CITY OF LIVE OAK

City of Live Oak
Wastewater Collection System Master Plan

November 2009

Prepared for
City of Live Oak

Prepared by
ECO:LOGIC
ENGINEERS · CONSULTANTS

3875 Atherton Road
Rocklin, CA 95765

916.773.8100 TEL
916.773.8448 FAX

www.ecologic-eng.com

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Contents

City of Live Oak – Wastewater Collection System Master Plan

Tables

Figures

Appendices

Executive Summary

The City of Live Oak (City) Wastewater Collection System Master Plan (Master Plan) is intended to provide guidance to the City on the ability of the existing wastewater collection system to accommodate current and future wastewater generation as well as to provide options for future development. Specific objectives of the Master Plan include:

- Evaluation of the capacity of the existing wastewater collection system during design storm conditions.
- Identification of capital improvement projects recommended to correct any identified existing deficiencies.
- Evaluation of the ability of the existing system to accommodate future flows at design storm conditions.
- Identification of capital improvement projects recommended to accommodate future development within the City Limits and Sphere of Influence (SOI), as identified in the *Draft City of Live Oak 2030 General Plan* (EDAW, September 2009).
- Provide a phased Capital Improvement Plan for the Wastewater Treatment Plant (WWTP).
- Establish a sewer connection fee for future developments.

In addition, in May 2006, the California State Water Resources Control Board (SWRCB) issued statewide general Waste Discharge Requirements (WDRs) (Order No. 2006-0003-DWQ) for all publicly owned sanitary sewer systems greater than one mile in length. With the adoption of these WDRs, municipalities are now required to document system capacities and maintenance procedures to minimize overflows and failures. A key element of the WDRs is the completion of a Sewer System Management Plan (SSMP). Within the SSMP, municipalities are required to complete a System Evaluation and Capacity Assurance Plan (SECAP). The SECAP determines where hydraulic deficiencies exist and outlines a capital improvement program to ensure adequate capacity for dry and wet weather flow conditions. This Wastewater Collection System Master Plan provides the City with a plan that is consistent with the General Plan as well as fulfills the SECAP requirements of the SSMP.

ES.1 PROJECT OVERVIEW

The City of Live Oak is located in the northeast corner of Sutter County between the base of the Sutter Buttes and the Feather River, approximately 10 miles north of Yuba City. The City currently provides sewer service to a residential population of approximately 8,500, as well as to civic, commercial, and industrial users within the City Limits. The City owns, operates, and maintains a network of approximately 131,000 linear feet (24.9 miles) of gravity and pressure pipe (ranging in size from 4- to 21-inches in diameter) and six pump stations. This system conveys an average dry weather flow of 0.60 million gallons per day (Mgal/d) from the users to the City of Live Oak Wastewater Treatment Plant (WWTP) (Figure ES-1).

Wastewater collection system capacity was assessed using a dynamic flow routing model, Wallingford Software's *InfoWorks*. The dynamic model simulates backwater, looped connections, surcharging, and pressure flow that may occur within the City's collection system and is considered one of the most sophisticated means to assess sewer system capacity. The *InfoWorks* model simulates collection system hydraulic response during peak flow events resulting from a combination of peak diurnal sanitary flows (the peak wastewater flow from residences and businesses throughout the day), groundwater infiltration, and rainfall dependent infiltration and inflow (extraneous flow entering the system during or directly after a rain event).

Components of the existing wastewater collection system were provided by the City in Geographic Information System (GIS) format for use in the hydraulic model. Manhole rim and invert elevations for the major trunk lines were professionally surveyed during August 2008. Other data, including pipe length, size, and slope, was obtained from AutoCAD and as-built drawings.

Existing sanitary wastewater flow as well as rainfall dependent infiltration and inflow within the City's system were determined by monitoring wastewater flow for a six-week period from January 28 to March 14, 2006. This flow monitoring data was used to construct and calibrate the hydraulic model.

Design storms are developed from statistical analysis of local precipitation records and represent the distribution of rainfall depths over a time increment for a given storm duration and frequency. Design storms are selected based on the level of protection desired for the wastewater collection system while considering the likelihood of the event. Based on experience with other similarly sized communities in the area, wastewater flows resulting from a 10-year frequency storm occurring over a 6-hour period (10-year, 6-hour design storm) were identified as the City's design service objective.

Wastewater collection systems can generally accommodate some degree of surcharging during peak hourly wet weather flow conditions. However, once a manhole surcharges, it takes very little additional flow for an overflow to occur. The criterion for acceptable levels of maximum surcharging, as established by the City of Live Oak, is defined in Table ES-1. This standard was used when evaluating capacity in flow limited segments of sewer pipelines in all modeled scenarios.

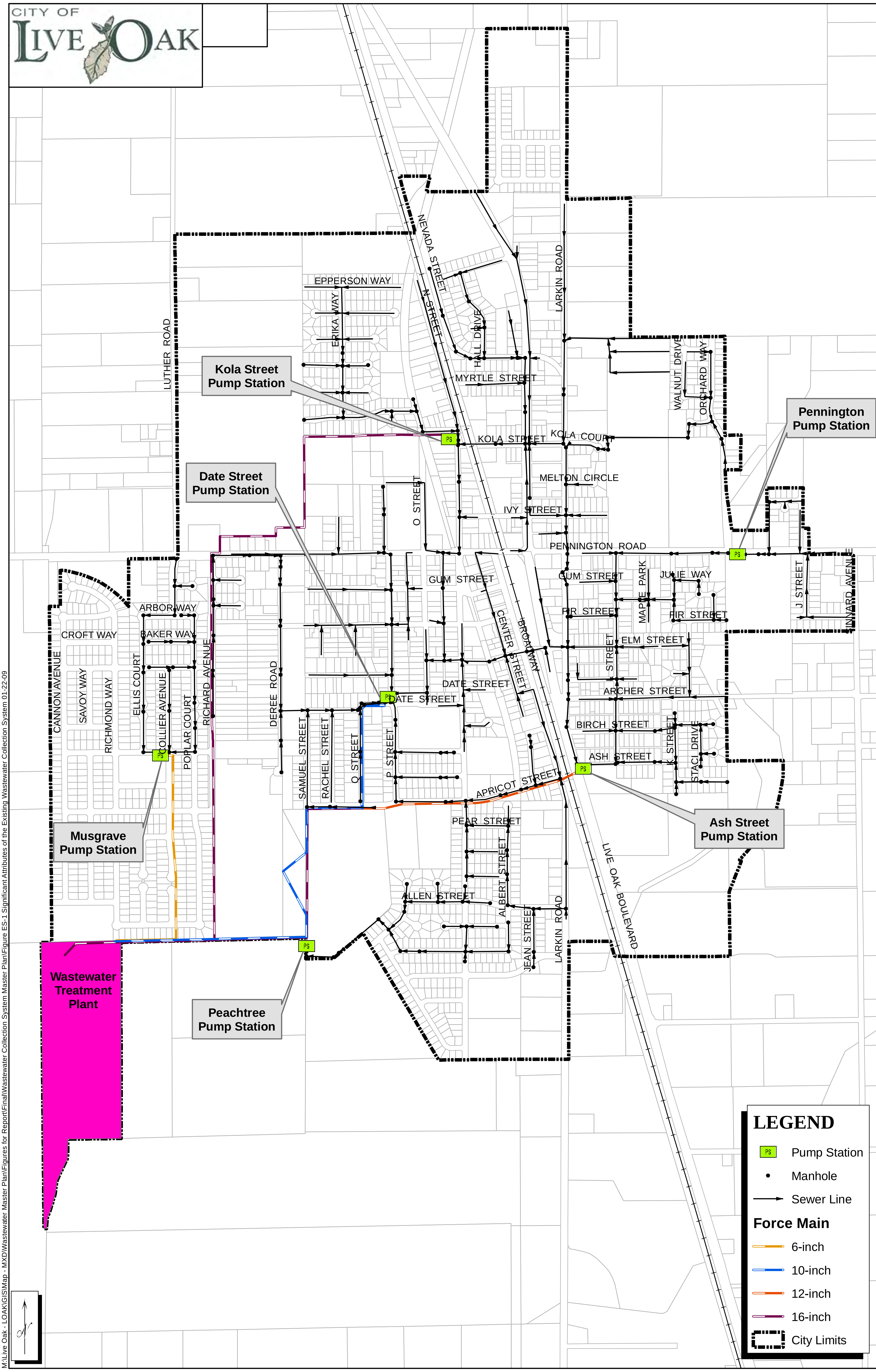

Figure ES-1
Significant Wastewater Collection System Attributes

Table ES-1
City of Live Oak
Recommended Capacity Evaluation Criteria
During Design Storm (10-year, 6-hour) Conditions

Manhole Depth [(a)]	Acceptable Level of Manhole Surcharging
Less than 4 feet	None
4 feet and greater	Not to exceed 4 feet below ground surface

(a) Manhole depth as measured from the crown of the pipe to the rim of the manhole.

ES.2 STUDY CONCLUSIONS

The City of Live Oak's collection system was modeled and analyzed for the following scenarios:

- Existing system with existing level of development (dry weather flow)
- Existing system with existing level of development during design storm (10-year, 6-hour) event
- Build-out of City Limits during design storm (10-year, 6-hour) event

In addition, strategies for accommodating flow from full development of the General Plan Sphere of Influence (SOI) were also analyzed.

ES.2.1 EXISTING SYSTEM

At the existing (May 2009) level of development, during the peak diurnal winter dry weather flow of 0.78 Mgal/d, model simulations indicated all pipes to be flowing at less than 80% capacity.

Under existing conditions, a 10-year, 6-hour design storm is predicted to generate a peak hourly flow of 3.7 Mgal/d at the WWTP. The peak hourly flow is predicted to cause several capacity bottlenecks in the system, as shown in Figure ES-2. The areas are caused by bottlenecks from pipes that are under capacity during the design storm event. However, none of these areas are predicted to cause surcharging above the recommended criteria.

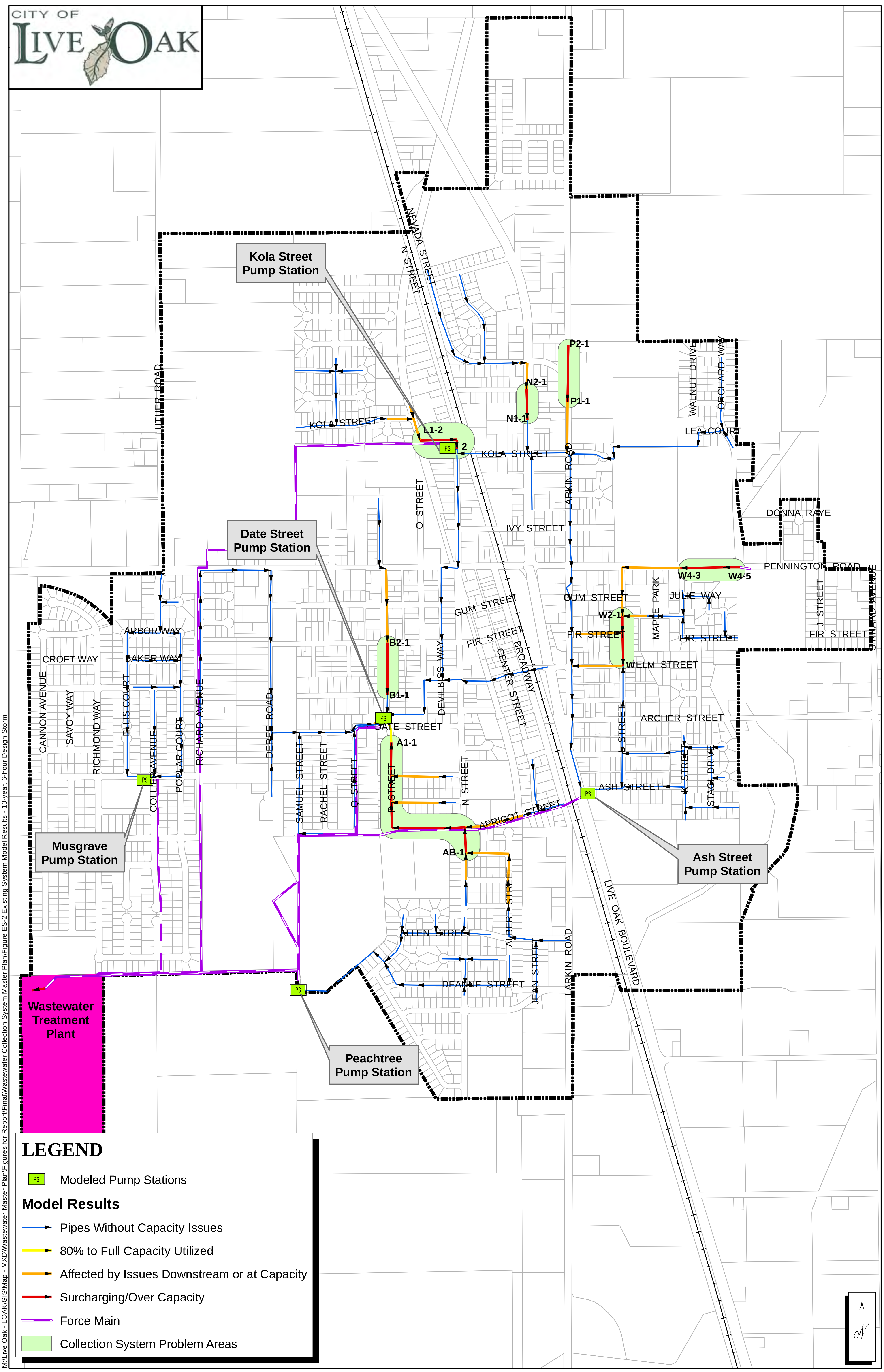

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Figure ES-2
Existing System Model Results - 10-year, 6-hour Design Storm

ES.2.2 BUILD-OUT OF CITY LIMITS

Build-out of the City Limits includes infill of all currently vacant parcels and redevelopment of underutilized parcels identified by the General Plan Consultant. With the addition of peak flow from these developments, the peak hourly flow at the WWTP during the 10-year, 6-hour design storm event is estimated to be 4.4 Mgal/d. The predicted surcharged locations during a 10-year, 6-hour design storm at build-out of City Limits are shown graphically in Figure ES-3. Manholes predicted to surcharge above the recommended criteria are shown as red dots. These manholes include:

- **Manhole L1-2 and upstream manholes:** The capacity limitation in the 10-inch sewer from Manhole L1-2 to Manhole 2 is predicted to cause flow to back up into the collection system upstream, resulting in potential surcharging that exceeds the recommended criteria.
- **Manholes AB-2 and AB-6:** Both of these manholes serve as a junction for upstream tributary pipes and are relatively shallow. Predicted surcharging during a design storm event exceeds the allowable criteria.

ES.3 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

This section summarizes recommendations for mitigating identified capacity issues and includes capital improvement projects (CIPs) for future development. Recommended improvements are provided in Table ES-2.

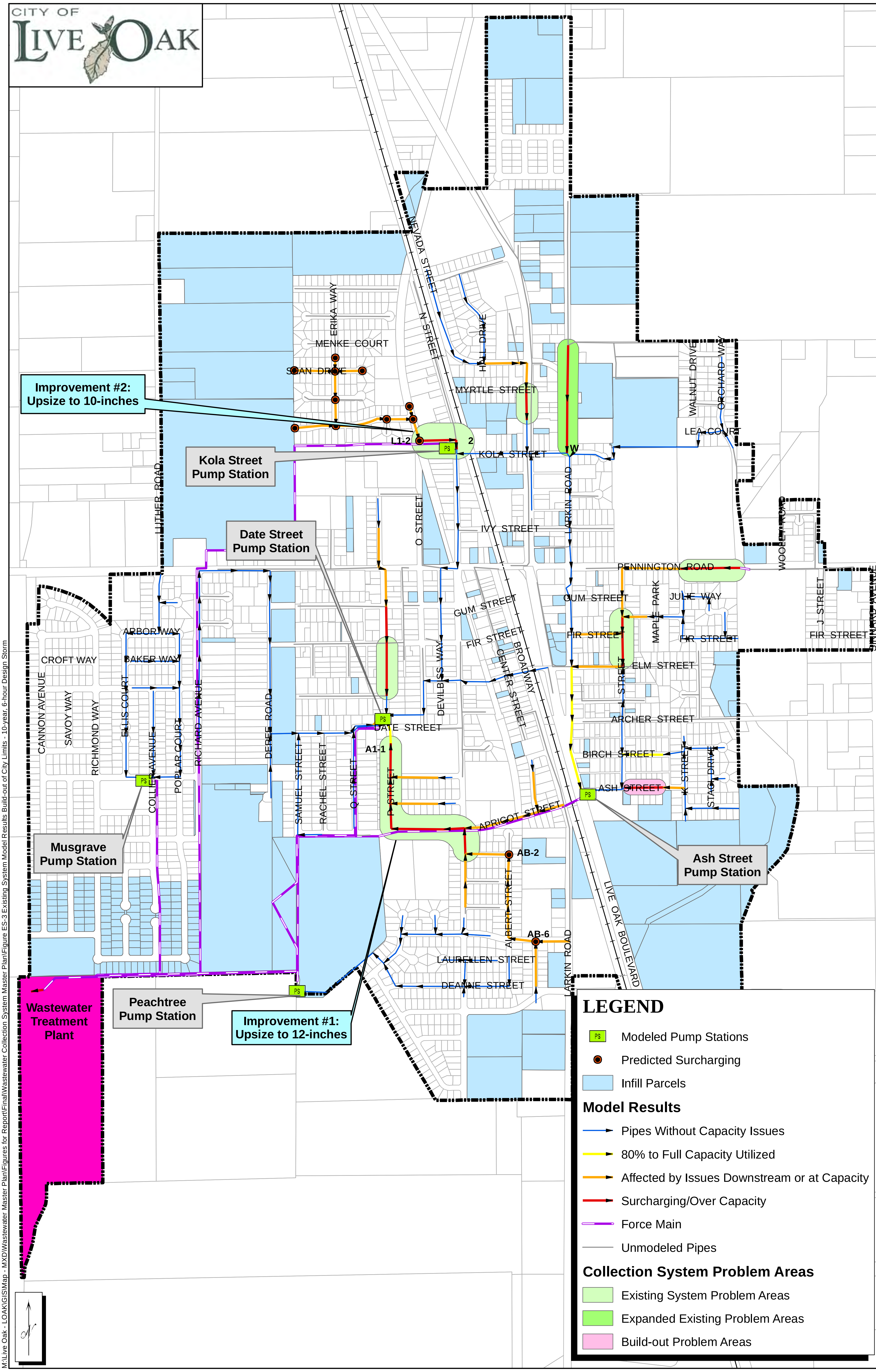
ES.3.1 MITIGATION STRATEGIES FOR EXISTING SYSTEM DEFICIENCIES

During a 10-year, 6-hour design storm at the existing level of development, no pipelines were predicted to exceed the recommended capacity evaluation criteria (Table ES-1). However, it is recommended that the predicted bottleneck areas highlighted in Figure ES-2 be observed during storm events to confirm the impact of peak wet weather flow on the system.

ES.3.2 EXISTING SYSTEM MITIGATION STRATEGY FOR BUILD-OUT OF CITY LIMITS

During model simulations, under 10-year, 6-hour design storm conditions, the addition of flow from infill development would result in two areas of the wastewater collection system that exceed the recommended capacity evaluation criteria described in Table ES-1.

To eliminate these predicted occurrences of surcharging, it is recommended that the pipeline upstream of the Date Street Pump Station, which flows north along N Street, west on Apricot Street, and north along P Street (Manhole AB-1 to Manhole A-1) be upsized from the existing 10-inch diameter to a 12-inch diameter pipe. It is also recommended that the two 6-inch pipes upstream of the Kola Street PS (Manhole L1-2 to Manhole 2) be upsized to 10-inches to provide capacity and reduce surcharging in the upstream gravity lines.



M:\Live Oak - LOA\GIS\Map - MXD\Wastewater Master Plan\Figures for Report\Final\Wastewater Collection System Master Plan\Figure ES-3 Existing System Model Results Build-out of City Limits - 10-year, 6-hour Design Storm

Figure ES-3
Existing System Model Results: Build-out of City Limits - 10-year, 6-hour Design Storm

Table ES-2
City of Live Oak
Recommended Pipeline Improvements for Existing System Deficiencies – Build-out of City Limits at 10-year, 6-hour Design Storm Conditions

Improvement Location	Recommended Improvement
N Street Trunk South of Date St. PS (Manhole AB-2 to A-1)	Upgrade 2,530 ft of pipe from 10- to 12-inch
Kola Street Trunk North of Kola St. PS (Manhole L1-2 to 2)	Upgrade 515 ft of pipe from 6- to 10-inch

ES.3.3 STRATEGIES TO ACCOMMODATE LONG-TERM SYSTEM NEEDS

Even with the pipeline improvements recommended, the City's existing collection system cannot handle flow from full build-out of the General Plan SOI. Development of the SOI will need to be accommodated with new trunk sewers. Suggested alignments of these future gravity trunk sewers are shown in Figure ES-4. A summary of the proposed diameter and length of the recommended new trunk sewers are summarized in Table ES-3.

Table ES-3
City of Live Oak
Proposed Sizing for Future Sewer Trunk Lines

New Trunk Line Route	Diameter (inches)	Length (feet)
East Route		
	18	8,279
	21	12,925
	27	8,457
West Route		
	21	6,548
	24	6,629
	27	287

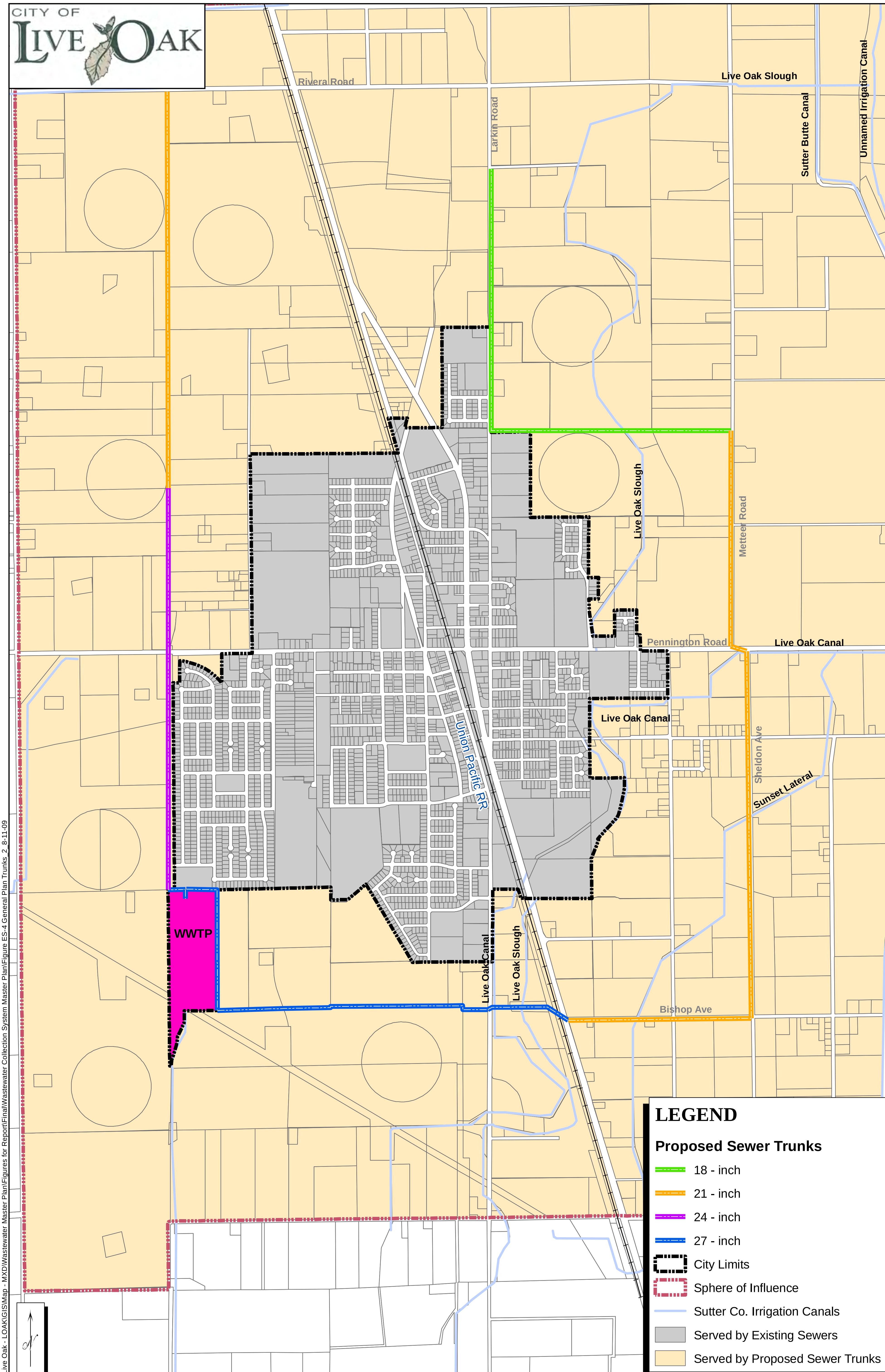


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Figure ES-4
Proposed Layout of General Plan Sewer Trunks

ES.4 SUMMARY OF CAPITAL COST ESTIMATES

Planning level opinions of probable cost (in current 2009 dollars) for recommended improvements to the existing system for build-out of the City Limits and for the major trunk lines shown in Figure ES-4 are provided in Table ES-4 and Table ES-5, respectively. Due to the nature of planning level estimates, a more comprehensive cost assessment for each recommended improvement should be evaluated during the pre-design analysis.

Table ES-4
City of Live Oak
Preliminary Opinion of Probable Cost for Build-Out of City Limits

Improvement Description	Pipe Bursting Cost $ [(a)]	Open Cut and Replace Cost, $ [(a)]
Improvement #1 - Upsize Pipe (MH AB-2 to MH A) to 12"	455,000	$577,000
Improvement #2 - Upsize Pipe (L1-2 to 2) to 10"	77,000	$98,000
Estimating Contingency (30%)	160,000	$202,000
SUBTOTAL – CONSTRUCTION COSTS (rounded)	**692,000**	**$877,000**
Design/Administration (10%)	69,000	$88,000
TOTAL (rounded)	**762,000**	**$965,000**

(a) September 2009 Costs; ENRCCI = 8,586.

Table ES-5
City of Live Oak
Preliminary Opinion of Probable Cost for Build-out of SOI - Proposed New Trunk Sewers

Improvement Description	Cost, $ [(a)]
Build-out Trunk Sewer – East Route	$12,100,000
Build-out Trunk Sewer – West Route	$5,800,000
Estimating Contingency (30%)	$5,400,000
SUBTOTAL – CONSTRUCTION COSTS (rounded)	**$23,300,000**
Design/Administration (10%)	$2,300,000
TOTAL (rounded)	**$25,600,000**

(a) September 2009 Costs; ENRCCI = 8,586.

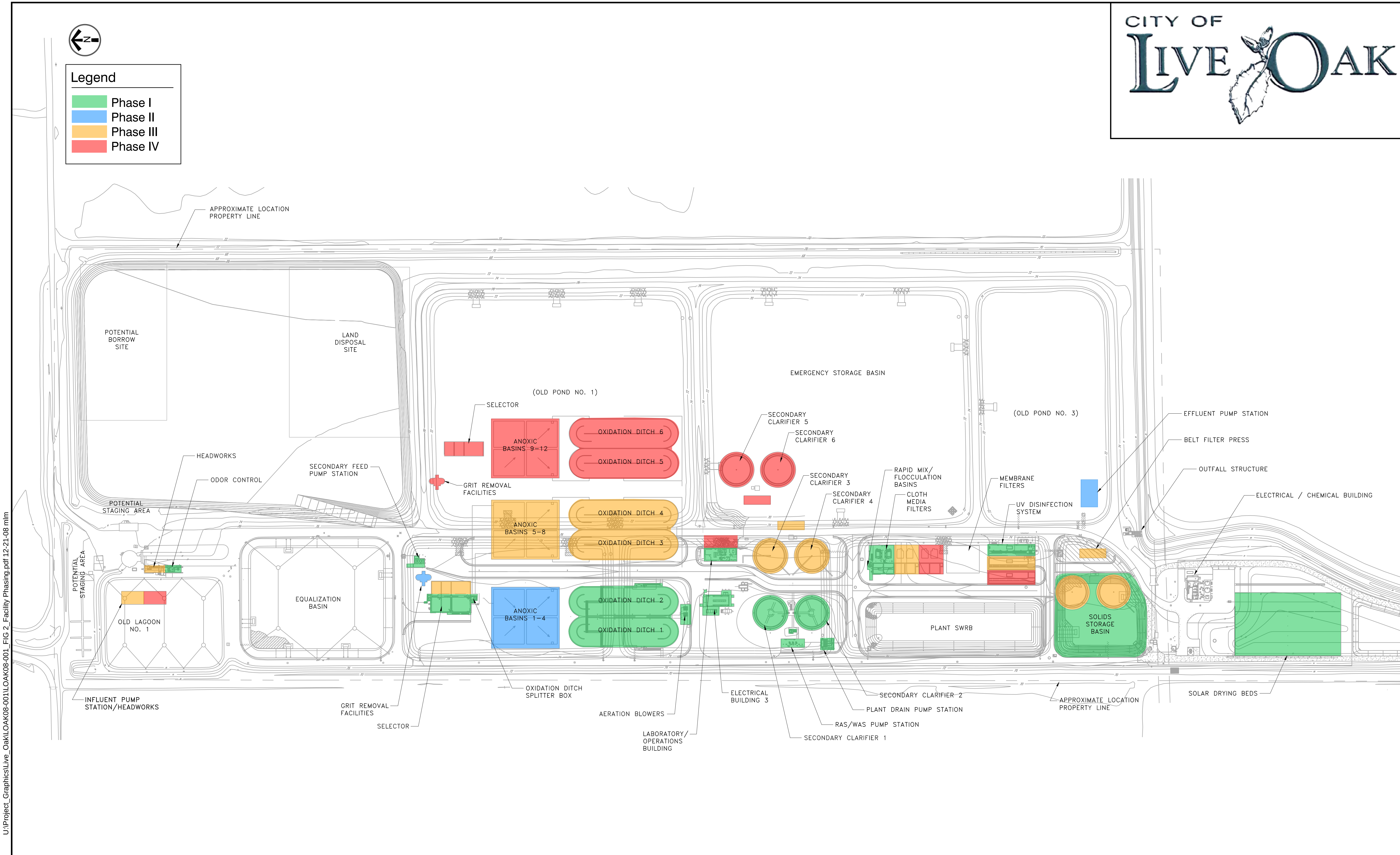
ES.5 SUMMARY OF WWTP CAPITAL IMPROVEMENT PLAN

Future WWTP capital improvement projects have been grouped into four distinct phases (Phase I through IV) and address future regulatory compliance, future expansion, and improved operations efficiency. Planning level opinion of probable costs for all project phases are summarized on Table ES-6. Future facilities are shown in Figure ES-5.

Table ES-6
City of Live Oak
Preliminary Opinion of Probable Cost for WWTP CIP

Improvement Description	Total Project Cost, $ [(a)]
Phase I	$22,060,000
Phase II	$12,800,000
Phase III	$23,300,000
Phase IV	$20,600,000

(a) September 2009 Costs; ENRCCI = 8,586.



Legend
Phase I
Phase II
Phase III
Phase IV
CITY OF LIVE OAK
APPROXIMATE LOCATION PROPERTY LINE
POTENTIAL BORROW SITE
LAND DISPOSAL SITE
(OLD POND NO. 1)
EMERGENCY STORAGE BASIN
(OLD POND NO. 3)
SELECTOR
ANOXIC BASINS 9-12
OXIDATION DITCH 6
OXIDATION DITCH 5
HEADWORKS
ODOR CONTROL
SECONDARY FEED PUMP STATION
GRIT REMOVAL FACILITIES
POTENTIAL STAGING AREA
ANOXIC BASINS 5-8
OXIDATION DITCH 4
OXIDATION DITCH 3
SECONDARY CLARIFIER 5
SECONDARY CLARIFIER 6
SECONDARY CLARIFIER 3
SECONDARY CLARIFIER 4
RAPID MIX/ FLOCCULATION BASINS
CLOTH MEDIA FILTERS
MEMBRANE FILTERS
UV DISINFECTION SYSTEM
EFFLUENT PUMP STATION
BELT FILTER PRESS
OUTFALL STRUCTURE
ELECTRICAL / CHEMICAL BUILDING
POTENTIAL STAGING AREA
OLD LAGOON NO. 1
EQUALIZATION BASIN
ANOXIC BASINS 1-4
OXIDATION DITCH 2
OXIDATION DITCH 1
PLANT SWRB
SOLIDS STORAGE BASIN
INFLUENT PUMP STATION/HEADWORKS
GRIT REMOVAL FACILITIES
SELECTOR
OXIDATION DITCH SPLITTER BOX
AERATION BLOWERS
LABORATORY/ OPERATIONS BUILDING
ELECTRICAL BUILDING 3
SECONDARY CLARIFIER 1
RAS/WAS PUMP STATION
PLANT DRAIN PUMP STATION
SECONDARY CLARIFIER 2
APPROXIMATE LOCATION PROPERTY LINE
SOLAR DRYING BEDS
U:\Project_Graphics\Live_Oak\LOAK08-001\LOAK08-001_FIG 2_Facility Phasing.pdf 12-21-08 mlm

ES.6 SEWER CONNECTION FEE ANALYSIS

Sewer connection fees were updated to reflect the new CIP project costs developed as part of collection system master plan. This fee replaces the current sewer connection fee and the AB1600 fee. The sewer connection fees, as a function of water meter size, are summarized on Table ES-7. The entire *Draft Sewer Connection Fee Analysis* by ECO:LOGIC Engineering is included as Appendix F.

Table ES-7
City of Live Oak
Summary of the Calculated 2009 Sewer Connection Fee

		Infrastructure					
Meter Size	**EDU Factor**	**Existing Buy-in Charge**	**Future CIP Costs**	**Sewer Lateral Connection**	**Subtotal Cost**	**Admin. Charge 1.50%**	**Total Connection Fee**
Less than 1"	1.00	$459	$6,752	$1,431	$8,642	$130	$8,722
1"	1.67	$766	$11,253	$1,431	$13,449	$202	$13,651
1 1/2"	3.33	$1.531	$22,506	$1,431	$25,468	$382	$25,850
2"	5.33	$2,450	$36,009	$1,431	$39,890	$598	$40,489
3"	11.67	$5,359	$78,771	$1,431	$85,560	$1,283	$86,844
4"	21.00	$9,646	$141,787	$1,431	$152,864	$2,293	$155,157
6"	46.67	$21,435	$315,083	$1,431	$337,949	$5,069	$343,018

Chapter 1

Introduction

1.1 PURPOSE

The City of Live Oak (City) Wastewater Collection System Master Plan (Master Plan) is intended to provide guidance to the City on the existing wastewater collection system and options for future development. Specific objectives of the Master Plan include:

- Evaluate the capacity of the existing wastewater collection system during design storm conditions.
- Determine capital improvements recommended to correct identified existing deficiencies.
- Determine capital improvements recommended to accommodate future development, as identified in the *Draft City of Live Oak 2030 General Plan* (EDAW, September 2009).

In addition, in May 2006, the California State Water Resources Control Board (SWRCB) issued statewide general waste discharge requirements (WDRs) for all publicly owned sanitary sewer systems greater than one mile in length. With the adoption of these WDRs, municipalities are now required to document system capacities and maintenance procedures to minimize overflows and failures. A key element of the WDRs is the completion of a Sewer System Management Plan (SSMP). Within the SSMP, municipalities are required to complete a System Evaluation and Capacity Assurance Plan (SECAP). The SECAP requires identification of existing hydraulic deficiencies and the development of a capital improvement program to ensure adequate capacity for dry and wet weather flow conditions.

This Master Plan will provide the City with a plan that is consistent with the objectives listed above as well as fulfills the requirements of the SECAP portion of the SSMP.

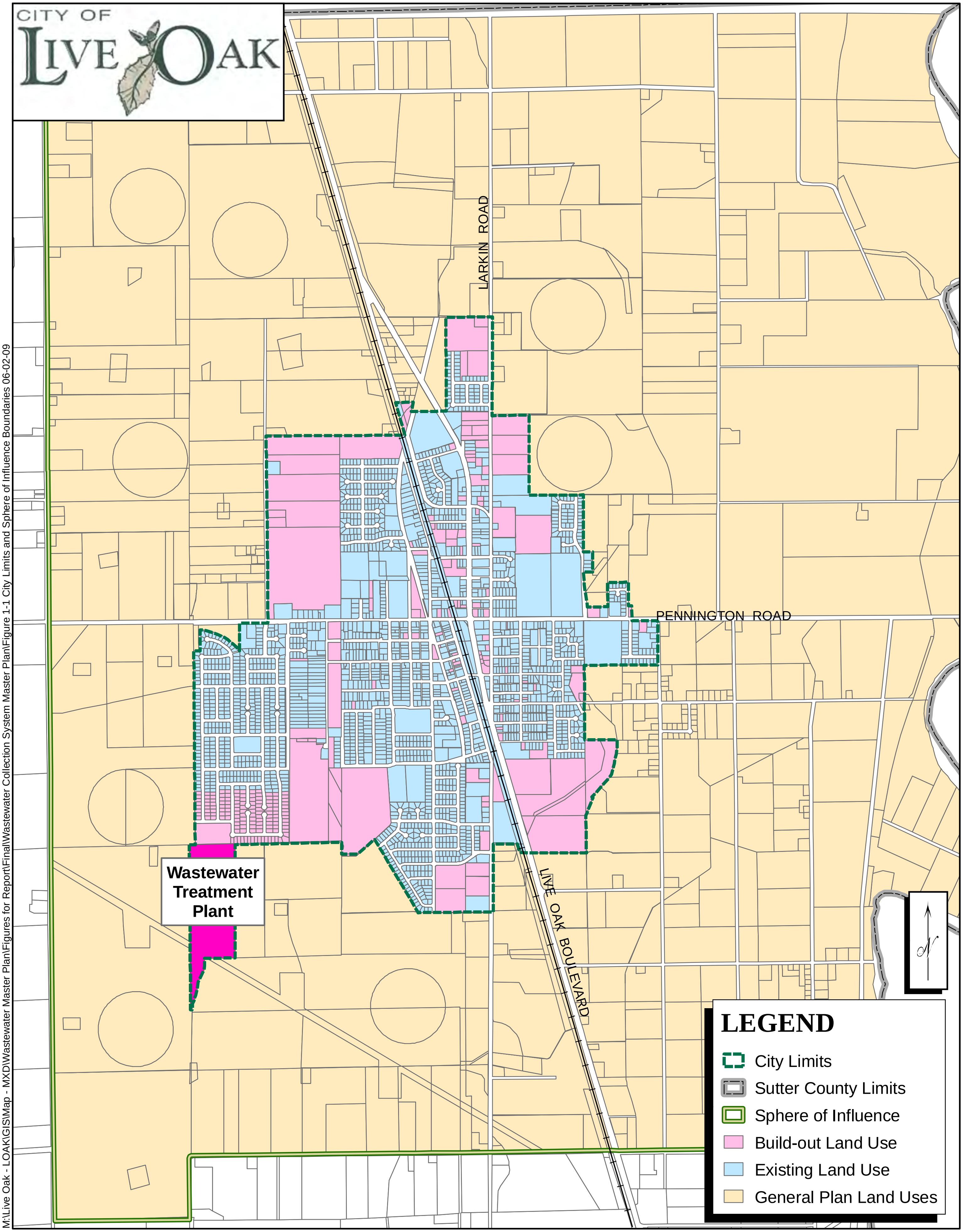
This report is divided into the following chapters:

- Chapter 1 – Introduction
- Chapter 2 – Existing Wastewater Collection System
- Chapter 3 – Land Use Data
- Chapter 4 – Future Flow Estimation
- Chapter 5 – Hydraulic Model
- Chapter 6 – Capacity Evaluation Results
- Chapter 7 – Recommendations
- Chapter 8 – Wastewater Treatment Plant

1.2 STUDY AREAS

The City of Live Oak is located in the northeast corner of Sutter County between the base of the Sutter Buttes and the Feather River, approximately 10 miles north of Yuba City. The City currently provides sewer service to a residential population of approximately 8,500, as well as to civic, commercial, and industrial users within the City Limits.

The City has recently updated their General Plan (*Draft City of Live Oak 2030 General Plan*, EDAW 2009). The previous General Plan was completed by the City of Live Oak in 1993. The updated General Plan identifies growth areas within the current City Limits and projects future growth and land uses in the surrounding Sphere of Influence (SOI). This Master Plan evaluates the ability of the existing wastewater collection system to provide capacity for build-out of the City Limits and develops alternatives for providing capacity to the updated General Plan growth areas outside the City Limits. The City Limits, SOI, and existing and projected growth areas are shown in Figure 1-1.



M:Live Oak - LOAK\GIS\Map - MXD\Wastewater Master Plan\Figures for Report\Final\Wastewater Collection System Master Plan\Figure 1-1 City Limits and Sphere of Influence Boundaries 06-02-09

ECO:LOGIC Engineering
City of Live Oak Wastewater Collection System Master Plan

Figure 1-1
City Limits and Sphere of Influence Boundaries

Chapter 2

Existing Wastewater Collection System

2.1 PURPOSE

The purpose of this chapter is to describe the City of Live Oak's (City) existing wastewater collection system, which provides service to users within the City Limits.

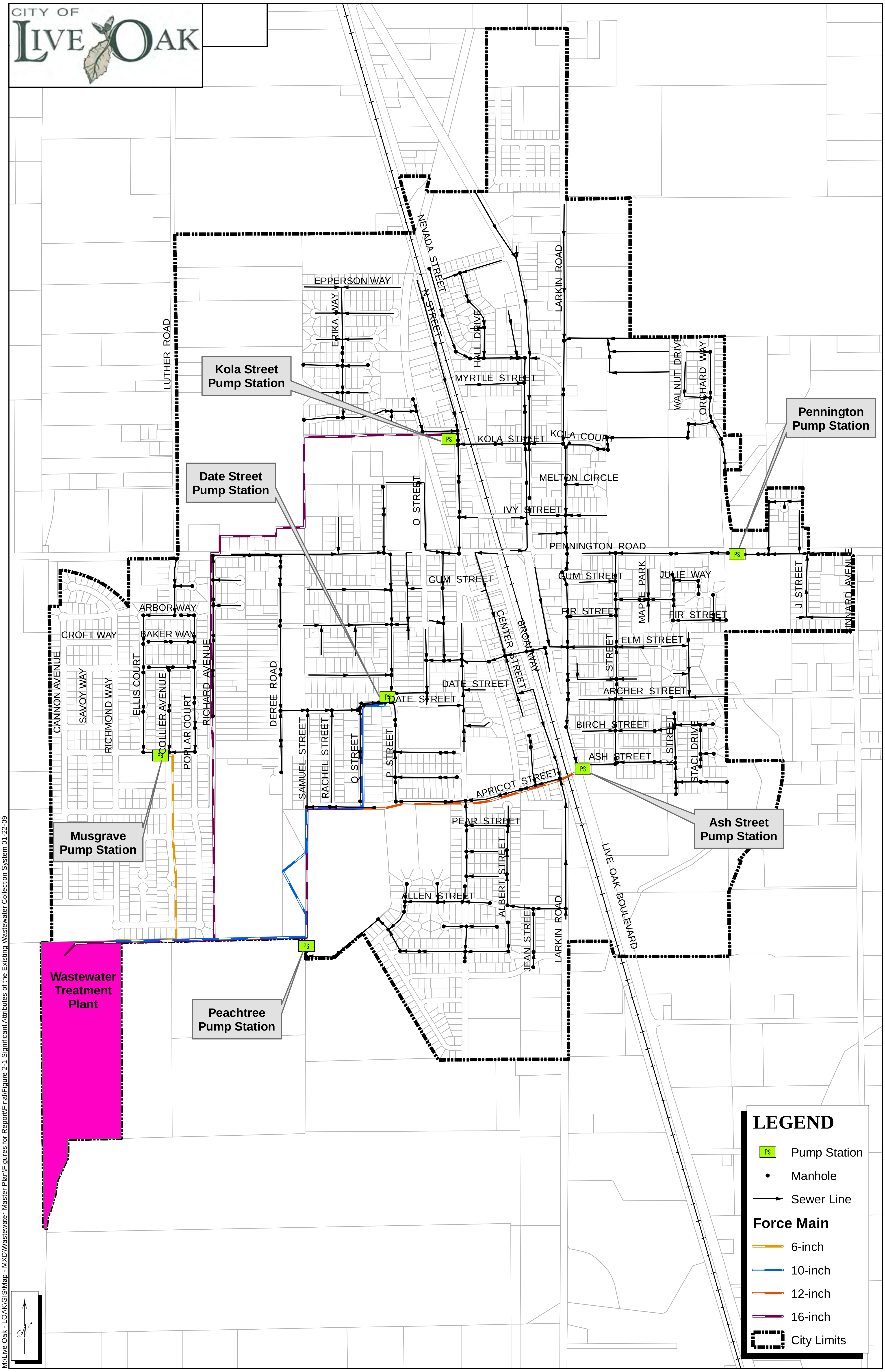
This chapter is divided into the following sections:

- Description of Existing Wastewater Collection System Facilities
- GIS Database
- Existing Wastewater Flow

2.2 DESCRIPTION OF EXISTING WASTEWATER COLLECTION SYSTEM FACILITIES

The City is located in the northeastern portion of the Central Valley at the base of the Sierra Nevada foothills. The terrain is primarily flat, sloping down slightly from north to south. The City's existing wastewater collection system generally follows this natural slope, flowing from north to south.

The City's existing wastewater collection system covers a service area of approximately 1,162 acres and provides service to over 3,100 residential, commercial, industrial and civic users. The City owns, operates, and maintains a network of approximately 131,000 linear feet (24.9 miles) of gravity and pressure pipe (ranging in size from 4- to 21-inches in diameter) and five pump stations, which convey flow from the users to the City of Live Oak Wastewater Treatment Plant (WWTP). The City also owns and operates the WWTP. The City's existing wastewater collection system and significant facilities are shown in Figure 2-1.



M:\Live Oak - LOAK\GIS\Map - MXD\Wastewater Master Plan\Figures for Report\Final\Figure 2-1 Significant Attributes of the Existing Wastewater Collection System 01-22-09

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Figure 2-1
Significant Wastewater Collection System Attributes

2.2.1 PUMP STATIONS

There are six existing pump stations within the wastewater collection system:

- Date Street Pump Station
- Ash Street Pump Station
- Kola Street Pump Station
- Musgrave Pump Station
- Pennington Pump Station
- Peachtree Pump Station

All of the pump stations convey wastewater via force mains directly to the headworks of the WWTP, with the exception of the Pennington Pump Station, which discharges to a gravity sewer.

The Date Street Pump Station discharges into parallel 10-inch ductile iron force mains, one of which carries flow directly to the headworks of the WWTP. The other ties into a 16-inch ductile iron force main at Q Street, which then carries flow to the WWTP. The Ash Street Pump Station discharges into a 12-inch ductile iron force main on Apricot Street, which also ties into the 16-inch force main at Q Street. The Peachtree Pump Station discharges in to an 8-inch ductile iron force main, which ties into the 16-inch force main at the WWTP access road. The Kola Street Pump Station discharges directly into its own 16-inch PVC force main, which discharges directly into the headworks of the WWTP. The Musgrave Pump Station discharges into a 6-inch PVC force main, which discharges directly to the WWTP. The Pennington Pump Station lifts wastewater from development to the east 1.8 feet into the gravity sewer on Pennington Road.

Characteristics of the six pump stations in the City's wastewater collection system are summarized in Table 2-1. The table includes the number of pumps at each station and the average rated capacity of each pump, expressed in gallons per minute (gpm).

Table 2-1
City of Live Oak
Summary of Existing Pump Stations

Pump Station	Number of Pumps			Capacity per Pump (gpm) [a]
	Total	Duty	Standby	
Date Street (Winter Operation)	2	1	1	1,470
Date Street (Summer Operation)	1	1	--	585
Ash Street (Winter Operation)	2	1	1	1,470
Ash Street (Summer Operation)	1	1	--	585
Kola Street	2	1	1	1,460
Musgrave	2	1	1	395
Pennington	2	1	1	160 [b]
Peachtree	2	1	1	500 [b]

(a) gpm = gallons per minute.
(b) Estimate provided by the City Engineer.

2.3 GIS DATABASE

Pipe and manhole data for the majority of the wastewater collection system was provided by the City in Geographic Information System (GIS) format. These GIS files were updated to include the following sources of information:

- Some missing rim and invert data was entered by hand from as-build drawings.
- A limited amount of missing rim and invert data was collected through survey.
- Existing elevation data (such as rims and inverts) were converted to a more recent datum (NAVD 88).
- Infrastructure was added for development that occurred between 2006 and 2008.

2.4 EXISTING WASTEWATER FLOW

The following sections describe typical wastewater flow characteristics in the collection system and the flow monitoring program used to determine existing flow in the system.

2.4.1 WASTEWATER FLOW CHARACTERIZATION

Wastewater collection systems are designed to convey peak hourly wet weather flow. Peak hourly wet weather flow is generally comprised of three elements: sanitary base flow, groundwater infiltration (GWI), and rainfall-dependent infiltration and inflow (RDI/I). Each component is described in more detail below and is shown graphically in Figure 2-2.

Sanitary (Base) Flow

Sanitary flow is the component of wastewater generated directly by residential, commercial, and industrial users throughout a community. It is also referred to as base flow.

The majority of base flow is generated by residential and commercial users (i.e. restaurants, grocery stores, shops, etc.). In many wastewater collection systems, additional base flow is generated by industrial users through process wastewater. However, in Live Oak, none of the industrial users generate any process wastewater and, therefore, these users are treated as typical commercial users.

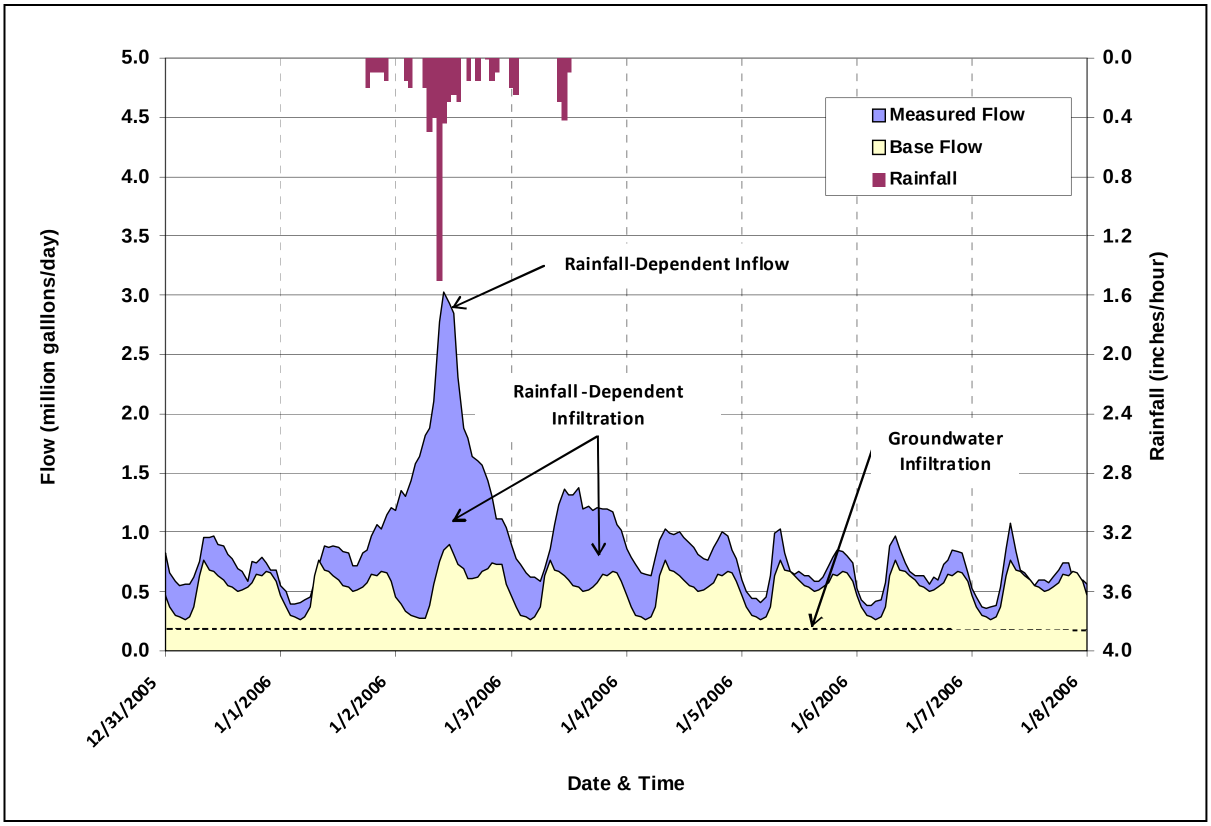


Figure 2-2
Example of Wastewater Flow Characterization Components

Groundwater Infiltration

Groundwater infiltration (GWI) is groundwater that enters the collection system through cracks in sewer pipes, leaky joints, damaged sewer lateral connections, and poorly sealed manhole walls. Groundwater infiltration tends to vary seasonally depending on groundwater depth in relation to the depth of the sewer pipes. Typically, groundwater infiltration is more significant during the wet season when groundwater elevations can rise due to rainfall.

Groundwater levels within the City tend to be relatively shallow throughout the year. The pump stations described previously were designed to keep the sewer pipes relatively shallow to help mitigate the impact of groundwater infiltration into the wastewater collection system.

Rainfall Dependent Infiltration and Inflow

Rainfall-dependent infiltration and inflow (RDI/I) is rainfall that enters the collection system by direct or indirect means. Infiltration is an indirect introduction of rainfall into the collection system through cracked sewer pipes, leaky joints, and manhole walls. Inflow quickly and directly enters the sewer system through leaky manholes covers, clean-outs, and illegal connections, typically creating a relatively high peak hourly flow (see Figure 2-2).

Diurnal Patterns

A diurnal flow pattern is the variation in flow occurring over the course of a full day. In a 24-hour period, wastewater flow varies significantly with maximum flow typically occurring in the morning and early evening, and minimum flow occurring in the late evening/early morning. Each area of the City's service area has its own unique pattern, which varies depending on the day of the week (weekdays and weekends). System-wide diurnal patterns for the collection system are shown in Figure 2-3. Diurnal patterns for weekdays and weekends are shown along with the weighted weekly average of the weekday and weekend. These diurnal patterns were developed from the summation of the average dry weather flow (ADWF) from all the flow monitors.

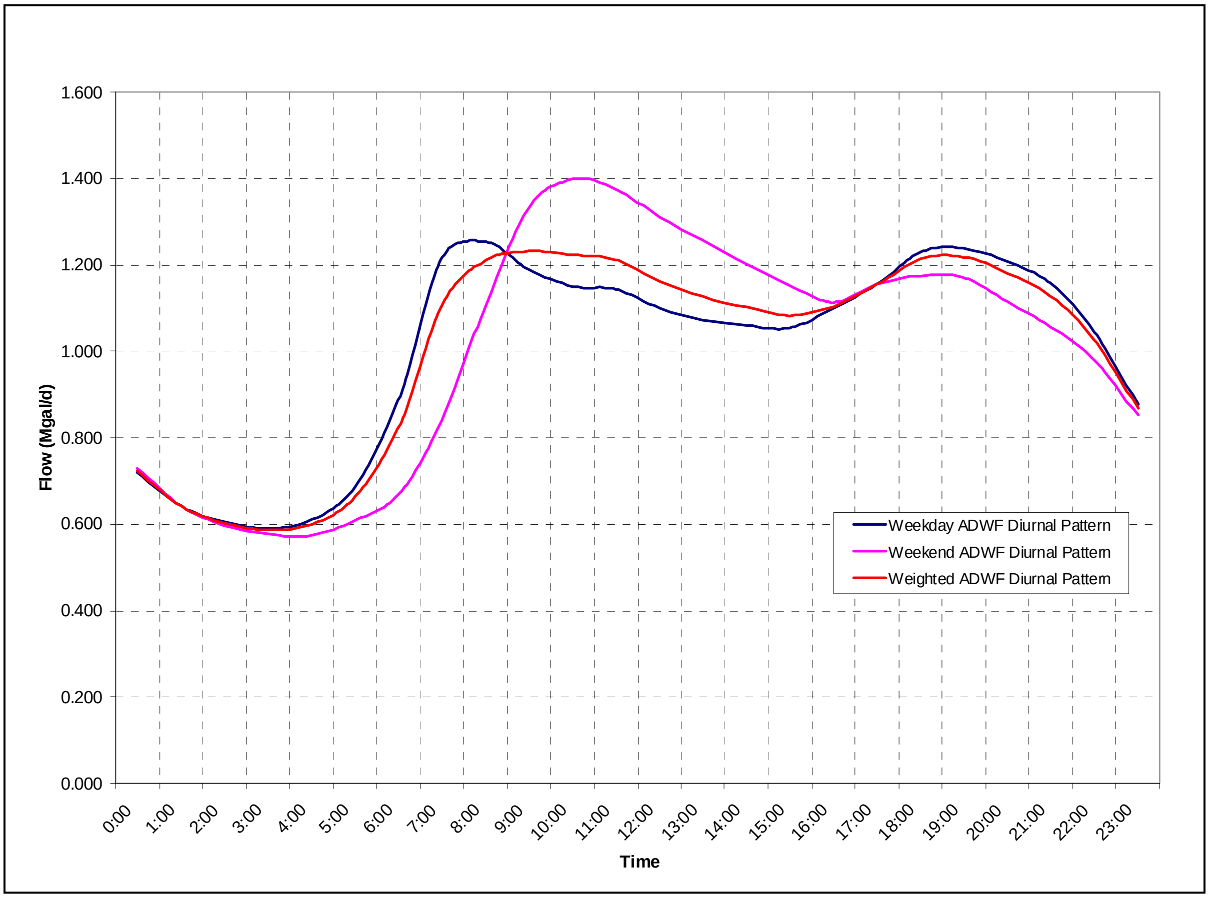


Figure 2-3
City of Live Oak
Wastewater Collection System Diurnal Flow Patterns

2.4.2 FLOW MONITORING

Flow monitoring for the City of Live Oak was completed by V&A Consulting Engineers (V&A). Flow monitoring was conducted for a seven-week period from January 28, 2006 to March 14, 2006.

Six monitoring sites were chosen to divide the City's collection system into the six sewer basins shown in Figure 2-4. A flow schematic of the sites and basins is included as Figure 2-5. As shown in Figure 2-5, all six basins flow directly to the wastewater treatment plant.

Dry and wet weather flow monitoring data was collected from each flow monitor to develop diurnal patterns for each sewer basin, recognize areas with inflow and infiltration issues, and observe each sewer basin's response to peak hourly wet weather flow. Ultimately, this data was used to calibrate the model, as discussed in Chapter 5.

Monitored Average and Peak Flows

Existing wastewater flow within the City's system during dry and wet weather conditions was determined during the flow monitoring period. Average dry weather, peak hourly average dry weather, and peak hourly (wet weather) flow observed at each flow monitoring site are shown in Table 2-2.

Because flow monitoring was performed during the winter wet weather season, average dry weather flow was determined from flow on days least affected by rainfall. However, these dry weather flows may contain a higher groundwater component than average dry weather flow during summer or fall months.

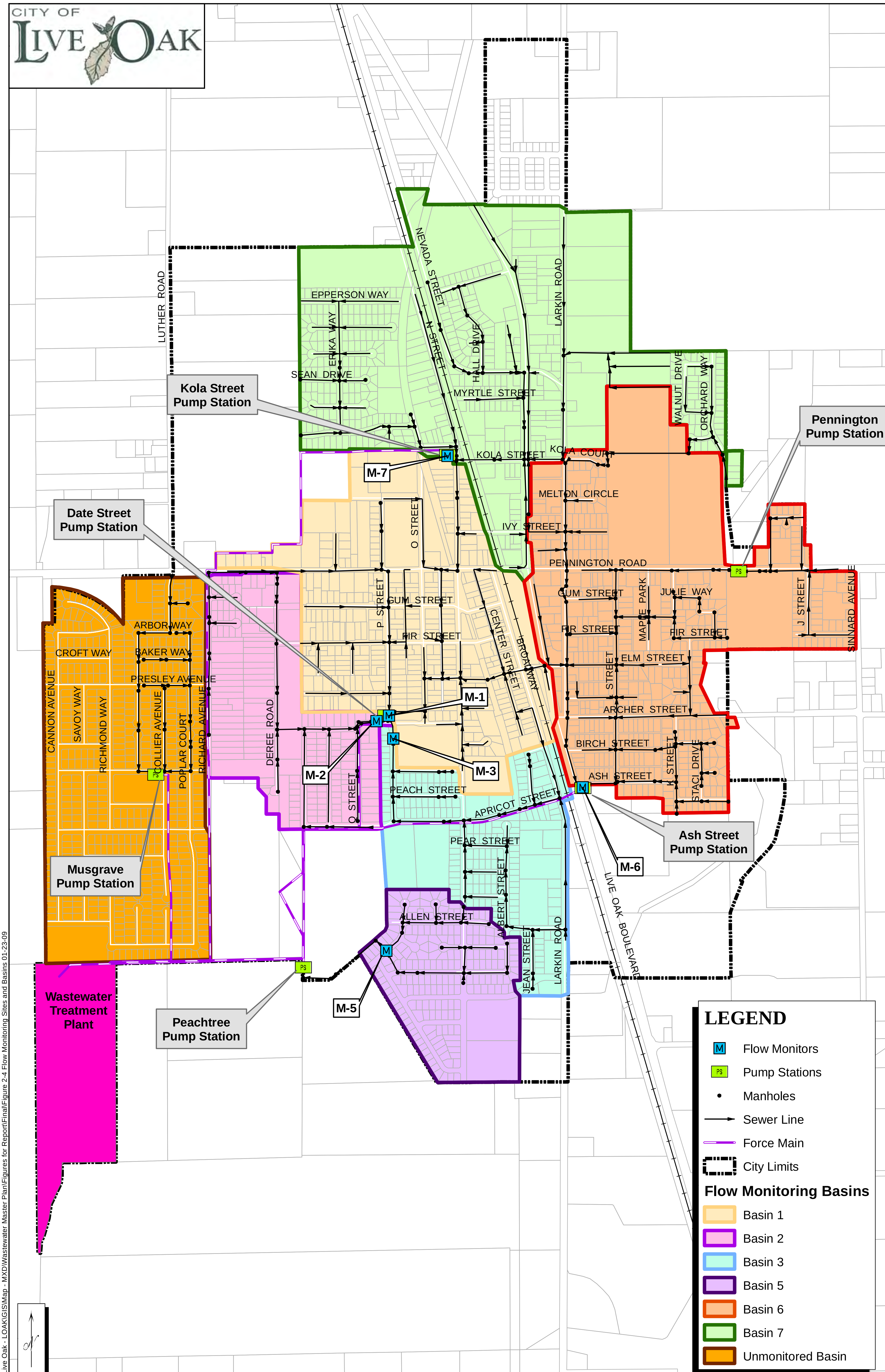
Table 2-2
City of Live Oak
Summary of Average Dry Weather and Peak Hourly Flow
January 28 to March 14, 2006

Flow Monitoring Site	Average Dry Weather Flow (Mgal/d) [(a), (b)]	Peak Hourly Average Dry Weather Flow (Mgal/d) [(a)]	Peak Hourly Wet Weather Flow (Mgal/d) [(a)]
1	0.19	0.25	0.60
2	0.05	0.07	0.13
3	0.11	0.15	0.30
5	0.05	0.08	0.22
6	0.23	0.36	0.68
7	0.14	0.22	0.55
TOTAL SYSTEM FLOW [(c)]	**0.78**	**1.13**	**2.13**

(a) Mgal/d = million gallons per day.

(b) Average dry weather flow during the winter may contain a higher groundwater component than average dry weather flow during summer or fall months.

(c) Total system flow was determined by adding flow from all flow monitoring sites.



M:\Live Oak - LOA\GIS\Map - MXD\Wastewater Master Plan\Figures for Report\Final\Figure 2-4 Flow Monitoring Sites and Basins 01-23-09

Figure 2-4
Flow Monitoring Sites and Basins

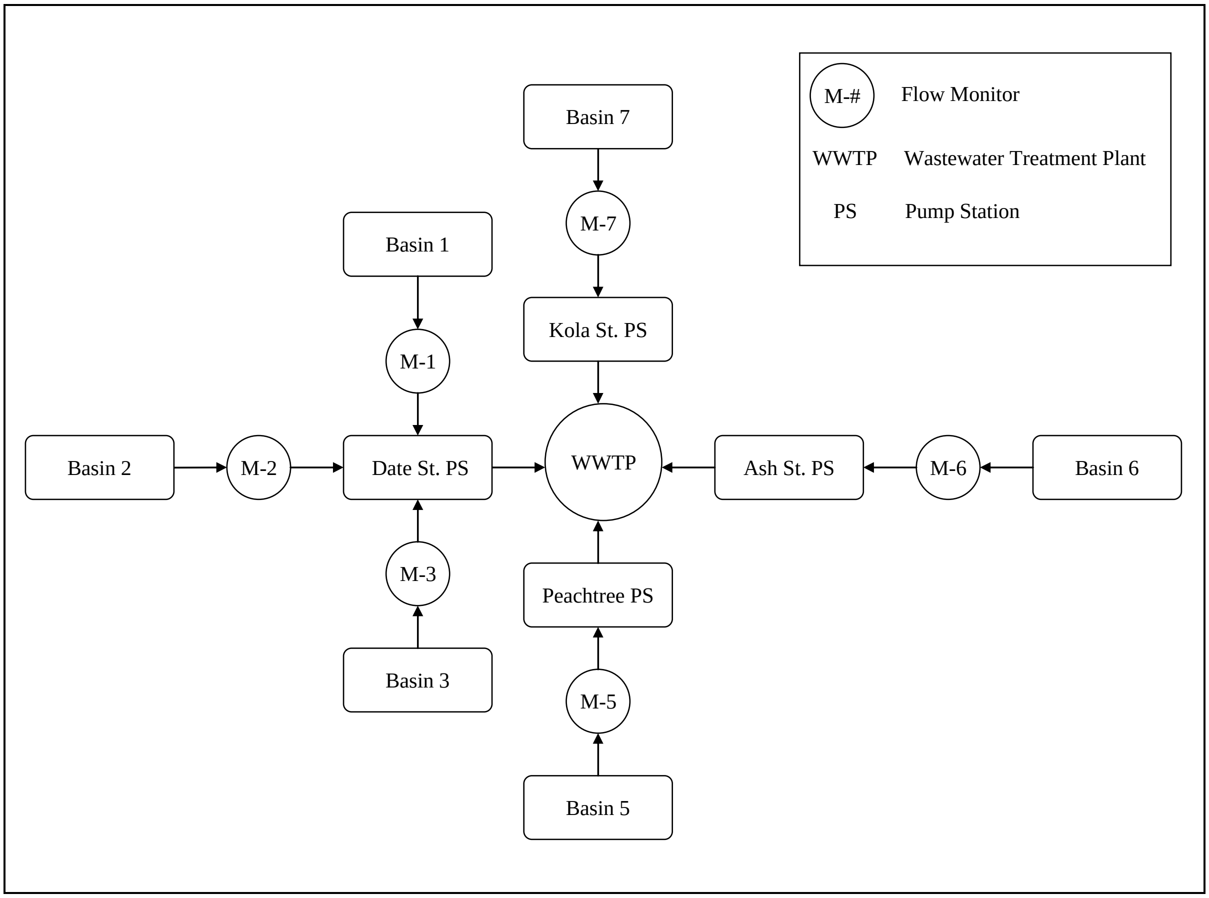


Figure 2-5
City of Live Oak
Wastewater Collection System Flow Schematic

2.4.3 Rainfall Data

Rainfall data was collected from one rain gauge installed and monitored by V&A during the same seven-week period as the flow monitoring (January 28, 2006 to March 14, 2006).

The largest rainfall event during the analysis period occurred from February 26 to 28, 2006. Total rainfall during this event was approximately 2.29 inches over a duration of 24 hours. The February 26 storm event was the beginning of a sequence of storms to pass through the City between February 26 and March 14, which totaled approximately 5.29 inches of rain.

2.4.4 Infiltration and Inflow Analysis Summary

V&A completed the *Sanitary Sewer Flow Monitoring and Inflow / Infiltration Study* in May of 2006 for the City of Live Oak. The results of the inflow / infiltration (I/I) study are summarized in Table 2-3.

Table 2-3
City of Live Oak
Flow Monitoring and I/I Results Summary
January 28 to March 14, 2006

Flow Monitor Site	ADWF (Mgal/d) (a)	Peak Flow (Mgal/d) (a)	Estimated Total I/I (million gallons)	R-Value (%)	Peak I/I Rate (Mgal/d) (a)	Peak I/I per ADWF	Peaking Factor	Infiltration Rank	Inflow Rank	Overall I/I Rank
1	0.194	0.60	3.4	**17.0**	0.41	2.1	**3.11**	1	3	2
2	0..050	0.13	0.34	3.4	0.07	1.4	2.56	6	6	6
3	0.105	0.30	0.75	**7.7**	0.16	1.5	2.83	5	5	5
5	0.052	0.22	0.86	**12.3**	0.15	2.9	**4.17**	2	1	1
6	0.235	0.68	2.0	**10.3**	0.39	2.1	2.88	3	4	4
7	0.141	0.55	2.2	**6.2**	0.41	2.9	**3.91**	3	2	3
System	**0.777**	**2.13**	**9.5**	**9.4**	**1.31**	**1.7**	**2.74**			

(a) Mgal/d = million gallons per day.

In addition, the following items were highlighted in the Flow Monitoring and I/I Study:

Inflow: An inflow peaking factor greater than 3.0 is often indicative of an inflow problem. The overall system average inflow peaking factor was approximately 2.74, which falls below the threshold value of 3.0. However, as can be seen in Table 2-3, Basins 1, 5 and 7 had peaking factors above the threshold value, which may indicate an inflow problem in these basins.

Infiltration: Infiltration above 5 percent often indicates an infiltration problem. The system average R-Value was approximately 9.4%, which is well above the threshold value of 5%. The only basin which did not display indications of excessive infiltration was Basin 2 (R-Value = 3.4).

Combined I/I: The infiltration component is a much stronger component than the inflow for the Live Oak Collection System. It is important to note that in Table 2-3, the ranking prioritization for “Overall I/I” weights the two components equally. It is recommended that the City determine if the infiltration component should be weighted stronger than the inflow component.

Groundwater Infiltration: For all sites and for the total system the ratios of minimum flow to baseline flow were higher than the ratio defined by the Water Pollution Control Federation. It is generally accepted that this indicates probable higher than normal groundwater infiltration during dry weather flow. It is important to note however, that average dry weather flow rates were determined during February, which may skew the analysis if groundwater levels were high due to storm events in December and January.

d/D Ratio: Only site 2 approached a full capacity condition, with a d/D ratio of 0.82. However, this proximity to full capacity may have been caused by the close proximity of the site to the Date Avenue Pump Station.

Chapter 3

Land Use Data

3.1 PURPOSE

The purpose of this chapter is to provide an overview of the existing and future land use designations that were used to estimate modeled wastewater flows. Existing and future land uses were provided by EDAW in September 2008 and May 2009 and correspond to land uses developed by EDAW in the *Draft City of Live Oak 2030 General Plan*.

More detailed information regarding existing and future land uses and how they were used in this study are described in the following sections:

- Existing Development
- Future Development

3.2 EXISTING DEVELOPMENT

In May 2009, EDAW provided land use information regarding existing development and vacancies within the City Limits for all development prior to May 2009. Residential land uses were provided in terms of dwelling units per acre (DU/acre).

For the purposes of this study, residential land uses were re-defined in terms of Equivalent Dwelling Units (EDUs). An EDU is a unit of measure that standardizes all land use types (housing, retail, office, etc) to the wastewater requirements of one single family housing unit. In this case, one EDU is equivalent to the amount of wastewater generated (gallons per day) by an average single-family detached household in the City of Live Oak. A density, expressed in homes per acre, for each residential land use was applied to acreages to calculate total DUs (and hence EDUs), with the exception of the "single family residential" designation. For this land use, one EDU per lot was assumed. Only residential land uses were converted from dwelling units (as defined by EDAW, summarized in Table 3-1) to EDUs.

Flows from commercial and industrial development were estimated on a per acreage basis (as further described in Chapter 4).

Table 3-1
City of Live Oak
Dwelling Unit and
Equivalent Dwelling Unit (EDU) Densities [a]

Land Use	DU Density (DU/acre) [b]	EDU Density (EDU/acre) [b]
Existing Development		
Single Family Residential	5.2	5.2
Rural Residential	0.1	0.1
Duplex	8.6	8.6
Multifamily Residential	8.1	8.1
Mobile Home	13	13
Future Development		
Small Lot Residential	5.83	5.19
Low Density Residential	3.89	3.89
Medium Density Residential	10	7.1
High Density Residential	19.45	12.45

(a) Based on existing land use provided in May 2009 by EDAW.
(b) DU = Dwelling unit; EDU = Equivalent dwelling unit; One EDU is equivalent to the amount of wastewater generated (gallons per day) by an average single-family detached household in the City of Live Oak.

Existing land uses are shown in Figure 3-1. Total acreages and EDUs for each existing land use designation are summarized in Table 3-2.

Table 3-2
City of Live Oak
Existing Land Use [a]

Land Use	Total Area (Acres)	Total EDUs [b]
Single Family Residential	423	2,071 [c]
Rural Residential	47	5
Duplex	10	86
Mobile Home	11	143
Multi-Family Residential	19	154
Civic / Public	135	--
Commercial	23	--
Industrial	20	--
Office	2	--
Park	6	--
Total	**696**	**2,459**

(a) Based on existing land use provided by EDAW in May 2009.
(b) EDU = Equivalent dwelling unit; One EDU is equivalent to the amount of wastewater generated (gallons per day) by an average single-family detached household in the City of Live Oak.
(c) For existing Single Family Residential, individual parcels were manually counted from GIS shapefiles provided by EDAW.

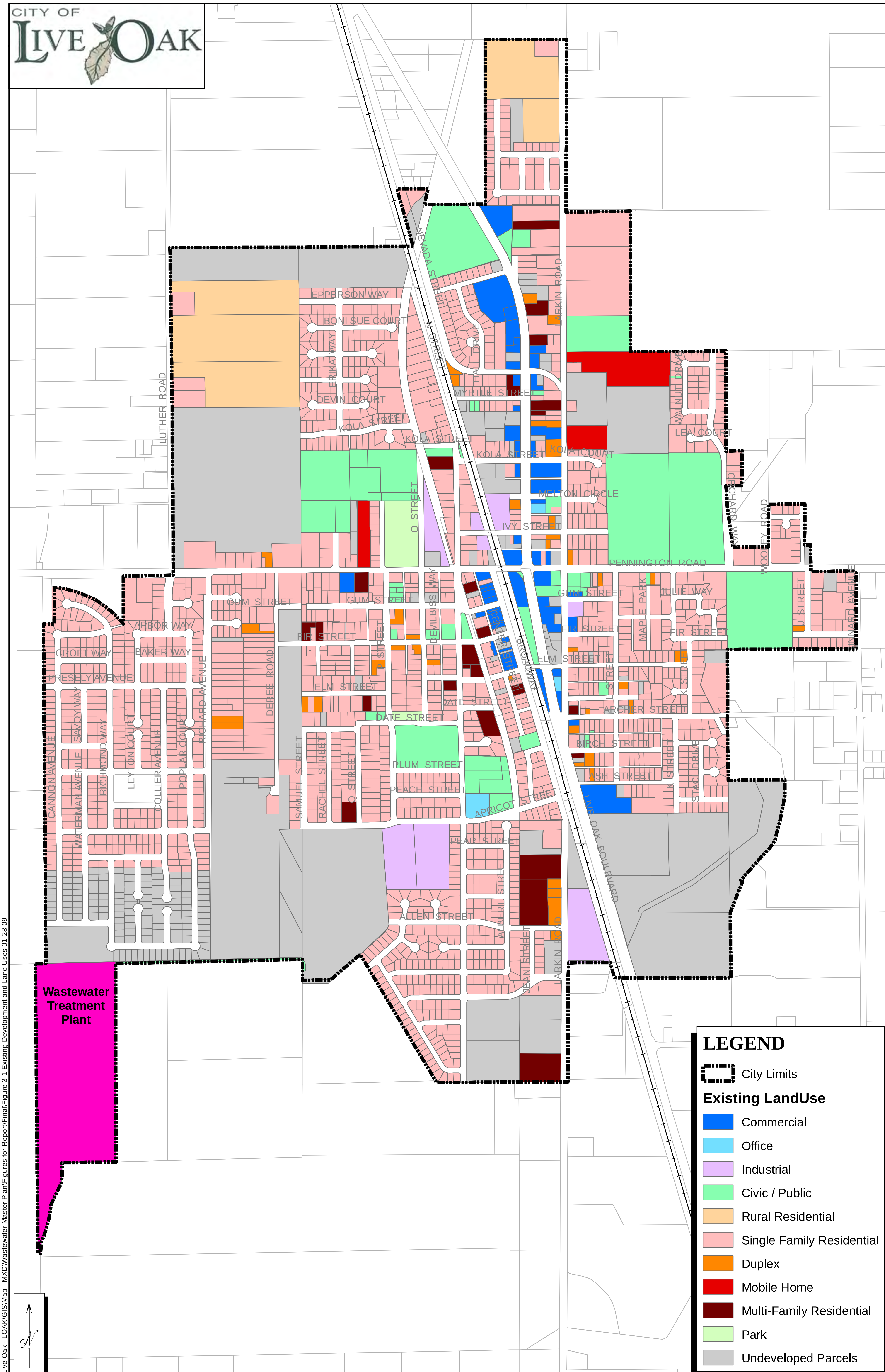


Figure 3-1
Existing Development and Land Uses
(as of May 2009)

3.3 FUTURE DEVELOPMENT AND POPULATION ESTIMATES

Future development was analyzed for two different scenarios:

- Build-out of vacant parcels within the City Limits and redevelopment
- Build-out of areas between the City Limits and the Sphere of Influence (SOI)

Vacant parcels and areas with redevelopment potential were provided by EDAW. These scenarios are described in more detail below.

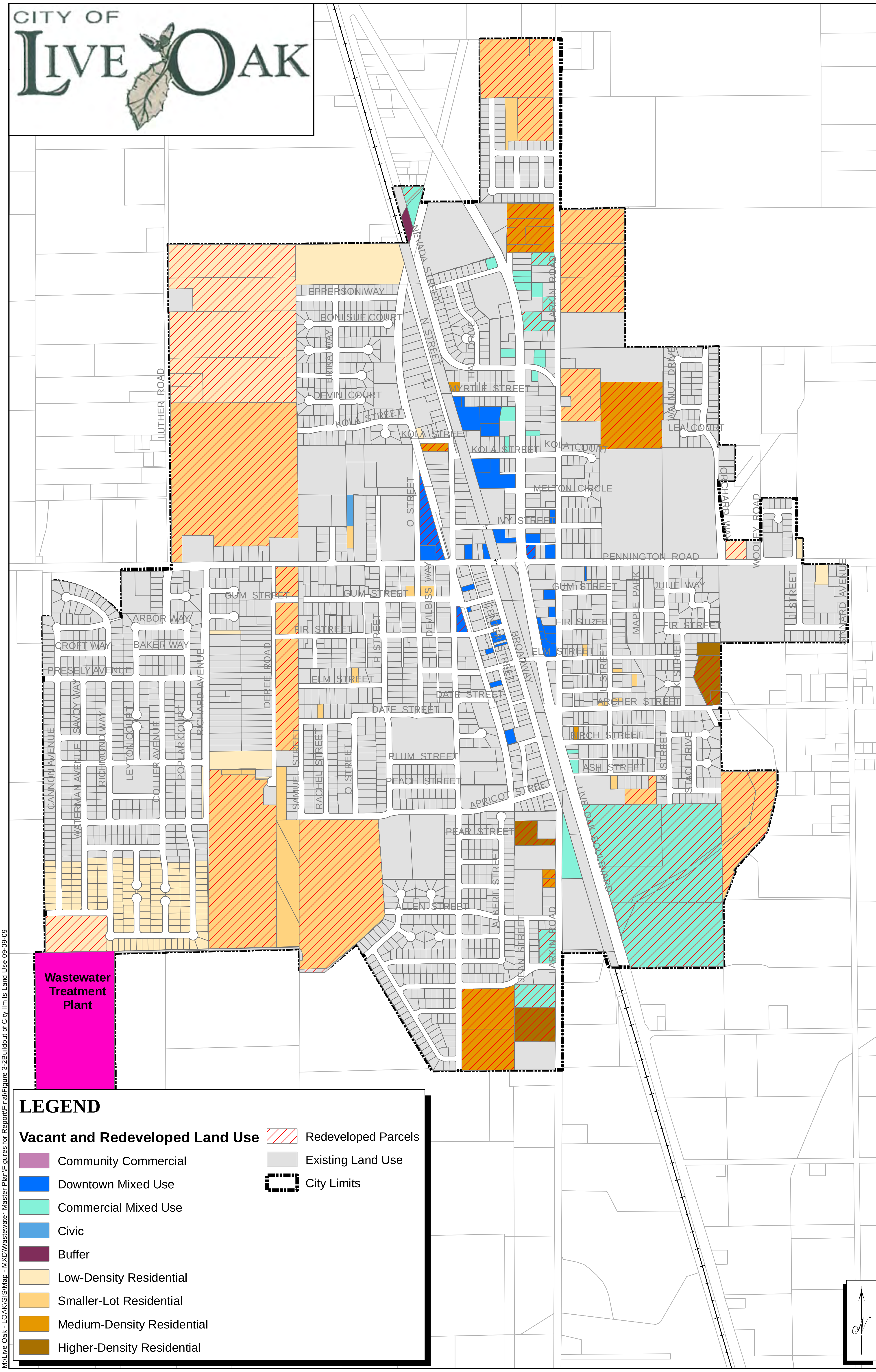
3.3.1 BUILD-OUT OF CITY LIMITS

Full build-out of the City Limits will occur when all vacant parcels are developed and planned redevelopment within the City Limits has occurred (Figure 3-2). Total acreages and residential EDUs for each land use are summarized in Table 3-3 and do not include existing areas that are not assumed to redevelop.

Table 3-3
City of Live Oak
Future Development Land Use [(a), (b)]

Land Use	Area (Acres)	Total EDUs [(c)]
Small Lot Residential	163	841
Low Density Residential	89	347
Medium Density Residential	27	191
High Density Residential	8	102
Civic	1	--
Commercial Mixed Use	57	87 [(d)]
Downtown Mixed Use	13	29 [(d)]
Total	**358**	**1,597**

(a) Based on General Plan land use provided by EDAW in May 2009.
(b) Does not include existing land use.
(c) EDU = Equivalent dwelling unit; One EDU is equivalent to the amount of wastewater generated (gallons per day) by an average single-family detached household in the City of Live Oak.
(d) Residential portions only.



M:\Live Oak - LOAK\GIS\Map - MXD\Wastewater Master Plan\Figures for Report\Final\Figure 3-2Buildout of City limits Land Use 09-09-09

Figure 3-2
Build-out of Vacant and Redeveloped Parcels in City Limits

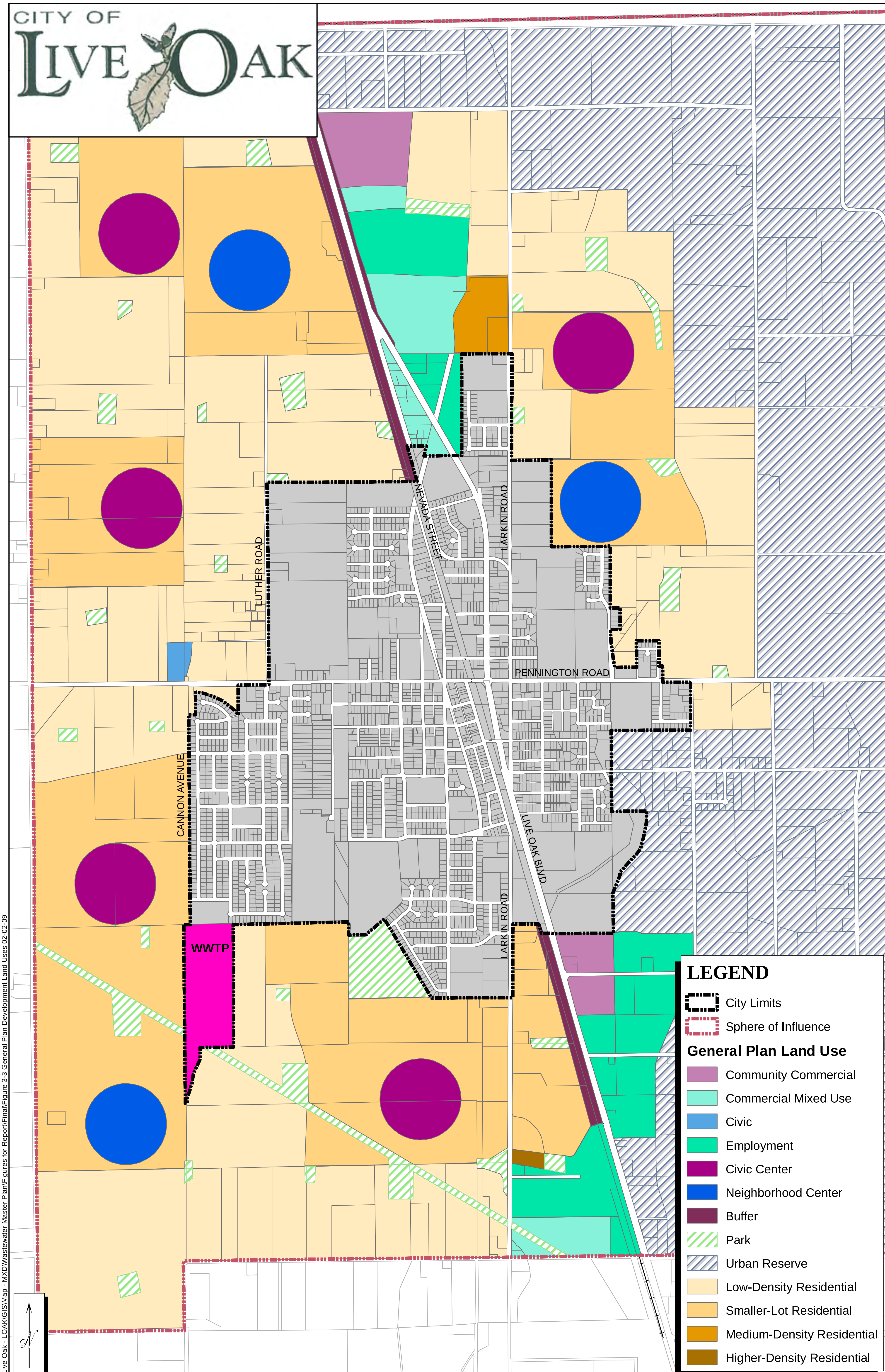
3.3.2 General Plan Sphere of Influence Land Use

Projected land uses within the proposed Sphere of Influence (SOI) and outside of the City Limits are summarized in Table 3-4 and shown in Figure 3-3. The areas for these projected land uses have not had acreage for street and infrastructure removed. For the purposes of this study and to provide conservative estimates of wastewater generation, generation rates were calculated from gross acreage.

Table 3-4
City of Live Oak
Future Development Land Use Outside of City Limits [a], [b]

Land Use	Areas (Acres) [c]	Total EDUs [d]
Small Lot Residential	1,017	5,301
Low Density Residential	1,434	5,566
Medium Density Residential	24	166
High Density Residential	3	36
Civic	13	--
Civic Center	157	483 [e]
Neighborhood Center	94	1,130 [e]
Commercial Mixed Use	81	153 [e]
Community Commercial	59	--
Employment	189	--
Park	130	--
Total	**3,201**	**12,835**

(a) Based on General Plan land use provided by EDAW in May 2009.
(b) Does not include existing land use.
(c) Gross acreage.
(d) EDU = Equivalent dwelling unit; One EDU is equivalent to the amount of wastewater generated (gallons per day) by an average single-family detached household in the City of Live Oak.
(e) Residential portions only.



M:\Live Oak - LOAK\GIS\Map - MXD\Wastewater Master Plan\Figures for Report\Final\Figure 3-3 General Plan Development Land Uses 02-02-09

Figure 3-3
General Plan Sphere of Influence Future Land Uses

Chapter 4

Future Flow Estimation

4.1 PURPOSE

The purpose of this chapter is to present an overview of the methods used to estimate wastewater flows for future development areas. Characteristics of existing wastewater flows are described in Chapter 2. Estimated flows were used in the hydraulic model to determine the ability of the existing system to accommodate infill development and to size build-out capital improvement projects.

4.2 FUTURE DEVELOPMENT WASTEWATER FLOWS

Future land use information was provided by EDAW as developed for the City of Live Oak's (City) updated General Plan (*Draft City of Live Oak 2030 General Plan* (EDAW, September 2009)). Included was information on infill development, redevelopment areas, and development beyond the City Limits, but within the Sphere of Influence (SOI) (as described in more detail in Chapter 3). Land use designations for planned future developments, including residential densities and commercial and industrial acreages, were provided for each of these land use types. Average unit wastewater generation rates for new development were compiled based on a review of flow monitoring data and wastewater generation rates used by other similar communities. These unit wastewater generation values were used to estimate flows from future developments.

This section describes average unit wastewater flow rates and peaking factors that were applied to estimate average daily dry weather and peak hourly wet weather flows, respectively, for future development areas.

4.2.1 AVERAGE DRY WEATHER FLOWS

Based on an anticipated population of approximately 49,000 at full build-out of the SOI and a wastewater generation rate of 80 gallons per day (gpd) per capita, future average dry weather flow is predicted to be approximately 3.9 million gallons per day (Mgal/d). This per capita generation rate was determined in previous flow analyses for the wastewater treatment plant and encompasses wastewater generation for all residential, commercial, civic, and industrial users. However, for the purposes of this analysis, commercial, industrial, and civic/public areas are assigned specific unit wastewater generation rates on an acreage basis based on the specific land use. An average unit wastewater generation rate of 850 gpd/acre was applied to future commercial and industrial applications, while a value of 660 gpd/acre was applied to future civil/public areas. These values were derived from the City of Roseville Sanitary Sewer Design Standards (March 2007) and are typical for California Central Valley communities. When separate unit generation rates are taken into account for commercial, industrial, and civic/public users, the revised residential wastewater generation rate is 68.5 gpd/capita.

As discussed in Chapter 3, wastewater generation for residential users was normalized to an equivalent dwelling unit (EDU) basis using a density of 2.8 persons per EDU, as provided in the updated General Plan. Therefore, an average unit flow of 192 gpd/EDU was used to determine wastewater generation for each future residential parcel.

Open spaces such as parks, orchards, and agricultural areas are assumed to contribute minimal to no wastewater to the system.

Average unit wastewater generation rates used in this study and recommended for future planning purposes are summarized in Table 4-1.

Table 4-1
City of Live Oak
Recommended Planning Wastewater Unit Flows

Land Use Designations	Future Land Use Unit Flow [(a)]
Commercial	
Commercial and Downtown Mixed Use	850 gpd/acre
Commercial/ Employment/ Community Commercial/ Office	850 gpd/acre
Public Use	
Civic/ Public	660 gpd/acre
Open Space	
Park	0 gpd/acre
Residential	
All Residential Designations	192 gpd/EDU

(a) gpd/acre = gallons per day per acre; gpd/EDU = gallons per day per equivalent dwelling unit.

Land use designations from the General Plan (discussed in Chapter 3) and the future land use unit flows shown in Table 4-1 were used to estimate future flows for two build-out scenarios: 1) build-out of City Limits and 2) build-out of the SOI. These scenarios are discussed in more detail in Chapter 6. Land use designations, the total area of each land use type, and the corresponding estimated wastewater flow for each build-out scenario is shown in Table 4-2.

Table 4-2
City of Live Oak
Estimated Acreage and EDU Count for each Land Use Designation for Future Development

Land Use Definitions	Development Phases [a]			
	Build-out of City Limits (Acres or EDUs) [b]	Build-out of City Limits (Mgal/d; average)	Build-out of SOI (Acres or EDUs) [b]	Build-out of SOI (Mgal/d; average)
Commercial				
Community Commercial	--	--	59	0.05
Employment	--	--	189	0.161
Combined				
Civic Center	--	--	157	0.111
Neighborhood Center	--	--	94	0.251
Commercial Mixed Use	57	0.137	81	0.097
Downtown Mixed Use	13	0.032	--	--
Public Use				
Civic	1	0.0007	13	0.008
Residential				
Small Lot Residential	128	0.138	1,054	1.05
Low Density Residential	89	0.072	1,434	1.07
Medium Density Residential	27	0.040	24	0.032
High Density Residential	8	0.021	3	0.007
TOTAL (rounded)	**323**	**0.44**	**3,238**	**2.84**

(a) Values are non-additive and only refer to build-out of the given area, not total City build-out at the development phase.

(b) Values expressed in acres for commercial, combined, and public land uses and in EDUs for residential land uses.

4.2.2 PEAK HOURLY WET WEATHER FLOWS

The unit flows listed in Table 4-1 represent average dry weather wastewater flow generated by users and do not include additional flow from storm events that cause peak hourly wet weather flow. Two methods were used to determine future peak wet weather flow: 1) peaking average daily dry weather flows with a design storm event in the model and 2) applying a peaking factor.

For all infill and new developments within the City (Build-out of City Limits), a 10-year, 6-hour design storm was used in the model to determine peak wet weather flow. For these future developments, a composite leakage rate was developed by taking a weighted average of the leakage rates from every flow monitoring basin throughout the system (as determined during wet weather model calibration, discussed in Chapter 5). Based on this composite leakage rate, the model introduced the corresponding amount of inflow and infiltration from these developments during the design storm into the collection system. The hourly design storm rainfall data was input into the model such that the peak rainfall (in the middle of the storm) coincided with the peak of the diurnal flow pattern (see Figure 2-4) thus maximizing the capacity impact of these future infill developments

For future development of the SOI, a peaking factor of 3 was applied to all unit wastewater generation rates in Table 4-1. This peaking factor was chosen because it is slightly more conservative than the system wide peaking factor of 2.74 determined by the flow monitoring analysis (provided in Chapter 2) while being consistent with the peaking factor for future growth used in ECO-LOGIC Engineering's pre-design reports for the WWTP. In addition, the peaking factor used is more conservative than the peaking factor of 2.17 as estimated using the Ten States Standards (*Recommended Standards for Wastewater Facilities: Policies for the Design, Review, and Approval of Plans and Specifications for Wastewater Collection and Treatment: 2004 Edition*).

Chapter 5

Hydraulic Model

5.1 PURPOSE

The purpose of this chapter is to present an overview of the construction and calibration of the hydraulic model for the City of Live Oak's (City) wastewater collection system.

This chapter is divided into the following major sections:

- Modeling Software
- Model Inputs and Construction
- Model Calibration

5.2 MODELING SOFTWARE

Wastewater collection system capacity was evaluated using a dynamic flow routing model, Wallingford Software's *InfoWorks*. Dynamic flow routing models are considered one of the most sophisticated means to assess sewer system capacity. The model simulates sewer system hydraulic response during peak hourly wet weather flow events resulting from a combination of peak diurnal sanitary flows, groundwater infiltration, and rainfall dependent infiltration and inflow.

5.3 MODEL INPUTS AND CONSTRUCTION

The following inputs were used in construction of the hydraulic model and are described in more detail below:

- Pipes and Manholes
- Pump and Lift Stations
- Subcatchments
- Design Storm

5.3.1 PIPES AND MANHOLES

All sewer lines with a diameter of 8-inches and greater were modeled. In addition, critical 6-inch lines were modeled when necessary. Modeled portions of the sewer are shown in Figures 5-1.

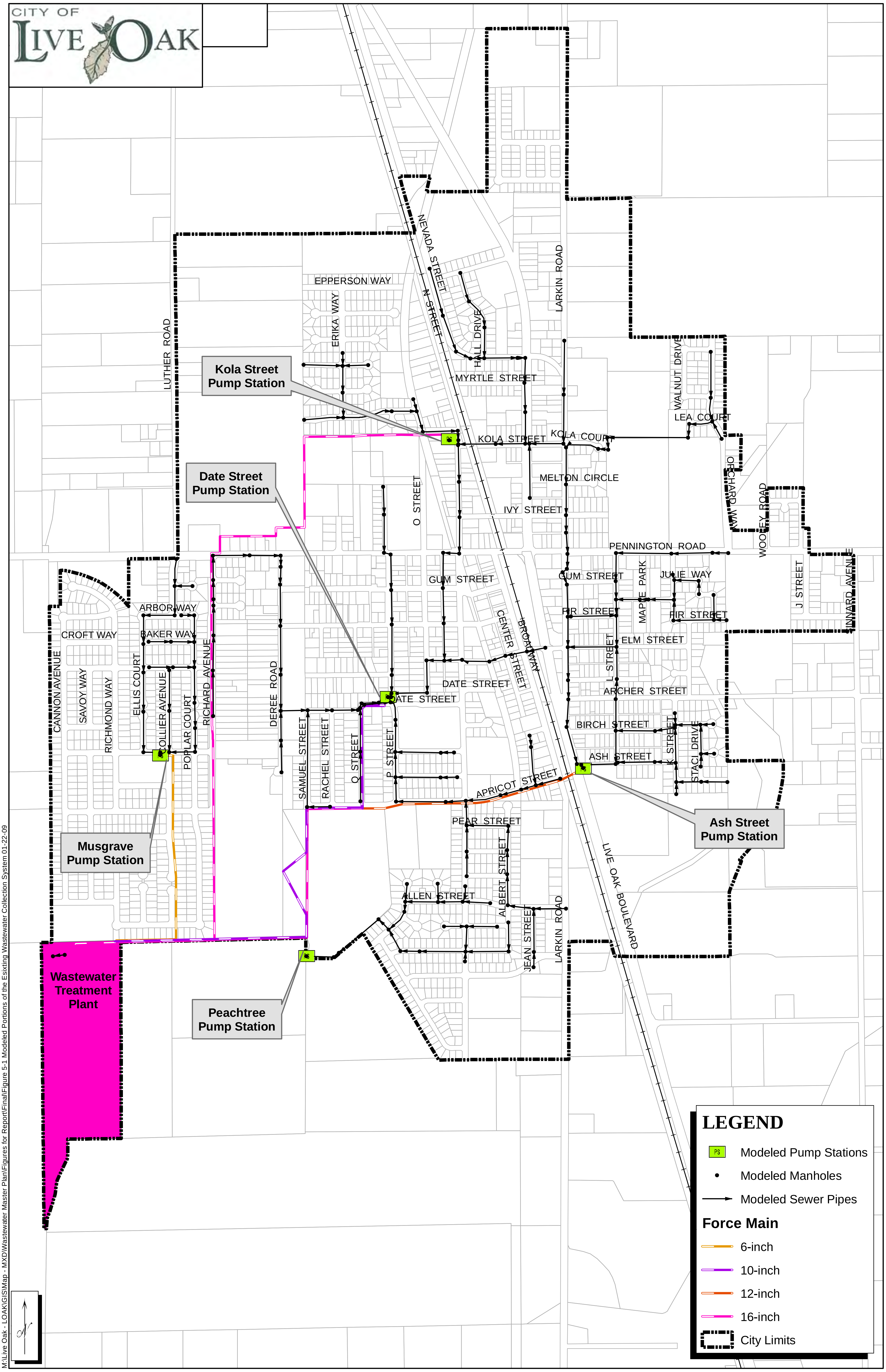


Figure 5-1
Modeled Portions of the Wastewater Collection System

5.3.2 PUMP STATIONS

All pump stations that were considered to have a significant impact on the system were modeled. Modeled pump stations and pumping capacities of these pump stations are provided in Table 5-1 below. Further details on these pump stations can be found in Chapter 2.

Table 5-1
City of Live Oak
Summary of Modeled Pump Stations

Pump Station	Number of Pumps			Approximate Capacity per Pump (gpm) [(a)]
	Total	Duty	Standby	
Date Street (Winter Operation)	2	1	1	1,470
Date Street (Summer Operation)	1	1	---	585
Ash Street (Winter Operation)	2	1	1	1,470
Ash Street (Summer Operation)	1	1	---	585
Kola Street	2	1	1	1,460
Musgrave Avenue	2	1	1	395
Peachtree	2	1	1	880 [(a)]

(a) Pump capacity was estimated by ECO:LOGIC Engineering, based on pump curves provided by the City Engineer.

5.3.3 SUBCATCHMENTS

Subcatchments are geographic areas within a wastewater service area that represent a composite of land uses (such as residential, commercial, and industrial) and discharge to a common manhole. An example of typical subcatchments is shown in Figure 5-2.

To determine total average daily dry weather flow from each subcatchment, the flow from each land use type was determined separately. Commercial, industrial, and public flows were accounted for as additional base flow calculated based on the acreage of the subcatchment and the per acreage flow developed in Chapter 4. A population, based on the residential land use, was assigned to each subcatchment to account for residential flow. Population was determined by multiplying the number of equivalent dwelling units (EDU) for each subcatchment by population density of 3.451 persons/EDU (California Department of Finance, http://www.dof.ca.gov/research/demographic/reports/). This population was then multiplied by a per capita wastewater generation rate (determined during dry weather calibration) to determine total average daily dry weather flow from the area. Flows for future subcatchments were determined using the process outlined in Chapter 4.

Figure 5-2
Example Subcatchments

5.3.4 DESIGN STORM

Design storms are developed from statistical analysis of local precipitation records and represent the distribution of rainfall depths over a time increment for a given storm duration and frequency. The design storm concept assumes that a precipitation event of a particular frequency will produce rainfall-dependent infiltration and inflow (peak hourly wet weather flows) of the same magnitude as a naturally occurring storm of the same duration and frequency.

The storm frequency is typically expressed in terms of the storm return period. Storm duration is expressed in hours or days of precipitation. Storms with large return periods and short durations result in high peak hourly wet weather flows. Design storms are selected based on the level of protection desired for the wastewater collection system while considering the likelihood of the event. Based on experience with other similarly sized communities in the area, it is recommended to provide adequate system capacity to convey peak hourly wet weather flow during a 10-year return period storm occurring over a 6-hour period (a 10-year, 6-hour storm).

Because design storms are developed based on local precipitation records, data from rainfall gauges in and around the City's service area were analyzed. According to the California

Department of Water Resources (http://cdec.water.ca.gov/), a 10-year, 6-hour design storm in the City's service area produces a total of 1.65 inches of rain.

A rainfall pattern (or hyetograph) was developed to distribute total rainfall over the storm's 6-hour duration. The hyetograph selected for this design storm is based on the Sacramento Method (Sacramento City and County Drainage Manual, December 1996), which assumes the highest intensity of rainfall occurs in the middle of the storm. The hyetograph used for the City's 10-year, 6-hour design storm is provided in Figure 5-3.

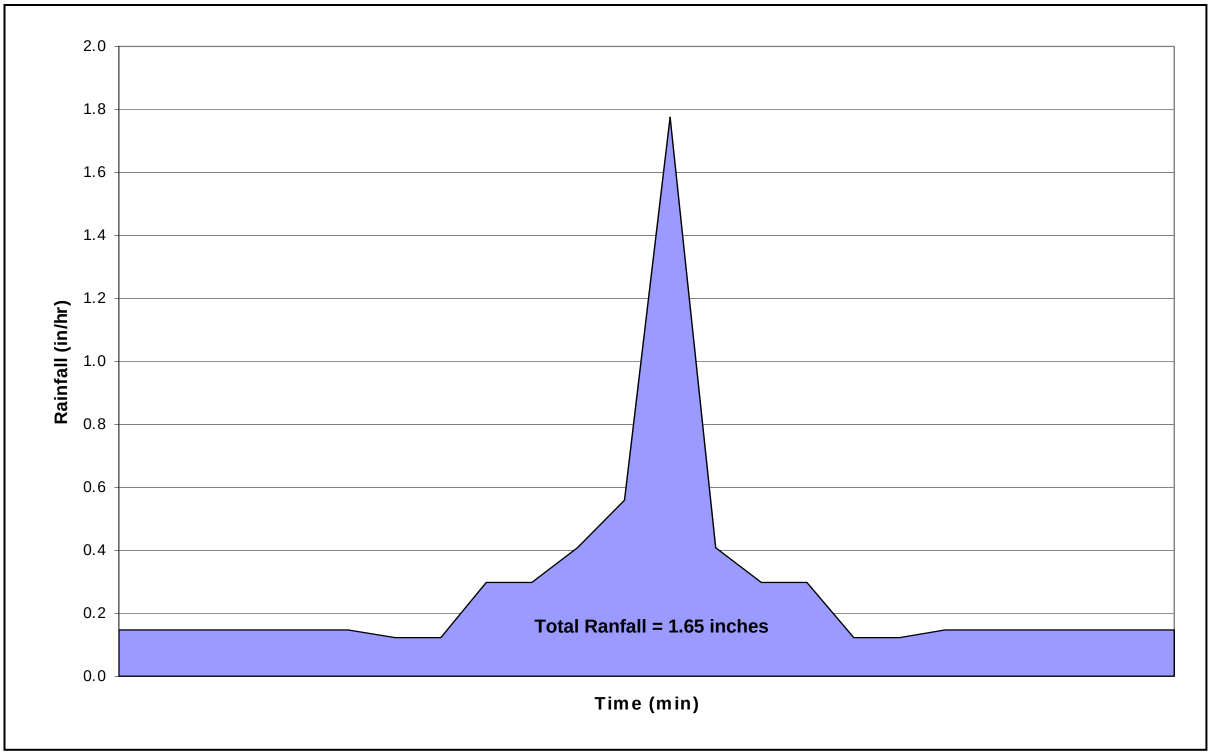


Figure 5-3
City of Live Oak
10-Year, 6-Hour Design Storm Hyetograph

5.4 MODEL CALIBRATION

Calibration is the process of matching hydraulically modeled results with observed results to assure that a model accurately reflects actual conditions. Hydraulic models are calibrated for both dry weather and wet weather conditions.

5.4.1 DRY WEATHER CALIBRATION

The estimated wastewater flow generated from each flow monitoring basin was calculated by multiplying the number of EDU for each land use type by an initial unit flow factor (Table 4-1). To calibrate the model, simulated flows were graphically compared to observed flows in *InfoWorks* at each flow monitoring location and unit flow factors adjusted until simulated flows sufficiently matched observed flows. An example of well calibrated dry weather flow for Flow

Monitor #1 is shown in Figure 5-4. Appendix A contains dry weather flow calibration figures for the remaining flow monitoring basins.

The average dry weather flow as measured at the wastewater treatment plant (WWTP) in September 2008 was 0.60 Mgal/d. The average dry weather flow during the flow monitoring period in early 2006 was 0.78 Mgal/d. Two explanations were determined for this drop in average dry weather flow seen at the WWTP:

1. Water meters were installed in the City in early 2006, which resulted in less water use and, therefore, less wastewater generation.
2. The average dry weather flow during the flow monitoring period in early 2006 was determined during winter conditions. With high groundwater levels in the City, a dry weather flow determined during this period will show a higher groundwater infiltration component.

The model was first calibrated to the 2006 flow monitoring data and then adjusted to reflect the changes in the 2008 WWTP data.

5.4.2 WET WEATHER CALIBRATION

Once the dry weather flow calibration was completed for each flow monitoring site, the wet weather calibration was performed using a significant storm event. To calibrate each of the six previously defined sewer basins, the flow monitoring and rainfall data collected during the February 26 to March 14, 2006 sequence of storm events were input into the model. The measured peak hourly wet weather flow at each flow monitor was compared to the simulated flow produced by the model.

As part of the calibration process, runoff surfaces were developed in the model for each flow monitoring basin. Two coefficients for these runoff surfaces were adjusted until the measured and simulated peak hourly wet weather flows matched. One coefficient represented a percentage of the total volume of rainfall that enters the collection system after falling upon the flow monitoring basin. The second runoff coefficient represented the speed at which this volume of water enters the collection system in each flow monitoring basin.

In certain instances the flow monitoring basins were assigned multiple runoff surfaces in the model to more accurately match the patterns of the observed flow. For example, one runoff surface in a basin was used to direct a percentage of the rainfall into the system at a slow rate, so as to account for rainfall dependent infiltration, while another runoff surface was used to direct a percentage of the rainfall into the system at a rapid rate, in order to account for inflow. This was especially important with the Live Oak collection system, aiding in the calibration of the system to a rapid sequence of rainfall events. An example of the wet weather calibration at Flow Monitor #6 is shown in Figure 5-5.

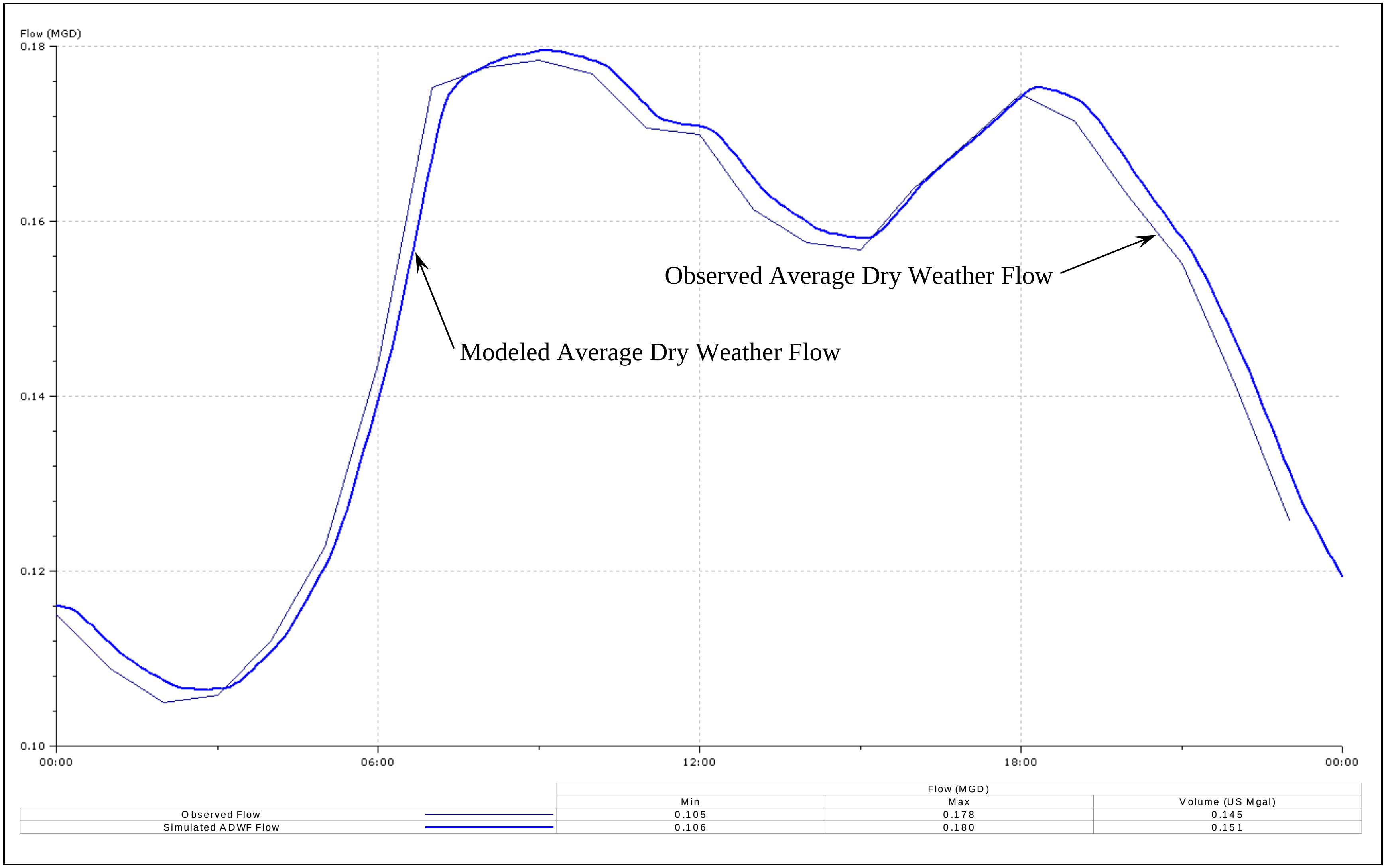
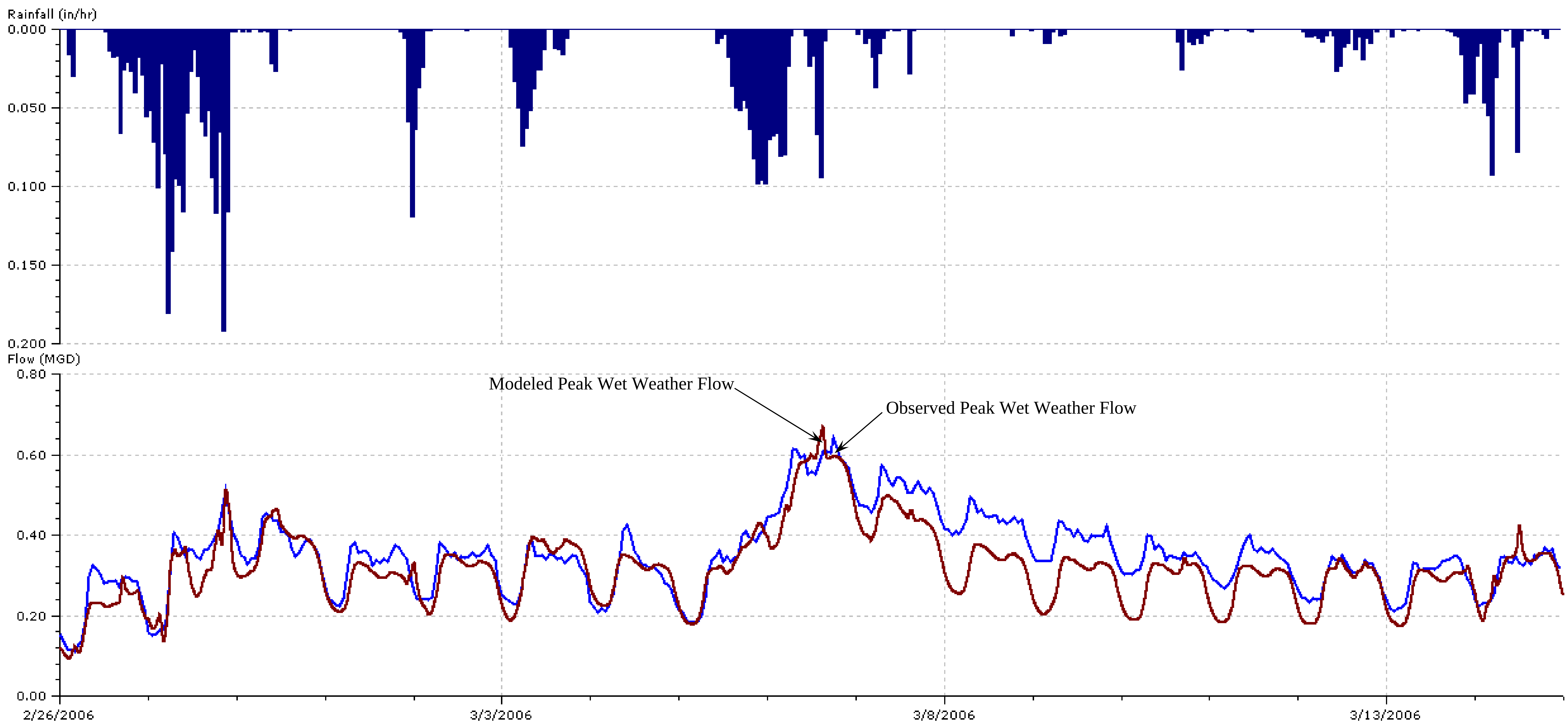


Figure 5-4
City of Live Oak
Dry Weather Flow Calibration for Flow Monitor #1



		Rainfall			Flow (MGD)		
		Depth (in)	Peak (in/hr)	Average (in/hr)	Min	Max	Volume (US Mgal)
Rain		5.277	0.192	0.013			
Observed Flow					0.110	0.642	5.958
Simulated Wet Weather Flow					0.093	0.668	5.377

Figure 5-5
City of Live Oak
Wet Weather Flow Calibration Flow Monitor #6

Chapter 6

Capacity Evaluation Results

6.1 PURPOSE

The purpose of this chapter is to provide a summary of the modeled results of the capacity evaluation. Modeling was conducted for winter dry weather flow and a 10-year, 6-hour design storm event for (1) the existing level of development and (2) build-out of the City Limits.

This chapter is divided into the following sections:

- Recommended Capacity Evaluation Criteria
- Modeled Scenarios
- Model Results – Existing Level of Development
- Model Results – Future Conditions

6.2 RECOMMENDED CAPACITY EVALUATION CRITERIA

Wastewater collection systems can generally accommodate some degree of surcharging during peak flow conditions. However, once a manhole surcharges, it takes very little extra flow for an overflow to occur. Criteria for acceptable levels of maximum surcharging were developed with input from City staff. These criteria are presented in Table 6-1. These acceptable levels were used as criteria in evaluating capacity in flow limited segments of sewer pipelines in all modeled scenarios.

Table 6-1
City of Live Oak
Recommended Capacity Evaluation Criteria
During Design Storm (10-year, 6-hour) Conditions

Manhole Depth [a]	Acceptable Level of Manhole Surcharging
Less than 4 feet	None
4 feet and greater	Not to exceed 4 feet below ground surface

(a) Manhole depth as measured from the crown of the pipe to the rim of the manhole.

6.3 MODELED SCENARIOS

Several scenarios were modeled to evaluate capacity at differing levels of development in the existing system. The following simulations are described in more detail in the remainder of this chapter:

- Existing system with existing level of development (dry weather flow)
- Existing system with existing level of development during design storm (10-year, 6-hour) event
- Build-out of City Limits during design storm (10-year, 6-hour) event

6.4 MODEL RESULTS ─ EXISTING LEVEL OF DEVELOPMENT

Modeling results, listed by pipe, for the scenarios described below are included in Appendix C.

6.4.1 EXISTING SYSTEM - DRY WEATHER FLOW

The current daily average dry weather flow as measured in September 2008 at the wastewater treatment plant (WWTP) is 0.60 million gallons per day (Mgal/d). The average dry weather flow during the flow monitoring period in early 2006 was 0.78 Mgal/d. This flow is a winter dry weather flow and contains a significant groundwater component due to the high groundwater levels in the City during the wet weather season. At the existing (May 2009) level of development, model simulations indicated all pipes to be flowing at less than 80% capacity, during peak diurnal winter dry weather flow.

6.4.2 EXISTING SYSTEM - DESIGN STORM (10-YEAR, 6-HOUR)

Under existing conditions, a 10-year, 6-hour design storm is predicted to generate a peak hourly flow of 3.7 Mgal/d at the WWTP. The peak hourly flow is predicted to cause several capacity bottlenecks in the system as shown in Figure 6-1. Pipes shown in yellow are near full pipe conditions (between 80% and 100% full). Pipes shown in orange are being impacted by a downstream bottleneck and are either at full pipe capacity or are surcharging because of the bottleneck. Pipes that are at capacity (bottlenecks) or are predicted to surcharge during the design storm are shown in red. The seven areas that are predicted to be over capacity/surcharge are shown in Figure 6-1 and include:

1. Manhole B2-1 to B1-1 (P Street north of Date Street Pump Station)
2. Manhole AB-1 to A1-1 (P Street south of Date Street Pump Station, east on Apricot Street, and south on N Street).
3. Manhole W4-5 to W4-3 (Pennington Road west of Pennington Pump Station)
4. Manhole W2-1 to W (L Street between Gum and Elm Streets)
5. Manhole P2-1 to P1-1 (Larkin Road north of Kola Street)

6. Manhole N2-1 to N1-1 (Live Oak Boulevard south of Myrtle Street)
7. Manhole L1-2 to 2 (Kola Street west of Kola Street Pump Station)

An example profile view of the pipes from Manhole L1-51 to Manhole 2 during the design storm event is shown in Figure 6-2. Of the sewer segments listed above, none were predicted to exceed the surcharging criteria outlined in Table 6-1. The predicted results concur with observations by City staff during recent significant storm events. However, it is recommended that these areas be monitored for surcharging during future storms to further verify the impact of peak wet weather flow.

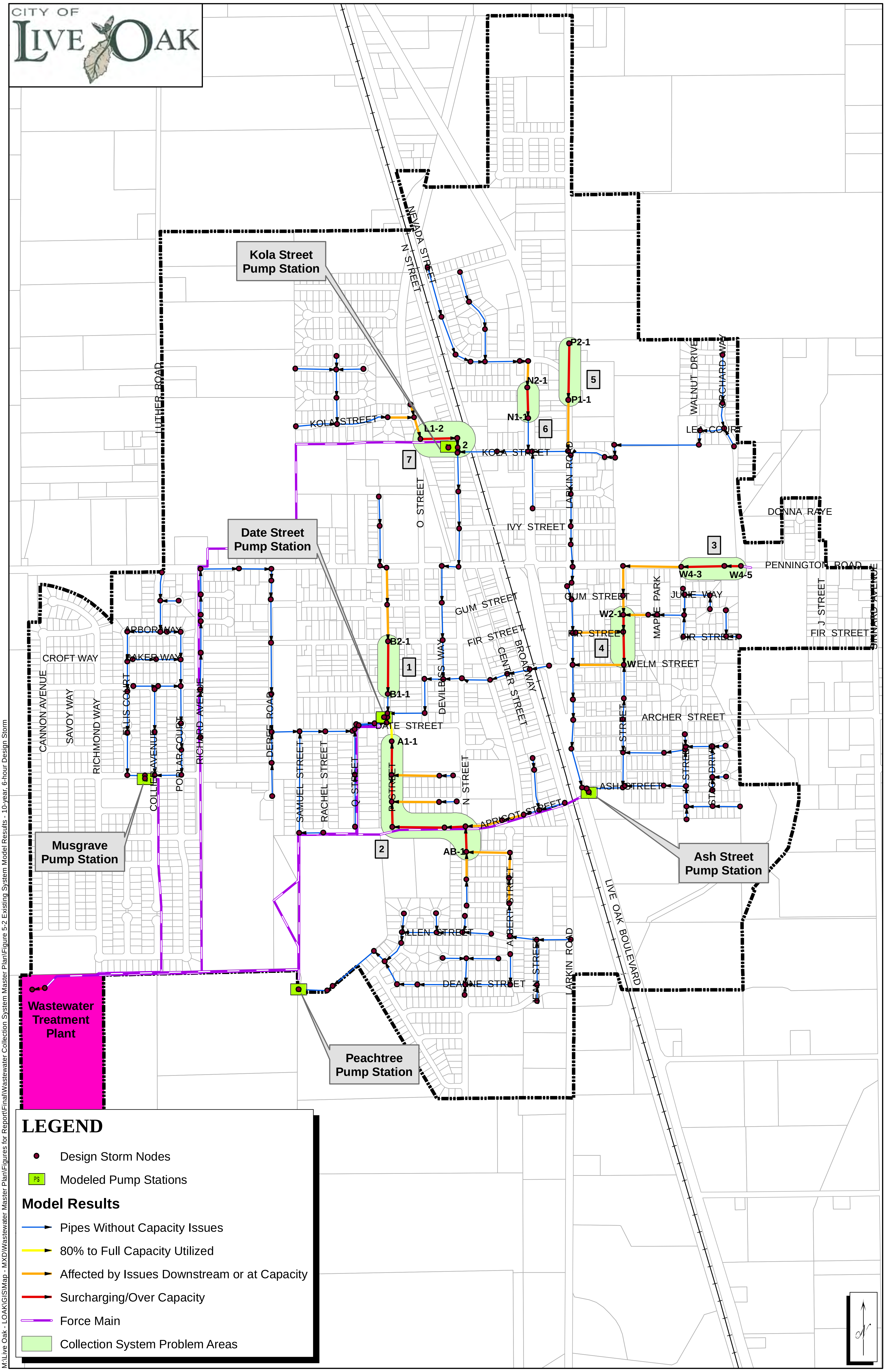


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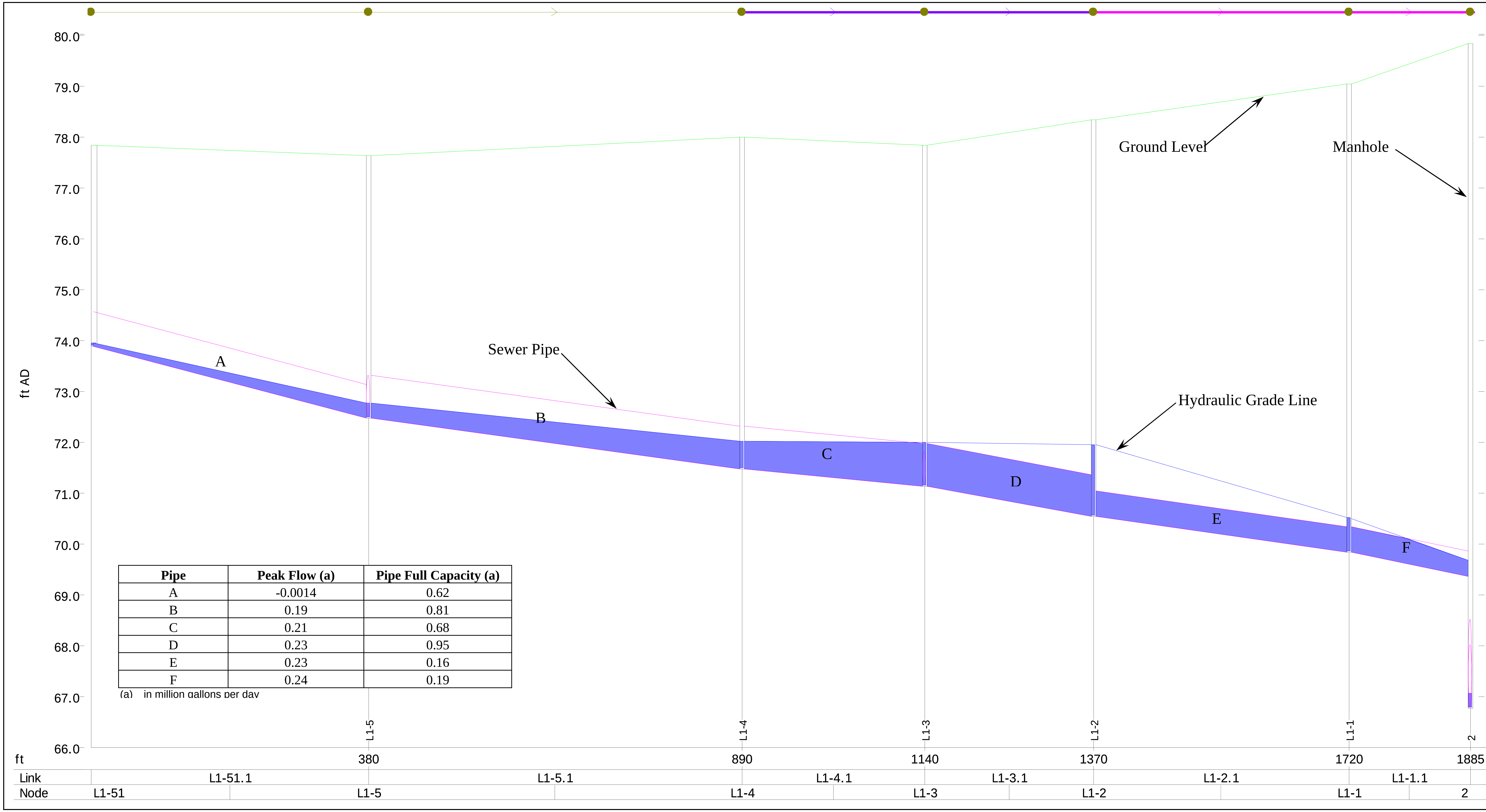
Figure 6-1
Existing System Model Results - 10-year, 6-hour Design Storm



Pipe	Peak Flow (a)	Pipe Full Capacity (a)
A	-0.0014	0.62
B	0.19	0.81
C	0.21	0.68
D	0.23	0.95
E	0.23	0.16
F	0.24	0.19

(a) in million gallons per day

Figure 6-2
Existing System Model Results - 10-year, 6-hour Design Storm: Line on Kola Street Tributary to the Kola Street Pump Station (Manhole L1-51 to Manhole 2)

6.5 MODEL RESULTS ─ FUTURE CONDITIONS

This section outlines the results of the impact of development from the build-out of the City Limits on the existing wastewater collection system. Interim capacity within the existing system available for development occurring outside of the City Limits is also discussed.

6.5.1 BUILD-OUT OF CITY LIMITS

Build-out of the City Limits occurs when all currently vacant parcels (infill) have been developed. In addition, the updated General Plan identified a number of parcels that have the potential to redevelop to a higher density (as discussed in Chapter 3). This analysis assumes that these areas have been redeveloped during the build-out of the City Limits.

Infill development was assumed to discharge to the closest available modeled portion of the existing sewer. Routing infill developments to the modeled portion of the collection system was determined by using the flow paths of the unmodeled portions of the system. A summary of each infill parcel, including estimated average and peak flow and anticipated discharge points is contained in Appendix D.

With the addition of peak flow from infill developments, the peak hourly flow at the WWTP during the 10-year, 6-hour design storm event is estimated to be 4.4 Mgal/d. The predicted surcharged locations during a 10-year, 6-hour design storm at build-out of City Limits are shown graphically in Figure 6-3. Manholes predicted to surcharge above the recommended criteria are shown as red dots. In addition to the seven areas of limited capacity listed in the previous section, the following pipe segment was also highlighted as having capacity limitations with the addition of infill development:

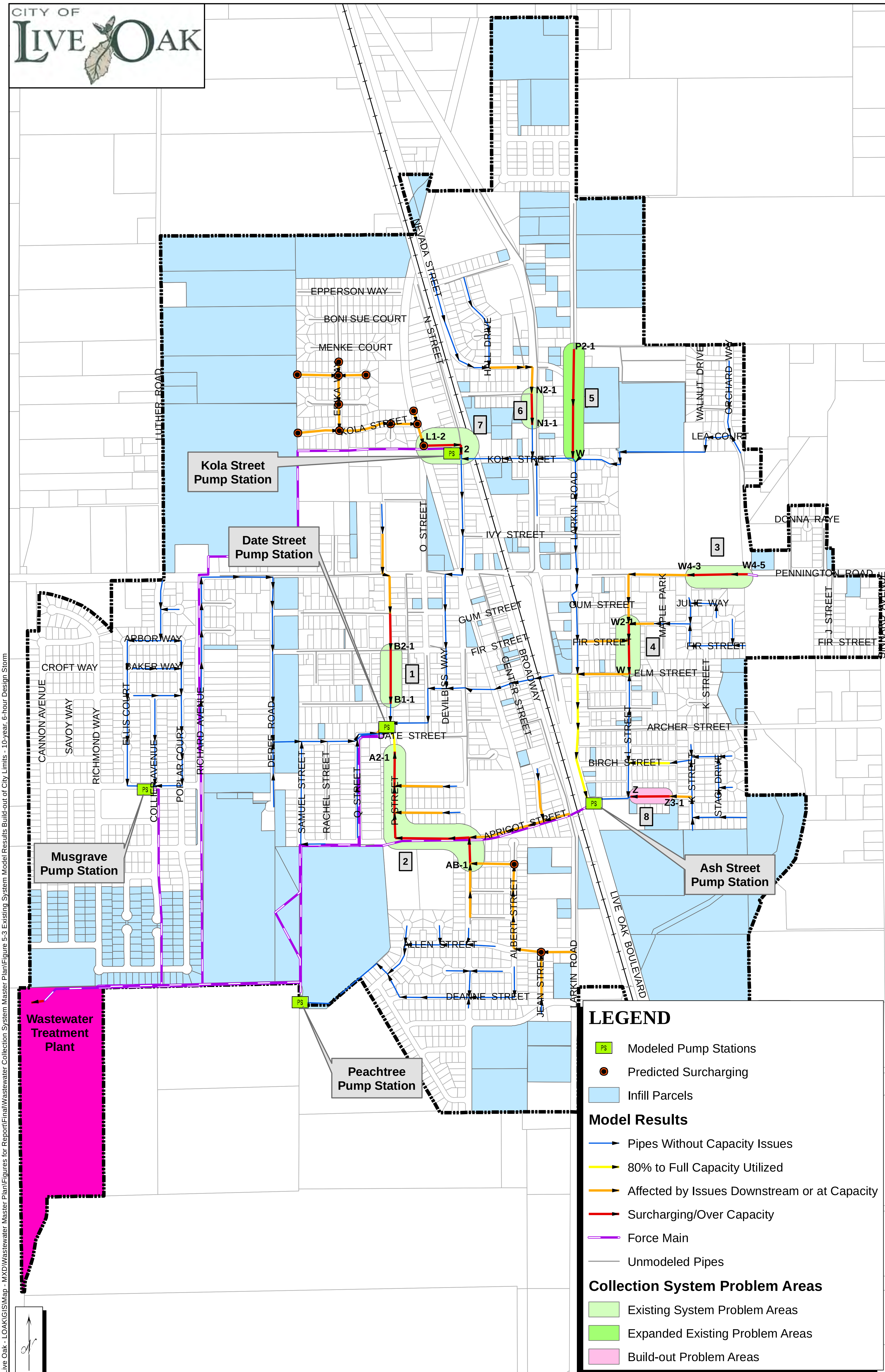
1. Manhole Z2-1 to Z (Ash Street east of the Ash Street Pump Station)

Additionally, surcharging in the pipeline on Larkin Road, north of Kola Street (Item 5 in the existing problems areas listed above; Manhole P2-1 to P1-1) extended to the next downstream manhole (Manhole 37).

The increased peak flow in some areas resulted in increased potential for manhole surcharging above the recommended criteria in two of the previously identified capacity limited sewers. These areas include:

- **Manhole L1-2 and upstream manholes:** The capacity limitation in the 10-inch sewer from Manhole L1-2 to Manhole 2 is predicted to cause flow to back up into the collection system upstream, resulting in potential surcharging which exceeds the recommended criteria (Figure 6-3). A profile view of a portion of this sewer is included in Figure 6-4.

- **Manholes AB-2 and AB-6:** Both of these manholes serve as a junction for the tributary pipes and are relatively shallow. Predicted surcharging during a design storm event exceeds the criteria recommended in Section 6.2.



M:\Live Oak - LOAK\GIS\Map - MXD\Wastewater Master Plan\Figures for Report\Final\Wastewater Collection System Master Plan\Figure 5-3 Existing System Model Results Build-out of City Limits - 10-year, 6-hour Design Storm

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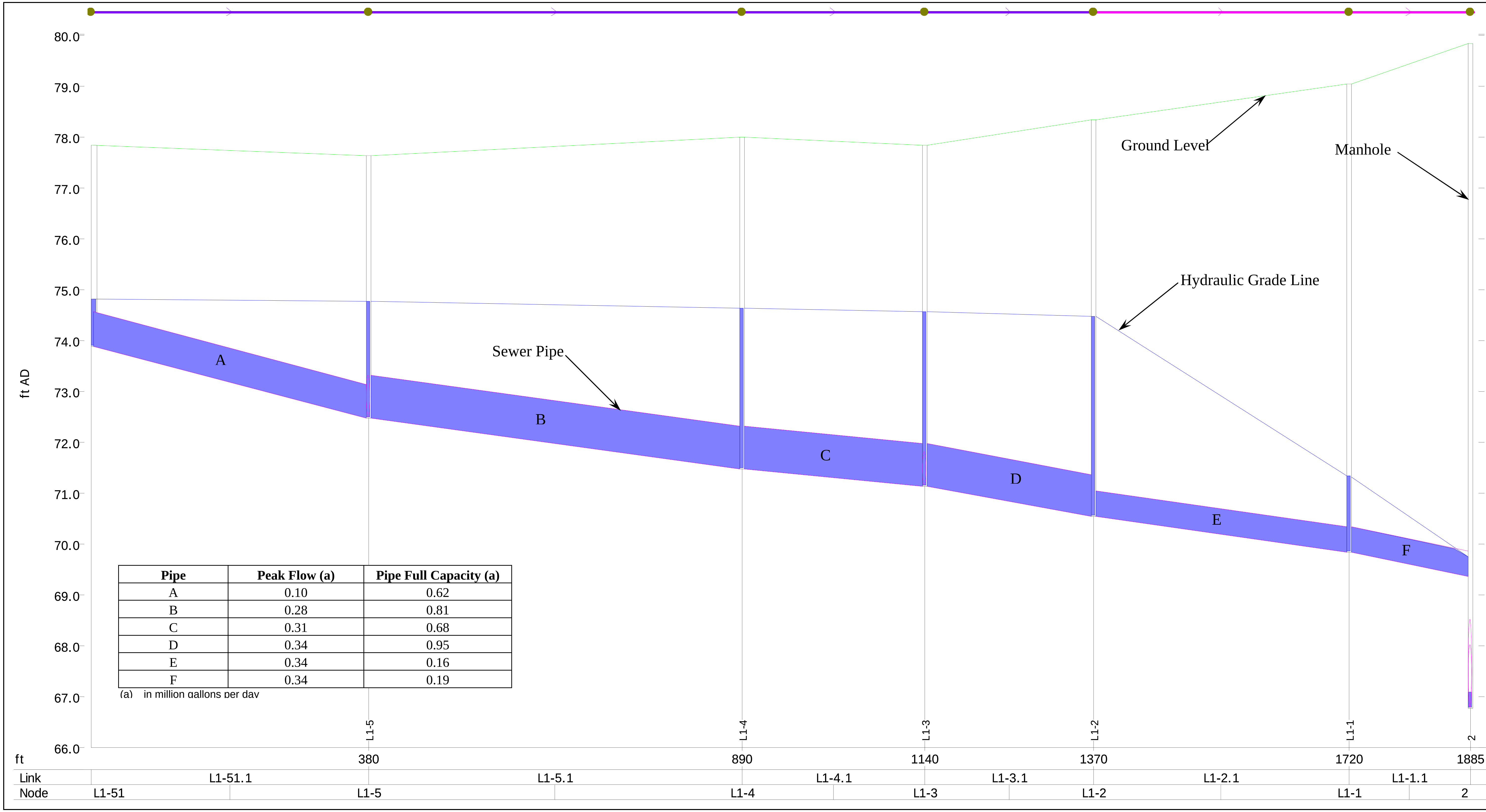
Figure 6-3
Existing System Model Results: Build-out of City Limits - 10-year, 6-hour Design Storm



Pipe	Peak Flow (a)	Pipe Full Capacity (a)
A	0.10	0.62
B	0.28	0.81
C	0.31	0.68
D	0.34	0.95
E	0.34	0.16
F	0.34	0.19

(a) in million gallons per day

Figure 6-4

Build out of City Limits Model Results – 10-year, 6-hour Design Storm: Sewer Line on Kola Street Tributary to the Kola Street Pump Station (Manhole L51–1 to Manhole 2)

Chapter 7

Recommendations

7.1 PURPOSE

The purpose of this chapter is to provide recommendations for mitigating capacity issues based on the model results detailed in Chapter 6. In addition, this chapter includes an interim plan for future development prior to construction of large trunk sewers and a build-out plan for accommodating full development of the Sphere of Influence (SOI). Planning level cost estimates for capacity mitigation strategies and build-out trunk sewers are also included.

This chapter is divided into the following sections:

- Mitigation Strategies for Existing System Deficiencies
- Interim and Long-Term Capital Improvement Plan
- Capital Cost Estimates

7.2 MITIGATION STRATEGIES FOR EXISTING SYSTEM DEFICIENCIES

Mitigation strategies for areas of limited capacity in the existing wastewater collection system are described below for two levels of development: (1) existing and (2) build-out of the City Limits.

7.2.1 EXISTING LEVEL OF DEVELOPMENT

During a 10-year, 6-hour design storm at the existing level of development, no pipelines in the collection system were predicted to exceed the recommended capacity evaluation criteria, described in Section 6.2. However, it is recommended that the seven areas highlighted in Chapter 6 be observed during storm events to confirm the impact of peak wet weather flow on the system.

The absence of sever capacity issues in the existing system during the 10 year, 6 hour storm is attributed to the improvements made to the system in 2004. The Kola Street Pump Station was built along with an interceptor pipeline along Kola Street from Larkin Road. This pump station and interceptor project was estimated by ECOLOGIC in the project feasibility report to relieve 21% of flow to Date Street Pump Station and 34% of flow to Ash Street Pump Station.

The second improvement was to upsize and reroute pipelines along L Street directly into the Ash Street Pump Station to relieve an overloaded section of trunk line along Larkin Road.

The available capacity in the collection system at the existing level of development, along with anticipated infill development for build-out of the City Limits, is shown in Figure 7-1. This available capacity can be utilized to accommodate infill development within the City. The available capacity in the existing system and the wastewater contributions from infill developments are both expressed in terms of equivalent dwelling units (EDUs). An EDU is a normalized value representing the wastewater generation from a single-family residential house in the City. For instance, an office complex may generate the equivalent amount of wastewater as 17 single family residences. The office complex is then said to be equivalent to 17 EDUs. Peak wastewater flow generated from each of the future development areas was estimated by multiplying the average projected flow by a peaking factor of three (as explained in Chapter 4). Using this method, the peak flow from one EDU is estimated to be about 504 gallons per day (gpd). Available capacity in the collection system (shown in Figure 7-1) was converted from flow to EDUs based on this value.

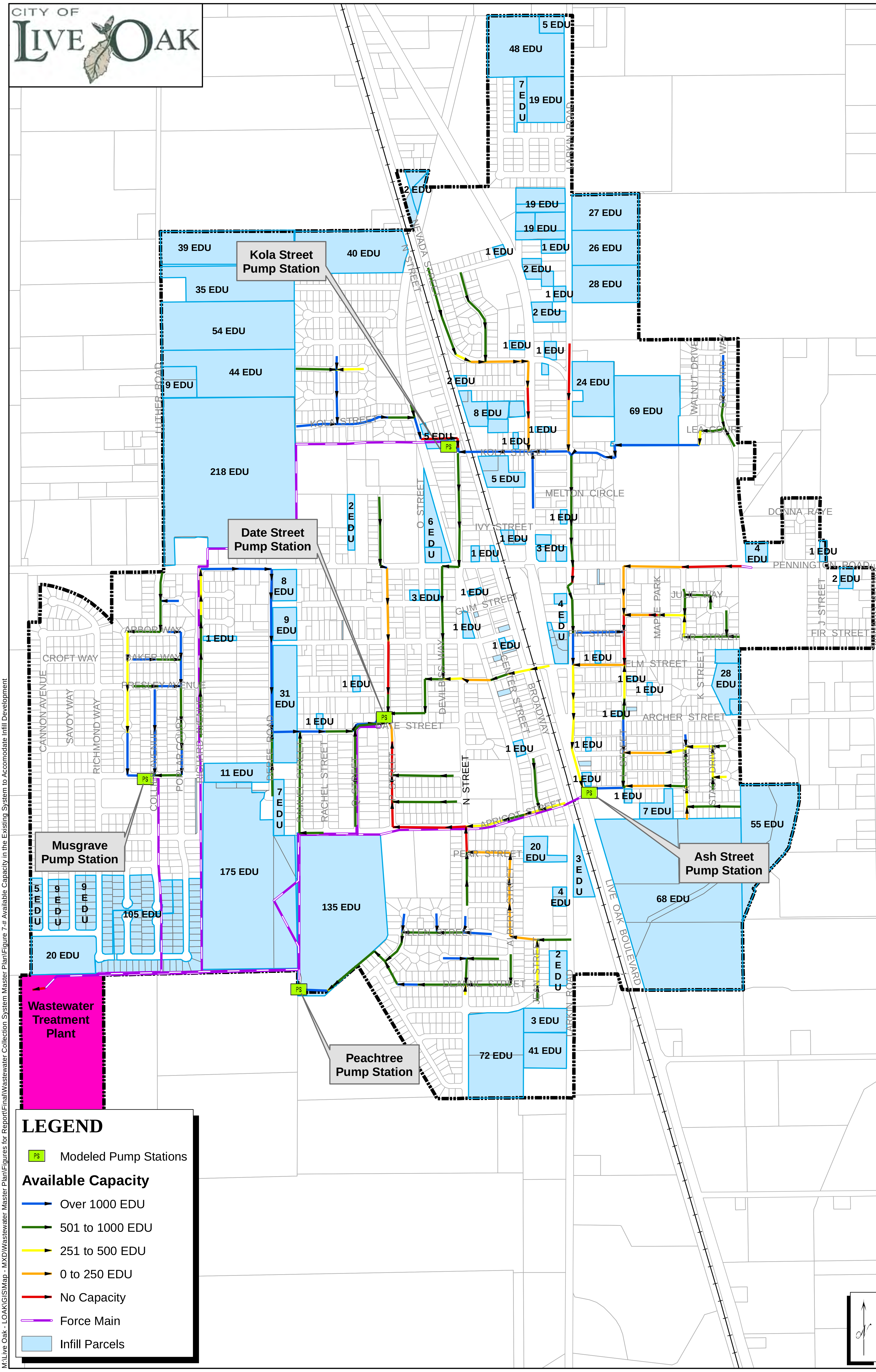


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Figure 7-1
Available Capacity in the Existing System to Accommodate Infill Development

7.2.2 BUILD-OUT OF CITY LIMITS

Based on the capacity results from Chapter 6, the addition of infill development would result in two areas of the wastewater collection system that exceed the recommended capacity evaluation criteria described in Section 6.2. These two areas include:

- **Manholes AB-2 and AB-6** (at the intersections of Albert and Pear Streets and Allen and Jean Streets, respectively)
- **Manhole L1-2 and upstream manholes** (upstream of the Kola Street Pump Station)

It is recommended that the following mitigation measures be implemented with the addition of any infill development that will impact these two sections of sewers. These recommended improvement areas are shown in Figure 7-2.

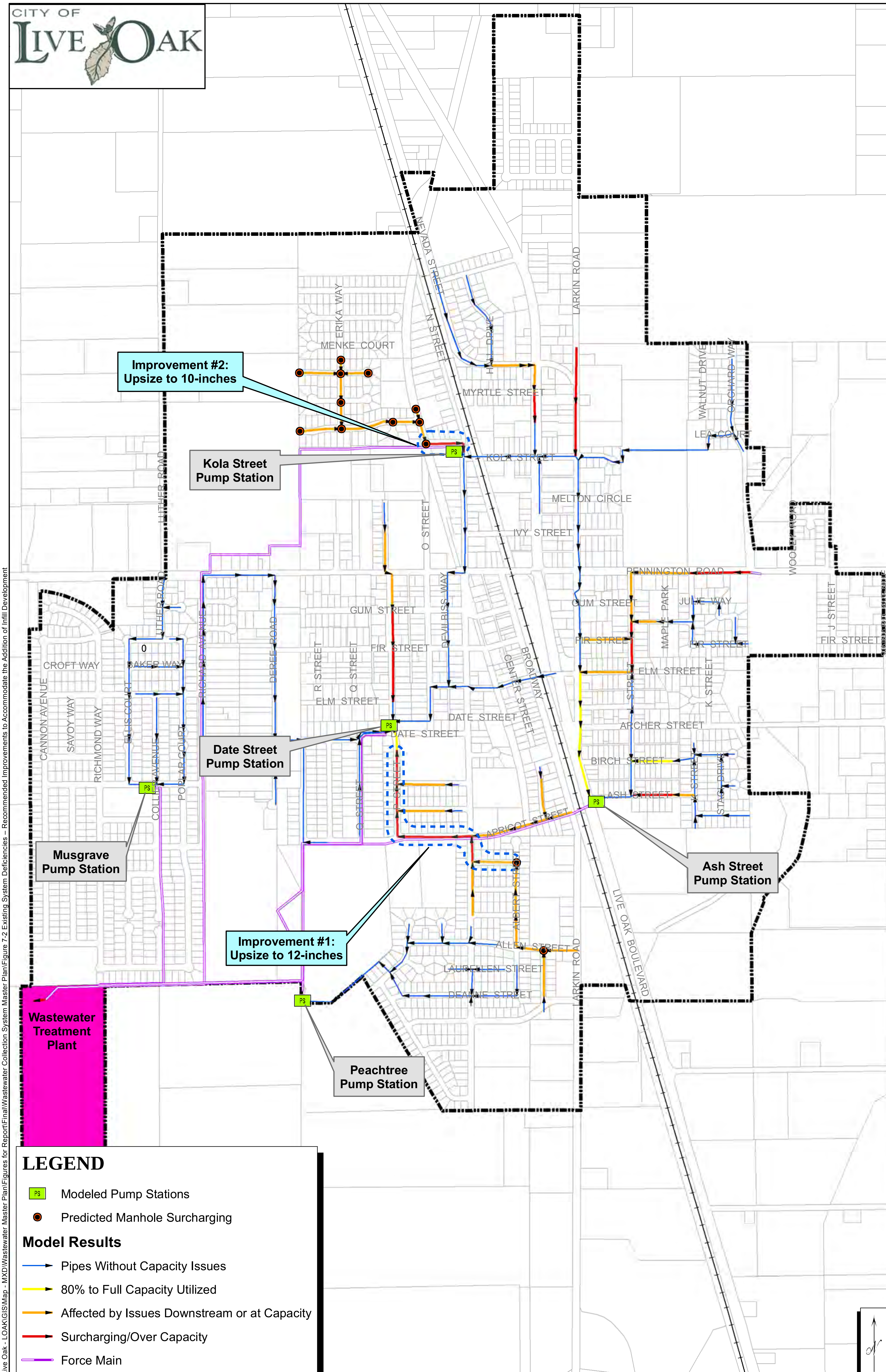
Recommended Improvement #1 (Manhole AB-2 to Manhole A-1)

According to model results, the pipeline upstream of the Date Street Pump Station, which flows north along N Street, west on Apricot Street and north along P Street, is over capacity during design storm conditions; though it is not predicted to overflow.

To relieve the capacity limitations in this area, it is recommended that the pipelines from Manhole AB-1 to Manhole A-1 be upsized from 10-inches in diameter to 12-inches in diameter. This upsizing will eliminate the bottleneck in that pipeline, which is causing unacceptable surcharging in manholes AB-2 and AB-6, as well as provide capacity to accommodate infill development from the build-out of the City Limits.

Recommended Improvement #2 – Upstream of Kola Street Pump Station (West)

The two 6-inch pipes, which flow east and south on Kola Street into the junction manhole (manhole L1-2 to 2) before the Kola Street Pump Station are predicted to create a significant bottleneck, which causes the manholes in the upstream pipes to surcharge above the recommended criteria. It is recommended that these two 6-inch pipes be upsized to 10-inches to provide capacity for the flow from the upstream 10-inch pipes.



M:\Live Oak - LOAK\GIS\Map - MXD\Wastewater Master Plan\Figures for Report\Final\Wastewater Collection System Master Plan\Figure 7-2 Existing System Deficiencies – Recommended Improvements to Accommodate the Addition of Infill Development

Figure 7-2
Existing System Deficiencies –
Recommended Improvements to Accommodate the Addition of Infill Development

7.3 INTERIM AND LONG-TERM CAPITAL IMPROVEMENT PLAN

The following section outlines strategies to accommodate future development in the City's Sphere of Influence (SOI). These strategies include both interim solutions for collecting wastewater from these areas prior to construction of new large trunk sewers and proposed routing for new trunk lines to provide long-term service for the ultimate build-out of the SOI.

7.3.1 INTERIM CAPACITY PLAN

Through the modeling process, it was determined that the City's existing wastewater collection system does not have the capacity to handle all wastewater flow from build-out of the SOI. Serving this entire area will eventually require the construction of large trunk sewers. Building large trunk sewers involves long-term planning and enough development to both contribute to project funding and to keep a minimum self-cleaning flow in the pipes. Thus, these sewers are unavailable to interim development occurring within the next few years.

This section outlines interim solutions for serving near-term development with existing infrastructure. All the interim solutions provided in this section assume that the improvements identified in Section 7.2 have been completed and that infill development has occurred.

An overview of future development areas (as defined in the General Plan; see Chapter 3) as well as estimated EDUs for each area within the SOI are shown in Figure 7-3. The remaining available capacity in the collection system after the addition of infill development is also shown in Figure 7-3. Depending on the timing of the development, some of these areas may utilize interim capacity in the existing collection system prior to construction of large trunk sewers. General Plan development and estimated available capacity is shown in more detail in Figures 7-3a through 7-3d.

Prior to utilizing interim capacity, it is highly recommended that a more detailed site-specific capacity analysis be performed on pipelines and pump stations that will be directly affected by connection of interim development.

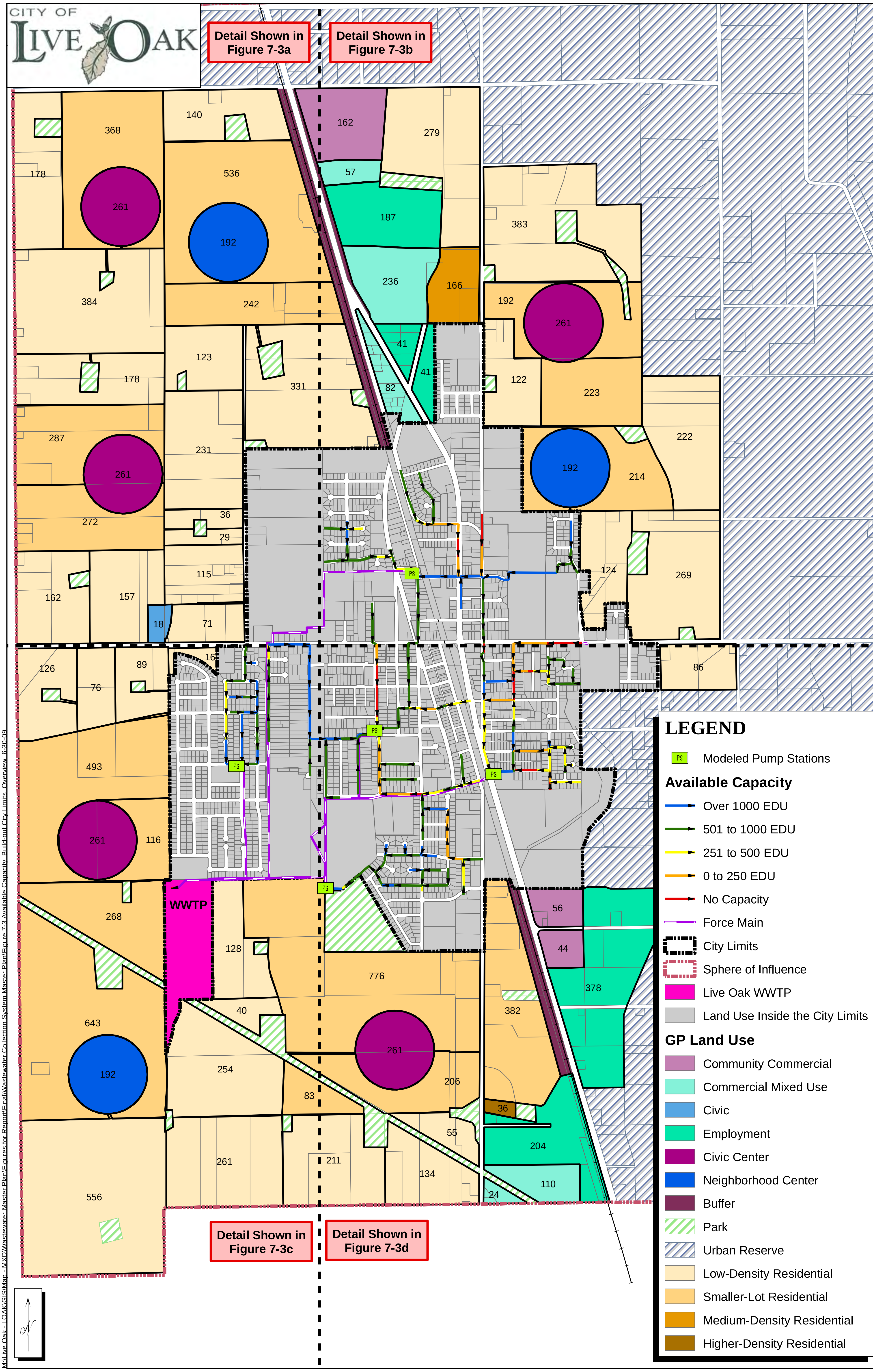


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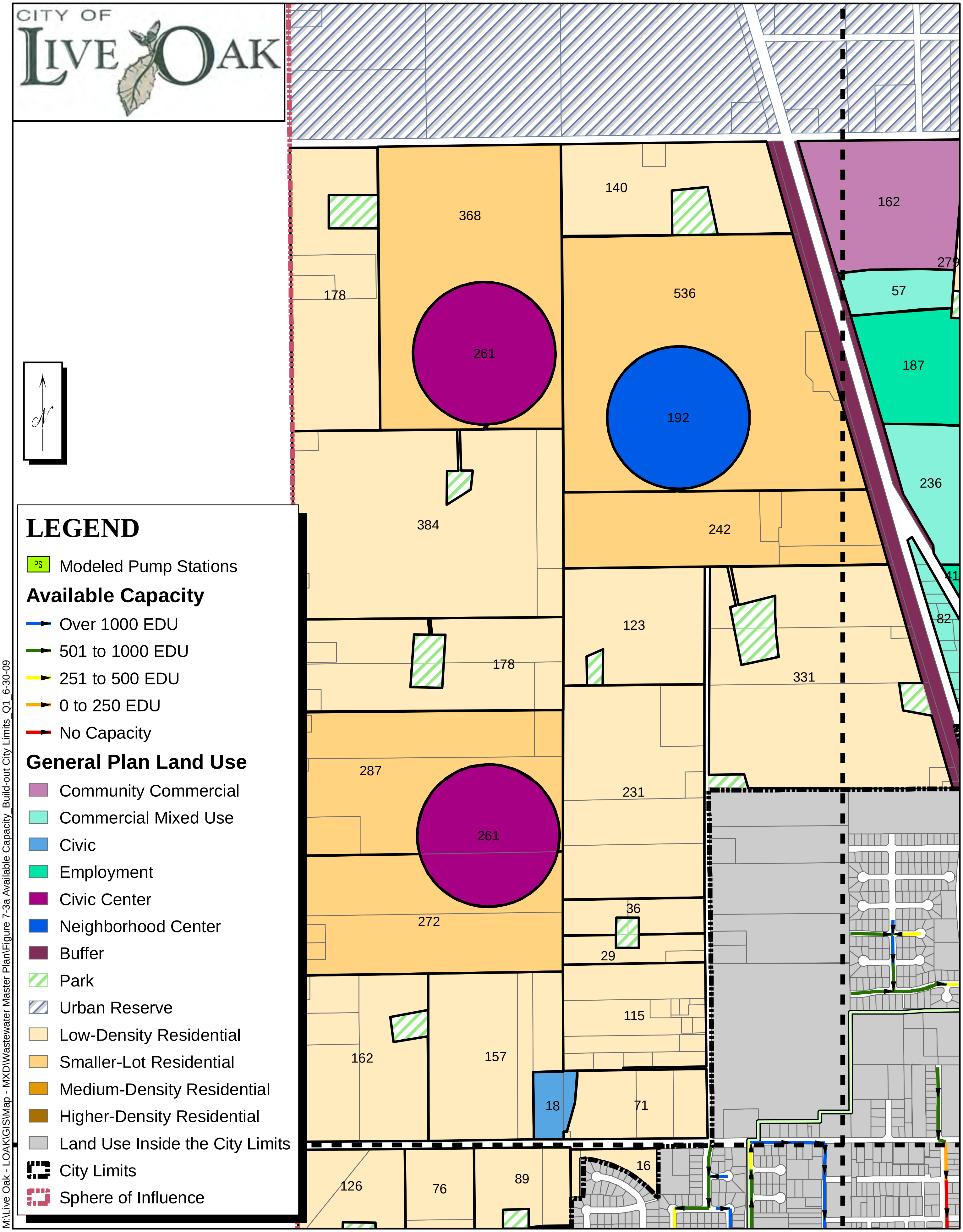
Figure 7-3
Overview of Interim Capacity for General Plan Development Outside of the City Limits



M:\Live Oak - LOAK\GIS\Map - MXD\Wastewater Master Plan\Figure 7-3a Available Capacity_Build-out City Limits_Q1 6-30-09

Figure 7-3a
Interim Capacity for General Plan Development - Northwest

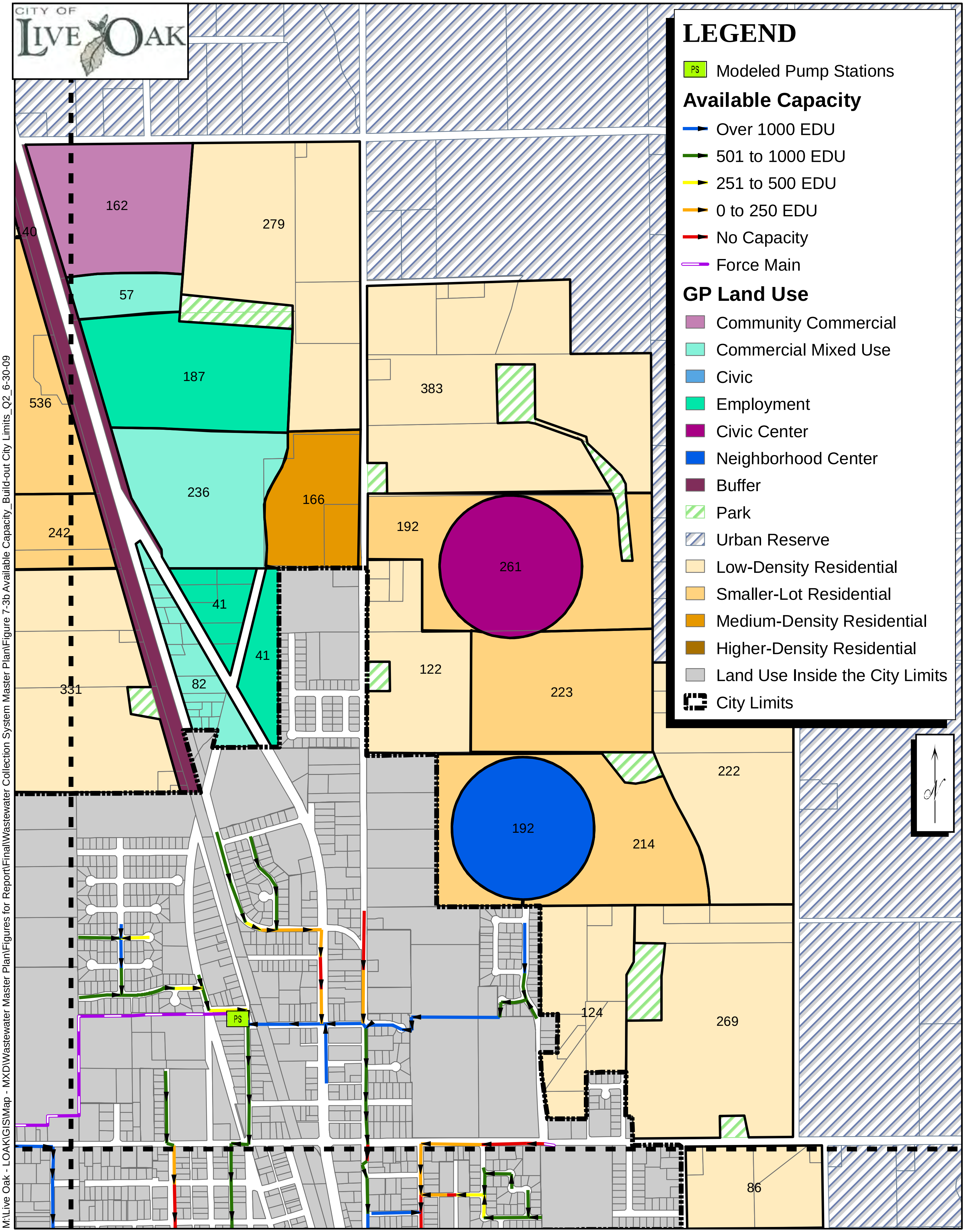


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Figure 7-3b
Interim Capacity for General Plan Development - Northeast

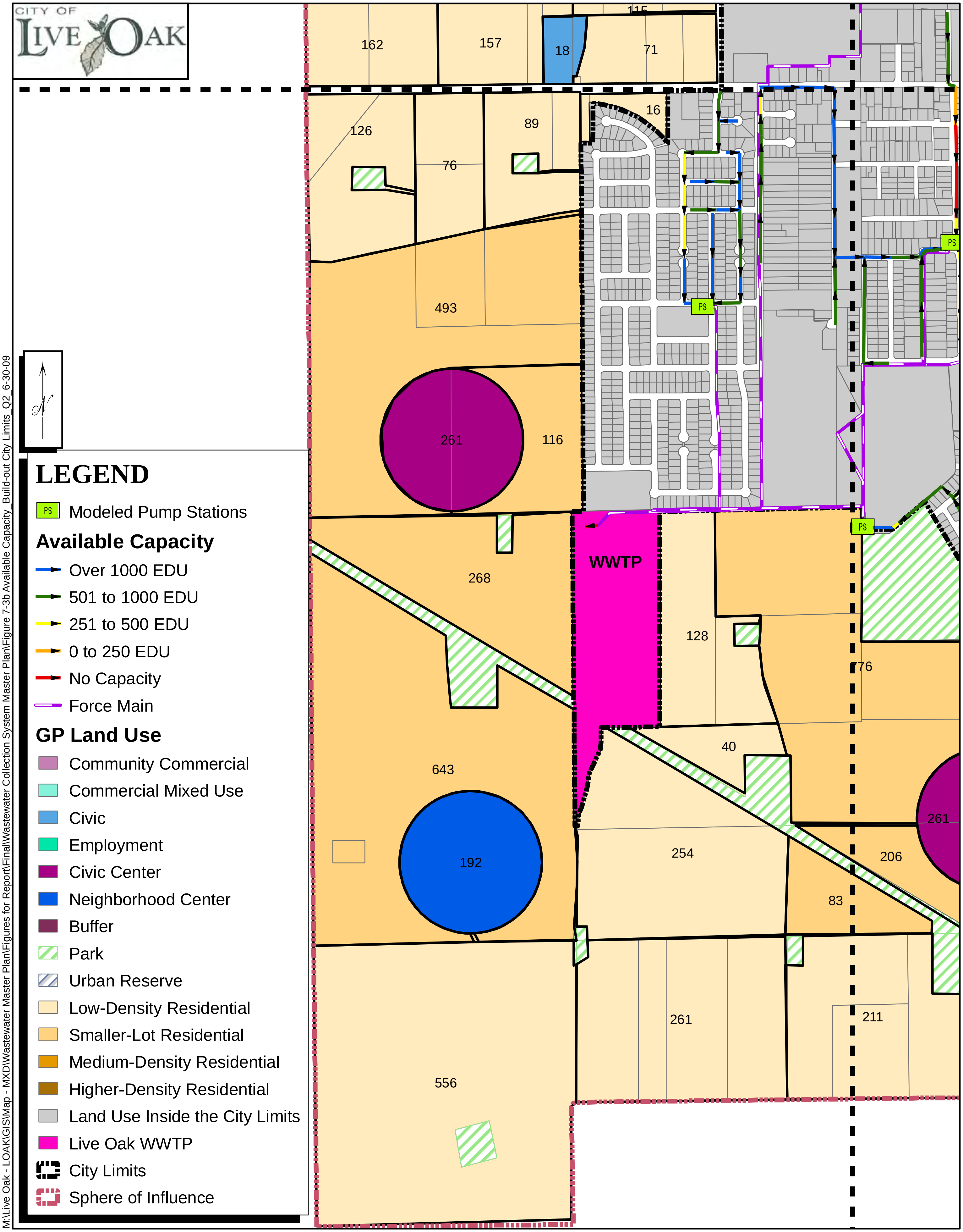

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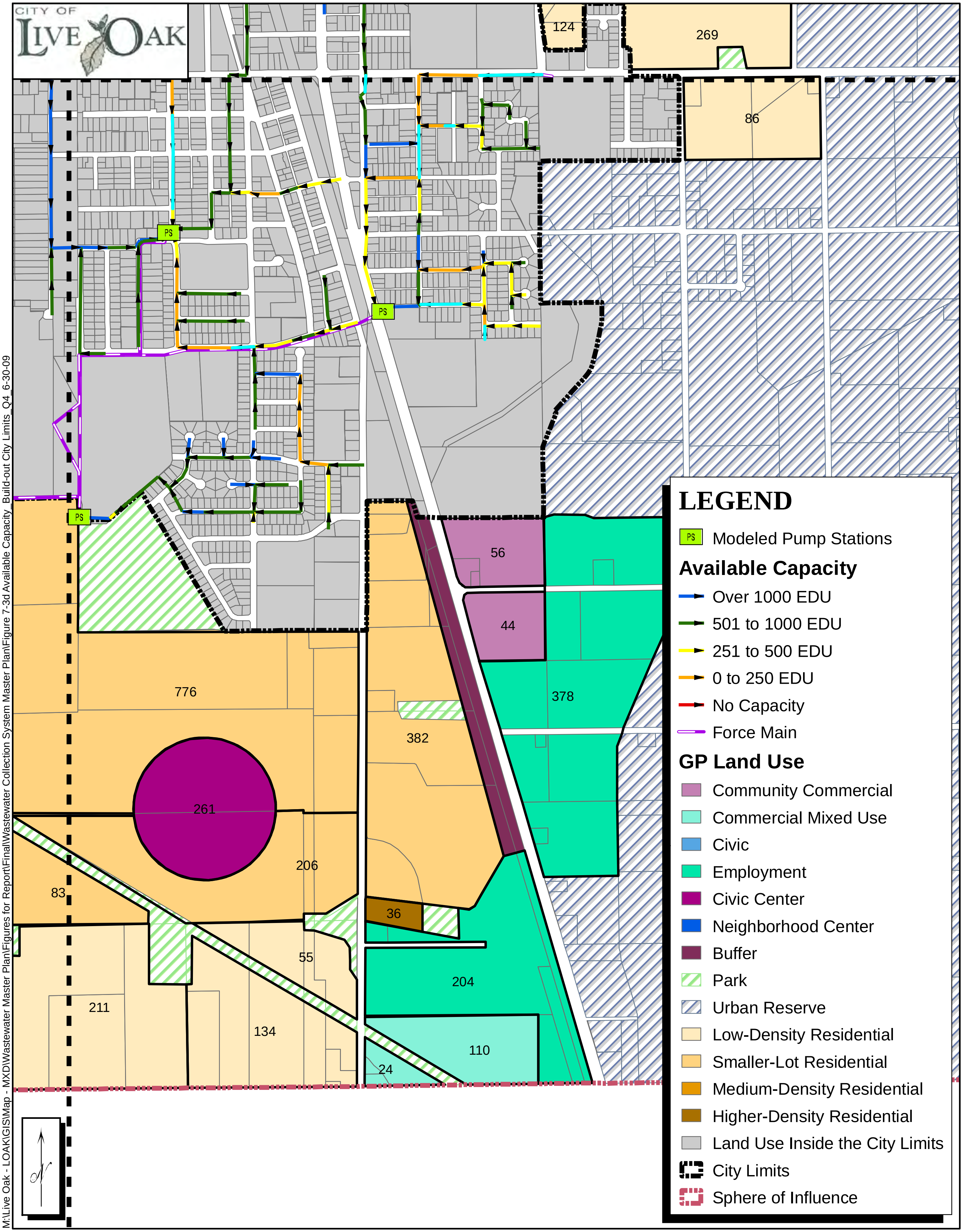
Figure 7-3c
Interim Capacity for General Plan Development - Southwest



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City of Live Oak Wastewater Collection System Master Plan

Figure 7-3d
Interim Capacity for General Plan Development - Southeast

7.3.2 Long-term System Needs

As shown in Figure 7-3, the existing system cannot accommodate all flow from future development areas without significant improvements throughout the system. Such improvements would be costly and would require major construction in high population areas. Therefore, a plan for serving future development areas in the SOI with new trunk sewers to the wastewater treatment plant (WWTP) is required.

To permanently serve the wastewater needs for these future development areas, two new trunk lines are proposed. Preliminary routes for these trunk lines and sizing for peak flow are presented in Figure 7-4. Peak flow and estimated pipe sizes for both the east and west trunks are shown in Table 7-1.

Table 7-1
City of Live Oak
Proposed Sizing for Future Sewer Trunk Lines

New Trunk Line Route [(a)]	Slope (feet/feet)	Full Pipe Velocity (feet/sec)	Total Peak Flow (Mgal/d) [(b)]
East Route			**4.2**
18 – inch	0.00067	2.0	1.4
21 – inch	0.00055	2.0	2.0
27 – inch	0.00039	2.0	4.2
West Route			**4.3**
21 – inch	0.00079	2.4	2.1
24 – inch	0.00056	2.2	3.3
27 – inch	0.00049	2.2	4.3

(a) Trunks were sized assuming pipes would flow at 70% of full depth. Capacity was calculated according to the 2003 City of Live Oak Public Works Improvement Standards using Mannings equation with a roughness value of 0.010 and a slope which would produce a full pipe velocity of 2 ft/s or greater.

(b) Mgal/d = million gallons per day.
Total peak flow = sum of peak flow for all areas assigned to specific route.

An eastern trunk would collect wastewater from the areas northeast, east, and south of the City and a western trunk would collect wastewater from areas north, west, and southwest of the City. Preliminary analysis indicates that some SOI areas may need to be pumped into the proposed trunks. Trunkline depths were set during analysis based on current known groundwater levels in the City in order to eliminate extensive dewatering costs during construction. It is assumed by the City that future pumping of tributary pipelines into the trunk will be operated by sanitary districts and will not impact proposed sewer connection fees. Analysis was based on the City standard that minimum slope be set to allow for a minimum full pipe velocity of two feet per second. Detailed design analysis should be performed to determine the ability of tributary sewers to flow into the trunk lines by gravity after pipeline routes are confirmed.

The new eastern sewer trunk could be routed from north to south along Larkin Road to the current City Limits, where it would flow east parallel to a Sutter County Irrigation Canal through a currently undeveloped field to Meteer Road. The trunk would then flow south along Meteer Road, east briefly on Pennington Road, and continue south on Sheldon Avenue to Bishop Avenue. From here, it would follow Bishop Avenue until it crossed under the Union Pacific Railroad and Live Oak Slough. The trunk could then flow west through currently undeveloped parcels to the southeast corner of the WWTP and north to a lift station where the flow would be lifted into the WWTP headworks. Routing the trunk under the railroad would require additional surveying and the acquisition of an easement. It is also recommended that Live Oak Slough be surveyed prior to construction of this sewer to verify if pumping will be required.

The new western sewer trunk could be routed south from Riviera Road through currently undeveloped fields to the northwest corner of the WWTP parcel and into a lift station which would pump the flow into the headworks.

7.4 CAPITAL COST ESTIMATES

Planning level opinions of probable cost for recommended improvements to the existing system for build-out of the City Limits (as described in Section 7.2) are provided in Table 7-2. Planning level opinions of probable cost are included for both pipe bursting and open cut and replacement.

Planning level opinions of probable cost for the major trunk lines shown in Figure 7-4 are provided in Table 7-3. A detailed cost breakdown for all estimates is provided in Appendix E.

The pipe costs include pipe material, excavation, laying and joining, backfill, manholes, testing, cleanup, and contractor's overhead and profit. This estimate also includes a 30% contingency for unknown conditions and a 10% allowance for design and administration. These costs do not include any pump stations that may be required along the routes or costs for easement acquisitions. All costs have been estimated at a current Engineering News-Record Construction Cost Index (ENRCCI) of 8,586 (September 2009).

Depending on the growth rate of the City, the build-out of the SOI might represent a 50-year or more development horizon. As a result, the City may elect to phase all or a portion of the trunk sewers to better match capacity needs with cash flow from development. Phasing options could involve construction of two smaller parallel sewers in place of one large one.

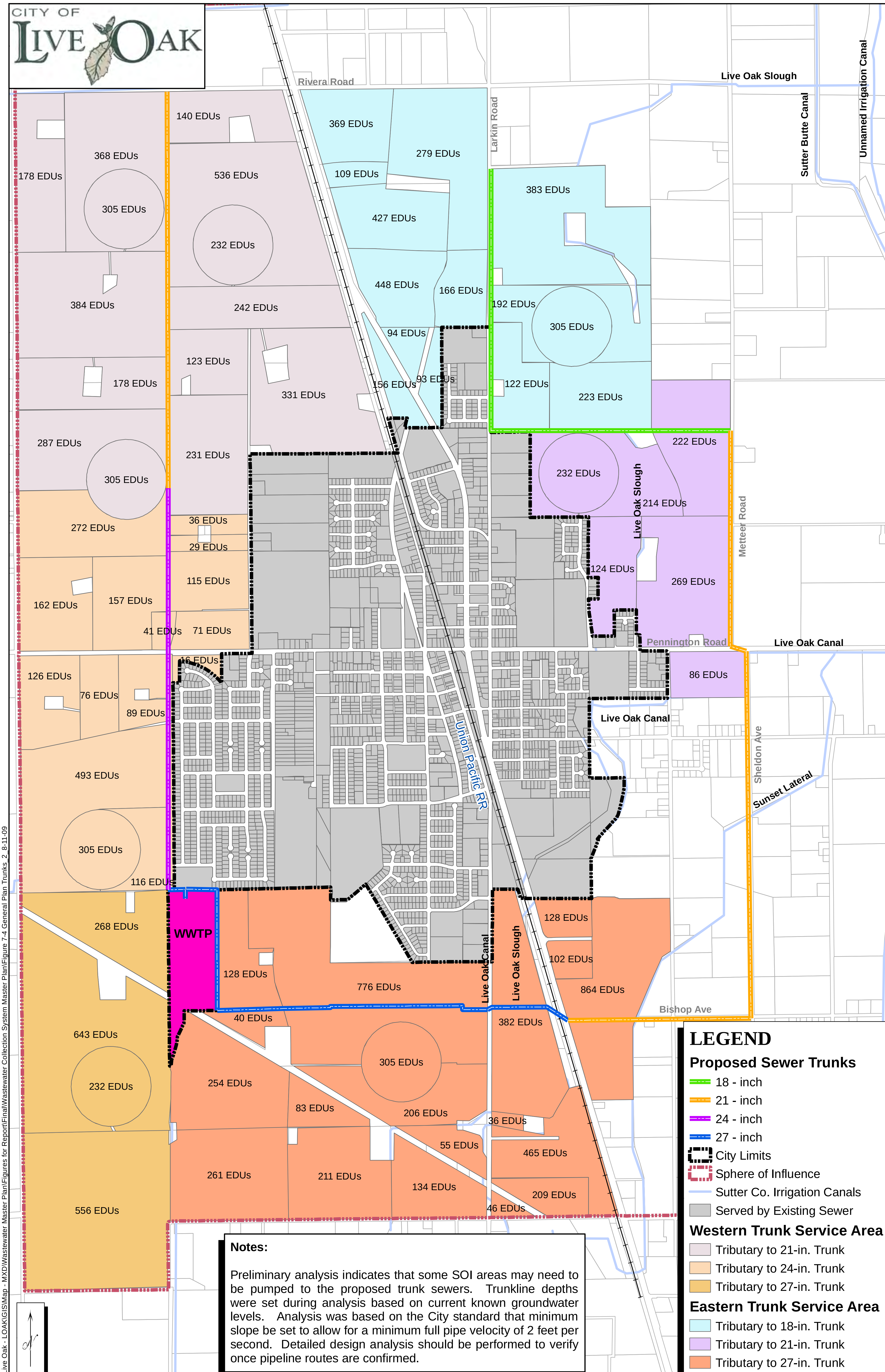

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Figure 7-4
Proposed Layout of General Plan Sewer Trunks

Table 7-2
City of Live Oak
Preliminary Opinion of Probable Cost for Build-Out of City Limits - Improvements #1 and #2

Improvement Description	Pipe Bursting Cost $ [a]	Open Cut and Replace Cost, $ [a]
Improvement #1 - Upsize Pipe (MH AB-2 to MH A) to 12"	455,000	$577,000
Improvement #2 - Upsize Pipe (L1-2 to 2) to 10"	77,000	$98,000
Estimating Contingency (30%)	160,000	$202,000
SUBTOTAL – CONSTRUCTION COSTS (rounded)	**692,000**	**$877,000**
Design/Administration (10%)	69,000	$88,000
TOTAL (rounded)	**762,000**	**$965,000**

(a) September 2009 Costs; ENRCCI = 8,586.

Table 7-3
City of Live Oak
Preliminary Opinion of Probable Cost for Build-out of SOI - Proposed New Trunk Sewers

Improvement Description	Cost, $ [a]
Build-out Trunk Sewer – East Route	$12,100,000
Build-out Trunk Sewer – West Route	$5,800,000
Estimating Contingency (30%)	$5,400,000
SUBTOTAL – CONSTRUCTION COSTS (rounded)	**$23,300,000**
Design/Administration (10%)	$2,300,000
TOTAL (rounded)	**$25,600,000**

(a) September 2009 Costs; ENRCCI = 8,586.

Chapter 8

Wastewater Treatment Plant

8.1 PURPOSE

The purpose of this chapter is to identify future capital projects, provide an estimate of costs, and prepare a preliminary expansion schedule for the City of Live Oak (City) Wastewater Treatment Plant (WWTP). This chapter does not replace a full facility plan. Several assumptions were made for selecting future treatment processes and alternatives will need to be evaluated in more detail prior to implementation of any of these capital projects.

This chapter is divided into the following sections:

- Existing Wastewater Treatment Facilities
- Future Flow Projections
- Facility Expansions to Accommodate Future Growth
- Expansion and Upgrade Project Phasing
- Replacement and Rehabilitation Projects
- Description of Capital Improvement Projects

8.2 EXISTING WASTEWATER TREATMENT FACILITIES

The Live Oak WWTP has a capacity of 1.4 million gallons/day (Mgal/d) average dry weather flow (ADWF). It provides secondary treatment of raw wastewater through a series of aerated ponds and lagoons, discharging disinfected effluent to an irrigation drain (Reclamation District 777 Lateral Drain Number 1). The average wastewater flow is currently approximately 0.78 Mgal/d.

The City is currently under a Cease and Desist Order (CDO) that requires significant upgrades to their existing WWTP. The CDO includes a compliance schedule that requires the City to construct these improvements by 2012. These improvements will increase the level of treatment to meet regulatory requirements, but will maintain the treatment capacity at 1.4 Mgal/d.

The CDO also contained provisions that allow the City to investigate the potential for regionalizing wastewater treatment with Yuba City. Yuba City's WWTP has available treatment capacity to accommodate the wastewater flow from the City of Live Oak. The City completed the feasibility study and elected to complete the WWTP improvements instead of connecting to the Yuba City WWTP. The primary driver for the City's decision was the higher costs to complete the regional project which would drive up the monthly sewer rates for the residents of the City of Live Oak.

8.3 FUTURE FLOW PROJECTIONS

The City has recently completed an update to its General Plan (*City of Live Oak 2030 General Plan* (EDAW, September 2009)), which expands its current City limit boundary to accommodate future growth. Ultimate build-out population is expected to be approximately 49,000. As the City's population increases, the associated wastewater flow will increase and the City will need to expand its WWTP treatment capacity. Future flow projections are summarized in Table 8-1. Future flows are based on a per capita flow estimate of 80 gallons per person per day and an average population growth rate of 4.8% per year. While there are many different flow and loading parameters that can be used to determine when future facilities are required, the basis for expanding WWTP facilities in this capital improvement program is average dry weather flow (ADWF). ADWF is generally defined as the three lowest flow months recorded for the year, typically between June and October.

Table 8-1
City of Live Oak
Approximate Future Flow
Projections by Year

Year	Approximate Population	Average Dry Weather Flow (Mgal/d) [(a)]
2008	8,500	0.70
2010	9,300	0.75
2015	11,800	0.94
2020	14,900	1.2
2025	18,900	1.5
2030	23,800	1.9
2035	30,100	2.4
2040	38,100	3.1
2045	49,200	3.9

(a) Mgal/d = million gallons per day

8.4 FACILITY EXPANSIONS TO ACCOMMODATE FUTURE GROWTH

The timing and sizing of facility expansions should be such that there is a 10- to 15-year time increment between projects. Constructing smaller expansion projects more frequently increases overall project costs because of costs associated with multiple designs, bidding services, and construction management. Construction management costs would be higher because two construction projects would have a longer overall construction period than a single construction project that provides the same capacity as the two smaller projects.

Conversely, building excess treatment capacity creates the risk of having larger facilities, which are not efficiently utilized until future growth requires that capacity. Agencies run the risk of building too much capacity with the anticipation of future growth paying for this capacity. If growth is not realized, the agency may be left with the expense of the expansion, without reimbursement from growth in a timely manner.

Ideally, the timing and facility sizing would fall between these two extremes. However, the rate of growth is unknown and facility expansions may take place more or less frequently than the ideal 10- to 15-year time increment. If growth rates are significantly higher than anticipated, then the facility expansion increment size can be increased. Conversely, if very low growth rates are expected then the expansion increment can be decreased. Regardless, it is important that the facilities be constructed *prior* to exceeding the WWTP capacity. Recommendations in this chapter assume expanded facilities need to be online one year prior to reaching the previous WWTP capacity. Note that it often takes two to three years to design and construct facility upgrades and expansion and planning should be undertaken several years before WWTP capacity is expected to be reached.

8.5 EXPANSION AND UPGRADE PROJECT PHASING

The proposed expansion increment for future facility expansions is 1.4 Mgal/d. Based on the projected growth rates, this increment would provide approximately 12 to 15 years between capacity expansions. Future capital improvement projects discussed below have been grouped into four distinct phases (Phase I through IV) and will address future regulatory compliance, future expansion, and improved operations efficiency. The timing of each capacity driven capital improvement project, as a function of projected ADWF, is shown in Figure 8-1.

8.5.1 FACILITY TREATMENT UPGRADES FOR REGULATORY COMPLIANCE

While facility expansions are based on future growth, facility upgrades are often based on compliance with future regulatory requirements. While it is impossible to predict all future regulations, recent regulatory trends can help identify potential future upgrade projects. These projects are described in each of the Phase I through IV below. These potential upgrades include moving the discharge location from the Reclamation District 777, Lateral Drain 1 to the Feather River and installing anoxic basins to facilitate nutrient removal. Upgrades that will not be included in the future compliance project include membrane filtration, ozone oxidation, and reverse osmosis. These upgrades are not imminent and can most likely be avoided through careful planning and permit negotiation.

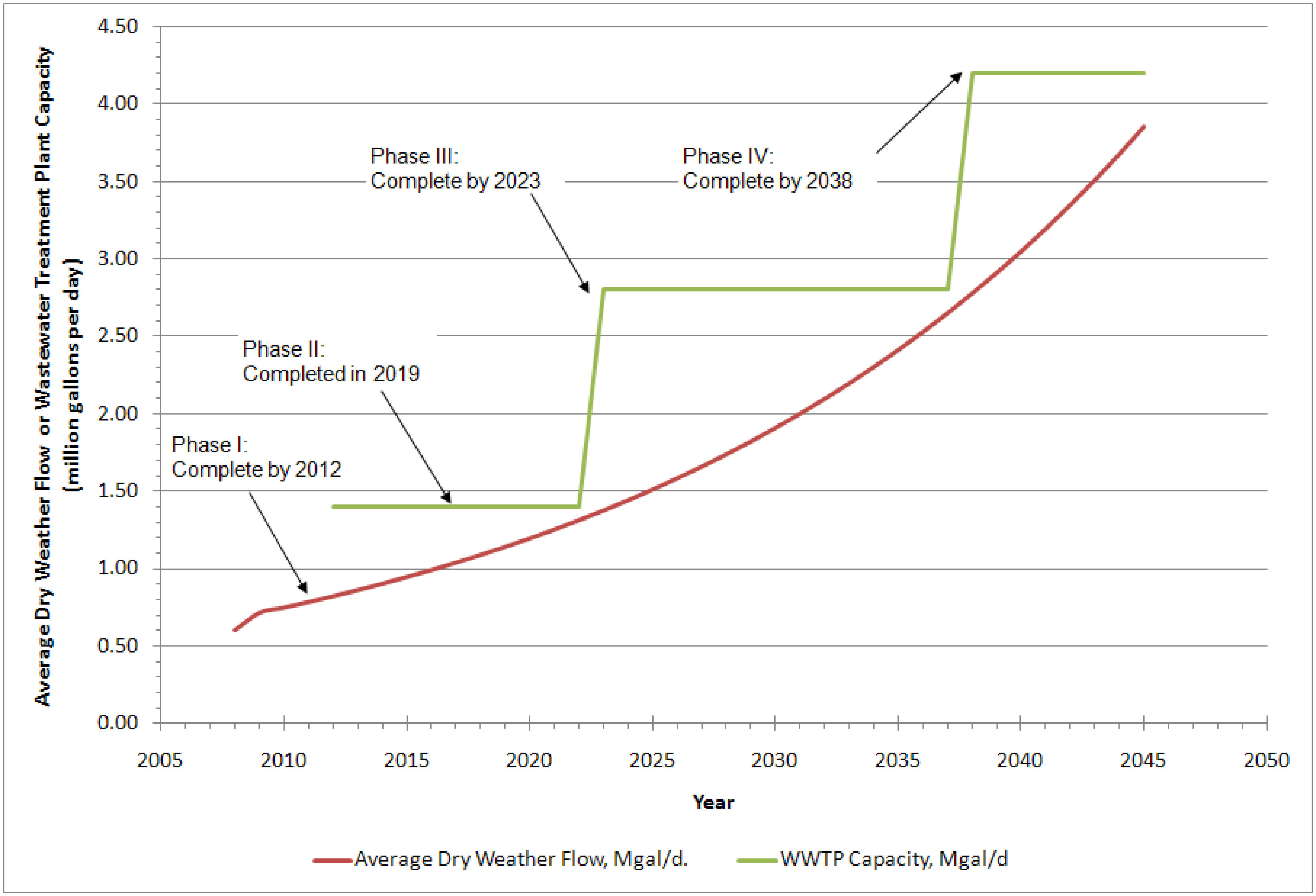


Figure 8-1
City of Live Oak
Projected Wastewater Average Dry Weather Flow and Capacity Expansion Timing

8.5.2 FACILITY UPGRADES TO INCREASE OPERATIONS EFFICIENCY

As wastewater treatment facilities increase in capacity, certain process areas that were appropriate for smaller facilities become impractical to operate. Additionally, some processes become more necessary as flow increases. Often, these original facilities can be modified to perform a different function in the future. However, in many cases these facilities are simply abandoned or demolished. The decision to design facilities that may be abandoned in the future needs to be carefully weighed against the additional cost to initially construct facilities that will remain in service for a longer period of time. For the Live Oak WWTP, there are two areas that are anticipated to require modification in the future: the headworks and the solids handling facilities. These examples are discussed below.

The headworks upgrades are anticipated to occur in Phase II, described below. The existing mechanical screens will need to be replaced or modified in the future. The existing headworks facility has two channels with a mechanical screen in one channel and a manual screen in the second channel. Rather than modifying the existing headworks by increasing the number of channels and associated screens, a better strategy would be to construct a new headworks structure with larger channels and different mechanical screens. In addition, adding a grit removal step to the existing WWTP during the Phase II project will prevent the solids build up in the oxidation ditches as well as remove the inert solids and reduce the overall volume of solids that will need to be dewatered in the new filter drying beds (Phase I upgrade). Additionally, grit removal facilities are shown to increase the life of solids handling pumps and associated piping due the removal of abrasive solids associated with grit.

The initial (Phase I) proposed solids handling facilities include a solids storage basin with filter drying beds. The filter drying beds are simple to operate for smaller facilities, but at higher flows the number of beds and the area required becomes very large. At this point the operational cost of these facilities is significantly higher than mechanical dewatering facilities. Therefore, these facilities will be converted in the future (Phase III) from drying beds to mechanical dewatering facilities. The drying beds will still be used in the future, but will serve as a backup process and to further increase the percents solids to reduce hauling costs. The drying beds will also provide the City the flexibility of treating the wastewater solids to a higher level so that the solids could be recycled for use as a soil amendment.

8.6 REPLACEMENT AND REHABILITATION PROJECTS

Replacement and rehabilitation projects are not addressed in this facilities analysis. Costs for replacement and rehabilitation should be collected as a separate account that funds depreciation. In general, there should be a fixed percentage of the sewer fund that is used to complete these projects. Examples of these projects include:

- Major Equipment Replacement - Pumps and major mechanical equipment wear out and require replacement over time.

- Rehabilitation of Processes – Larger equipment will need to be rebuilt and steel and concrete tankage will need to be recoated to prevent corrosion.
- Upgrade of smaller equipment – As technology changes over time, some equipment will require replacement as it becomes obsolete.

8.7 DESCRIPTION OF CAPITAL IMPROVEMENT PROJECTS

Future capital improvement projects have been grouped into four distinct phases (Phase I through IV) and address future regulatory compliance, future expansion, and improved operations efficiency. The Capital Improvement Projects (CIP) are described below and shown in Figure 8-2.

The WWTP phasing plan is a conservative plan that provides the City with a capital improvement plan but also provides flexibility for changing future conditions. There are opportunities in the future to evaluate other WWTP alternatives should regulatory requirement or development patterns change. For example, should new regulatory requirements confirm the need for a new pump station, pipeline and outfall to the Feather River, it is recommended that the City investigate the feasibility of constructing a Satellite WWTP located on the eastern portion of the City's sphere of influence. This satellite facility would provide treatment for the new east trunk sewer. The east-west trunk line could be eliminated if the satellite facility is constructed. Furthermore, the new facility would be closer to the Feather River which would reduce the overall pumping and conveyance costs for river discharge.

8.7.1 PHASE I CAPITAL IMPROVEMENT PROJECT

The Phase I CIP is based on meeting the new regulatory requirements and the CDO, with no expansion in treatment capacity. The project will include an upgrade to replace the existing aerated pond treatment system with a tertiary treatment facility. The new facility will continue to have a treatment capacity of 1.4 Mgal/d. The design for these new facilities was completed in January 2008 and the new facilities are expected to be operational by December 2012, based on the regulatory compliance schedule.

The new treatment facilities include the following project elements:

- New odor control facilities for the existing headworks.
- Piping and gate modifications at the existing headworks facility.
- Equalization facilities to shave off peak hourly flows from the secondary treatment system.
- New pump station to feed screened influent to the secondary treatment system.
- New secondary treatment process consisting of a three stage anaerobic selector, two oxidation ditches with fine bubble diffuser submersible mixers and aeration blowers, two secondary clarifiers, two flow splitter structures, a return activated sludge (RAS) pump station, and a scum pump station.

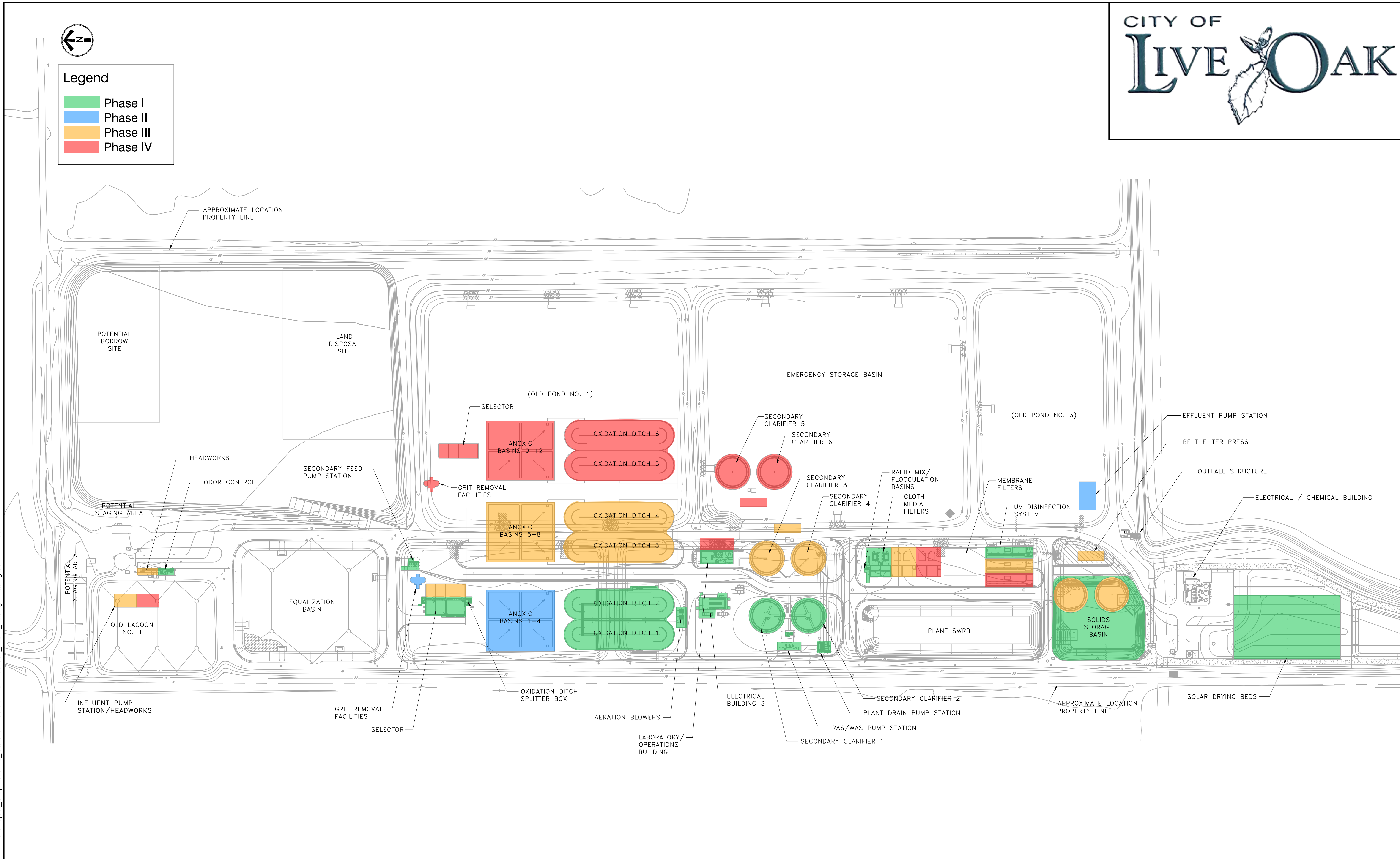
- Tertiary treatment process consisting of chemical feed and storage facility modifications, new rapid mix and flocculation basins, and a dual train cloth media filter system.
- New ultraviolet disinfection system consisting of a single channel with five UV banks.
- New outfall with a cascading aerator and an emergency diversion gate.
- New solids handling facilities consisting of a solids storage basin, solids feed pump station, and filter drying beds.
- New support facilities including a laboratory and operations trailer, new stormwater retention basin, electrical building, and a plant drain pump station.

The estimated capital costs for these facilities are summarized on Table 8-2.

Table 8-2
City of Live Oak
Phase I WWTP Project Cost Estimate

Structure / Project Component	Cost [(a)]
Mobilization and Insurance	$500,000
Headworks Improvements	$200,000
Equalization & Emergency Storage Basin	$410,000
Secondary Feed Pump Station	$210,000
Secondary Treatment System	$6,000,000
Tertiary Filtration System	$1,800,000
UV Disinfection System	$1,300,000
Plant Water Pump Station	$90,000
Solids Handling Facilities	$1,650,000
Site Improvements	$2,000,000
Yard Piping and Structures	$1,700,000
Lab/Admin Building	$500,000
Electrical and Instrumentation	$2,300,000
Allowance for Change Orders (5%)	$1,000,000
Construction Cost	$19,660,000
CM, Admin (15%) [(b)]	$2,400,000
Total Project Cost	**$22,060,000**

(a) Based on recent project bid results and construction cost index (ENRCCI = 8586).
(b) Percentage reduced from 25% to 15% due to project already being designed.



U:\Project_Graphics\Live_Oak\LOAK08-001\LOAK08-001_FIG 2_Facility Phasing.pdf 12-21-08 mlm

Figure 8-2
Live Oak WWTP Phasing Plan

8.7.2 PHASE II CAPITAL IMPROVEMENT PROJECT

Phase II improvements are based on both meeting anticipated regulatory requirements and improving the operations of the facility. For planning purposes, it is assumed that the soonest that these facilities are required is by 2019, the earliest possible regulatory deadline for these facilities. This date allows for conservative planning for these projects. Since this project is not capacity driven, there is considerable flexibility for when the Phase II project can be initiated.

Phase II facility upgrades include the following project elements:

- Relocating effluent discharge via construction of an effluent pump station, pipeline, and outfall diffuser in the Feather River to meet new regulatory requirements through dilution.
- Upgrading the existing facilities to provide biological nutrient removal by constructing new anoxic basins.
- Constructing new grit removal facilities consisting of a dual train vortex grit removal system with a grit pump, grit classifier, and hydro cyclone.

The estimated capital costs for these facilities are summarized on Table 8-3.

Table 8-3
City of Live Oak
Phase II WWTP Project Cost Estimate

Structure / Project Component	Cost [a]
Mobilization and Insurance	$300,000
Anoxic Basins	$1,500,000
Grit Removal Facilities	$700,000
Effluent Pump Station	$1,000,000
Outfall Pipeline	$2,500,000
Diffuser	$200,000
Site Improvements	$500,000
Yard Piping and Structures	$500,000
Electrical and Instrumentation (15%)	$1,000,000
Contingency (20%)	$2,000,000
Construction Cost	$10,200,000
Engineering, CM, Admin (25%)	$2,600,000
Total Project Cost	**$12,800,000**

(a) Based on construction cost index (ENRCCI = 8586)

If new regulatory requirements confirm the need for a new pump station and pipeline to the Feather River, it is recommended that the City investigate the feasibility of constructing a Satellite WWTP located to the east that would serve the new east trunk sewer. The east-west trunk line could be eliminated if the satellite facility is constructed.

8.7.3 PHASE III CAPITAL IMPROVEMENT PROJECT

Phase III improvements are a combination of facility expansion and facility upgrades and are planned for completion in the year 2023. The project would increase the ADWF treatment capacity from 1.4 Mgal/d to 2.8 Mgal/d through the addition of new process trains. Facility upgrades include construction of a new influent pump station, headworks facilities, and new solids handling facilities.

Description of Facility Upgrades

Based on the future trunk sewers described in Chapter 7, a new influent pump station would be constructed to pump raw sewage from the new trunk sewers into a new headworks facility. The new influent pump station would be constructed to handle the peak flow capacity of the new trunks. As described in Chapter 2, the existing flow is already pumped from lift stations located throughout collection system. The exact configuration of these new facilities in relation to the existing facilities should be reevaluated as part of the preliminary design report for this Phase.

The existing headworks facilities will eventually need to be replaced when the equipment exceeds its useful life and reaches its hydraulic capacity. This replacement will most likely occur prior to when the flows exceed the system's capacity. Constructing a new larger headworks facility is preferable to modifying the existing headworks facility. A three channel headworks with two channels outfitted with perforated plate screens would be constructed. The third channel would have a manual bar rack. The existing headworks would be modified such that the flows can be routed to the new headworks facility

The new solids handling facilities will include aerobic digesters and an enclosed facility consisting of mechanical dewatering equipment. For the purposes of this report, a rotary screw press is assumed for the solids dewatering facilities. The timing of the new solids handling facilities will be based on the performance of the filter drying beds. At this time, the new solids handling facilities are planned for construction during Phase III.

Description of Facility Expansion

The new facilities required to expand the treatment capacity from 1.4 Mgal/d to 2.8 Mgal/d include the following project elements:

- A third pump in the secondary feed pump station.
- A third grit removal basin.
- A third anoxic selector basin.
- Two oxidation ditches.
- Two secondary clarifiers.
- A second RAS pump station.
- A second scum pump station.
- Two additional cloth media filters.
- A second UV disinfection channel.

The estimated capital costs for these facilities are summarized on Table 8-4.

Table 8-4
City of Live Oak
Phase III WWTP Project Cost Estimate

Structure / Project Component	Cost [(a)]
Mobilization and Insurance	$500,000
New Headworks	$1,500,000
Secondary Feed Pump Station	$210,000
Secondary Treatment System	$7,000,000
Tertiary Filtration System	$1,200,000
UV Disinfection System	$1,100,000
Solids Handling Facilities	$1,500,000
Site Improvements	$1,000,000
Yard Piping and Structures	$700,000
Electrical and Instrumentation (20%)	$3,000,000
Contingency (20%)	$3,000,000
Construction Cost	$20,700,000
Engineering, CM, Admin (25%)	$2,600,000
Total Project Cost	**$23,300,000**

(a) Based on construction cost index (ENRCCI = 8586)

8.7.4 PHASE IV CAPITAL IMPROVEMENT PROJECT

Phase IV improvements will consist of only facility expansion elements and are planned for completion in the year 2038. No upgrades are planned for this CIP. The new facilities would expand the treatment capacity from 2.8 Mgal/d to 4.2 Mgal/d and include the following project elements:

- A new secondary feed pump station
- A fourth grit removal basin
- A fourth anoxic selector basin
- Two oxidation ditches
- Two secondary clarifiers
- A third RAS pump station
- A third scum pump station
- Two additional cloth media filters
- A third UV disinfection channel

The estimated capital costs for these facilities are summarized on Table 8-5.

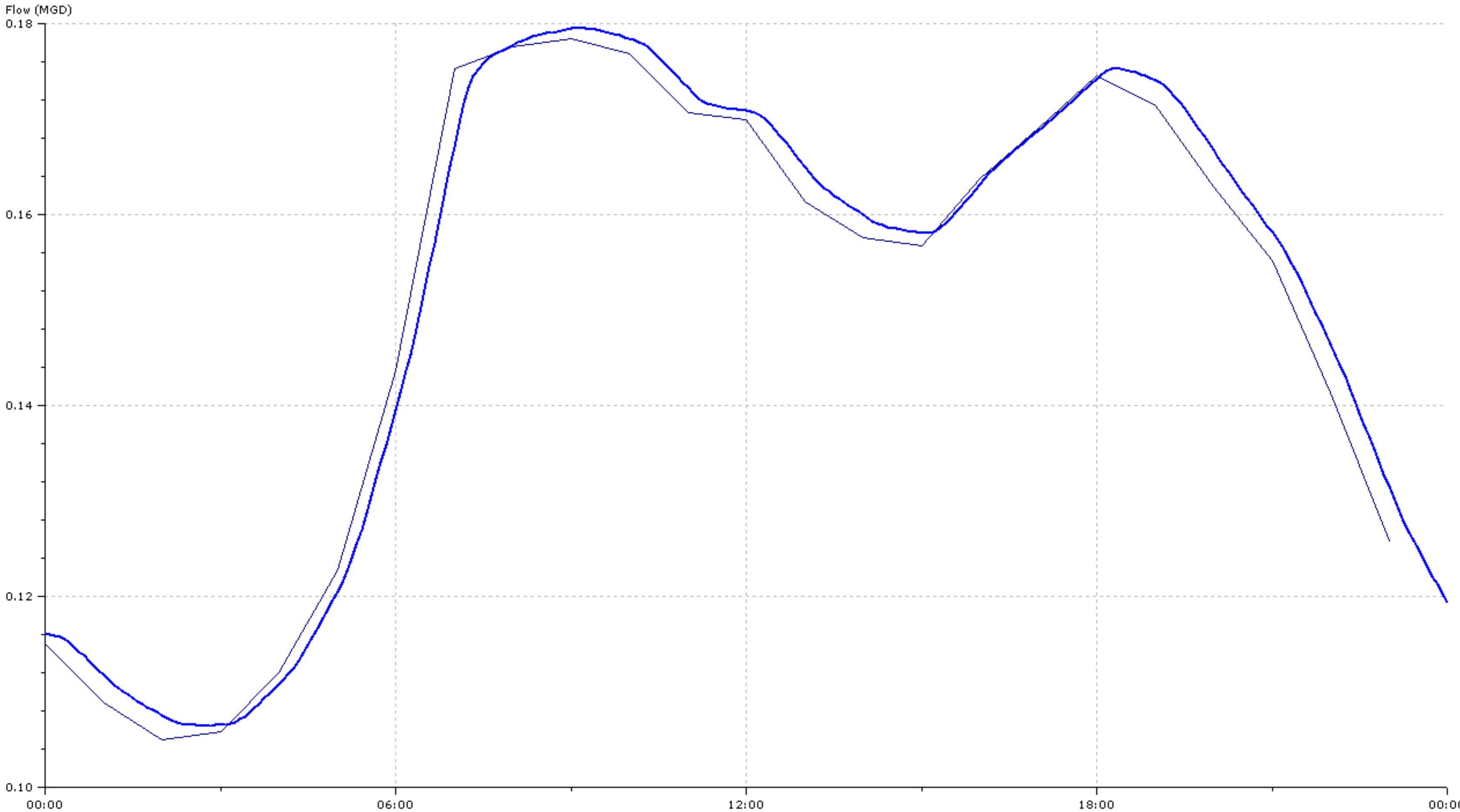
Table 8-5
City of Live Oak
Phase IV WWTP Project Cost Estimate

Structure / Project Component	Cost [(a)]
Mobilization and Insurance	$500,000
Secondary Treatment System	$7,000,000
Tertiary Filtration System	$1,200,000
UV Disinfection System	$1,000,000
Site Improvements	$1,000,000
Yard Piping and Structures	$700,000
Electrical and Instrumentation (20%)	$2,300,000
Contingency (20%)	$2,800,000
Construction Cost	$16,500,000
Engineering, CM, Admin (25%)	$4,100,000
Total Project Cost	**$20,600,000**

(a) Based on construction cost index (ENRCCI = 8586)

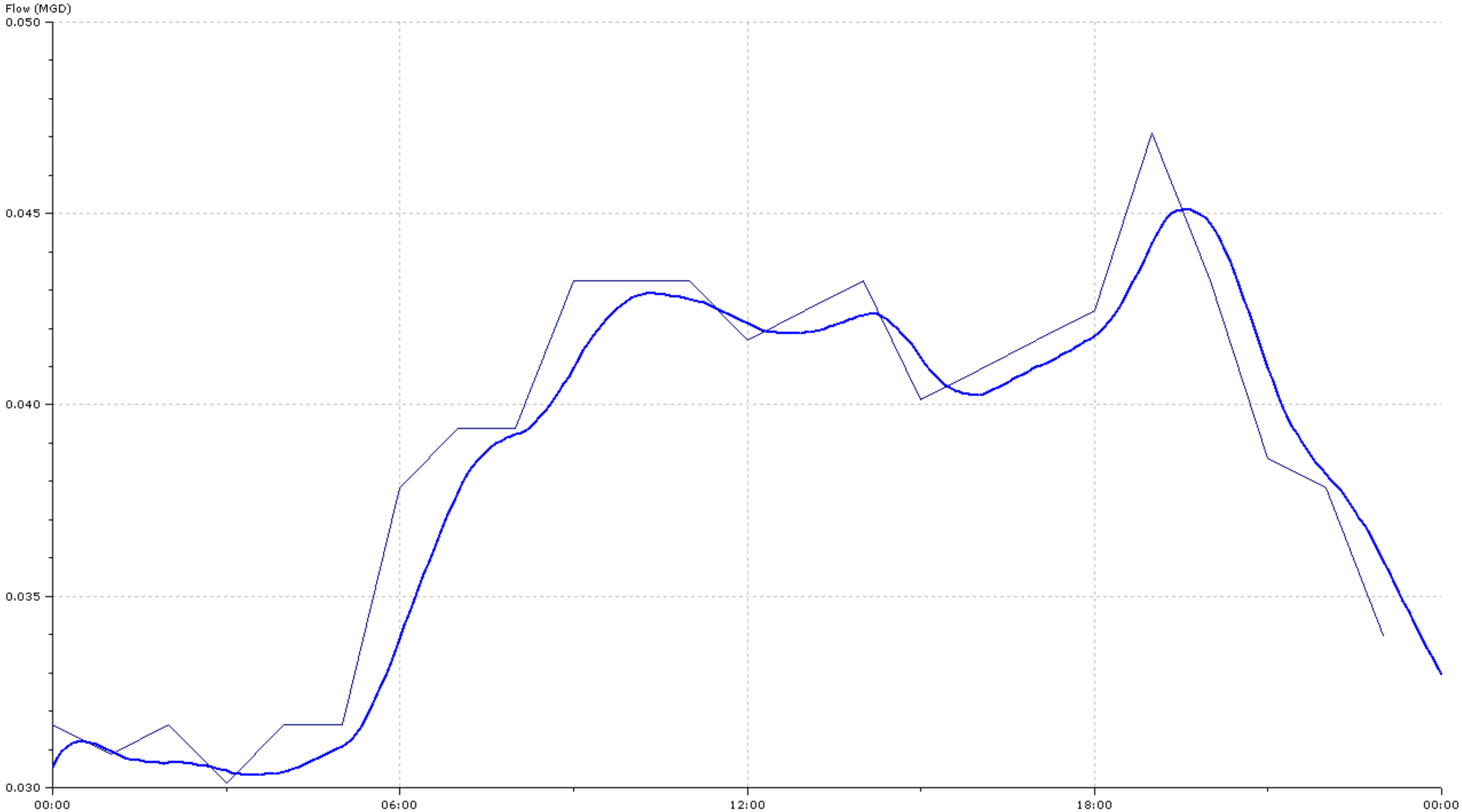
Appendix A

City of Live Oak Flow Calibration Graphs



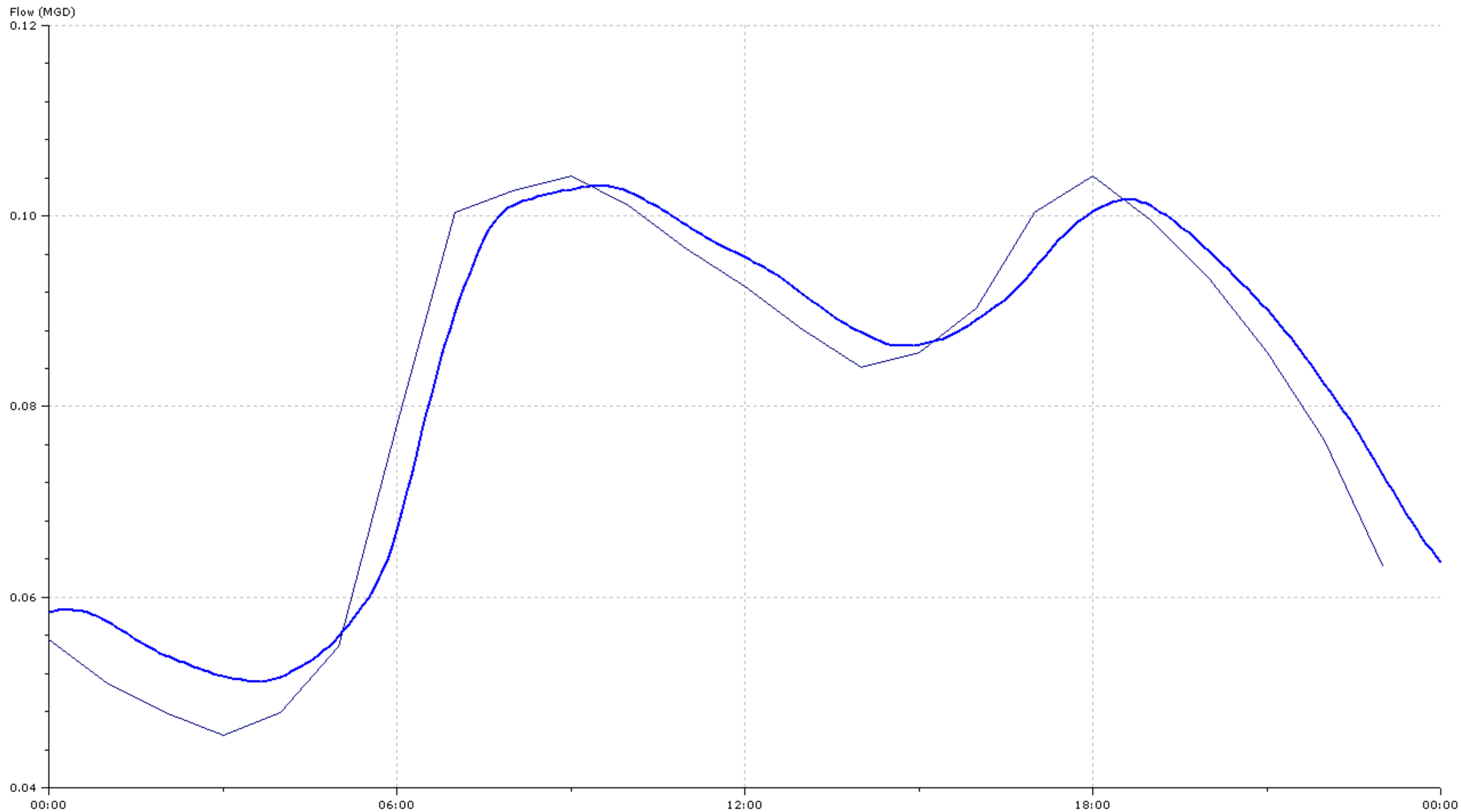
	Flow (MGD)		
	Min	Max	Volume (US Mgal)
Observed Flow	0.105	0.178	0.145
Simulated ADWF Flow	0.106	0.180	0.151

Figure A-1
City of Live Oak
Dry Weather Flow Calibration for Flow Monitor #1



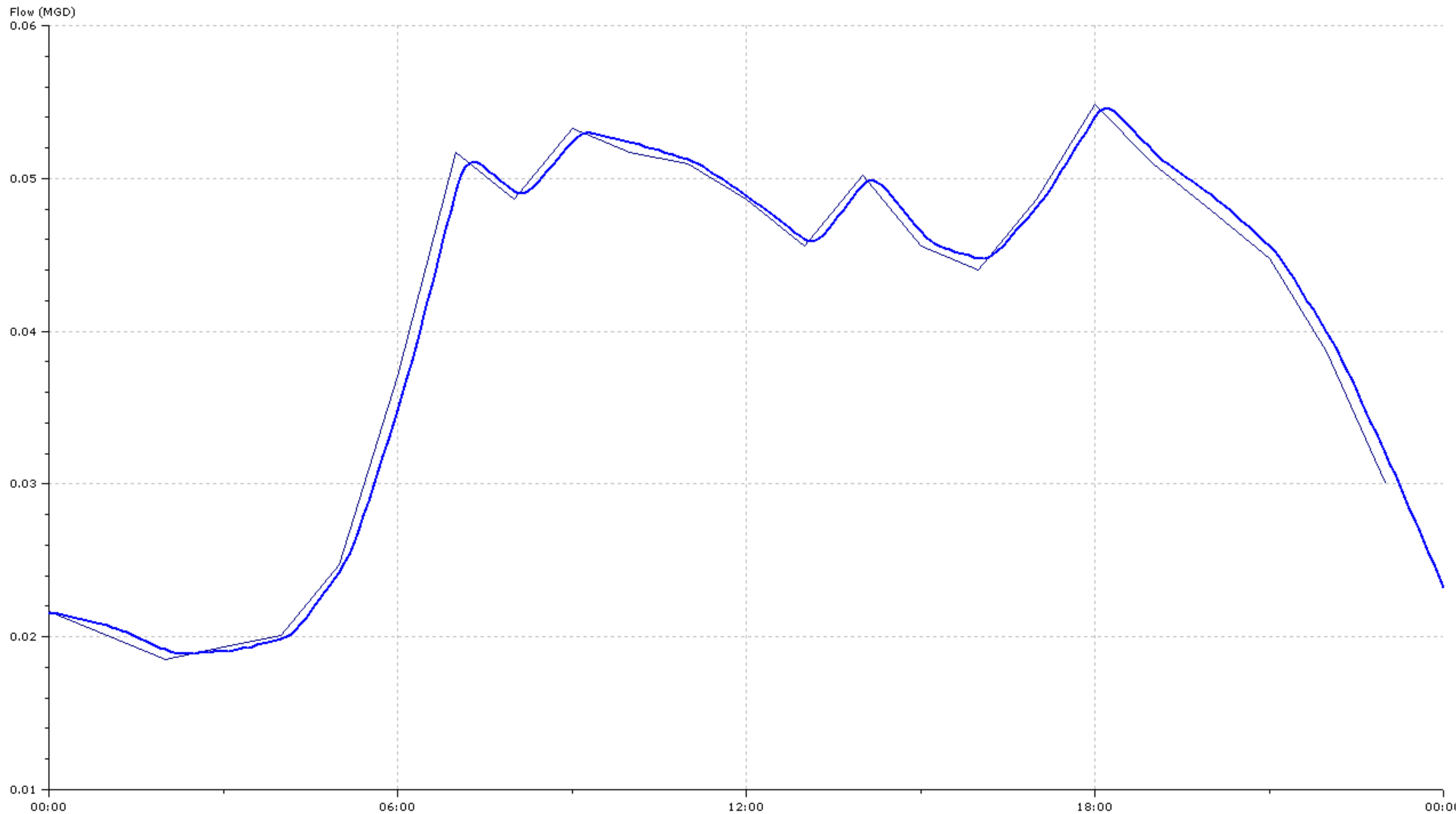
	Flow (MGD) Min	Max	Volume (US Mgal)
Observed Flow	0.030	0.047	0.037
Simulated ADWF Flow	0.030	0.045	0.038

Figure A-2
City of Live Oak
Dry Weather Flow Calibration for Flow Monitor #2



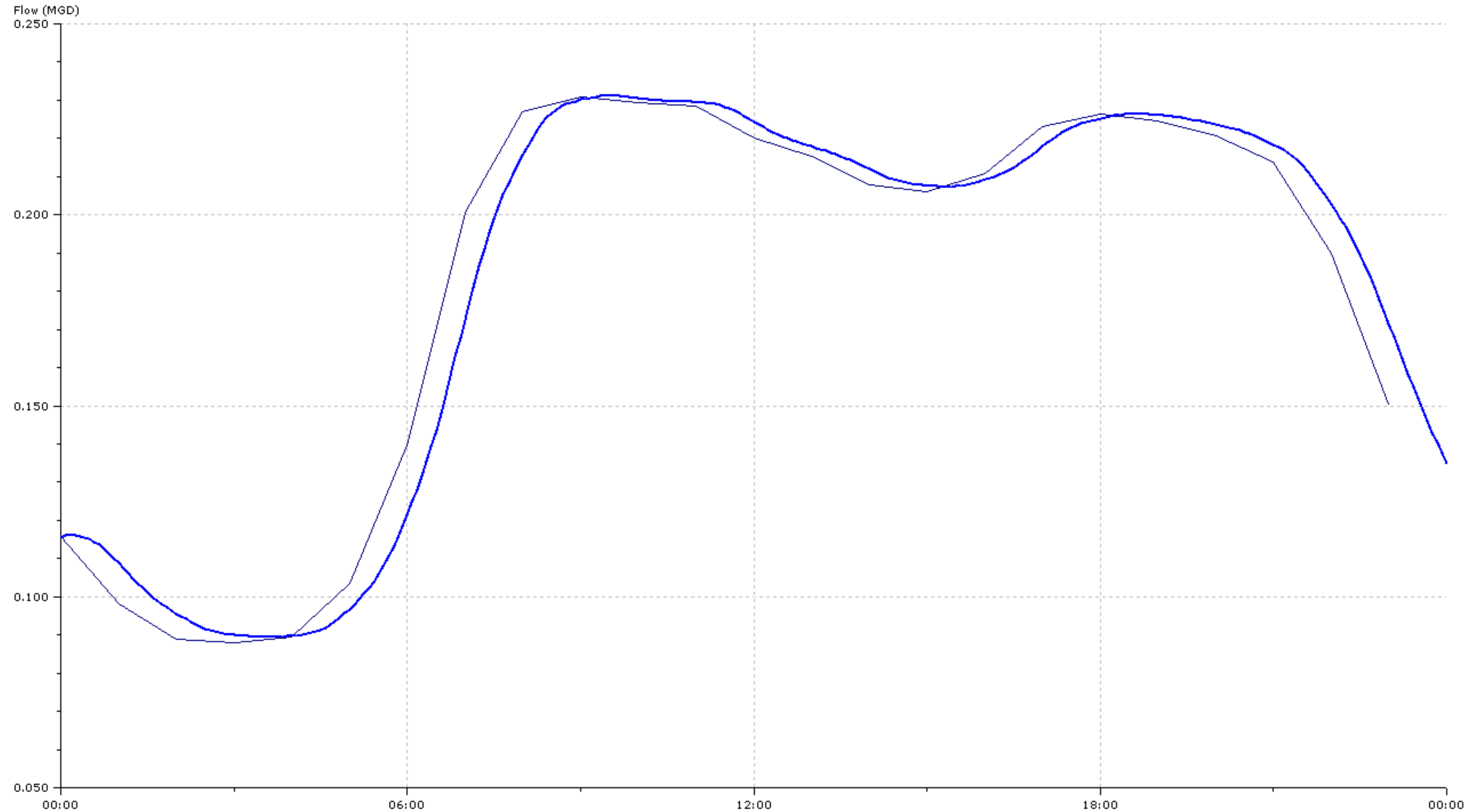
	Flow (MGD)		
	Min	Max	Volume (US Mgal)
Observed Flow	0.046	0.104	0.079
Simulated ADWF Flow	0.051	0.103	0.083

Figure A-3
City of Live Oak
Dry Weather Flow Calibration for Flow Monitor #3



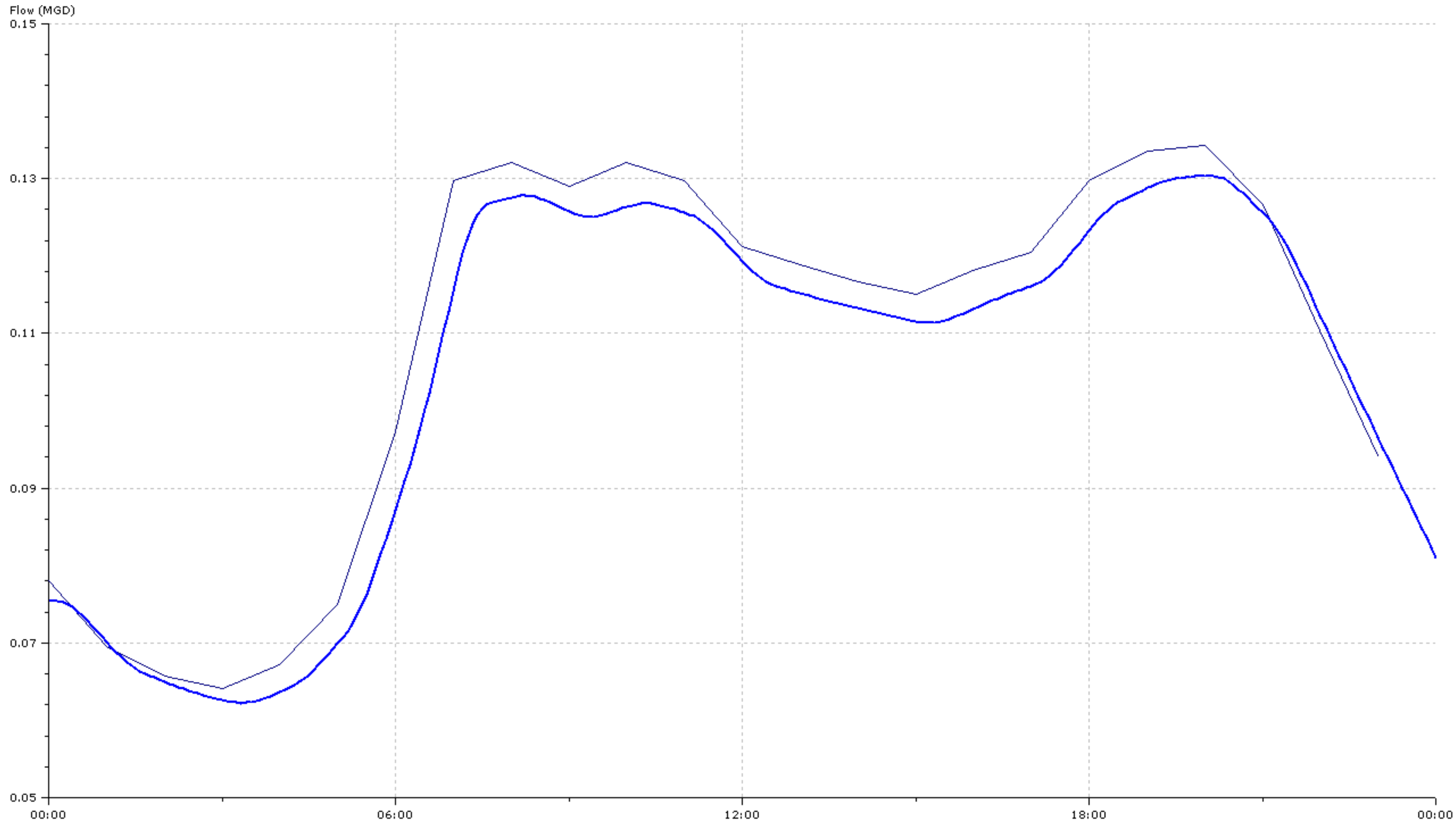
		Flow (MGD) Min	Flow (MGD) Max	Flow (MGD) Volume (US Mgal)
Observed Flow		0.019	0.055	0.039
Simulated ADWF Flow		0.019	0.055	0.040

Figure A-4
City of Live Oak
Dry Weather Flow Calibration for Flow Monitor #5



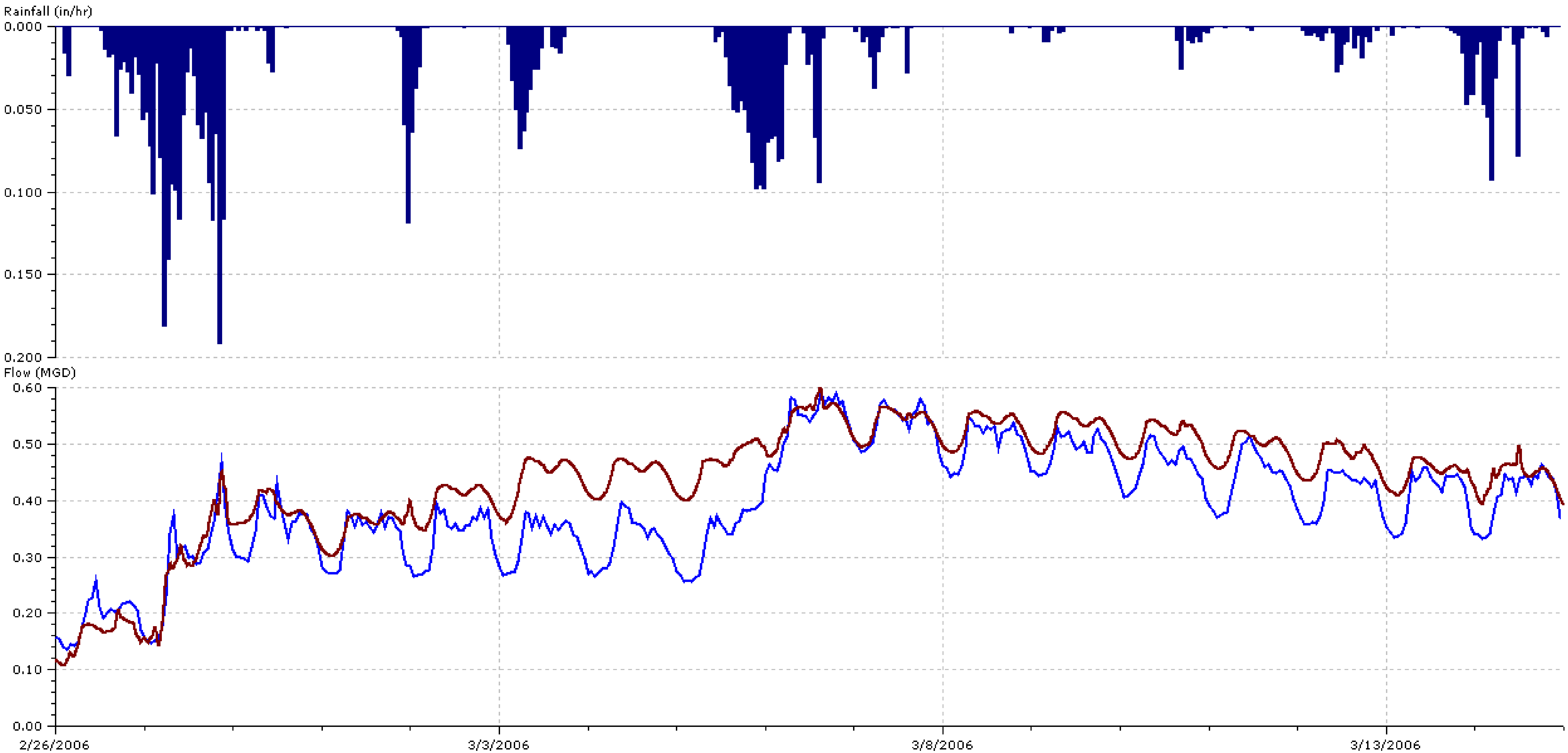
	Flow (MGD) Min	Flow (MGD) Max	Flow (MGD) Volume (US Mgal)
Observed Flow	0.088	0.231	0.176
Simulated ADWF Flow	0.089	0.231	0.182

Figure A-5
City of Live Oak
Dry Weather Flow Calibration for Flow Monitor #6



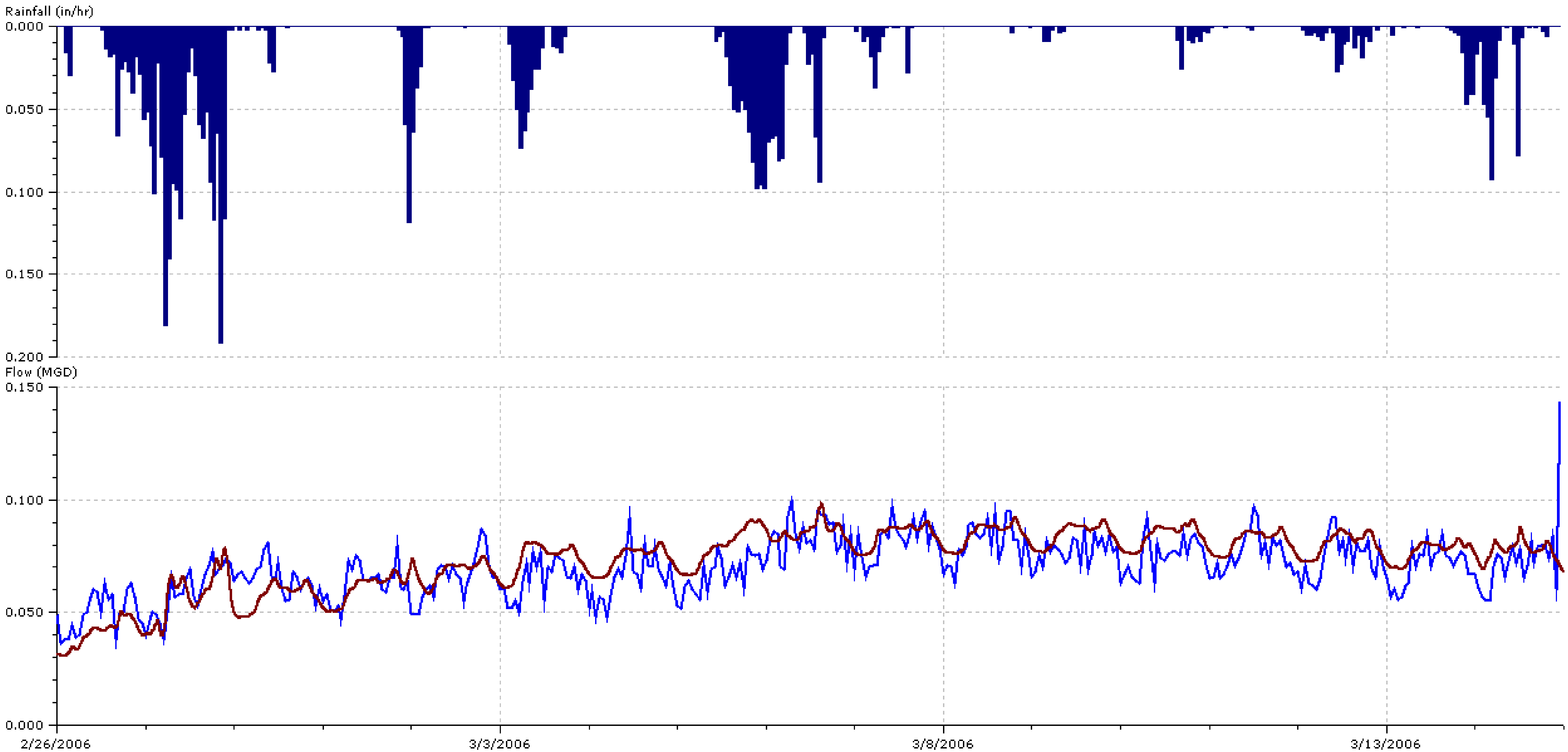
		Flow (MGD)		
		Min	Max	Volume (US Mgal)
Observed Flow		0.064	0.134	0.105
Simulated ADWF Flow		0.062	0.130	0.105

Figure A-6
City of Live Oak
Dry Weather Flow Calibration for Flow Monitor #7



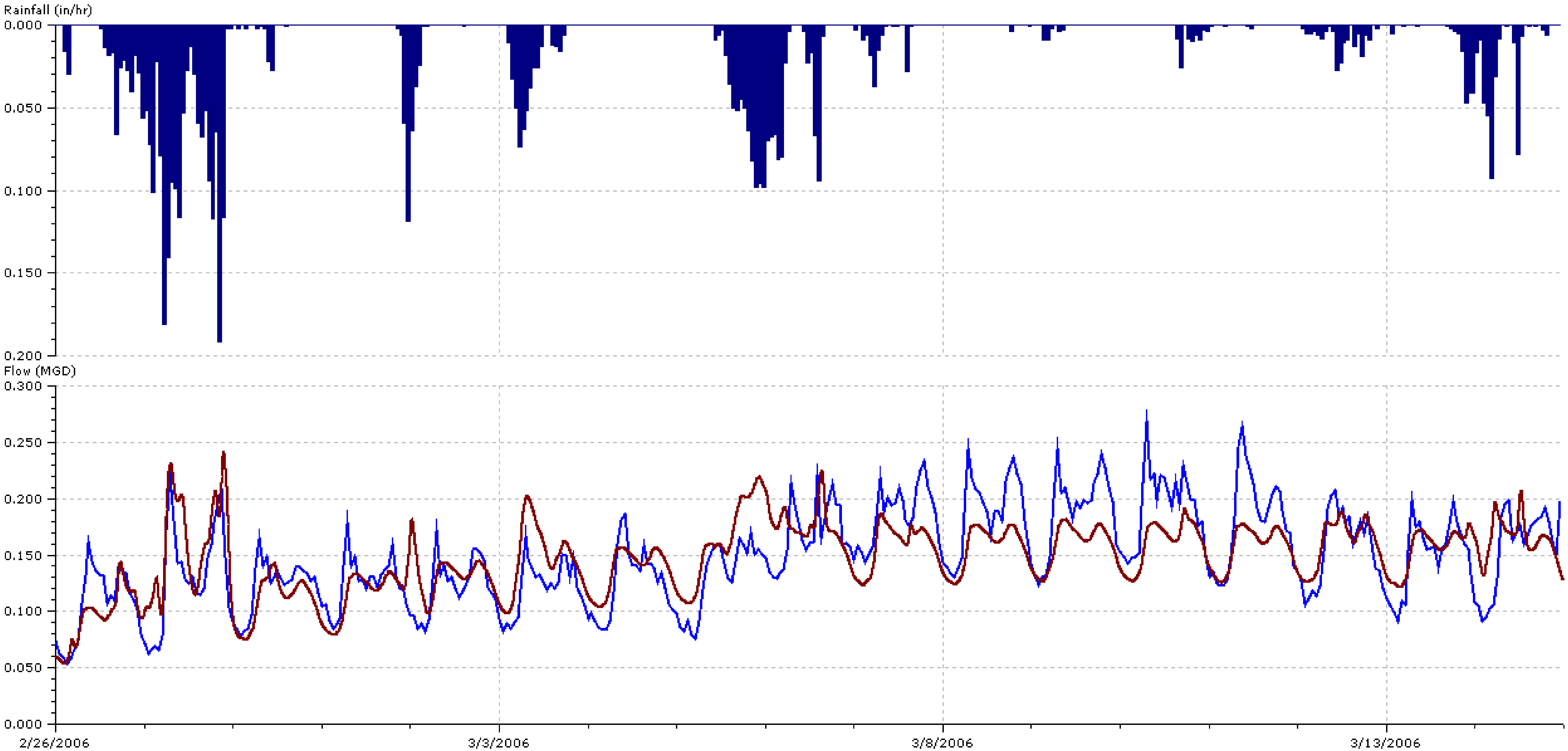
		Rainfall			Flow (MGD)		
		Depth (in)	Peak (in/hr)	Average (in/hr)	Min	Max	Volume (US Mgal)
Rain		5.277	0.192	0.013			
Observed Wet Weather Flow					0.135	0.591	6.676
Simulated Wet Weather Flow					0.107	0.600	7.427

Figure A-7
City of Live Oak
Wet Weather Flow Calibration for Flow Monitor #1



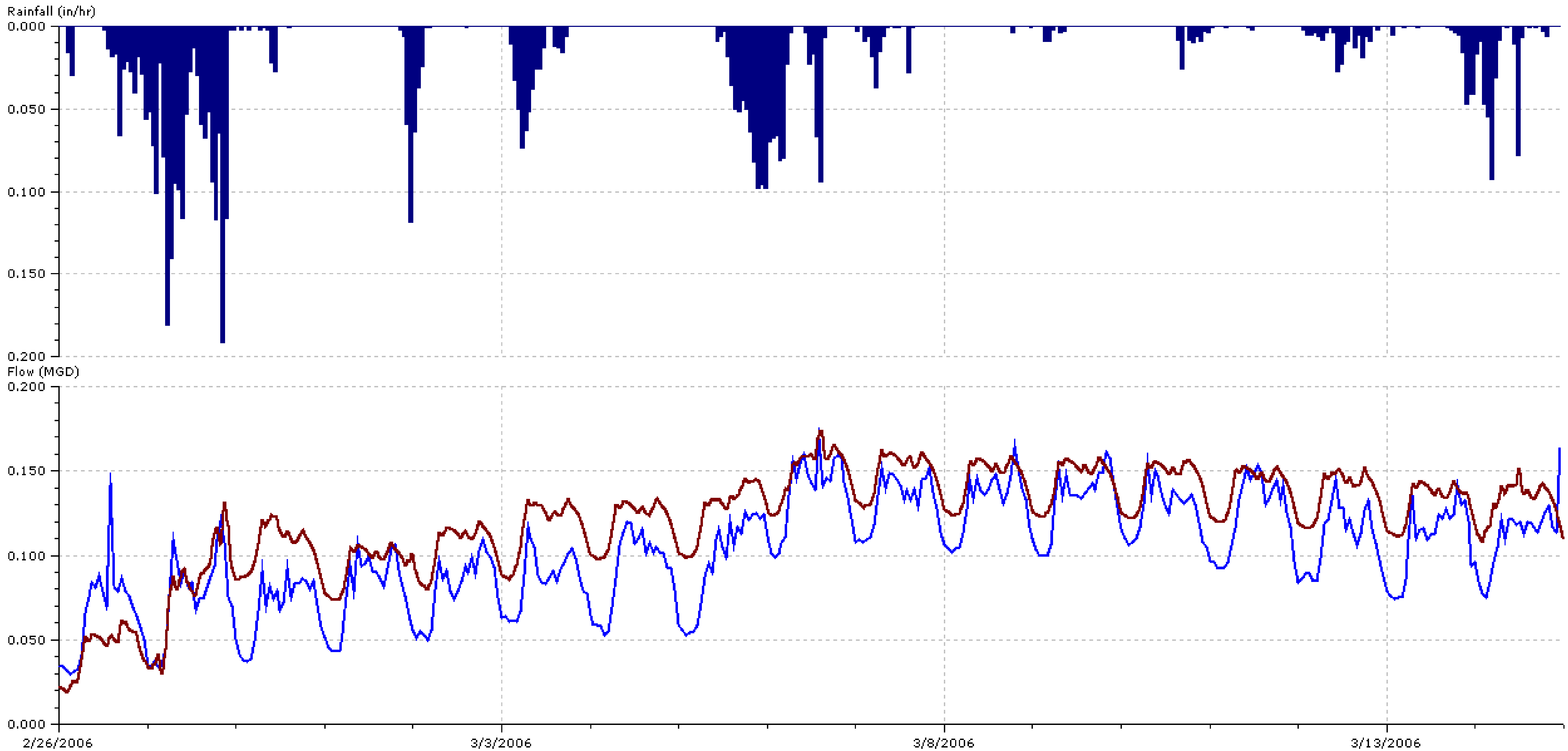
		Rainfall			Flow (MGD)		
		Depth (in)	Peak (in/hr)	Average (in/hr)	Min	Max	Volume (US Mgal)
Rain		5.277	0.192	0.013			
Observed Wet Weather Flow					0.036	0.144	1.189
Simulated Wet Weather Flow					0.031	0.098	1.247

Figure A-8
City of Live Oak
Wet Weather Flow Calibration for Flow Monitor #2



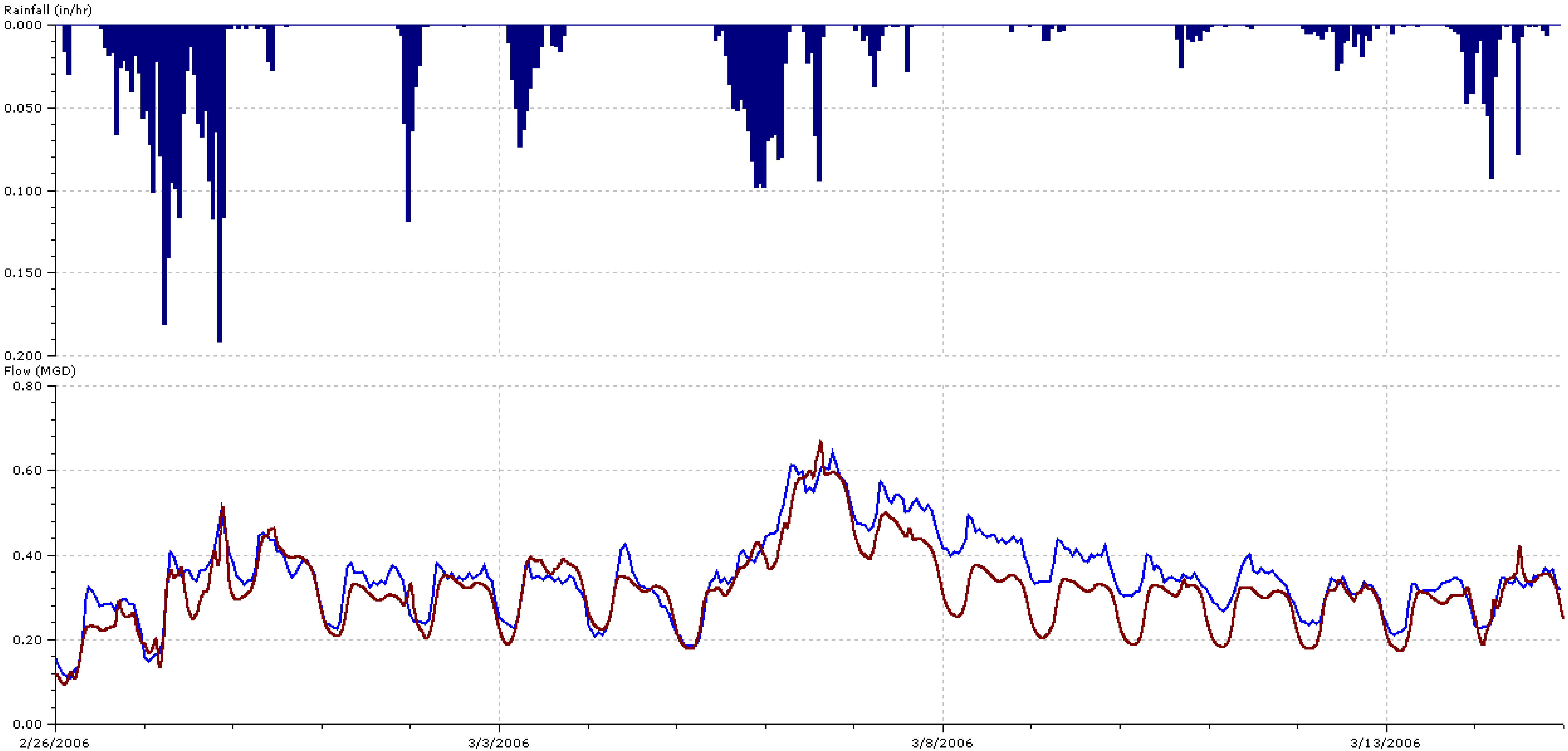
	Rainfall			Flow (MGD)		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min	Max	Volume (US Mgal)
Rain	5.277	0.192	0.013			
Observed Wet Weather Flow				0.053	0.269	2.541
Simulated Wet Weather Flow				0.053	0.242	2.502

Figure A-9
City of Live Oak
Wet Weather Flow Calibration for Flow Monitor #3



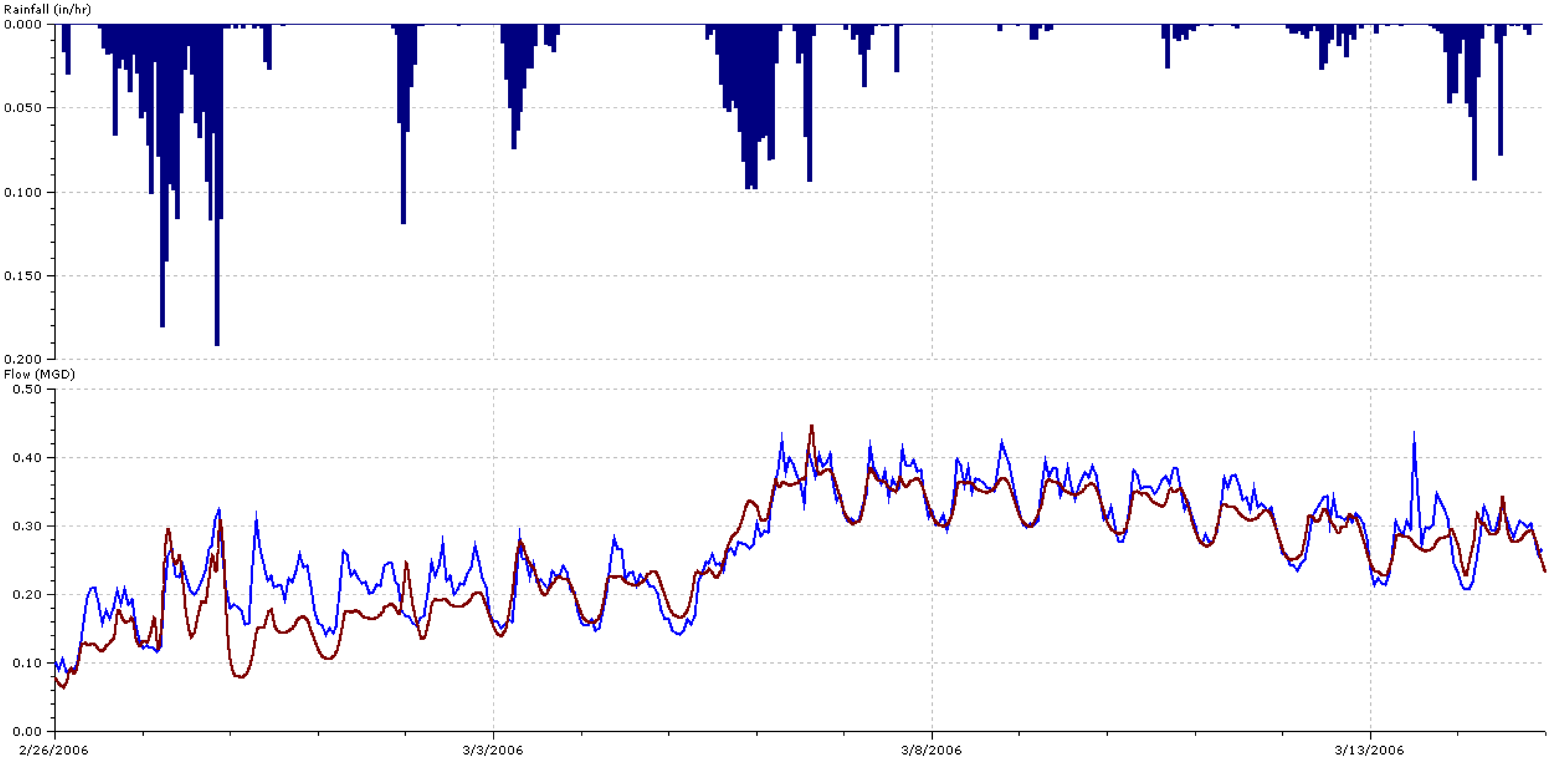
	Rainfall Depth (in)	Rainfall Peak (in/hr)	Rainfall Average (in/hr)	Flow (MGD) Min	Flow (MGD) Max	Flow (MGD) Volume (US Mgal)
Rain	5.277	0.192	0.013			
Observed Wet Weather Flow				0.030	0.169	1.751
Simulated Wet Weather Flow				0.019	0.173	2.061

Figure A-10
City of Live Oak
Wet Weather Flow Calibration for Flow Monitor #5



		Rainfall			Flow (MGD)		
		Depth (in)	Peak (in/hr)	Average (in/hr)	Min	Max	Volume (US Mgal)
Rain		5.277	0.192	0.013			
Observed Wet Weather Flow					0.110	0.642	5.958
Simulated Wet Weather Flow					0.093	0.668	5.377

Figure A-11
City of Live Oak
Wet Weather Flow Calibration for Flow Monitor #6



		Rainfall			Flow (MGD)		
		Depth (in)	Peak (in/hr)	Average (in/hr)	Min	Max	Volume (US Mgal)
Rain		5.277	0.192	0.013			
Observed Wet Weather Flow					0.088	0.424	4.575
Simulated Wet Weather Flow					0.064	0.445	4.314

Figure A-12
City of Live Oak
Wet Weather Flow Calibration for Flow Monitor #7

Appendix B

City of Live Oak Manhole Inventory

Modeled Manhole Inventory

Manhole ID	Invert Elevation (feet)	Rim Elevation (feet)
Kola St. PS (1)	79.74	57.11
10	79.14	67.54
11	78.24	66.94
12	78.24	66.14
13	78.64	61.38
14	79.14	68.17
15	80.24	71.34
16	78.34	71.84
17	78.34	69.04
18	79.84	67.28
19	79.84	66.54
2	79.84	66.78
20	79.04	65.94
21	79.84	62.44
22	79.94	71.34
23	80.14	69.52
24	79.64	72.84
25	79.34	69.70
26	79.14	68.49
27	75.7	58.11
28	79.04	61.75
29	78.94	72.44
3	78.64	68.93
30	79.64	70.63
Musgrave PS (31)	77.4	51.80
34	78.22	70.54
35	78.73	70.04
37	79.24	69.68
38	78.94	68.18
39	79.74	67.26
4	78.64	69.10
40	78.14	70.57
5	78.04	69.53
6	77.94	68.51
7	81.04	70.84
8	79.04	68.92
9	79.84	69.64
A	74.79	65.89
A1-1	73.84	66.41
A10-S	76.14	68.89
A2-1	74.8	66.76
A2-2	74.24	67.79
A2-3	74.84	68.16
A3-1	74.04	67.05
A3-2	73.24	67.84
A3-3	74.44	68.47
A4-1	74.84	67.26
A5-1	75.44	67.59
A6-1	76.54	67.82
A7-1	77.24	68.16

Manhole ID	Invert Elevation (feet)	Rim Elevation (feet)
A8-1	77.04	68.49
A9-1	75.74	68.64
A9-2	75.24	69.99
A9-21	74.94	70.29
AA	75.24	65.84
AA-1	75.34	66.14
AA-2	75.34	66.25
AA-21	76.03	66.42
AA1-1	75.32	66.70
AA1-2	78.34	68.93
AA1-3	76.94	69.41
AA2-1	76.84	67.00
AA2-2	78.74	68.04
AA2-3	79.34	68.64
AA3-1	77.84	67.51
AA4-1	77.84	68.06
AA5-1	78.64	68.46
AA6-1	78.84	68.65
AA7-1	77.94	68.85
AA8-1	78.94	69.21
AA9-1	79.34	69.59
AA9-2	78.24	70.4
AA9-3	78.14	71.2
AA9-4	77.44	72
AA9-5	77.64	72.8
AAA	75.74	67.18
AAA-1	74.99	67.82
AAA-2	74.94	67.94
AAA-3	75.34	68.84
AAA-4	75.74	69.74
AB-1	76.94	68.14
AB-2	73.84	69.15
AB-3	76.94	69.66
AB-4	76.94	70.15
AB-5	76.84	70.83
AB-6	75.04	71.35
AB-7	74.74	72.16
AB-71	76.42	72.84
AC-1	75.14	69.07
AC-2	76.04	69.95
B	74.94	65.95
B1-1	75.24	67.52
B2-1	76.64	68.18
B3-1	77.94	68.64
B4-1	77.34	69.13
B4-2	76.94	69.68
B4-21	76.94	71.04
B4-22	77.84	72.05
Ash St. PS (BP-1)	77.84	56.5
BP-10	76.84	67.81

Modeled Manhole Inventory

Manhole ID	Invert Elevation (feet)	Rim Elevation (feet)
BP-10A	76.84	67.81
BP-11	77.64	68.21
BP-12	77.74	68.64
BP-13	78.24	69.09
BP-14	78.94	69.89
BP-2	77.84	65.64
BP-3	78.24	65.71
BP-4	77.44	66.02
BP-5	78.14	66.25
BP-6	78.54	66.4
BP-6A	77.64	66.66
BP-7	76.84	67.26
BP-8	76.94	67.61
BP-9	77.04	67.72
C	76.94	66.29
D	75.84	66.64
Date St P.S.	63.83	54.5
DE-2	79.84	72.31
DE-3	76.84	73.53
DE-4	76.37	73.01
DE-41	76.96	72.57
DE-5	76.92	73.76
DE-8	78.33	75.19
E	75.84	66.82
F	77.84	67.37
G	77.09	67.73
H	77.34	68.09
HS-1	79.44	70.86
I	78.04	68.28
J	77.94	68.64
K	77.14	69
KE-1	78.74	70.5
KE-2	79.84	70.69
L	78.94	69.37
L1-1	79.04	69.84
L1-2	78.34	70.54
L1-3	77.84	71.15
L1-31	78.24	71.42
L1-4	77.99	71.49
L1-5	77.64	72.48
L1-51	77.84	73.89
L1-6	78.34	72.98
L1-7	78.69	73.49
L1-71	78.54	74.89
L1-72	78.84	75.05
L1-8	79.04	73.79
N1-1	78.94	71.06
N2-1	78.24	71.54
N3-1	79.34	71.9
N3-2	79.44	72.2

Manhole ID	Invert Elevation (feet)	Rim Elevation (feet)
N3-3	79.84	73.51
N3-31	80.84	74.14
N3-32	80.84	75.44
N3-33	80.84	76.53
N7-1	80.54	73.33
N7-2	78.94	74.34
N7-3	79.34	75.21
N7-4	79.74	76.19
O-11	77.84	72.08
P1-1	79.24	71.86
P2-1	79.84	72.61
Peachtree PS (PT-1)	73.9	50.9
PT-10	76.09	69.24
PT-11	75.41	68.18
PT-12	75.54	69.62
PT-13	75.75	71.07
PT-14	75.4	69.48
PT-15	74.14	65.03
PT-16	74.4	65.61
PT-17	74.83	68.32
PT-18	75.65	69.65
PT-19	75.3	66.79
PT-2	76.24	61.64
PT-20	75.33	67.75
PT-21	75.94	69.7
PT-22	75.63	69.57
PT-3	76.24	61.88
PT-4	76.24	62.87
PT-5	73.99	63.99
PT-6	74.24	64.56
PT-7	75.54	65.88
PT-8	75.84	67.69
PT-9	75.44	67.3
Q	73.94	67.39
R	77.34	67.57
S	76.94	67.98
S-10	76.04	72.52
SS	77.18	68.29
T	77.34	68.51
W	77.16	69.56
W1-1	77.74	69.95
W1-2	75.54	71.41
W2-1	78.05	70.15
W2-10	78.19	74.03
W2-2	78.12	71.47
W2-3	77.83	71.73
W2-4	78.04	72.31
W2-5	77.44	72.96
W2-6	78.09	74.19
W2-61	78.44	74.48

Modeled Manhole Inventory

Manhole ID	Invert Elevation (feet)	Rim Elevation (feet)
W2-7	78.84	74.91
W2-8	77.84	72.86
W2-81	77.84	73.04
W2-9	77.64	73.64
W3-1	77.34	70.41
W4-1	77.84	70.77
W4-3	78.44	71.92
W4-4	77.84	72.91
W4-5	78.84	73.05
WW	77.84	69.97
Y2-1	77.74	71.57
Y3-1	76.64	71.89
Y4-1	76.04	71.95

Manhole ID	Invert Elevation (feet)	Rim Elevation (feet)
Y4-11	76.84	72.01
Y5-1	76.74	72.32
Y5-11	77.34	72.53
Y5-2	76.14	72.76
Y5-21	76.54	72.94
Y5-22	76.64	73.01
Z	78.04	71.08
Z2-1	78.54	71.78
Z3-1	76.34	72.39
Z4-1	76.64	72.71
Z4-11	76.94	72.83
Z4-2	76.88	73.09
Z4-21	77.34	73.46

Appendix C

City of Live Oak Model Results

City of Live Oak
Modeled Pipe - Attributes and Modeling Results

Modeled Pipe Attributes						Existing Development Model Results			Build-out of City Limits Model Results		
US Node ID	DS Node ID	US Invert Level (feet)	DS Invert Level (feet)	Length (feet)	Slope (%)	Diameter (inches)	Full Pipe Capacity (Mgal/d)	Design Storm Peak Flow (Mgal/d)	Improvement Pipe Diameter (inches) [a]	Improvement Full Pipe Capacity (inches) [a]	Design Storm Peak Flow (Mgal/d)
10	11	67.54	66.94	287	0.21	8	0.36	0.08	--	--	0.08
11	12	66.94	66.14	400	0.20	8	0.35	0.08	--	--	0.08
12	13	66.14	61.38	413	1.15	8	0.84	0.08	--	--	0.08
13	27	61.38	58.21	173	1.83	10	1.92	0.22	--	--	0.25
14	10	68.17	67.54	292	0.22	8	0.36	0.08	--	--	0.08
15	9	71.34	69.64	179	0.95	8	0.76	0.01	--	--	0.01
16	17	71.84	69.04	415	0.68	8	0.64	0.00	--	--	0.00
17	28	69.04	61.75	419	1.74	8	1.03	0.00	--	--	0.00
18	19	67.28	66.54	361	0.21	8	0.35	0.02	--	--	0.02
19	20	66.54	65.94	258	0.23	8	0.38	0.02	--	--	0.02
2	1	66.78	63.97	93	3.02	21	17.80	0.82	--	--	0.93
20	21	65.94	62.44	242	1.45	8	0.94	0.02	--	--	0.02
21	28	62.44	61.75	261	0.26	8	0.40	0.03	--	--	0.06
22	23	71.34	69.52	269	0.68	8	0.64	0.00	--	--	0.00
23	18	69.52	67.28	258	0.87	8	0.73	0.01	--	--	0.01
24	22	72.84	71.34	133	1.13	8	0.83	0.00	--	--	0.00
25	26	69.7	68.49	242	0.50	8	0.55	0.00	--	--	0.00
26	18	68.49	67.28	217	0.56	8	0.58	0.00	--	--	0.00
27	31	58.11	57.8	27	1.13	10	1.51	0.26	--	--	0.34
28	27	61.75	58.21	90	3.93	10	2.81	0.05	--	--	0.09
29	30	72.44	70.63	227	0.80	8	0.70	0.00	--	--	0.00
3	38	68.93	68.18	300	0.25	15	2.09	0.57	--	--	0.59
30	23	70.63	69.52	236	0.47	8	0.54	0.00	--	--	0.00
34	AA9-2	70.54	70.4	63	0.22	8	0.37	0.04	--	--	0.04
35	AA9-1	70.04	69.59	248	0.18	8	0.33	0.04	--	--	0.04
37	4	69.68	69.1	347	0.17	15	1.71	0.24	--	--	0.24
38	39	68.18	67.26	378	0.24	15	2.06	0.59	--	--	0.61
39	2	67.26	66.78	41	1.17	15	4.52	0.59	--	--	0.61
4	3	69.1	68.93	40	0.43	15	2.72	0.37	--	--	0.36
40	WW	70.57	69.97	190	0.32	8	0.44	0.06	--	--	0.05
40	5	70.57	69.53	322	0.32	10	0.80	0.06	--	--	0.06
5	6	69.53	68.51	338	0.30	10	0.78	0.23	--	--	0.31
6	BP-2	68.51	65.64	350	0.82	10	1.28	0.36	--	--	0.54
7	9	70.84	69.64	276	0.44	8	0.52	0.00	--	--	0.00
8	14	68.92	68.17	319	0.24	8	0.38	0.02	--	--	0.02
9	8	69.64	68.92	298	0.24	8	0.38	0.01	--	--	0.01
A	Date St P.S.	65.89	62(a)	35	11.11	16	16.54	1.21	--	--	1.30
A1-1	A	66.41	65.89	290	0.18	10	0.60	0.56	12	0.98	0.58
A10-S	A9-1	68.89	68.64	260	0.10	10	0.44	0.18	--	--	0.16
A2-1	A1-1	66.76	66.41	340	0.10	10	0.45	0.56	12	0.74	0.58
A2-2	A2-1	67.79	66.76	390	0.26	8	0.40	0.01	--	--	0.00
A2-3	A2-2	68.16	67.79	210	0.18	8	0.33	0.00	--	--	0.00
A3-1	A2-1	67.05	66.76	245	0.12	10	0.49	0.52	12	0.79	0.54
A3-2	A3-1	67.84	67.05	390	0.20	8	0.35	0.00	--	--	0.00
A3-3	A3-2	68.47	67.84	210	0.30	8	0.43	0.00	--	--	0.00

City of Live Oak

Modeled Pipe - Attributes and Modeling Results

Modeled Pipe Attributes						Existing Development Model Results			Build-out of City Limits Model Results		
US Node ID	DS Node ID	US Invert Level (feet)	DS Invert Level (feet)	Length (feet)	Slope (%)	Diameter (inches)	Full Pipe Capacity (Mgal/d)	Design Storm Peak Flow (Mgal/d)	Improvement Pipe Diameter (inches) [a]	Improvement Full Pipe Capacity (inches) [a]	Design Storm Peak Flow (Mgal/d)
10	11	67.54	66.94	287	0.21	8	0.36	0.08	--	--	0.08
11	12	66.94	66.14	400	0.20	8	0.35	0.08	--	--	0.08
A4-1	A3-1	67.26	67.05	250	0.08	10	0.41	0.50	12	0.67	0.52
A5-1	A4-1	67.59	67.26	380	0.09	10	0.42	0.50	12	0.68	0.52
A6-1	A5-1	67.82	67.59	320	0.07	10	0.38	0.50	12	0.62	0.52
A7-1	A6-1	68.16	67.82	380	0.09	10	0.42	0.19	--	--	0.17
A8-1	A7-1	68.49	68.16	210	0.16	10	0.56	0.21	--	--	0.19
A9-1	A8-1	68.64	68.49	145	0.10	10	0.46	0.23	--	--	0.21
A9-2	A9-1	69.99	68.64	400	0.34	8	0.45	0.00	--	--	0.00
A9-21	A9-2	70.29	69.99	90	0.33	8	0.45	0.00	--	--	0.00
AA	Date St P.S.	65.84	62(a)	180	2.13	12	3.36	0.17	--	--	0.17
AA-1	AA	66.14	65.84	170	0.18	12	0.97	0.16	--	--	0.17
AA-2	AA-1	66.25	66.14	80	0.14	12	0.85	0.16	--	--	0.17
AA-21	AA-2	66.42	66.25	250	0.07	12	0.60	0.16	--	--	0.18
AA1-1	AA-21	66.7	66.42	240	0.12	12	0.79	0.15	--	--	0.16
AA1-2	AA1-1	68.93	66.7	970	0.23	8	0.37	0.00	--	--	0.00
AA1-3	AA1-2	69.41	68.93	250	0.19	8	0.34	0.00	--	--	0.00
AA2-1	AA1-1	67	66.7	280	0.11	12	0.75	0.14	--	--	0.15
AA2-2	AA2-1	68.04	67	320	0.33	8	0.45	0.01	--	--	0.03
AA2-3	AA2-2	68.64	68.04	290	0.21	8	0.36	0.01	--	--	0.02
AA3-1	AA2-1	67.51	67	420	0.12	12	0.80	0.10	--	--	0.08
AA4-1	AA3-1	68.06	67.51	450	0.12	12	0.81	0.10	--	--	0.08
AA5-1	AA4-1	68.46	68.06	370	0.11	12	0.76	0.09	--	--	0.07
AA6-1	AA5-1	68.65	68.46	200	0.10	12	0.71	0.09	--	--	0.07
AA7-1	AA6-1	68.85	68.65	150	0.13	12	0.84	0.09	--	--	0.07
AA8-1	AA7-1	69.21	68.85	340	0.11	12	0.75	0.06	--	--	0.06
AA9-1	AA8-1	69.59	69.21	350	0.11	12	0.76	0.05	--	--	0.05
AA9-2	35	70.4	70.04	197	0.18	8	0.33	0.04	--	--	0.04
AA9-3	34	71.2	70.54	303	0.22	8	0.36	0.02	--	--	0.02
AA9-4	AA9-3	72	71.2	430	0.19	8	0.34	0.02	--	--	0.02
AA9-5	AA9-4	72.8	72	370	0.22	8	0.36	0.00	--	--	0.00
AAA	Date St P.S.	67.18	62(a)	59	8.77	8	2.73	0.02	--	--	0.02
AAA-1	AAA	67.82	67.18	250	0.26	8	0.47	0.02	--	--	0.02
AAA-2	AAA-1	67.94	67.82	65	0.19	8	0.40	0.02	--	--	0.02
AAA-3	AAA-2	68.84	67.94	430	0.21	8	0.42	0.02	--	--	0.00
AAA-4	AAA-3	69.74	68.84	480	0.19	8	0.40	0.00	--	--	0.02
AB-1	A6-1	68.14	67.82	270	0.12	8	0.27	0.33	12	0.79	0.38
AB-2	AB-1	69.15	68.14	435	0.23	8	0.38	0.29	12	1.11	0.34
AB-3	AB-2	69.66	69.15	250	0.20	8	0.35	0.24	--	--	0.28
AB-4	AB-3	70.15	69.66	250	0.20	8	0.35	0.24	--	--	0.28
AB-5	AB-4	70.83	70.15	320	0.21	8	0.36	0.25	--	--	0.30
AB-6	AB-5	71.35	70.83	270	0.19	8	0.34	0.25	--	--	0.32
AB-7	AB-6	72.16	71.35	380	0.21	8	0.36	0.10	--	--	0.16
AB-71	AB-7	72.84	72.16	180	0.38	8	0.48	0.10	--	--	0.17
AC-1	AB-1	69.07	68.14	260	0.36	8	0.47	0.04	--	--	0.04

City of Live Oak

Modeled Pipe - Attributes and Modeling Results

Modeled Pipe Attributes						Existing Development Model Results			Build-out of City Limits Model Results		
US Node ID	DS Node ID	US Invert Level (feet)	DS Invert Level (feet)	Length (feet)	Slope (%)	Diameter (inches)	Full Pipe Capacity (Mgal/d)	Design Storm Peak Flow (Mgal/d)	Improvement Pipe Diameter (inches) [a]	Improvement Full Pipe Capacity (inches) [a]	Design Storm Peak Flow (Mgal/d)
10	11	67.54	66.94	287	0.21	8	0.36	0.08	--	--	0.08
11	12	66.94	66.14	400	0.20	8	0.35	0.08	--	--	0.08
AC-2	AC-1	69.95	69.07	250	0.35	8	0.46	0.02	--	--	0.02
B	A	65.95	65.89	50	0.12	15	1.45	0.73	--	--	0.81
B1-1	B	67.52	65.95	175	0.90	8	0.74	0.42	--	--	0.51
B2-1	B1-1	68.18	67.52	510	0.13	8	0.28	0.37	--	--	0.46
B3-1	B2-1	68.64	68.18	370	0.12	8	0.28	0.23	--	--	0.32
B4-1	B3-1	69.13	68.65	350	0.14	8	0.29	0.17	--	--	0.24
B4-2	B4-1	69.68	69.13	50	1.10	8	0.82	0.17	--	--	0.26
B4-21	B4-2	71.04	69.68	400	0.34	8	0.46	0.07	--	--	0.10
B4-22	B4-21	72.05	71.04	280	0.36	8	0.47	0.07	--	--	0.07
BP-10	BP-10A	67.81	67.81	26	0.00	12	0.00	0.39	--	--	0.42
BP-10A	BP-9	67.81	67.72	56	0.16	12	0.92	0.39	--	--	0.42
BP-11	BP-10	68.21	67.81	368	0.11	12	0.76	0.39	--	--	0.41
BP-12	BP-11	68.64	68.21	176	0.24	10	0.70	0.37	--	--	0.40
BP-13	BP-12	69.09	68.64	319	0.14	10	0.53	0.19	--	--	0.22
BP-14	BP-13	69.89	69.09	408	0.20	10	0.63	0.06	--	--	0.09
BP-14	37	72.73	72.52	47	0.45	15	2.79	0.00	--	--	0.00
BP-2	BP-1	65.64	65.08	41	1.37	16	6.85	1.21	--	--	1.45
BP-3	BP-2	65.71	65.64	33	0.21	15	2.27	0.91	--	--	0.94
BP-4	BP-3	66.02	65.71	391	0.08	15	1.18	0.91	--	--	0.94
BP-5	BP-4	66.25	66.02	281	0.08	15	1.19	0.91	--	--	0.94
BP-6	BP-5	66.4	66.25	193	0.08	15	1.16	0.91	--	--	0.95
BP-6A	BP-6	66.66	66.4	325	0.08	15	1.18	0.92	--	--	0.95
BP-7	BP-6A	67.26	66.66	316	0.19	12	1.00	0.38	--	--	0.41
BP-8	BP-7	67.61	67.26	315	0.11	12	0.77	0.39	--	--	0.41
BP-9	BP-8	67.72	67.61	103	0.11	12	0.75	0.39	--	--	0.42
C	B	66.29	65.95	365	0.09	12	0.70	0.32	--	--	0.30
D	C	66.64	66.29	320	0.11	12	0.76	0.32	--	--	0.30
DE-2	HS-1	72.31	70.86	140	1.04	10	1.87	0.06	--	--	0.06
DE-3	DE-4	73.53	73.01	250	0.21	8	0.46	0.01	--	--	0.01
DE-4	DE-41	73.01	72.57	260	0.17	8	0.42	0.03	--	--	0.03
DE-41	DE-2	72.57	72.31	840	0.03	10	0.32	0.03	--	--	0.03
DE-5	DE-4	73.76	73.01	480	0.16	8	0.40	0.01	--	--	0.01
DE-8	DE-5	75.19	73.76	280	0.51	8	0.73	0.00	--	--	0.00
E	D	66.82	66.64	180	0.10	12	0.73	0.31	--	--	0.30
F	E	67.37	66.82	370	0.15	10	0.55	0.12	--	--	0.10
G	F	67.73	67.37	350	0.10	10	0.45	0.10	--	--	0.08
H	G	68.09	67.73	380	0.10	10	0.44	0.09	--	--	0.07
HS-1	KE-2	70.86	70.69	110	0.16	10	0.72	0.06	--	--	0.09
I	H	68.28	68.09	190	0.10	10	0.45	0.04	--	--	0.04
J	I	68.64	68.28	365	0.10	10	0.44	0.04	--	--	0.04
K	J	69	68.64	370	0.10	10	0.44	0.01	--	--	0.01
KE-1	BP-14	70.5	69.89	350	0.17	10	0.77	0.06	--	--	0.09
KE-2	KE-1	70.69	70.5	80	0.24	10	0.90	0.06	--	--	0.09

City of Live Oak

Modeled Pipe - Attributes and Modeling Results

Modeled Pipe Attributes						Existing Development Model Results			Build-out of City Limits Model Results		
US Node ID	DS Node ID	US Invert Level (feet)	DS Invert Level (feet)	Length (feet)	Slope (%)	Diameter (inches)	Full Pipe Capacity (Mgal/d)	Design Storm Peak Flow (Mgal/d)	Improvement Pipe Diameter (inches) [(a)]	Improvement Full Pipe Capacity (inches) [(a)]	Design Storm Peak Flow (Mgal/d)
10	11	67.54	66.94	287	0.21	8	0.36	0.08	--	--	0.08
11	12	66.94	66.14	400	0.20	8	0.35	0.08	--	--	0.08
L	K	69.37	69	320	0.12	10	0.48	0.01	--	--	0.01
L1-1	2	69.84	69.37	165	0.29	6	0.19	0.24	10	0.76	0.34
L1-2	L1-1	70.54	69.84	350	0.20	6	0.16	0.23	10	0.63	0.34
L1-3	L1-2	71.15	70.54	230	0.27	10	0.95	0.23	--	--	0.34
L1-31	L1-3	71.42	71.15	110	0.25	8	0.50	0.05	--	--	0.05
L1-4	L1-3	71.49	71.15	250	0.14	10	0.68	0.20	--	--	0.31
L1-5	L1-4	72.48	71.49	510	0.19	10	0.81	0.19	--	--	0.28
L1-51	L1-5	73.89	72.48	380	0.37	8	0.62	0.00	--	--	0.10
L1-6	L1-5	72.98	72.48	260	0.19	10	0.81	0.19	--	--	0.26
L1-7	L1-6	73.49	72.98	250	0.20	10	0.83	0.15	--	--	0.24
L1-71	L1-7	74.89	73.49	370	0.38	8	0.62	0.06	--	--	0.13
L1-72	L1-7	75.05	74.89	262	0.06	8	0.25	0.02	--	--	0.02
L1-8	L1-7	73.79	73.49	120	0.25	10	0.92	0.07	--	--	0.10
N1-1	3	71.06	68.93	340	0.63	6	0.29	0.17	--	--	0.18
N2-1	N1-1	71.54	71.06	310	0.16	6	0.14	0.17	--	--	0.17
N3-1	N2-1	71.9	71.54	240	0.15	6	0.14	0.13	--	--	0.13
N3-2	N3-1	72.2	71.9	100	0.30	6	0.20	0.13	--	--	0.13
N3-3	N7-1	73.51	73.33	100	0.18	6	0.15	0.06	--	--	0.06
N3-31	N3-3	74.14	73.51	170	0.37	6	0.22	0.06	--	--	0.06
N3-32	N3-31	75.44	74.14	385	0.34	8	0.45	0.06	--	--	0.06
N3-33	N3-32	76.53	75.44	500	0.22	8	0.36	0.06	--	--	0.06
N7-1	N3-2	73.33	72.2	300	0.38	6	0.22	0.11	--	--	0.11
N7-2	N7-1	74.34	73.33	370	0.27	8	0.41	0.04	--	--	0.04
N7-3	N7-2	75.21	74.34	290	0.30	8	0.43	0.01	--	--	0.01
N7-4	N7-3	76.19	75.21	320	0.31	8	0.43	0.01	--	--	0.01
O-11	4	72.08	69.1	530	0.56	8	0.59	0.01	--	--	0.01
P1-1	37	71.86	69.68	500	0.44	6	0.24	0.23	--	--	0.22
P2-1	P1-1	72.61	71.86	500	0.15	6	0.14	0.23	--	--	0.21
PT-10	PT-11	69.24	68.18	110	0.96	8	0.77	0.00	--	--	0.00
PT-11	PT-9	71.02	70.14	255	0.35	8	0.46	0.00	--	--	0.00
PT-12	PT-11	69.62	68.18	309	0.47	8	0.53	0.00	--	--	0.00
PT-13	PT-14	71.07	69.48	295	0.54	8	0.57	0.01	--	--	0.01
PT-14	PT-9	69.48	67.3	437	0.50	8	0.55	0.01	--	--	0.01
PT-15	PT-5	65.03	63.99	245	0.42	8	0.51	0.11	--	--	0.11
PT-16	PT-15	65.61	65.03	103	0.56	8	0.59	0.11	--	--	0.11
PT-17	PT-16	68.32	65.61	182	1.49	8	0.95	0.00	--	--	0.00
PT-18	PT-19	69.65	66.79	187	1.53	8	0.97	0.00	--	--	0.00
PT-19	PT-16	66.79	65.61	335	0.35	8	0.46	0.02	--	--	0.02
PT-2	PT-1	61.64	57.55	236	1.73	8	1.03	0.25	--	--	0.25
PT-20	PT-19	67.75	66.79	250	0.38	8	0.48	0.02	--	--	0.02
PT-21	PT-20	69.7	67.75	281	0.69	8	0.65	0.02	--	--	0.02
PT-22	PT-20	72.41	70.59	163	1.12	8	0.83	0.00	--	--	0.00
PT-3	PT-2	61.88	61.64	67	0.36	8	0.47	0.25	--	--	0.25

City of Live Oak

Modeled Pipe - Attributes and Modeling Results

Modeled Pipe Attributes						Existing Development Model Results			Build-out of City Limits Model Results		
US Node ID	DS Node ID	US Invert Level (feet)	DS Invert Level (feet)	Length (feet)	Slope (%)	Diameter (inches)	Full Pipe Capacity (Mgal/d)	Design Storm Peak Flow (Mgal/d)	Improvement Pipe Diameter (inches) (a)	Improvement Full Pipe Capacity (inches) (a)	Design Storm Peak Flow (Mgal/d)
10	11	67.54	66.94	287	0.21	8	0.36	0.08	--	--	0.08
11	12	66.94	66.14	400	0.20	8	0.35	0.08	--	--	0.08
PT-4	PT-3	62.87	61.88	228	0.43	8	0.51	0.20	--	--	0.20
PT-5	PT-4	63.99	62.87	229	0.49	8	0.55	0.20	--	--	0.20
PT-6	PT-5	64.56	63.99	146	0.39	8	0.49	0.10	--	--	0.10
PT-7	PT-6	65.88	64.56	160	0.83	8	0.71	0.10	--	--	0.10
PT-8	PT-9	67.69	67.3	350	0.11	8	0.26	0.08	--	--	0.08
PT-9	PT-7	67.3	65.88	420	0.34	8	0.45	0.10	--	--	0.10
Q	E	67.39	66.82	185	0.31	8	0.43	0.19	--	--	0.19
R	Q	67.57	67.39	300	0.06	8	0.19	0.06	--	--	0.07
S	R	67.98	67.57	160	0.26	8	0.40	0.06	--	--	0.08
S-10	AB-6	72.52	71.35	329	0.36	8	0.47	0.00	--	--	0.06
SS	S	68.29	67.98	265	0.12	8	0.27	0.02	--	--	0.02
T	SS	68.51	68.29	185	0.12	8	0.27	0.02	--	--	0.02
W	BP-6A	69.56	66.66	480	0.60	8	0.61	0.50	--	--	0.50
W1-1	W	69.95	69.56	230	0.17	8	0.32	0.39	--	--	0.39
W1-2	W1-1	71.41	69.95	230	0.64	8	0.62	0.03	--	--	0.03
W2-1	W1-1	70.15	69.95	150	0.13	8	0.29	0.37	--	--	0.37
W2-10	W2-9	74.03	73.64	150	0.26	8	0.40	0.02	--	--	0.02
W2-2	W2-1	71.47	70.15	250	0.53	6	0.26	0.21	--	--	0.21
W2-3	W2-2	71.73	71.47	80	0.33	6	0.21	0.21	--	--	0.21
W2-4	W2-3	72.31	71.73	260	0.22	8	0.37	0.17	--	--	0.17
W2-5	W2-4	72.96	72.31	220	0.30	8	0.42	0.13	--	--	0.13
W2-6	W2-5	74.19	72.96	410	0.30	8	0.43	0.13	--	--	0.13
W2-61	W2-6	74.48	74.19	110	0.26	8	0.40	0.06	--	--	0.06
W2-7	W2-6	74.91	74.19	250	0.29	8	0.42	0.08	--	--	0.08
W2-8	W2-4	72.86	72.31	180	0.31	8	0.43	0.02	--	--	0.02
W2-81	W2-8	73.04	72.86	70	0.26	8	0.40	0.00	--	--	0.00
W2-9	W2-8	73.64	72.86	250	0.31	8	0.44	0.02	--	--	0.02
W3-1	W2-1	70.41	70.15	190	0.14	8	0.29	0.18	--	--	0.18
W4-1	W3-1	70.77	70.41	300	0.12	8	0.27	0.16	--	--	0.16
W4-3	W4-1	71.92	70.77	510	0.23	6	0.17	0.16	--	--	0.16
W4-4	W4-3	72.91	71.92	535	0.19	6	0.16	0.15	--	--	0.16
W4-5	W4-4	73.05	72.91	70	0.20	6	0.16	0.17	--	--	0.18
WW	W	69.97	69.56	330	0.12	8	0.28	0.12	--	--	0.11
Y2-1	5	71.57	69.53	375	0.54	6	0.27	0.13	--	--	0.22
Y3-1	Y2-1	71.89	71.57	210	0.15	8	0.30	0.12	--	--	0.21
Y4-1	Y3-1	71.95	71.89	40	0.15	8	0.30	0.06	--	--	0.05
Y4-11	Y4-1	72.01	71.95	8	0.75	8	0.68	0.00	--	--	0.00
Y5-1	Y4-1	72.32	71.95	240	0.15	8	0.31	0.06	--	--	0.05
Y5-11	Y5-1	72.53	72.32	150	0.14	8	0.29	0.00	--	--	0.00
Y5-2	Y5-1	72.76	72.32	290	0.15	8	0.30	0.04	--	--	0.04
Y5-21	Y5-2	72.94	72.76	100	0.18	8	0.33	0.00	--	--	0.00
Y5-22	Y5-2	73.01	72.76	170	0.15	8	0.30	0.04	--	--	0.04
Z	6	71.08	71.03	26	0.19	10	0.62	0.10	--	--	0.19

City of Live Oak
Modeled Pipe - Attributes and Modeling Results

Modeled Pipe Attributes						Existing Development Model Results			Build-out of City Limits Model Results		
US Node ID	DS Node ID	US Invert Level (feet)	DS Invert Level (feet)	Length (feet)	Slope (%)	Diameter (inches)	Full Pipe Capacity (Mgal/d)	Design Storm Peak Flow (Mgal/d)	Improvement Pipe Diameter (inches) (a)	Improvement Full Pipe Capacity (inches) (a)	Design Storm Peak Flow (Mgal/d)
10	11	67.54	66.94	287	0.21	8	0.36	0.08	--	--	0.08
11	12	66.94	66.14	400	0.20	8	0.35	0.08	--	--	0.08
Z2-1	Z	71.78	71.08	380	0.18	6	0.16	0.08	--	--	0.18
Z3-1	Y3-1	72.39	71.89	220	0.23	8	0.37	0.07	--	--	0.16
Z3-1	Z2-1	72.39	71.78	220	0.28	8	0.41	0.07	--	--	0.17
Z4-1	Z3-1	72.71	72.39	190	0.17	8	0.32	0.12	--	--	0.32
Z4-11	Z4-1	72.83	72.71	120	0.10	8	0.25	0.12	--	--	0.29
Z4-2	Z4-1	73.09	72.71	250	0.15	8	0.30	0.00	--	--	0.04
Z4-21	Z4-2	73.46	73.09	270	0.137	8	0.29	0	--	--	0

(a) Interpolated data
(b) It was assumed pipes would be replaced at the existing gradient

Appendix D

City of Live Oak Infill Development Inventory

City of Live Oak

Buildout of City Limits - Estimated Peak Diurnal and Peak Wet Weather Flow from Each Infill Parcel

APN	Discharge Manhole ID (Modeled)	Area (Ac)	Peak Diurnal Flow (Mgal/d))	Peak Wet Weather Flow (Mgal/d)
06-010-001	L1-8	10.17	0.0083	0.0284
06-020-007	N3-33	0.53	0.0013	0.0024
06-020-008	N3-33	0.59	0.0014	0.0027
06-030-001	P2-1	1.66	0.0025	0.0060
06-030-002	P2-1	0.94	0.0014	0.0034
06-030-003	P2-1	1.20	0.0019	0.0044
06-030-004	P2-1	0.88	0.0012	0.0031
06-030-005	4	0.76	0.0010	0.0026
06-050-031	N3-2	0.29	0.0008	0.0014
06-050-032	N7-4	0.26	0.0005	0.0010
06-060-004	P2-1	0.41	0.0011	0.0019
06-060-006	4	1.18	0.0029	0.0054
06-060-011	4	0.29	0.0007	0.0013
06-060-012	4	0.26	0.0006	0.0012
06-060-013	4	0.25	0.0006	0.0011
06-060-017	4	0.39	0.0009	0.0018
06-060-022	P2-1	0.72	0.0017	0.0032
06-070-008	4	0.22	0.0006	0.0010
06-070-012	4	0.23	0.0006	0.0011
06-080-006	L1-2	0.14	0.0002	0.0005
06-091-031	N2-1	0.24	0.0004	0.0009
06-092-019	3	0.58	0.0014	0.0027
06-092-021	N1-1	0.81	0.0021	0.0038
06-092-021	N1-1	0.51	0.0013	0.0024
06-092-022	N2-1	0.18	0.0004	0.0008
06-092-023	N2-1	1.25	0.0031	0.0058
06-093-001	4	0.16	0.0004	0.0007
06-093-008	4	0.18	0.0004	0.0007
06-100-025	P1-1	4.68	0.0050	0.0149
06-100-026	HS-1	9.77	0.0143	0.0340
06-111-001	1	0.53	0.0008	0.0019
06-124-009	38	0.18	0.0004	0.0008
06-125-001	38	0.56	0.0014	0.0026
06-125-008	38	1.67	0.0043	0.0078

APN	Discharge Manhole ID	Area (Ac)	Peak Diurnal Flow (Mgal/d)	Peak Wet Weather Flow (Mgal/d)
06-129-012	BP-12	0.20	0.0004	0.0008
06-132-005	B4-2	0.49	0.0007	0.0019
06-132-005	B4-2	0.35	0.0004	0.0013
06-142-001	H	2.10	0.0055	0.0099
06-142-003	H	0.55	0.0013	0.0025
06-143-003	S	0.19	0.0004	0.0008
06-143-006	S	0.28	0.0008	0.0014
06-151-001	3	0.19	0.0005	0.0009
06-151-002	3	0.16	0.0004	0.0007
06-151-004	3	0.13	0.0003	0.0006
06-152-003	BP-11	0.33	0.0009	0.0016
06-152-006	BP-11	0.29	0.0008	0.0014
06-152-007	BP-11	0.32	0.0008	0.0015
06-171-005	B2-1	0.21	0.0002	0.0007
06-173-010	G	0.33	0.0004	0.0011
06-175-001	Q	0.47	0.0012	0.0023
06-176-012	S	0.15	0.0004	0.0007
06-181-006	BP-8	0.28	0.0008	0.0014
06-181-019	BP-6A	0.07	0.0002	0.0003
06-181-027	BP-7	0.17	0.0004	0.0007
06-181-029	BP-6A	0.08	0.0002	0.0004
06-181-030	BP-6A	0.10	0.0003	0.0005
06-181-031	BP-6A	0.24	0.0006	0.0011
06-181-032	BP-6A	0.22	0.0006	0.0010
06-181-033	BP-6A	0.49	0.0013	0.0023
06-201-026	B1-1	0.25	0.0002	0.0007
06-215-001	S	0.07	0.0002	0.0003
06-215-003	S	0.18	0.0005	0.0009
06-223-010	BP-6A	0.14	0.0002	0.0005
06-225-006	WW	0.10	0.0002	0.0004
06-230-003	40	2.23	0.0058	0.0105
06-230-004	40	0.33	0.0008	0.0015
06-232-005	W	0.10	0.0002	0.0004
06-232-029	WW	0.14	0.0002	0.0005

City of Live Oak

Buildout of City Limits - Estimated Peak Diurnal and Peak Wet Weather Flow from Each Infill Parcel

APN	Discharge Manhole ID (Modeled)	Area (Ac)	Peak Diurnal Flow (Mgal/d))	Peak Wet Weather Flow (Mgal/d)
06-233-003	40	0.70	0.0019	0.0033
06-261-015	A9-21	0.31	0.0008	0.0015
06-263-013	5	0.17	0.0002	0.0006
06-264-013	BP-3	0.24	0.0005	0.0011
06-303-008	Z2-1	1.39	0.0014	0.0044
06-303-010	Z	0.22	0.0002	0.0007
06-310-002	Z4-11	12.55	0.0302	0.0502
06-310-003	Z4-11	1.19	0.0029	0.0048
06-310-004	Z4-11	5.24	0.0126	0.0209
06-310-005	Z4-11	10.33	0.0249	0.0413
06-310-006	Z4-11	0.98	0.0024	0.0039
06-310-007	Z4-11	14.69	0.0354	0.0587
06-310-008	Z4-21	6.01	0.0065	0.0181
06-310-009	Z4-21	4.56	0.0049	0.0137
06-330-004	A10-S	1.70	0.0042	0.0078
06-330-009	AB-2	1.59	0.0041	0.0079
06-351-014	L1-51	42.04	0.0451	0.1117
06-361-018	AA9-3	0.31	0.0002	0.0009
06-370-003	P2-1	5.33	0.0058	0.0169
06-370-004	P2-1	5.03	0.0054	0.0160
06-370-005	P2-1	5.19	0.0056	0.0165
06-390-015	AA2-3	1.29	0.0014	0.0042
06-400-002	AA5-1	1.62	0.0017	0.0051
06-400-003	AA4-1	1.69	0.0019	0.0054
06-400-004	AA2-1	6.04	0.0064	0.0199
06-433-018	W4-5	0.62	0.0004	0.0020
06-470-035	PT-1	25.98	0.0279	0.0720
06-470-038	AB-71	3.28	0.0085	0.0165
06-470-039	AB-71	2.22	0.0053	0.0107
06-530-002	A10-S	0.29	0.0004	0.0010
06-530-003	A10-S	0.28	0.0004	0.0010

APN	Discharge Manhole ID	Area (Ac)	Peak Diurnal Flow (Mgal/d)	Peak Wet Weather Flow (Mgal/d)
06-530-026	S-10	1.33	0.0032	0.0062
06-550-049	AA-21	0.21	0.0002	0.0007
06-560-001	P2-1	0.95	0.0010	0.0030
06-560-002	4	9.18	0.0099	0.0279
06-560-003	P2-1	3.69	0.0039	0.0117
06-570-019	W4-5	0.93	0.0008	0.0032
06-570-021	W4-5	0.28	0.0002	0.0009
06-580-086	4	1.34	0.0014	0.0043
06-600-001	L1-71	13.87	0.0112	0.0370
06-600-004	L1-71	11.29	0.0091	0.0307
06-600-006	L1-71	9.92	0.0081	0.0273
06-600-007	L1-71	8.89	0.0072	0.0247
06-600-008	L1-71	0.99	0.0008	0.0029
06-600-009	L1-71	1.30	0.0011	0.0038
06-630-008	AA2-2	2.72	0.0023	0.0086
06-700-071	AB-71	5.07	0.0074	0.0184
06-700-072	AB-71	5.07	0.0074	0.0184
NA*	13, 21 and 28	27.26	0.0219	0.0862

* The most current land use data available does not have APNs for undeveloped parcels in the Pennington Ranch Development. This portion of the Pennington Ranch Development consists of 136 low density residential parcels and the combined area, peak diurnal, and peak wet weather flows are presented above.

Appendix E

City of Live Oak Capital Improvement Cost Estimates

Table E-1

City of Live Oak Wastewater Collection System Master Plan

Preliminary Cost Estimate for Existing System Deficiencies at Build-out of City Limits

Improvements #1 and #2

ECO:LOGIC Engineering

DATE CREATED: 9/8/2009

PROJECT: LIVE OAK SEWER MASTER PLAN
PRELIMINARY COST ESTIMATE

UPDATED: 9/8/2009

PREPARED BY: NJW

JOB NUMBER: LOAK08-001

CHECKED BY: MCL

DESCRIPTION: Existing System Deficiencies - Improvements #1 and #2

CURRENT ENR CCI: 8,586

ITEM NO.	DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
	EXISTING SYSTEM IMPROVEMENTS				
1	Upsize Pipe (MH AB-1 to MH A) to 12"	2,530	LF	$180.00	$455,400
2	Upsize Pipe (L1-2 to 2) to 10"	515	LF	$150.00	$77,250
	SUBTOTAL				**$532,650**
	Estimating Contingency	30	%		$159,795
	SUBTOTAL CONSTRUCTION COSTS				**$692,445**
	Design/Administration	10	%		$69,245
	TOTAL CONSTRUCTION COSTS				**$761,690**

Notes:

(a) Unit price calculated at a rate of $15/inch diameter.

(b) Unit price assumes pipe bursting.

Table E-2

City of Live Oak Wastewater Collection System Master Plan

Preliminary Cost Estimate for Existing System Deficiencies at Build-out of City Limits

Improvements #1 and #2

ECO:LOGIC Engineering

		DATE CREATED:	9/8/2009
PROJECT:	LIVE OAK SEWER MASTER PLAN	**UPDATED:**	9/8/2009
	PRELIMINARY COST ESTIMATE		
		PREPARED BY:	NJW
JOB NUMBER:	LOAK08-001		
		CHECKED BY:	MCL
DESCRIPTION:	Existing System Deficiencies - Improvements #1 and #2	**CURRENT ENR CCI:**	8,586

ITEM NO.	DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
	EXISTING SYSTEM IMPROVEMENTS				
1	Upsize Pipe (MH AB-1 to MH A) to 12"	2,530	LF	$228.00	$576,840
2	Upsize Pipe (L1-2 to 2) to 10"	515	LF	$190.00	$97,850
	SUBTOTAL				**$674,690**
	Estimating Contingency	30	%		$202,407
	SUBTOTAL CONSTRUCTION COSTS				**$877,097**
	Design/Administration	10	%		$87,710
	TOTAL CONSTRUCTION COSTS				**$964,807**

Notes:

(a) Unit price calculated at a rate of $19/inch diameter.

(b) Unit price assumes open cut and replace. It includes excavation, materials and construction as well as installation of manholes.

Table E-3
City of Live Oak Wastewater Collection System Master Plan
Preliminary Cost Estimate for Build-out of Primary and Secondary SOIs - Proposed New Trunk Sewers

ECO:LOGIC Engineering

PROJECT:	LIVE OAK SEWER MASTER PLAN PRELIMINARY COST ESTIMATE	**DATE CREATED:**	9/8/2009
		UPDATED:	9/8/2009
JOB NUMBER:	LOAK08-001	**PREPARED BY:**	NJW
		CHECKED BY:	MCL
DESCRIPTION:	Build-out of SOI Proposed New Trunk Sewers	**CURRENT ENR CCI:**	8,586

ITEM NO.	DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
1	**BUILD-OUT NEW TRUNKS - EAST ROUTE**				
	18" Sewers	8,279	LF	$342.00	$2,831,418
	21" Sewers	12,900	LF	$399.00	$5,147,100
	27" Sewers	8,042	LF	$513.00	$4,125,546
2	**BUILD-OUT NEW TRUNKS - SOUTH ROUTE**				
	21" Sewers	6,561	LF	$399.00	$2,617,839
	24" Sewers	6,639	LF	$456.00	$3,027,384
	27" Sewers	287	LF	$513.00	$147,231
	SUBTOTAL				**$17,896,518**
	Estimating Contingency	30	%		$5,368,955
	SUBTOTAL CONSTRUCTION COSTS				**$23,265,473**
	Design/Administration	10	%		$2,326,547
	TOTAL CONSTRUCTION COSTS				**$25,592,021**

Notes:
(a) Does not specifically include pump station costs or costs for easement acquisitions.
(b) Unit price calculated at a rate of $19/inch diameter-linear foot
(c) Unit price includes excavation, materials and construction as well as installation of manholes.

Appendix F

City of Live Oak DRAFT Sewer Connection Fee Analysis

3875 Atherton Road
Rocklin, CA 95765
916.773.8100 TEL
916.773.8448 FAX

ECO:LOGIC ENGINEERS · CONSULTANTS

To: Satwant Takhar, City of Live Oak

From: Georgette Aronow

CC: Michael Harrison, Melissa Lee

Date: October 26, 2009

RE: Draft Sewer Connection Fee Analysis

ECO:LOGIC is currently in the process of preparing the Wastewater Collection System Master Plan for the City of Live Oak. As part of that analysis it was requested that the Sewer Connection Fee and the AB 1600 Fee be updated.

This analysis calculates one fee that would replace both the current Sewer Connection Fee and the AB 1600 Fee. The fee calculated in this analysis will be referred to as the 2009 Sewer Connection Fee and includes three components:

1) ***System Buy-In***: The system buy-in charge based on the City's existing sewer infrastructure assets. The analysis is based on the total cost of all of the sewer assets at installation less accumulated depreciation. The asset value information is based on the City's sewer asset depreciation table, which is included as Attachment 1.

2) ***Future CIP Project Costs***: The future CIP project costs are based on the projected facility needs as identified in the Sewer Master Plan. These costs were split between existing and future users based on benefit. The costs allocated to future users are included in the 2009 Sewer Connection Fee.

3) ***Sewer Lateral Installation***: Like the 2009 Water Connection Fee that includes the cost of installing the water meter, the 2009 Sewer Connection Fee includes the cost of installing the sewer lateral connection from the property line to the main trunkline.

Each of these fee components and how they were computed are discussed in greater detail below. **Table 1** summarizes the calculated connection fee. The fee includes a 1.5 percent administration charge to help cover the cost of City staff's administration of the fee program.

Table 1
City of Live Oak
Sewer Connection Fee Analysis
Summary of the Calculated 2009 Sewer Connection Fee

DRAFT

		Infrastructure					
Meter Size	EDU Factor	Existing Buy-in Charge	Future CIP Costs	Sewer Lateral Connection	Subtotal Cost	Admin. Charge 1.50%	Total Connection Fee
Less than 1"	1.00	$459	$6,752	$1,431	$8,642	$130	$8,772
1"	1.67	$766	$11,253	$1,431	$13,449	$202	$13,651
1 1/2"	3.33	$1,531	$22,506	$1,431	$25,468	$382	$25,850
2"	5.33	$2,450	$36,009	$1,431	$39,890	$598	$40,489
3"	11.67	$5,359	$78,771	$1,431	$85,560	$1,283	$86,844
4"	21.00	$9,646	$141,787	$1,431	$152,864	$2,293	$155,157
6"	46.67	$21,435	$315,083	$1,431	$337,949	$5,069	$343,018

MAJOR ASSUMPTIONS

This analysis and calculation of the 2009 Sewer Connection Fee is predicated on several major assumptions, discussed in further detail below.

EQUIVALENT DWELLING UNITS (EDUS)

For sewer service, one equivalent dwelling unit (EDU) is the amount of sewer flow an average single family residence is assumed to use. The Wastewater Collection System Master Plan assumes that one EDU uses 192 gallons per day.

The total capacity added to the sewer system by future improvements is estimated at 3.3 million gallons per day (gpd). This capacity would serve approximately 17,188 future EDUs, assuming 192 gallons per day of sewer flow per EDU.

Existing EDUs are based on the 2009 Water Connection Fee analysis, which is based on water sold in 2008. Total water sold in 2008 was approximately 469 million gallons. This equates to approximately 1.3 million gallons per day and 2,570 current (existing) EDUs, assuming 500 gpd per EDU.

Therefore, there is capacity for 19,757 EDUs to be serviced upon completion of sewer infrastructure improvements described in the Sewer Master Plan.

EDU FACTORS

EDU factors are the method for equating a single family unit to other types of customers, such as non-residential customers. In the case of water infrastructure, it is typical to use the water meter size as a way of establishing EDU factors. Each meter size has a maximum flow rate and can be equated back to one EDU (a single family unit). The water meter flow rates for Live Oak were determined based on the INVENSYS Catalog, the typical type of meter installed by the City of Live Oak.

It is not uncommon to use the same EDU factors for sewer fees. Presumably not all water flows to the sewer, however, the relationship between the less than 1 inch meter, based on capacity, to other meter sizes remains the same as for water. The water flow rates and EDU factors are shown in **Table 2**. It is proposed that these same EDU factors be used for sewer.

Table 2
City of Live Oak
Sewer Connection Fee Analysis
Proposed EDU Factors

Meter Size, in	Capacity (gpm) [1]	Proposed EDU Factor
Less than 1	30	1
1	50	1.7
1.5	100	3.3
2	160	5.3
3	350	11.7
4	630	21.0
6	1,400	46.7

[1] Based on INVENSYS Catalog

SYSTEM BUY-IN CHARGE

The system buy-in costs are based on an inventory of the City's existing sewer assets (sewer pipelines, pump stations, existing treatment plant facilities, etc.). The analysis uses the City's sewer asset depreciation schedule as the basis for this calculation and is included as Attachment 1.

The total sewer assets are estimated at $11.28 million, based on estimated costs at installation. Of that $11.28 million, the City has accumulated approximately $2.20 million in depreciation. The remaining net value of the assets, is therefore, estimated at $9.07 million as shown in Table 3.

The $9.07 million represents the value of the assets to spread over both existing and future users. The total cost is divided by the total EDUs, estimated at 19,757, for a cost per EDU of $459.32.

Table 3
City of Live Oak
Sewer Connection Fee Analysis
Summary of the Buy-In-Cost Analysis

DRAFT

Utility	Estimated Cost at Installation	Est. Total Accumulated Depreciation	Buy-In Costs Net of Accumulated Depreciation
	Costs Rounded to Thousands of Dollars		
Sewer Assets	$11,281,499	$2,206,627	$9,074,872
EDUs			
Existing			2,570
Future			17,188
Total			**19,757**
Cost per EDU			**$459.32**

FUTURE CIP COSTS

The future CIP costs represent the costs of future facilities to be built to serve new development. Table 4 shows the facilities and costs as identified by the Sewer Master Plan. These costs are then distributed to existing and future users based on benefit of the facilities. The majority of the costs, $75.52 million of the $104.35 million in total costs, are allocated to new development.

The City received a $10 million grant from the Clean Water State Revolving Fund (CWSRF) as part of the ARRA stimulus monies to help fund the Wastewater Treatment Plant Upgrades (Phase I) currently underway. The project will benefit both existing and new users equally and so, the grant was distributed equally among existing and future users as well.

It is likely that the City will have to finance the costs of the future infrastructure improvements. At the moment, the timeframe for these projects (collection system improvements and future improvements to the WWTP) is unknown. However, Table 5 calculates the cost per EDU including a financing factor.

The financing factor included in this initial calculation does not represent the full cost of financing. The annualized debt service payments are discounted by 3.5 percent, to reflect that the City is not planning to build these projects immediately. This results in the interest cost being cut by a factor of 50 percent.

Table 4
City of Live Oak
Sewer Connection Fee Analysis
Summary of Master Plan Capital Improvement Costs and Allocation to Existing and New Users

	Master Plan	Cost Distribution			Cost Allocation		
Description	**Capital Cost**	**Grant**	**Existing**	**New**	**Grant**	**Existing**	**New**
Collection System Improvements	$25,592,051		0%	100%		$0	$25,592,051
Treatment Plant Upgrades & Expansions							
Phase I WWTP [1]	$22,060,000	45%	27%	27%	$10,000,000	$6,030,000	$6,030,000
Phase II WWTP	$12,800,000		100%	0%		$12,800,000	$0
Phase III WWTP	$23,300,000		0%	100%		$0	$23,300,000
Phase IIII WWTP	$20,600,000		0%	100%		$0	$20,600,000
Total	**$104,352,051**				**$10,000,000**	**$18,830,000**	**$75,522,051**

[1] Currently under construction.

Table 5
City of Live Oak
Sewer Connection Fee Analysis
Sewer - Future Facility Cost per EDU

DRAFT

ITEM	*Assumption*	TOTAL COST
Total Project Cost		$75,522,051
Financing Factor [1]	**0.54**	$40,524,105
TOTAL COST		**$116,046,156**
Additional Capacity Added (GPD)		3,300,000
Cost per Gallon		**$35.17**
Gallons/Day per EDU		192
Cost per EDU [3]		**$6,752**

"cost_EDU"

[1] Assumes that 100 percent of the costs are financed:

Financing Costs;	
Amount Financed	$75,522,051.00
Rate	6.00%
Term	30
Bond Load Factor	15%
Annual Debt Service	$6,309,584.02
Total Debt Service	$189,287,520.55
Net Present Value of Debt Service 3.5% *discount factor*	$116,046,155.79
Net Proceeds	$75,522,051.00
Financing Cost	$40,524,104.79

[2] As determined by ECO:LOGIC
[3] Assumes that the Fee will be escalated by 3.5% each year.

The new facilities will add approximately 3.3 million gallons of additional capacity. If the total cost is divided by the additional capacity, the resulting cost per treated gallon is estimated at $35.17.

One EDU is assumed to use approximately 192 gallons per day of sewer flow. Therefore, the cost per EDU is calculated at $35.17 * 192 to equal $6,752 per EDU.

SEWER LATERAL INSTALLATION COST

Table 6 shows the City's estimated cost for installing a sewer lateral connection. This cost is included in the fee amount. It includes both the capital cost and the labor cost for the sewer lateral installation.

Table 6
City of Live Oak
Sewer Connection Fee Analysis
Cost of Installation for a 4-inch Lateral

DRAFT

	Hours	Cost/Hour	Cost
Piping(1)			$400.00
Tapping Saddle			$100.00
Wye			$260.00
Cleanout Lid and Concrete			$30.97
Subtotal			$790.97
Labor	8	$80.00	$640.00
Total			$1,430.97
Total Rounded			$1,431.00

Notes:
(1) Assume 20 LF of piping and $10/in LF unit cost

These three cost components are added together to compute the 2009 Sewer Connection Fee as shown in Table 1 above.

OTHER RECOMMENDATIONS

It is recommended that the City establish in its ordinance, at the time of fee adoption, the ability to increase the fee by 3.5% annually, at a minimum. The annual increase could also be linked to consumer price index (CPI) or the ENR Construction Cost Index.

This is particularly important if the City does plan to move forward with financing any of the CIP projects. If the fee is inflated annually, then the City should be able to recuperate the majority of the financing costs over time. The annual adjustment will also allow the City to stay current as the actual costs of the sewer lateral installation will likely increase over time.

The City should also consider reviewing and updating the fee analysis every three years, particularly since at this time the construction timing of the projects are unknown.

Attachment 1

Sewer System Asset List and Calculated Depreciation

City of Live Oak

FUND: 013 - SEWER ENTERPRISE FISCAL YEAR: 07/2009-06/2010

DATE ACQUIRED	DESCRIPTION	ID	TOTAL LIFE	TOTAL COST	SALVAGE VALUE	PRIOR PERIOD ACCUM DEPR	CURRENT PERIOD 07/2009-06/2010	NET VALUE
01/01/78	1978 CHAMPION S	000005-00	60	6,059.23	0.00	6,059.23	0.00	0.00
01/01/82	1982 VACTOR JET	000008-00	60	75,000.00	0.00	75,000.00	0.00	0.00
01/01/97	SEWER TREATMENT	000062-00	60	200.00	0.00	200.00	0.00	0.00
01/01/90	SEWER TREATMENT	000062-01	60	71.00	0.00	71.00	0.00	0.00
01/01/77	SEWER TREATMENT	000062-02	360	551.00	0.00	551.00	0.00	0.00
01/01/80	SEWER TREATMENT	000062-03	60	230.00	0.00	230.00	0.00	0.00
01/01/88	SEWER TREATMENT	000062-04	60	337.00	0.00	337.00	0.00	0.00
01/01/95	SEWER TREATMENT	000062-05	60	414.00	0.00	414.00	0.00	0.00
01/01/85	SEWER TREATMENT	000062-06	60	951.00	0.00	951.00	0.00	0.00
01/01/95	SEWER TREATMENT	000062-07	60	414.00	0.00	414.00	0.00	0.00
01/01/98	SEWER TREATMENT	000062-08	60	356.00	0.00	356.00	0.00	0.00
01/01/60	SEWER TREATMENT	000062-09	60	12.00	0.00	12.00	0.00	0.00
01/01/90	SEWER TREATMENT	000062-10	60	656.00	0.00	656.00	0.00	0.00
01/01/90	SEWER TREATMENT	000062-11	60	459.00	0.00	459.00	0.00	0.00
01/01/90	SEWER TREATMENT	000062-12	60	353.00	0.00	353.00	0.00	0.00
01/01/90	SEWER TREATMENT	000062-13	60	353.00	0.00	353.00	0.00	0.00
01/01/90	SEWER TREATMENT	000062-14	60	353.00	0.00	353.00	0.00	0.00
01/01/90	SEWER TREATMENT	000062-15	60	353.00	0.00	353.00	0.00	0.00
01/01/95	SEWER TREATMENT	000062-16	60	331.00	0.00	331.00	0.00	0.00
01/01/77	SEWER TREATMENT	000062-17	240	18,500.00	0.00	18,500.00	0.00	0.00
01/01/96	SEWER TREATMENT	000062-19	60	335.00	0.00	335.00	0.00	0.00
01/01/51	SEWER TREATMENT	000062-20	60	234.00	0.00	234.00	0.00	0.00
01/01/51	SEWER TREATMENT	000062-21	360	8,000.00	0.00	8,000.00	0.00	0.00
01/01/88	SEWER TREATMENT	000062-22	60	1,500.00	0.00	1,500.00	0.00	0.00
01/01/51	SEWER TREATMENT	000062-23	600	1,500.00	0.00	1,500.00	0.00	0.00
01/01/51	SEWER TREATMENT	000062-24	600	3,500.00	0.00	3,500.00	0.00	0.00
01/01/77	SEWER TREATMENT	000062-25	360	25,000.00	0.00	25,000.00	0.00	0.00
01/01/88	SEWER TREATMENT	000062-26	360	25,000.00	0.00	17,920.77	0.00	7,079.23
01/01/88	SEWER TREATMENT	000062-27	600	15,000.00	0.00	6,451.71	0.00	8,548.29
01/01/51	SEWER TREATMENT	000062-28	600	2,000.00	0.00	2,000.00	0.00	0.00
01/01/88	SEWER TREATMENT	000062-29	60	15,000.00	0.00	15,000.00	0.00	0.00
01/01/88	SEWER TREATMENT	000062-30	180	1,000.00	0.00	1,000.00	0.00	0.00
11/17/03	SEWER TREATMENT	000062-31	60	91.00	0.00	91.00	0.00	0.00
01/06/53	SEWER TREATMENT	000063-00	0	5,222.00	0.00	0.00	0.00	5,222.00
01/06/53	SEWER TREATMENT	000063-01	0	43,515.00	0.00	0.00	0.00	43,515.00
01/06/53	SEWER TREATMENT	000063-02	300	38,641.00	0.00	38,641.00	0.00	0.00
02/05/54	SEWER TREATMENT	000063-03	0	7,801.00	0.00	0.00	0.00	7,801.00
01/06/53	SEWER TREATMENT	000063-04	0	60,291.00	0.00	0.00	0.00	60,291.00
01/01/51	GRAVITY SEWER P	000077-00	720	90,100.00	0.00	87,863.23	0.00	2,236.77
01/01/52	GRAVITY SEWER P	000077-01	720	3,771.00	0.00	3,614.85	0.00	156.15
01/01/63	GRAVITY SEWER P	000077-02	600	52,216.00	0.00	48,573.97	0.00	3,642.03
01/01/75	GRAVITY SEWER P	000077-03	600	7,801.00	0.00	5,384.62	0.00	2,416.38
01/01/78	GRAVITY SEWER P	000077-04	600	242,185.00	0.00	152,627.93	0.00	89,557.07
01/01/79	GRAVITY SEWER P	000077-05	600	26,006.00	0.00	15,869.23	0.00	10,136.77
01/01/80	GRAVITY SEWER P	000077-06	600	29,189.00	0.00	17,227.69	0.00	11,961.31
01/01/83	GRAVITY SEWER P	000077-07	600	139,342.00	0.00	73,874.86	0.00	65,467.14
01/01/84	GRAVITY SEWER P	000077-08	600	18,859.00	0.00	9,621.29	0.00	9,237.71
01/01/85	GRAVITY SEWER P	000077-09	600	95,336.00	0.00	46,726.37	0.00	48,609.63
01/01/88	GRAVITY SEWER P	000077-10	600	15,803.00	0.00	6,797.15	0.00	9,005.85
01/01/91	GRAVITY SEWER P	000077-11	600	71,961.00	0.00	26,630.95	0.00	45,330.05

City of Live Oak

FUND: 013 - SEWER ENTERPRISE FISCAL YEAR: 07/2009-06/2010

DATE ACQUIRED	DESCRIPTION	ID	TOTAL LIFE	TOTAL COST	SALVAGE VALUE	PRIOR PERIOD ACCUM DEPR	CURRENT PERIOD 07/2009-06/2010	NET VALUE
01/01/92	GRAVITY SEWER P	000077-12	600	67,555.00	0.00	23,649.38	0.00	43,905.62
01/01/93	GRAVITY SEWER P	000077-13	600	195,107.00	0.00	64,390.36	0.00	130,716.64
01/01/94	GRAVITY SEWER P	000077-14	600	341,782.00	0.00	105,961.19	0.00	235,820.81
01/01/97	GRAVITY SEWER P	000077-15	600	108,992.00	0.00	27,245.25	0.00	81,746.75
01/01/51	PRESSURE SEWER	000087-00	720	16,112.00	0.00	15,711.98	0.00	400.02
01/01/52	PRESSURE SEWER	000087-01	720	640.00	0.00	613.45	0.00	26.55
01/01/63	PRESSURE SEWER	000087-02	600	8,689.00	0.00	8,082.96	0.00	606.04
01/01/75	PRESSURE SEWER	000087-03	600	4,850.00	0.00	3,347.84	0.00	1,502.16
01/01/78	PRESSURE SEWER	000087-04	600	43,025.00	0.00	27,114.98	0.00	15,910.02
01/01/79	PRESSURE SEWER	000087-05	600	5,626.00	0.00	3,433.01	0.00	2,192.99
01/01/80	PRESSURE SEWER	000087-06	600	5,443.00	0.00	3,212.65	0.00	2,230.35
01/01/83	PRESSURE SEWER	000087-07	600	27,819.00	0.00	14,748.87	0.00	13,070.13
01/01/84	PRESSURE SEWER	000087-08	600	3,918.00	0.00	1,998.93	0.00	1,919.07
01/01/85	PRESSURE SEWER	000087-09	600	19,088.00	0.00	9,355.61	0.00	9,732.39
01/01/88	PRESSURE SEWER	000087-10	600	3,302.00	0.00	1,420.19	0.00	1,881.81
01/01/91	PRESSURE SEWER	000087-11	600	14,693.00	0.00	5,437.67	0.00	9,255.33
01/01/92	PRESSURE SEWER	000087-12	600	13,977.00	0.00	4,892.92	0.00	9,084.08
01/01/93	PRESSURE SEWER	000087-13	600	34,197.00	0.00	11,285.77	0.00	22,911.23
01/01/94	PRESSURE SEWER	000087-14	600	59,571.00	0.00	18,468.46	0.00	41,102.54
01/01/97	PRESSURE SEWER	000087-15	600	64,061.00	0.00	16,013.56	0.00	48,047.44
09/14/04	APRICOT VILLAGE	000107-07	600	11,000.00	0.00	1,054.19	0.00	9,945.81
04/20/05	HOME FIRST ESTA	000109-08	600	132,188.00	0.00	11,084.87	0.00	121,103.13
05/04/05	PENNINGTON RANC	000110-08	600	657,550.00	0.00	54,666.12	0.00	602,883.88
06/30/05	2006 FORD F-550	000113-00	60	24,774.13	0.00	19,819.27	0.00	4,954.86
12/09/05	CRANE FOR 2006	000113-01	60	17,932.20	0.00	12,820.21	0.00	5,111.99
04/07/05	SEWER UPGRADE P	000116-00	360	5,978,503.28	0.00	843,409.42	0.00	5,135,093.86
11/10/05	2006 FORD F-250	000119-00	60	19,592.60	0.00	14,330.44	0.00	5,262.16
02/15/06	WALNUT VIEW SUB	000120-08	600	661,178.00	0.00	44,598.91	0.00	616,579.09
02/15/06	PEACHTREE II PH	000121-08	600	37,332.00	0.00	2,518.23	0.00	34,813.77
04/19/06	VALLEY OAK ESTA	000123-08	600	59,410.00	0.00	3,796.94	0.00	55,613.06
05/03/06	PEACHTREE III S	000124-08	600	271,785.00	0.00	17,057.36	0.00	254,727.64
06/07/06	PENNINGTON RANC	000128-08	600	537,730.00	0.00	32,954.57	0.00	504,775.43
08/17/06	2006 CATERPILLA	000133-00	60	61,695.31	0.00	34,960.68	0.00	26,734.63
06/30/07	2006 CATERPILLA	000133-01	60	2,700.00	0.00	1,080.00	0.00	1,620.00
07/18/07	PENNINGTON RANC	000142-08	600	583,816.00	0.00	22,379.69	0.00	561,436.31
03/06/09	2009 PBM 3PT SP	000148-00	60	2,831.40	0.00	188.76	0.00	2,642.64
03/06/09	2009 RHINO BRUS	000148-01	60	2,395.22	0.00	159.68	0.00	2,235.54
03/20/09	2009 FORD F-350	000149-00	60	28,486.84	0.00	1,424.34	0.00	27,062.50
	REPORT TOTALS			11,281,499.21	0.00	2,206,627.56	0.00	9,074,871.65

CLASS TOTALS BY FUND

ACTIVE ASSETS

FUND	CLASS	NUMBER	TOTAL COST	SALVAGE VALUE	DEPRECIATION	NET VALUE
013	100	5	155,470.00	0.00	38,641.00	116,829.00
013	300	4	90,785.77	0.00	48,394.26	42,391.51
013	400	3	139,395.31	0.00	111,040.68	28,354.63
013	500	33	128,280.62	0.00	107,774.92	20,505.70
013	700	43	10,767,567.51	0.00	1,900,776.70	8,866,790.81
GRAND TOTALS:		88	11,281,499.21	0.00	2,206,627.56	9,074,871.65

DEPARTMENT TOTALS

ACTIVE ASSETS

FUND DEPARTMENT	NUMBER	TOTAL COST	SALVAGE VALUE	DEPRECIATION	NET VALUE
013 1300	88	11,281,499.21	0.00	2,206,627.56	9,074,871.65
GRAND TOTALS:	88	11,281,499.21	0.00	2,206,627.56	9,074,871.65

City of Live Oak

G/L ACCOUNT TOTALS

ACTIVE ASSETS

FUND ACCOUNT	NUMBER	TOTAL COST	DEPRECIATION
013 1027	4	116,829.00	
013 1029	1	38,641.00	
013 1031	83	11,126,029.21	
013 1033	84		2,206,627.56
GRAND TOTALS:	88	11,281,499.21	2,206,627.56