceptor (LNWI).

This section describes the various improvements and modifications required for the City's pump station and forcemain system. This section is divided into the following sections:

- Existing System Flows
- Pumping System
- Recommended General Pump Station Improvements
- Connection to the LNWI
- LNWI Assessment Methodology
- Forcemain Modifications Required as Part of the LNWI Connection
- Pump Station Modifications Required as Part of the LNWI Connection
- Construction and Startup Scheduling
- Pump Station Modification Costs

8.1 EXISTING AND PROJECTED SYSTEM FLOWS

EXISTING PUMPING SYSTEM

Five of the seven major pump stations in the existing system convey wastewater generated north of the Ship Channel into pressure piping ranging in size up to 24 and 27-inch diameter piping generally situated on Sacramento-Yolo Port District property paralleling Stone Boulevard from Park Boulevard to the WWTP. One 20-inch pressure pipelines constructed in the 1980's carry flow from the Bryte, South, Industrial and Northport pump stations to the upstream terminus of the 24-inch pipeline south of the intersection of Stone and Park Boulevards. The 24-inch pipeline increases to 27-inch size near Jefferson Boulevard, where lateral pipeline connections add flow from the Jefferson pump station from the north and from the Southport pump station. The Southport pump station, recently reconstructed in 1999, serves the entire developed area south of the Ship Channel including the Bridgeway Island pump station discharge.

Table 8-1 provides a summary of projected flows and existing pumping capacities at each of the seven major pump stations.

TABLE 8-1
PROJECTED FLOW ESTIMATES AND CAPACITIES AT EACH PUMP STATION

	Current Average mgd	Future Average mgd	Future PHWWF mgd	Total Capacity mgd	Reliable Capacity mgd
Bryte	1.7	1.93	6.5	6.75	4.5
Industrial	0.4	0.4	1.4	3.3	2.2
Jefferson	1	2.64	5.6	8.4	5.6
Northport	1	1.21	3.61	5.4	3.6
South	0.7	0.70	1.1	2.4	1.6
Bridgeway Island	0.3	1.6	5.0	5.0	2.3
Southport	0.9	6.1	10.7	10.7	5.2

Most of the City land area and all of the pump stations are located near a ground elevation of 10 feet above mean sea level (MSL) with upstream gravity sewers typically near or below zero MSL with the influent hydraulic grade at the headworks at about 50 feet above MSL. The City WWTP is located at the highest point in the service area, with ground elevation at about 40 feet above MSL. Forcemain pressure conditions are sufficient to lift wastewater from the gravity sewer levels upstream of the pump stations the 40 to 50 feet to the WWTP elevation and overcome friction losses in the forcemain pipelines. Current design conditions at the seven major City pump stations are presented in Table 8-2.

TABLE 8-2
EXISTING MAJOR PUMP STATION DESIGN CRITERIA

Pump Station	Sump Design Level (MSL)	Number of Pumps		Peak Flow (gpm)	Design Dynamic Head (feet)[a]		
		Total	Operating[b]		Static	Dynamic	Total
Bryte	-7	3	2	4,640	57	76	133
Jefferson	3	3	2	2,030	47	75	122
Northport	-10	3	2	4,490	60	61	121
Industrial	-6	3	2	3,770	56	65	121
South	-3	3	2	2,070	53	12	65
Total North of Ship Channel				17,000			
Bridgeway Island	-17	3	2	3,500	18	142	160
Southport	-15	4	3	8,330	65	95	160
Total Southport				11,800			

a Peak flow conditions.

b At design peak flow condition. Buildout Conditions shown for the Southport and Bridgeway Island Pump Station.

8.2 RECOMMENDED GENERAL PUMP STATION IMPROVEMENTS

Facility improvements to improve operation and reliability are recommended to be completed at each pump station. While not directly related to the City's connection to the LNWI, it is significantly cost effective and easier to implement if these projects are completed in conjunction with the LNWI modifications. The projects include improvements to standby power systems, corrosion investigations and control, and supervisory control and data acquisition (SCADA) improvements.

Standby power generators are currently in place at the Jefferson, Bryte, and Southport pump stations. For permanent planning, generators would be desirable at all major pump stations. Accordingly, standby generator equipment is proposed for the Northport, Industrial, and South pump stations. The large size of the Southport generator would require a load bank to accommodate smaller pump motors.

All of the major pump stations consist of a concrete wet well and an adjacent prefabricated steel capsule containing pumping equipment and suction and discharge piping and valving. The interior of the stations are accessed from ground level via a mechanical maintenance lift within a vertical steel tube. The entire steel structure at each station is protected from corrosion by special interior and exterior paint coatings and an electrolytic system consisting of a magnesium sacrificial anode. Soils in West Sacramento are known to be corrosive. It is possible that the anodes installed originally with the older pump stations are near or completely neutralized.

An evaluation of the structural integrity and extent of corrosion at each station is needed as part of the long-term capital improvement program. This evaluation, which is unrelated to the LNWI connection plan, is estimated to cost up to about $10,000 and should be completed as part of preliminary pump station design activities.

The existing pump station SCADA system is obsolete and technical support will become increasingly difficult in the coming years. The system does not provide two way communications nor peer-to-peer communications, which will be a requirement of the future control system. The entire system should be replaced with a state of the art system.

The central computer is the brain and memory of a modern SCADA system and should be located where it can be monitored as operations require. Presumably, this would be at a central public works site or corporation yard if the City WWTP is abandoned. The central computer typically includes a local back-up computer as well as a laptop computer for weekend, holiday and evening monitoring by on-call operators.

All of the computers typically include the latest personal computer (PC) technology as well as customized specialty software. The software is customized to allow for animated graphics interface, remote control and monitoring capability and historical trending for regulatory requirements and planned maintenance programs. A series of uninterruptible power supplies (UPS) for short-term back-up power are also required. Communication with remote terminal units (RTUS) can be via telephone or several different types of radio technology.

The full cost of a SCADA system can vary considerably, depending in part on whether existing components can be salvaged for use. Based on quotes obtained as part of this study, this range could be from under $100,000 to nearly $300,000. A reasonable budget for a small system with six to ten remote sites is $150,000, assuming no building or structure modifications would be required.

8.3 CONNECTION TO THE LNWI

The LNWI facilities are currently being designed and are expected to be constructed through 2006. These facilities are shown on Figure 8-1. The preliminary design information available by the SRCSD in 2002 includes the following major facilities included within the LNWI project:

- Dual 60-inch SRCSD forcemains from under the Sacramento River near the I-80 Bridge extending south through the City, under the Ship Channel, to a gravity transition structure in Southport.
- A gravity transition structure in Southport located near Linden Road receiving flows from the SRCSD's dual 60-inch forcemains, the City's forcemain from under the northern City, and the City's forcemains from Southport.
- A 120-inch diameter gravity sewer conveying all flows through Southport to a pump station located outside the City of West Sacramento's City Limits. The City will be provided three locations to connect into the gravity section of the LNWI.

The City and the District have a preliminary agreement whereby the District is responsible for funding, designing, and constructing certain City facilities. These facilities include:

- The City's forcemain and all necessary inter-ties conveying all City flows north of the Ship Channel. The forcemain connection has been established at the confluence of 20-inch forcemains near Stone Boulevard, with connector size to be determined.
- Connection of the Southport Pump Station to the LNWI. Valving, piping and connection details are shown in Figure 8-2.

The City is responsible for modifications to each pump station.

LNWI ASSESSMENT METHODOLOGY

The West Sacramento pumping system was modeled as part of this study to facilitate assessment of changes to system operating conditions upon connection to the LNWI system. Once the model was created using known physical and operating characteristics of the system, model simulations were used to assess various LNWI connection configurations for needed modifications to City facilities.

The hydraulic flow model, constructed using Water CAD Version 4 by Haestead Methods, solves pressure pipe networks iteratively using Hazen-Williams pipe friction losses, and mass and energy conservation principals. The basic model input structure consists of pipe elements (links), pipe interconnections (nodes), inflow sources (pump stations), and outflows (WWTP). Pipe flow velocity, node hydraulic grade lines (HGL) and other results are calculated for various selected flow and LNWI connections scenarios.

System curve ranges were estimated for each pump station by running the rest of the pump stations at minimum, average, and peak flows then taking the difference between the pump suction and discharge node HGLs with zero, average, and peak pump station flows.

Insert

Figure 8-1 Forcemain Model Output After Connecting to the LNWI

Because the model assumes full pipe flow at low system flows, pump station system curves are calculated to be less than the static lift to intermediate pipe node elevations. In these situations forcemain vacuum relief valves would open allowing gravity flow to occur from high pipe nodes. Therefore in developing system curves the pump TDH was not allowed to fall below the maximum static lift to the highest intermediate node elevation.

LNWI connection configurations modeled for effect on City facilities operations consisted of the following:

- Point of connection north of Ship Channel at (near) the confluence of 20-inch forcemains near Stone Boulevard, to the City's new 30-inch forcemain.
- Southport and Bridgeway Island pump station discharges combined for connection directly to the LNWI transition structure into the City's new 24-inch forcemain.

The connector pipeline sizes and configurations were optimized by the following determinants including life-cycle costs, including capital improvements, operating expenses, and reliability. The most significant operating cost variable with respect to connector sizing is the effect on pump station electric power demand.

Based on model runs using a variety of connection configurations, system head conditions under projected future peak flows are low enough such that pumps at six of the existing seven major pump stations will need to be replaced with units more appropriately sized. Bridgeway Island pump station pumps will not need replacement. This conclusion is drawn from model results that indicate operating conditions at each pump station under average and peak flows significantly below even minimum acceptable levels for the smallest impellers available for existing pumps.

Operation below these minimum flow levels would typically result in runout motor overload conditions and excessive mechanical vibrations on a routine basis. Since all feasible connection scenarios result in the need to replace pumps at all stations (except for Bridgeway Island), differences in capital costs for pump replacement are therefore not significant in comparing the connection options.

Peak pump station output determines motor horsepower sizing for the new pumps that will be proposed. Average conditions are used in determining predicted annual power cost savings. Another observation that can be made from model system curve information is that the differential in operating power savings at each pump station between the "maximum" and "minimum" connector size configurations is insignificant compared to predicted power draw at future average flows. Therefore, factors other than future City power costs will govern sizing of the LNWI connector pipelines.

Maintenance of adequate flow velocities in the LNWI connector pipelines is important to minimize deposition of raw wastewater solids. This is critical not only for City and for SRCSD maintenance purposes, but also to minimize odor risk downstream during periodic cleaning activities that would perhaps need to be more frequent.

FORCEMAIN MODIFICATIONS REQUIRED AS PART OF THE LNWI CONNECTION

Modifications will also be required to the City's forcemain system to direct pumped flows from the WWTP south to the LNWI gravity transition structure. These modifications and forcemain additions are the responsibility of the SRCSD and described in general terms below. SRCSD is funding required forcemain modifications and extensions required as part of the LNWI.

Preliminary hydraulic modeling of the City's system after connection to the LNWI has been conducted to determine the new pumping head conditions experienced at each pump station. These assumptions would be confirmed at completion of LNWI design (in late 2003). The LNWI forcemain connector configuration is proposed to consist of the following:

- An intertie in the existing 24-inch pipeline near the confluence of the two 20-inch forcemains south of Stone Boulevard.
- A 30-inch connector pipeline from the above intertie crossing the Ship Channel to the LNWI transition structure paralleling the LNWI forcemains. Under the ship channel the 30-inch pipeline will be split into two- 20-inch forcemains.
- Interconnection of the existing Southport and Bridgeway Island pump station discharge forcemains.
- A 24-inch connector pipeline from the Southport/ Bridgeway Island forcemain intertie to the LNWI transition structure.

A schematic of the City's forcemain connection after the LNWI is presented in Figure 8-1. Figure 8-2 shows forcemain modifications in the Southport area after the LNWI

8.4 PUMP STATION MODIFICATIONS REQUIRED AS PART OF THE LNWI CONNECTION

A station-by-station evaluation of potentially needed improvements for the LNWI system interconnection was made as part of this study. Preliminary findings with respect to specific pump and motor needs are summarized in Table 8-2. Similar head requirements are expected for the Bridgeway Island Pump Station after the LNWI, so no specific pump and motor modifications have been identified at this time. It is important to note that these proposed pumps are based on initial LNWI information. It is expected that refinement to these estimates (i.e. different pumps) will be required after the SRCSD finalizes its design in late 2003.

Using as a basis the distribution of system flows upon which pump equipment at each stations was originally designed, interconnection with the LNWI would result in the need to replace all pumps at each of the six major pump stations. The reduction in static head of about 45 feet would result in pump total dynamic head reductions of 30 to 70 percent. While some of the pumps could operate at very low speed to accommodate this condition, they would be very power inefficient and would be subject to internal vibrations that could be destructive over time.

The standard Smith and Loveless equipment configuration consists of a close-coupled drive motor and pump impeller. With significantly smaller pump sizing, often a new motor is needed even if the existing motor is of adequate size. For planning purposes, it is assumed that new pumps would also

Insert

Figure 8-2 Proposed Changes in Southport After LNWI

require new motors as well. A final determination of this need will be made upon detailed analysis and design of replacement equipment.

TABLE 8-2
PROPOSED PUMP CHANGES AS A RESULT OF CONNECTING TO THE LNWI

Pump Station	Existing		Proposed Based on Design Flows	
	Flow[a] / Head[b]	Pump[c] / Motor[d]	Flow[a] / Head[b]	Pump[c] / Motor[d]
Northport	1250 / 121	8D4C / 75	1250 / 76	6D3 / 40
Industrial	765 / 121	6D3 / 50	765 / 76	4D5 / 25
Southport	1800 / 160	— / 150	1800 / 115	8D4 / 100
South	1100 / 65	6D5 / 40	1100 / 20	6B3 / 7.5
Jefferson	1945 / 122	8D4B / 100	1945 / 77	8D4C / 100
Bryte	1563 / 133	8D4C / 100	1563 / 88	8D4C / 50

a Flow per pump (GPM) – One Pump Standby.
b Total Dynamic Head (Feet).
c Smith & LoveLess Pump Model.
d Motor (Horsepower).

Estimates of costs for pump modifications provided within this report are based on replacement of all pump and motor assemblies at each station including appurtenant minor mechanical and electrical features.

8.5 LNWI CONSTRUCTION AND STARTUP SCHEDULING

It is intended that full operation of existing City facilities be maintained throughout construction of the LNWI and even after its startup serving the SRCSD. Detailed design of improvements in the City system can therefore be deferred to well after commencement of the LNWI construction. Interconnection pipelines and flow control valving will be the responsibility of the SRCSD in close coordination with the City to maintain the existing forcemain system, gravity sewers, and other utility services in continuous operation. City improvements to its pump stations and forcemain system would preferably be scheduled for construction near or after the end of the LNWI construction sequence. In fact, it may be advisable to defer construction of City improvements until after the LNWI has been operational for a period of time. Interconnection valves would be kept closed until modifications to City pump stations are completed.

City pipeline and pump station modifications would logically be completed in the following sequence:

1. Interconnecting pipelines can be completed with secure isolation valving at any time during the latter period of the LNWI construction.

2. Pump station SCADA system can be installed at any time prior to conversion to the LNWI system, even near term.

3. On-site pump station structural repairs, if any, should be constructed as soon as practicable.

4. Modification or replacement of only one pump and motor assembly at each pump station should be completed prior to the planned initial conversion over to LNWI system, with remaining pumps operating through the existing system.

5. Startup of conversion to LNWI system during dry weather season using the single modified or replaced pump at each pump station. In the event of problems during a predetermined transitional phase, operation can revert back to the existing City system using the existing pumps.

6. Once satisfactory interconnection operation is achieved, the remaining existing pumps and motors would be modified in sequence with backup reliability provided by portable pumps.

Operation of the existing forcemain system during LNWI construction will be subject to potential outages if pipelines are inadvertently damaged or to accommodate temporary bypassing. Development of a proposed strategy for the City readiness must be in response to plans by the SRCSD for protection and maintenance of City utilities. Accordingly, recommendations for City contingency planning will be deferred until the LNWI detailed design phase.

8.6 PUMP STATION MODIFICATION COSTS

Improvements to the City collection, pumping, and forcemain system required to facilitate connection to the LNWI will be identified after a more detailed analysis of the system can be completed incorporating final LNWI design provisions. Therefore, suggested improvement costs herein remain at the reconnaissance level for City capital improvement planning purposes. Estimated costs for preliminary proposed pump station modifications are summarized in Table 8-3 based on current (Summer 2002) price levels. A large contingency allowance is added due to the reconnaissance level of analysis at this stage. No costs have been developed for the forcemain modifications. These costs will be included as part of SRCSD's LNWI project. For financial planning purposes, the general breakdown of pump station costs are approximately $750,000 for LNWI related improvements (changing our pumps and motors to meet new head conditions) and $650,000 for general pump station improvements which would be necessary as a matter of improved station reliability. Table 9-4 spreads this $650,000 into $200,000 for SCADA improvements $100,000 for design and $350,000 for construction. The $650,000 would be reflected in the City's annual CIP and allocated to existing customers. The LNWI costs would be distributed to new users through wastewater connection fees. It is expected both categories of improvements would be constructed as part of the same project

Insert

TABLE 8-3
PUMP STATION UPGRADE COSTS

SECTION 9

Program Costs, Implementation Schedule, and Financing Plan

This section describes the recommended sewer system improvements, implementation schedule, program costs, and fee impacts and is organized into the following sections:

- Program Objectives
- Cost Estimating Criteria
- Recommended Rehabilitation Program
- Phased Capital Improvement Program
- Anticipated Connection Fee and Rate Impacts

9.1 PROGRAM OBJECTIVES

The proposed improvement program consists of annual rehabilitation projects, pump station modifications, necessary modifications to connect to the Lower Northwest Interceptor (LNWI), and expansion of the City's system in Southport.

SEWER REHABILITATION PROJECTS

In the coming years, the EPA will require each municipality to develop a Capacity, Management, Operation, and Maintenance (CMOM) program for its sewer system as discussed in Section 6. The most significant impact of CMOM to the City is the development of a system-wide evaluation and rehabilitation program to identify and correct sources of infiltration and inflows (I/I) and convey wastewater without overflows. The program would include budgeting funds to perform annual field investigations, and make repairs on portions of the collection system each year. The City currently does not budget significant annual funds towards sewer rehabilitation. The CMOM program requires additional costs, which would be paid for by through monthly sewer fees.

The City has seen continued deterioration of its older pipelines. Larger reinforced concrete pipes (RCP) which were placed 40 to 50 years ago exhibit the most significant deterioration. It is expected that these sewers will require either replacement or rehabilitation in the future. Recent inspections indicate that some of these RCP sewers should be replaced as soon as possible,

The recommended evaluation program includes flow monitoring, closed circuit television (CCTV) inspections, smoke testing, visual inspections and detailed record keeping to determine the effectiveness of rehabilitation work. Rehabilitation projects will include a combination of pipe repairs, installation of liners, and pipe and manhole replacement projects.

UPGRADES AND IMPROVEMENTS TO THE EXISTING PUMP STATIONS

The City's pump stations will require modifications and upgrades to improve station reliability. Modifications include addition of a new supervisory control and data acquisition (SCADA) to monitor flows and transmit alarms, improved corrosion controls, and replacement of old equipment. The costs of these projects would be funded through charges to existing customers through monthly service charges.

CONNECTION TO THE LNWI

In 2006, the City wastewater system is planned to be connected into the Sacramento Regional Sanitation District through the LNWI. Over the next several years the City will need to plan, design, and construct facilities to redirect flows into the LNWI. These projects include modifications to the existing pump stations. The costs of these projects would be funded through wastewater connection fees. The District will fund required modifications to the forcemain system.

NEW SEWERS AND PUMP STATIONS IN SOUTHPORT

Until the LNWI is completed, existing and new development in the Southport area will continue to be served by the Southport Pump Station and the existing City WWTP. After construction of the LNWI, flows will be redirected to the LNWI at different locations within Southport. The costs of these facilities will be funded entirely by new customers through wastewater connection fees.

9.2 COST ESTIMATE CRITERIA

Cost estimates provided in this program include system evaluation and rehabilitation costs, construction costs of new sewers and pump stations, and costs for connecting the City to the LNWI. Each cost estimate area is described below:

SYSTEM REHABILITATION COSTS

Major costs for the sewer evaluation program include costs for pipeline inspection, cleaning, and rehabilitation. For pipeline repairs, lining is significantly less expensive than pipe replacement assuming that upsizing is not required. Several "trenchless" technologies are available for pipeline rehabilitation. They include Cured-In-Place-Pipe (CIPP), Fold-and-Form (FF) and sliplining. All of these methods utilize the existing pipe as host, providing structural integrity for the new lining. Many of the methods can also be used to make spot repairs to localized problems within the pipeline. Liners typically decrease the amount of I/I entering the system.

The most appropriate repair method, whether it be a spot repair in a pipeline, a defective joint, manhole or entire reach of pipeline depends on several factors, including the location, depth, type of pipe, condition of the existing pipe, number of services, etc. Decisions among rehabilitation methods are typically decided on a case-by-case basis. For this discussion, "lining" refers to any of these techniques. Costs are comparable for FF, CIPP, and sliplining for budgeting purposes.

Table 9-1 includes planning level unit costs for various pipeline evaluation and rehabilitation methods. These costs are intended to provide budgetary costs, and will depend on site-specific conditions and labor and materials costs at the time the improvements are constructed.

TABLE 9-1
UNIT COSTS FOR PIPELINE INSPECTION AND REHABILITATION

Method	Cost	Unit	Notes
CCTV	$1.60	$ per length foot	Includes hydraulic cleaning prior to CCTV inspection.
Smoke Testing	$0.44	$ per length foot	
Manhole Rehabilitation	$1,900	$ per manhole	
Point Repair	$2,500	$ per repair	
Lateral Repair	$5,000	$ per lateral	
Lining (small diameter)	$6.00	$ per inch diameter per length foot	For 8", 10" and 12" diameter pipes. Includes a 20 percent allowance for City engineering, inspection, and administration costs.
Lining (large diameter)	$8.00	$ per inch diameter per length foot	For 18"+ diameter pipes. Includes a 20 percent allowance for City engineering, inspection, and administration costs.

NEW SEWERAGE FACILITIES COSTS

New sewerage facilities in Southport were discussed in the Southport Sanitary Sewer Master Plan, last updated in April 2003. The Master Plan identified required trunk sewers and pump stations to serve the buildout of the Southport area. The construction costs for new sewer lines and pump stations in Southport are estimated at $ 15.4 M. The revised list of new major sewer lines and costs is provided in Appendix C.

The sewage facility costs for full development of Southport are provided in Table 9-2 and have been expanded to include City administration costs, planning, engineering, right of way acquisition costs, and contingencies. The total cost for new trunk sewers and pump stations in Southport is estimated at $15.4 M.

The areas of the City north of the Ship Channel are mostly built out and are served by existing sewer systems. Depending on zoning changes, future redevelopment of these areas may require new pipelines. The Triangle Area Specific Plan is a known example of how planned City redevelopment is expected to shift "dry" industrial land uses to more water intensive commercial and residential zoning. In these cases, new sewer costs are expected to be included as part of the redevelopment financing for the area. As a result, only new sewers in Southport are shown in this Master Plan's capital improvement program.

CITY FUNDED LNWI COSTS

The City will finance and construct required improvements to its pump stations and forcemains to connect to the LNWI. Pump station costs are developed in Section 8 based on a reconnaissance level evaluation of required station upgrades. Costs summarized in Table 8-3 are further divided into costs required as part of the LNWI (which would be attributed to new users) and costs required to improve the operation and reliability of the existing facility (which would be attributed to existing customers). It is estimated that required retrofit of City pump stations to connect to the LNWI would cost approximately $750,000. Additionally, City costs for inspection, utility coordination, and design review of the LNWI during its implementation are estimated at $600,000. These costs are provided in Table 9-2.

As shown in Table 9-2, the total costs for new sewer facilities and connection to the LNWI are estimated at $21.5 M. This would represent the total program costs for new sewage facilities and would be collected through new development connection charges.

TABLE 9-2
ESTIMATED COSTS FOR NEW SEWER FACILITIES AND CONNECTION TO THE LNWI

Item	Cost (M $)[a]
New Collection Systems in Southport	11.5
Largo Pump Station (Buildout)	2.0
Parlin Pump Station (Buildout)	1.9
Construction Subtotal	**15.4**
Planning, ROW, Eng., Contingencies (@29%)	4.4
Subtotal, New Wastewater Facilities	**19.8**
City Administration Costs (@2 %)	0.35
LNWI Existing Pump Station Retrofit	0.75
LNWI Inspection and Program Management	0.6
Total Program Cost	**21.5**

[a] Based on an ENRCCI of 6700.

RECOMMENDED SYSTEM REHABILITATION PROGRAM

Over the past several years, the City has taken initial steps to evaluate the severity and general location of sewer system deterioration and inflow and infiltration (I/I) reduction potential. Results from previous studies and this master plan indicate the following general approach for a future sewer rehabilitation program:

- **Develop a formal maintenance management program to determine relative severity of problems throughout the system.** The program would include a more rigorous cleaning and inspection program so that sewers are hydraulically cleaned at least once every 5-10 years, with known problem areas cleaned more frequently to the extent necessary. Given the magnitude of projects expected each year, it is assumed that the City would hire outside resources for cleaning, inspection, and pipe rehab.
- Target inspection and rehabilitation of the older reinforced concrete pipe (RCP) sewers. The City's older sewers are a combination of vitrified clay pipe (VCP), polyvinyl chloride (PVC), and RCP. The lifespan of sewer pipelines is commonly estimated at 50 years, and the majority of the older portions of the system is at least 50 years old. Based on observations by City maintenance staff and preliminary inspection, the RCP within the City has deteriorated, and in some cases, collapsed. Inspection and rehabilitation of larger RCP pipes should be the first priority. The condition of the VCP pipe needs further study, particularly in the areas where the systems was constructed prior to 1970. To date, significant maintenance has not been required for the VCP sewers.
- Conduct a focused I/I reduction program in the Jefferson Tributary Area. The scope of this program was described in the City's 1999 Phase 2 I/I Reduction Analysis Report. The program

involves repairing 75 of the leakiest laterals in the Jefferson Tributary Area to determine the extent I/I could be reduced and associated costs. The results of this program would be applied to other areas of the City.

The general needs for each tributary area are described below:

Jefferson Tributary Area

The Jefferson Tributary Area is comprised of mostly RCP sewers and, given the age and proximity to the Sacramento River, has been a significant source of I/I. The remainder of the RCP sewers in the Jefferson Tributary Area that have not been cleaned or inspected should be inspected by CCTV to locate and identify necessary pipe repairs. Concurrently, the City should conduct a focused I/I reduction program by repairing 25 percent (approximately 75 out of 300 laterals) to determine how effective the infiltration can be removed.

The Triangle Area subsystem of the Jefferson Tributary Area needs to be evaluated as development occurs since it is expected to be redeveloped with higher density commercial/ industrial land uses than currently exists. The existing 12-inch pipe (along Merkley Ave) that currently serves the area is not expected to have sufficient capacity. Engineering studies for this redevelopment project would need to evaluate how best to convey wastewater from the Triangle Area to the Jefferson Pump Station.

The Jefferson Pump Station will be retrofitted with new pumps, motors, and variable speed drives for the LNWI connection. The pump station would also be equipped with a new supervisory control and data acquisition (SCADA) to monitor and record flows and transmit alarms.

Bryte Tributary Area

The Bryte Tributary Area is comprised primarily of RCP and VCP sewers, constructed prior to 1970. Previous investigations identified certain pipelines need immediate repairs, including the RCP sewers along West Capitol Avenue that were observed to be partially collapsed in come areas. Sewer lining followed by grout injection of the voids appears to have worked well for other portions of this sewer and is recommended to be implemented again. The remainder of the Bryte Tributary Area system should be cleaned and televised to identify necessary pipe repairs.

The Bryte Pump Station will be retrofitted with new pumps, motors, and variable speed drives for the LNWI connection. The pump station would also be equipped with a new SCADA system to monitor and record flows and transmit alarms.

South Tributary Area

Sewers in the South Tributary Area are mostly RCP. Larger RCP sewers along Park Ave. and Alabama Ave have been televised showing levels of deterioration, which would warrant repairs as soon as practicable. The remainder of the South Tributary Area should be cleaned and televised to identify other necessary pipe repairs.

The South Pump Station will be retrofitted with new pumps, motors, and variable speed drives for the LNWI connection. The pump station would also be equipped with a new SCADA system to monitor and record flows and transmit alarms, as well as a new standby generator.

Northport Tributary Area

Sewers in the Northport Tributary Area are mostly VCP, the condition of which is largely unknown. Previous studies within Northport identified a limited smoke testing program to determine the locations of inflow sources within the system. Additionally, the major sewers should be cleaned and inspected to determine the relative condition of the sewers. Specific repairs to this area have not been identified at this time.

The Northport Pump Station will be retrofitted with new pumps, motors and variable speed drives for the LNWI connection. The pump station would also be equipped with a new SCADA system to monitor flows and transmit alarms, as well as a new standby generator.

Industrial Tributary Area

Sewers in the Industrial Tributary Area are mostly VCP, the conditions of which are largely unknown. Known leaky sewers along West Capital Avenue have recently been replaced with plastic pipe. Major sewers should be cleaned and inspected to determine the relative condition of the sewers. Specific repairs to this area have not been identified at this time.

The Industrial Pump Station will be retrofitted with new pumps and motors for the LNWI connection. The pump station would also be equipped with a new SCADA system to monitor flows and transmit alarms, as well as a new standby generator.

PHASED CAPITAL IMPROVEMENT PROGRAM

The phased capital improvement program (CIP) includes existing sewer system rehabilitation projects and modifications to City pump stations. Table 9-3 provides a listing of known CIP projects organized by tributary area and type of project. These projects (exclusive of the new system costs) are estimated at approximately $8.0 M (in 2003 dollars) and would be funded by monthly service charges.

Existing Sewer Rehabilitation Program

The sewer system improvements have been organized by tributary area and prioritized by sewer problem severity, size, and type (the larger RCP sewers are given first priority). For the purposes of long-range capital planning, it has been assumed that all major RCP sewers will require some level of rehabilitation over the next 10 years. This assumption is based on the fact that every RCP sewer recently inspected (by CCTV) by the City has exhibited noticeable deterioration. In addition, previous inflow and infiltration (I&I) studies by the City have recommended focused leak repair projects in the Jefferson and Northport areas. These projects are also included in the CIP listing.

Pump Station Modifications

As discussed in Section 8, it is advisable that the City defer construction of improvements that commit City flows to the LNWI until the SRCSD system is fully operational. City improvement projects can be planned independent from and unaffected by unanticipated delays that may occur in the LNWI construction, over which the City has little control.

To this end, a suggested schedule for LNWI related activities by the City is as follows:

- Install the new SCADA system in Fiscal year 2003. The flow data collected over the next few years will be important to confirm peak and average flows at each pump station and the alarm and monitoring system will assist in the LNWI connection startup.
- Complete design of pump station improvements in 2006, prior to the LNWI completion.
- After LNWI startup and satisfactory operation, advertise for and receive bids for construction of pump station improvements in the following phased sequence to be completed during the dry season:
  1. Replace one pump and motor and necessary variable speed controls at each pump station.
  2. Complete testing of replaced pump unit first off-line, and then simultaneously by diverting flow temporarily to the LNWI system.
  3. After satisfactorily testing all of the initial pump station pumps, commence full time diversions to the LNWI system.
  4. Complete required pump, motor, and speed control replacements at all pump stations prior to onset of wet season.

The City construction sequence should not be initiated until conditions warrant certain shutdown of the City treatment plant.

9.3 CONNECTION FEE AND RATE IMPACTS

The estimated costs for new sewer facilities ($21.5 M, Table 9-2) and additional annual system rehabilitation projects ($8.0 M, Table 9-3) have been used to estimate future connection fees and monthly service charges over the next 10 years. Appendix B provides the sewer-financing plan spreadsheets used to develop monthly charges and connection fees.

This CIP listing has been phased so that approximately the same amount of funding is required each year over a 10-year period. This annual CIP is provided in Table 9-4. As shown, the City would be spending on the order of $800,000 per year over the next 10 years. The improvements to the pump stations required as part of the LNWI are shown to occur in 2006, as part of the overall improvements to the pump stations. However, the costs for the new pumps and motors will be assigned to future connection fees and have therefore not been listed.

Table 9-5 provides a summary of the estimated monthly service charges and connection fees over the next 10 years. As shown, the City's current service charge is $22.99 per month per EDU. This rate would increase at about 3 percent each year to $30. After connection to the SRCSD in 2007, a portion of the service charge is collected for the SRCSD operations.

Table 9-5 also shows the City's project system connection fee over the next 10 years and the impact of connecting to the LNWI. The City's current connection fee is approximately $4,242 per EDU. This connection fee will need to be increased to fund the new sewer facilities in Southport and modifications required as part of the LNWI. It is recommended to increase this fee to 5,005 starting in 2003. After connection to the SRCSD, this fee would jump to around $7,110 to reflect the higher treatment / interceptor fee imposed by the SRCSD. Assumptions used to develop these projections can be found in Appendix B.

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TABLE 9-3
CITY OF WEST SACRAMENTO SEWER SYSTEM CAPITAL IMPROVEMENT PROGRAM PROJECT LISTING

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TABLE 9-4 PROJECTED MONTHLY SEWER SERVICE CHARGE SEWER FINANCING PLAN

Appendix A

Sewer Inventory Information

Appendix B

Financial Plan

Appendix C

Sewer Pipe Inventory and Costs for Southport

(Table C-1 from the Southport Sanitary Sewer Master Plan, April 2003)

Section 1

Introduction

Section 2

Existing and Future Land Use

Section 3

Study Methodology

Section 4

Existing and Projected Flows

Section 5

Existing Sewer System

Section 6

Regulatory Requirements and CMOM

Section 7

Recommended Sewer Maintenance and Rehabilitation Program

Section 8

Recommended Wastewater Pump Station and Forcemain Modifications

Section 9

Program Costs, Implementation Schedule, and Financing Plan