Chapter 6
MODEL DEVELOPMENT

This chapter presents an overview of the activities undertaken to develop and calibrate the hydraulic models for West Basin Municipal Water District's (West Basin) recycled water distribution systems. This chapter contains the following sections:

- Hydraulic Modeling Overview – This section explains the purpose of hydraulic models and their uses and limitations.
- Hydraulic Model Creation – This section describes the model development and the data and processes used to create each hydraulic model.
- Hydraulic Model Calibration – This section describes the processes used to gather field data and calibrate each model in order to establish a level of confidence in the model results.

Detailed information on the creation and calibration of each of the models are included in Appendix E, Model Development and Calibration, and Appendix H, Model User Manual.

6.1 HYDRAULIC MODELING OVERVIEW

A hydraulic computer model is an important tool for many analyses of water systems. Models are used as a part of distribution system master plans to identify deficiencies in distribution systems, and to plan capital improvements.

The Hydraulic Model is composed of three main parts:

- The data file storing geometry for geographic location of facilities.
- The database that defines the physical system. The database for West Basin's models is linked to the geographic data file.
- A computer program "calculator" that solves a series of hydraulic equations to define the performance of the water system in terms of pressure and flow.

The geographic data file provides water system facility locations and is typically represented as an AutoCAD or a Geographic Information Systems (GIS) file. Elements used in this file to model system facilities include pipes, junction nodes (connection points for pipes and location of demands), control valves, pumps, tanks, and reservoirs.

The database includes distribution system facility information such as facility size and geometry, operational characteristics, equivalent performance characteristics, and production/consumption data. Facility size and geometries include length and diameter of pipe, tank dimensions, size of valve, and pump curves. Operational characteristics include parameters that control how facilities move water through the system, such as on and off settings for pumps, pressure or flow controls for hydraulically actuated valves, or main line valve closures. Equivalent performance characteristics are used to represent equivalent facilities where detailed information is unavailable or unnecessary. Data for production and consumption determine where the water enters and exits the distribution system.

The computer program “calculator” analyzes the hydraulic information in the database file and generates results for pressures, flow rates, and operating statuses. The key to maximizing benefits from the hydraulic model is to correctly interpret results and understand how the recycled water distribution system is affected by the various components of the model. This understanding enables the engineer to be proactive in developing solutions to existing and future water system goals and objectives. With this approach, the hydraulic model is then used as a tool to identify the adequacy of system performance and identify solutions to have the water system operate according to established performance criteria.

Developing a good computer model begins with entering the best available information into the database and calibrating the model to match existing conditions in the field. Once the model has been calibrated, it becomes an invaluable tool to solve planning and operational problems. It can simulate the existing and future systems, identify system deficiencies, analyze impacts from increased demands or changes to supplies, and determine the appropriateness of proposed improvements for the system.

Ten (10) hydraulic models were developed as part this project. These models are:

- Hyperion Secondary Effluent Pumping Station System
- Title 22 Distribution System
- West Coast Barrier Water System
- Chevron High Pressure Boiler Feed System
- Chevron Low Pressure Boiler Feed System
- Chevron Nitrified Water System
- Edward C. Little Water Recycling Facility Brine Line
- bp Reverse Osmosis System
- bp Nitrified Water System
- Carson Regional Water Recycling Facility Brine Line

As specified by West Basin, the hydraulic model analyses were conducted in H_2OMAP® Water. The one exception to this is the model of the Edward C. Little Water Recycling Facility (ELWRF) brine line. Los Angeles County’s Water Surface Pressure Gradient (WSPG) software was used to model the brine line due to the fact that it was found to flow as an open channel in some portions of the pipe. This is further discussed in Section 6.3.3.6.

6.2 HYDRAULIC MODEL CREATION

The hydraulic models were created through the use of existing GIS files, as-built drawings, record drawings, construction plans, the customer database and demands developed from record information, the diurnal use curves developed from field and distributed control system (DCS) information during the calibration period, manufacturer pump curves, and operational controls provided by West Basin.

The first step in creating each model was to set up the geometry of the system. This was done by drawing each component of the model and giving it a unique identification number that was assigned in a logical manner. The next step was to input the facility information. This includes diameter, length, and roughness for pipes; elevations, demands, and use patterns for nodes; dimensions and water levels for tanks; size and minor losses for valves; and pump curves for pumps. The last step was to define the operational controls for each model element. This includes pump on and off settings, valve controls, and maximum and minimum tank levels.

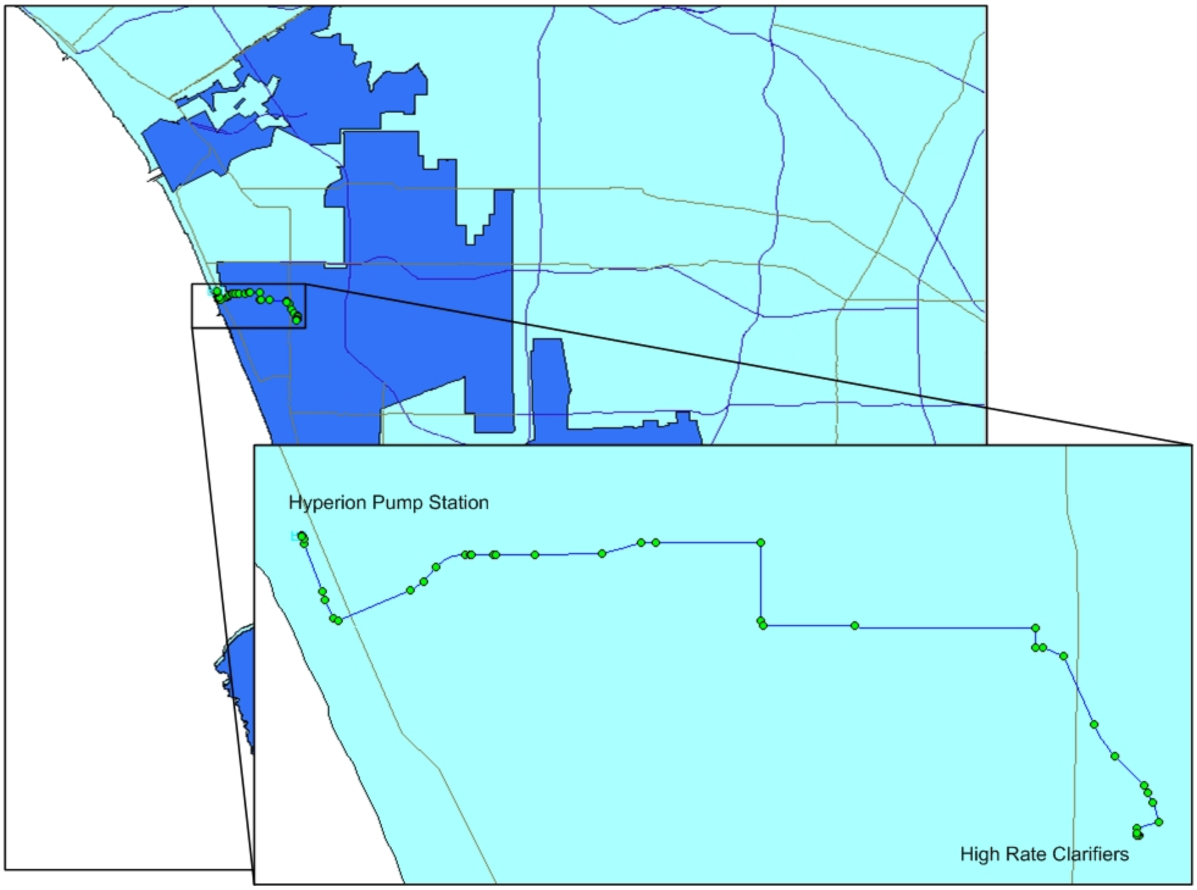
The following sections provide a brief description of the hydraulic model creation for each system. For more detailed information, refer to Appendix H, the Model User's Manual. The demand conditions for the model scenarios are detailed in Section 7, Section 8, and Appendix H, the Model User's Manual.

6.2.1 Hyperion Secondary Effluent Pumping System

The Hyperion Secondary Effluent Pumping System includes Hyperion Secondary Effluent Pump Station (HSEPS) and the Hyperion Secondary Effluent Force Main (HSEFM) conveying the secondary effluent from Hyperion Wastewater Treatment Plant (HWWTP) to ELWRF. As shown in Figure 6.1, the Hyperion Secondary Effluent Pumping System hydraulic model starts at West Basin's HSEPS, located at southeast corner of HWWTP, and ends at the secondary effluent inlet connections at ELWRF. These secondary effluent inlet connections are upstream of the pre-treatment high rate clarifiers, converted Title 22 influent, and microfiltration feed system. The model includes the following components:

- HSEPS wet well
- HSEPS with two constant speed pumps and two variable speed pumps and a firm capacity of 35,200 gpm (51 mgd)
- 15,445 feet of 48-inch diameter (discharge header) and 60-inch diameter force main

Figure 6.1
Hyperion Secondary Effluent Pump Station and Force Main



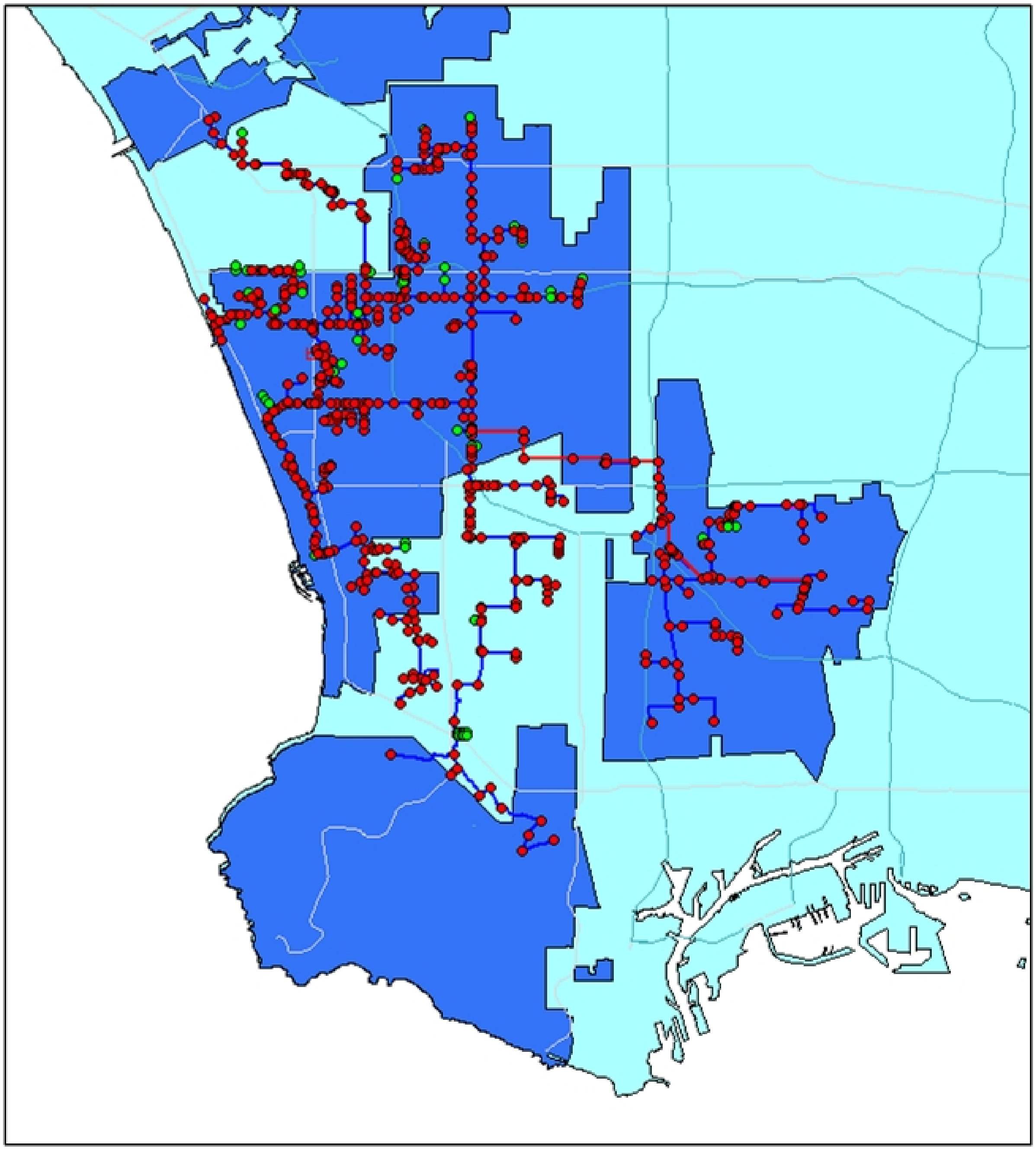
6.2.2 Title 22 Distribution System

The Title 22 Distribution System hydraulic model starts at the ELWRF Title 22 product storage tanks and pump stations. It then branches out to all existing and potential customers, covering 19 cities and unincorporated Los Angeles County areas. A screenshot of the Title 22 Distribution System hydraulic model is shown in Figure 6.2.

The model includes the following components:

- Two 5.0 million gallon Title 22 product storage tanks at ELWRF
- Title 22 Tank 1 Product Pump Station with two constant speed pumps and two variable speed pumps
- Title 22 Tank 2 Product Pump Station with two constant speed pumps and two variable speed pumps
- 78 miles of existing pipeline ranging from 4-inches to 60-inches in diameter
- 48 miles of potential pipeline ranging from 4-inches to 42-inches in diameter

Figure 6.2
Title 22 Distribution System Hydraulic Model



The firm capacity of the two pump stations, without one of the largest pumps in operation, is calculated to be 43,500 gpm (62.6 mgd).

Customer demands developed as described in Section 3 were input into the model at nodes in proximity of the service location. Diurnal patterns were developed based upon DCS flow data and flowmeter data collected in the field. DCS flow data was provided for the following satellite plants:

- Carson Regional Water Recycling Facility
- Chevron Nitrification Facility
- ExxonMobil Water Recycling Facility

Data was collected via flowmeters at 15 customer meters as shown in Figure 6.3 and listed on Table 6.1

Table 6.1 Title 22 Distribution System Flowmeter Locations
Capital Implementation Master Plan
West Basin Municipal Water District

Site Number	Location	City or County
1A	Home Depot Center	City of Carson
3	Goodyear	City of Carson
4	Victoria Golf Course	City of Carson
6	El Segundo Golf Course	City of El Segundo
9A	Southern California Edison Generation Station	City of El Segundo
10	Centinela Park	City of Inglewood
1A	Inglewood Park Cemetery	City of Inglewood
12	Morningside High School	City of Inglewood
13	Mira Costa High School	City of Manhattan Beach
16	Columbia Park	City of Torrance
17	Toyota Motor Sales	City of Torrance
8A	Chester Washington Golf Course	Los Angeles County
19	Hyperion Treatment Plant	City of Los Angeles
20	LAX @ 6400 Westchester Parkway	City of Los Angeles
21	Loyola Marymount University	City of Los Angeles

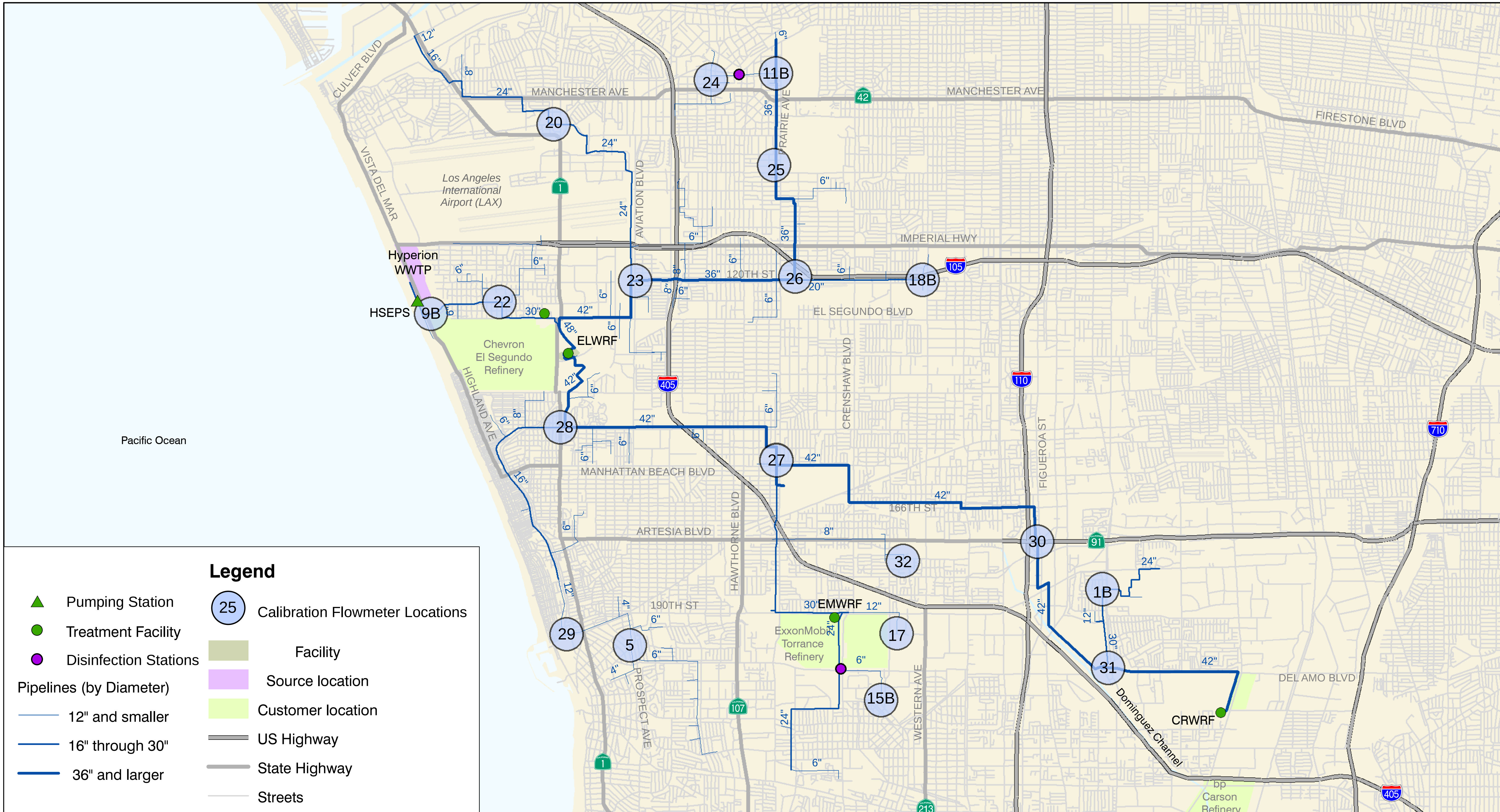


Figure 6.3
Title 22 Pressure Data Logger and Flowmeter Locations

carollo
in association with
AKM SPi

West Basin Municipal Water District
Capital Implementation Master Plan For Recycled Water Systems

Individual diurnal patterns were developed for each of the three satellite plants and 15 customers listed above. Additional generic diurnal patterns were developed from this data to represent the following types of users:

- Greenbelt Irrigation – customers that provide landscape irrigation along streets and highways
- Golf Course / School / Park Irrigation – neighborhood and community parks, elementary, jr. high, and high schools
- University – large schools or universities (CSUDH, LMU, etc.)
- Industrial – industries having consistent usage during business hours
- Mixed use – customers with multiple uses (landscape irrigation, non-potable uses, cooling towers)
- Other – all other customers that do not fall into one of the categories listed above

Detailed graphs of all recycled water diurnal patterns can be found in Appendix H, the Model User's Manual, while five of the generic patterns are shown in Chapter 3.

6.2.3 West Coast Barrier Water System

The West Coast Barrier Water System hydraulic model starts at the Barrier Pump Station at ELWRF and ends at the Barrier Blend Station located on El Segundo Boulevard within the City of El Segundo. Figure 6.4 is a screen capture of the West Coast Barrier Water System hydraulic model. The inset shows a more detailed view of the five pumps in the Barrier Pump Station as represented in the model. The model includes the following components:

- 55,000 gallon clearwell
- West Coast Barrier Water Pump Station with five constant speed pumps and a firm capacity of 10,500 gpm (15.1 mgd)
- Flow control valve on pump discharge
- 4,780 feet of 30-inch diameter transmission pipeline

6.2.4 Chevron High Pressure Boiler Feed System

The Chevron High Pressure Boiler Feed System model starts at the HPBF Product Pump Station located at ELWRF and ends at the Chevron High Pressure Boiler Feed Storage Tank located within Chevron El Segundo Refinery property. A screen capture of the Chevron High Pressure Boiler Feed System hydraulic model is shown in Figure 6.5.

Figure 6.4
West Coast Barrier Water System Hydraulic Model & Barrier Water Pump Station

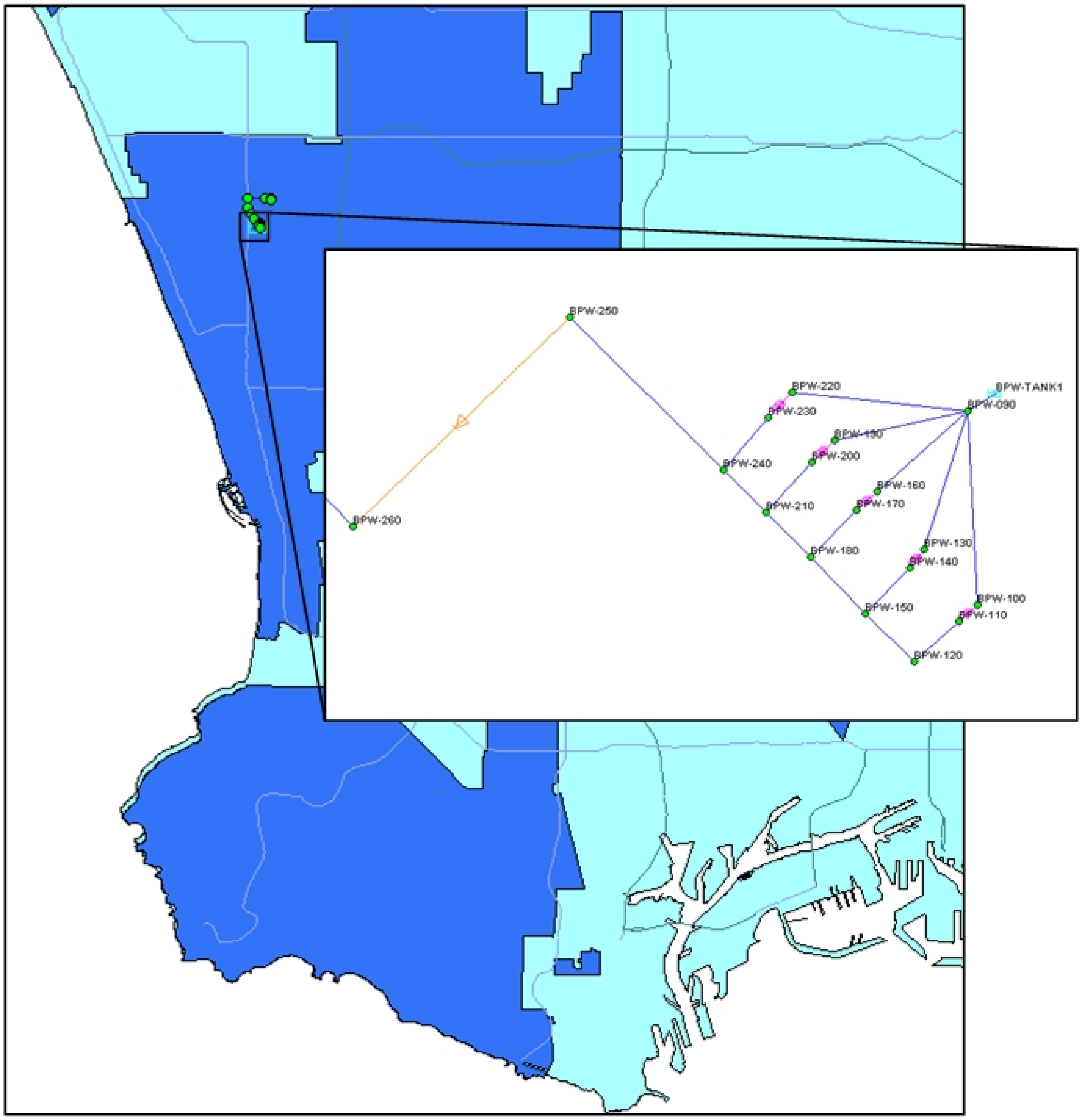
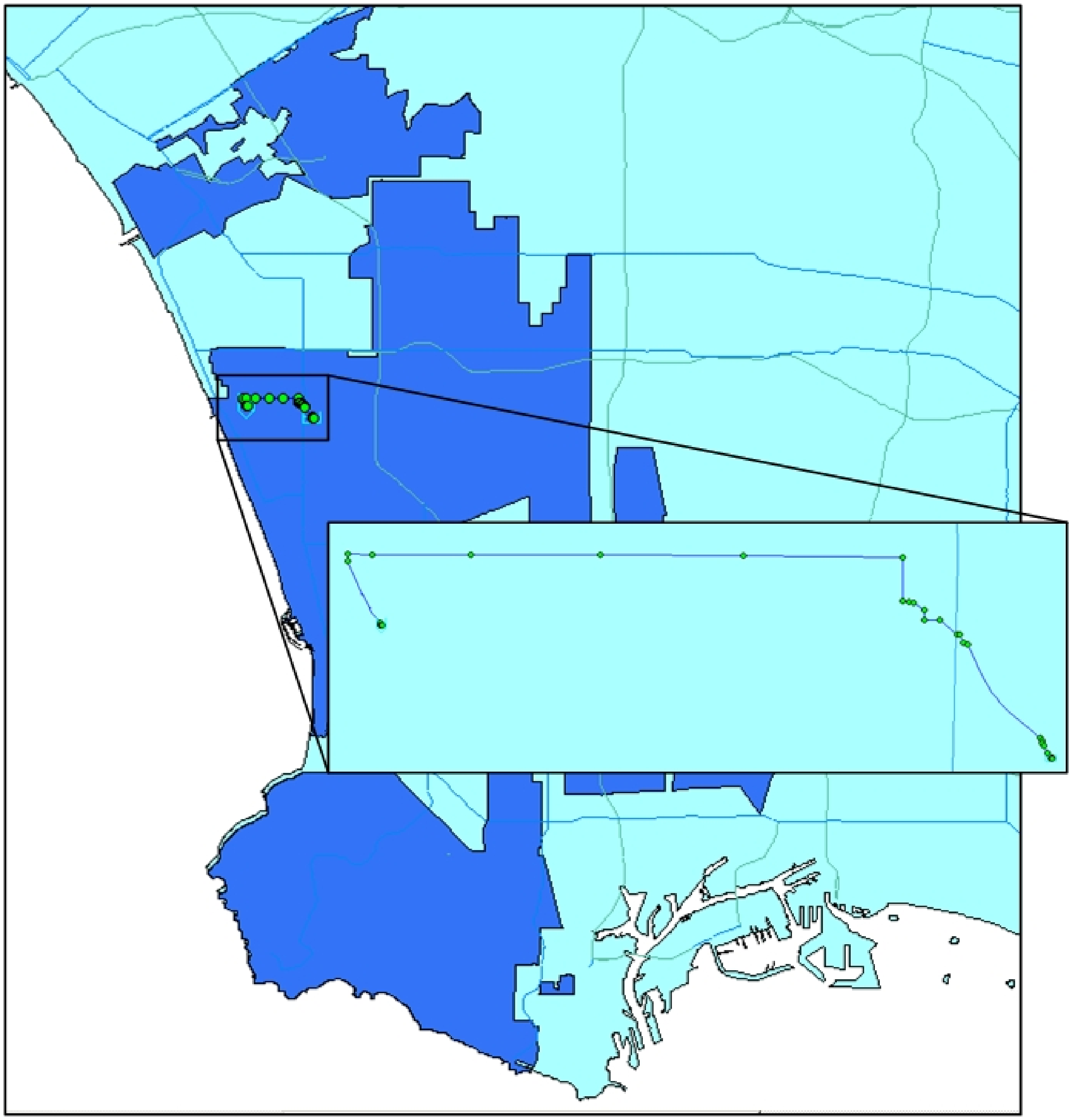


Figure 6.5
Chevron High Pressure Boiler Feed System Hydraulic Model



The model includes the following components:

- 50,000 gallon HPBF clear well
- HPBF Product Pump Station with two variable speed pumps and a firm capacity of 1,800 gpm
- 10,300 feet of 12-inch diameter transmission main
- Chevron on-site High Pressure Boiler Feed Storage Tank with an operating volume of 1,344,000 gallons

6.2.5 Chevron Low Pressure Boiler Feed System

The Chevron Low Pressure Boiler Feed System model starts at the LPBF Product Pump Station located at ELWRF and ends at the Chevron Low Pressure Boiler Feed Storage Tank located within Chevron El Segundo Refinery. The model includes the following components:

- 50,000 gallon LPBF clear well
- LPBF Product Pump Station with three variable speed pumps and a firm capacity of 1,800 gpm
- 10,400 feet of 10-inch diameter and 12-inch diameter transmission main
- Chevron on-site Low Pressure Boiler Feed Storage Tank with an operating volume of 890,000 gallons

A screen capture of the Chevron Low Pressure Boiler Feed System hydraulic model is shown in Figure 6.6.

6.2.6 Chevron Nitrified Water System

The Chevron Nitrified Water System model starts at the Nitrified Product Water Storage Tank located at the CNF in the City of El Segundo and ends at the property boundary of the Chevron El Segundo Refinery at Lomita Street. A screen capture of the Chevron Nitrified Water System hydraulic model is shown in Figure 6.6.

The model includes the following components:

- Nitrified Product Water Storage Tank with operating volume of 564,000 gallons
- Chevron Nitrified Water Product Pump Station with one variable speed and two constant speed pumps and a firm capacity of 3,600 gpm
- 2,970 feet of 20-inch diameter transmission main

Figure 6.6
Chevron Low Pressure Boiler Feed System Hydraulic Model

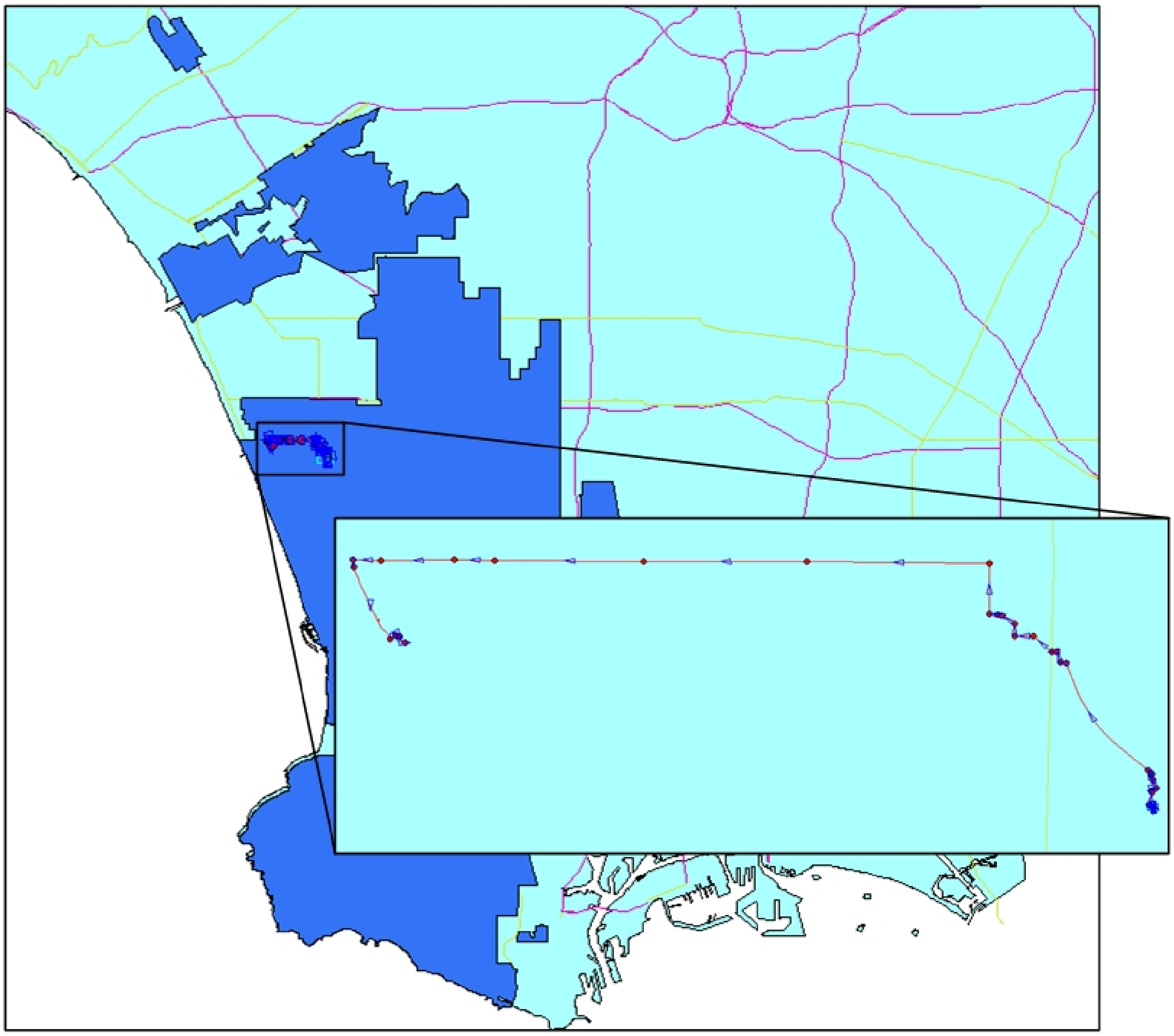
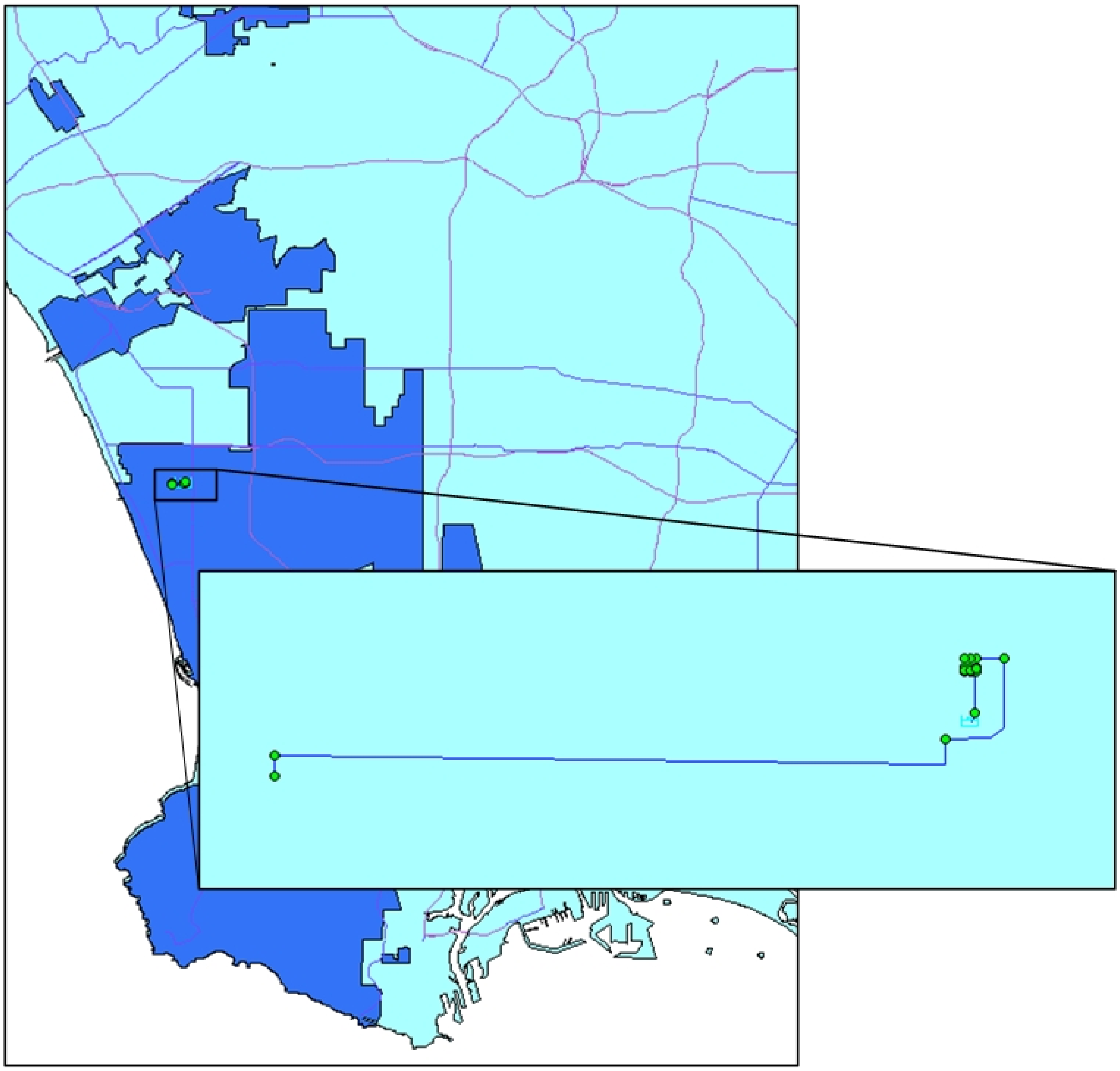


Figure 6.7
Chevron Nitrified Water System Hydraulic Model



6.2.7 Edward C. Little Water Recycling Facility Brine Line

The ELWRF Brine Line model starts at ELWRF and ends at the City of Los Angeles' HWWTP's ocean outfall.

The model includes the following components:

- 17,880 feet of 18-inch diameter pipeline

Because the brine line has several high points, and reported low pressure at the outlet, it was modeled utilizing the Los Angeles County Department of Public Works' WSPG program. One of the high points is located along El Segundo Boulevard east of Center Street, and another one is located along Grand Avenue west of Loma Vista Street. These high points form hydraulic controls, where flows go through critical depth. Downstream of these controls, the flows become supercritical with high velocities. As a result, hydraulic jumps occur at the point where the pipe profile flattens.

6.2.8 bp Reverse Osmosis System

The bp Reverse Osmosis (RO) System model starts at the RO Product Water Storage Tank at the CRWRF and ends at the bp Carson Refinery meter vault within bp property boundaries, located on the southeast corner of Wilmington Avenue and 223rd Street. A screen capture of the bp Reverse Osmosis System hydraulic model is shown in Figure 6.8.

The model includes the following components:

- 1.16 million gallon RO Product Water Storage Tank at CRWRF
- bp RO Product Water Pump Station with three variable speed pumps and a firm capacity of 3,450 gpm
- 6,030 feet of 24-inch diameter and 30-inch diameter distribution pipeline

6.2.9 bp Nitrified Water System

The bp Nitrified Water System starts at the Nitrified Product Water Storage Tank at CRWRF and ends at the meter vault within the bp Carson Refinery property, located on the southeast corner of Wilmington Avenue and 223rd Street. A screen capture of the bp Nitrified Water System hydraulic model is shown in Figure 6.9.

Figure 6.8
bp Reverse Osmosis System Hydraulic Model

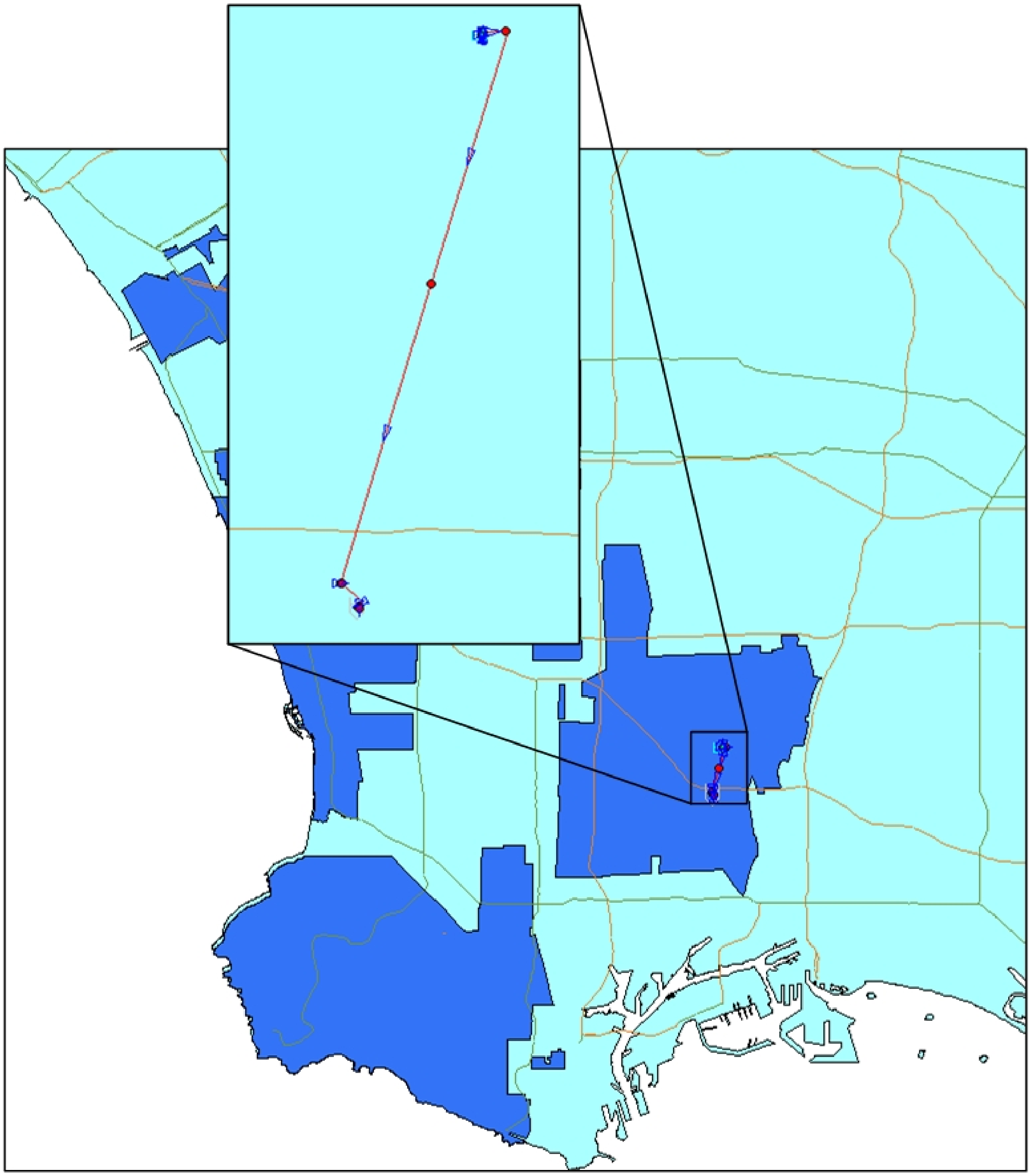
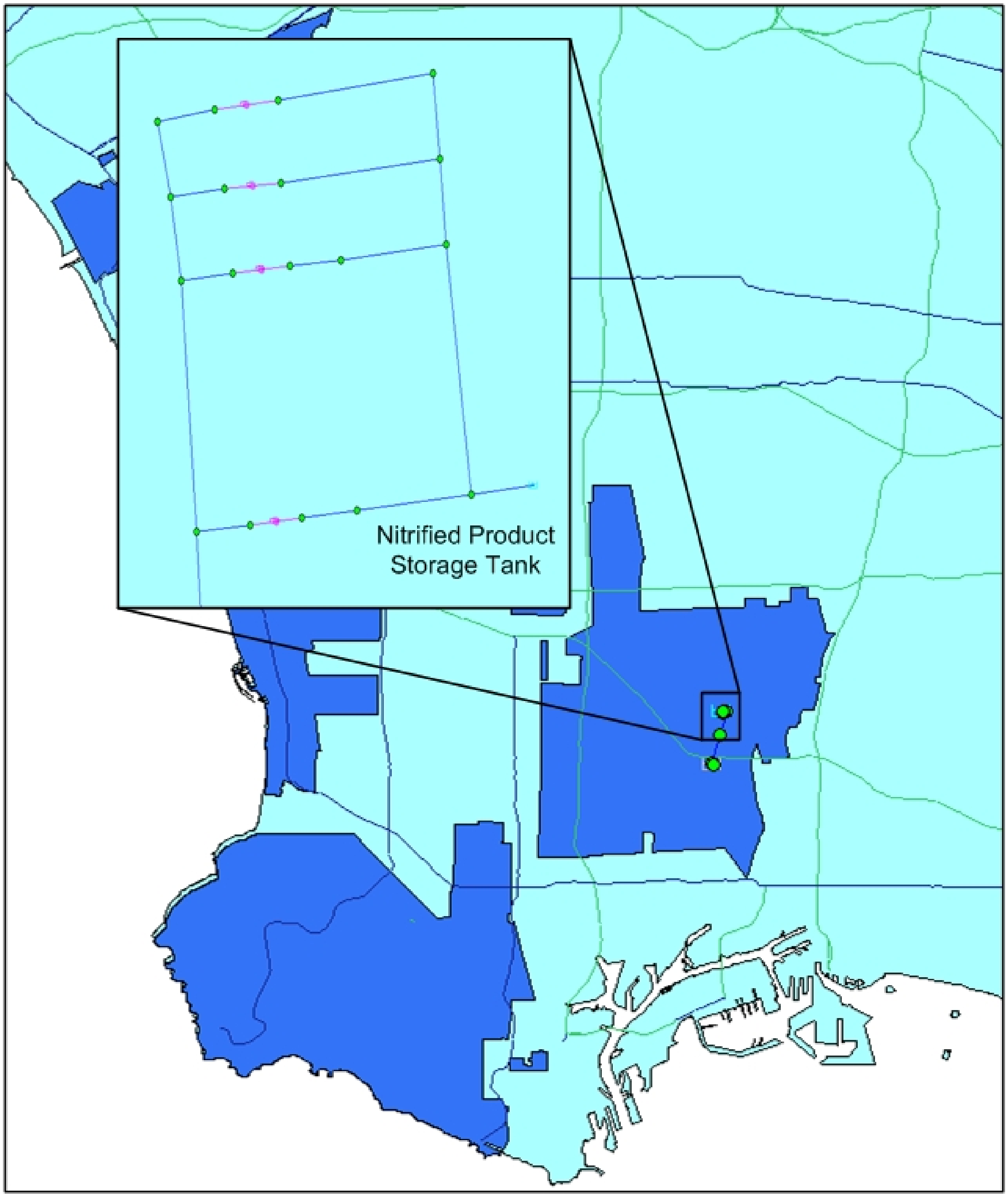


Figure 6.9
bp Nitrified Water System Hydraulic Model



The model includes the following components:

- 25,000-gallon Nitrified Product Water Storage Tank at CRWRF
- bp Nitrified Product Water Pump Station with two variable speed pumps and a firm capacity of 625 gpm
- 6,710 feet of 12-inch diameter distribution pipeline

6.2.10 Carson Regional Water Recycling Facility Brine Line

The RO concentrate collected from the Carson Regional Water Recycling Facility (CRWRF) is discharged to CRWRF Brine Line, which starts at the CRWRF and terminates at the Los Angeles County Sanitation District (LACSD) Joint Water Pollution Control Plant (JWPCP) Outfall Surge Tower located in the City of Carson. A screen capture of the CRWRF Brine Line hydraulic model is shown in Figure 6.10.

The model includes the following components:

- Variable-head reservoir modeling backpressure from RO trains
- 28,406 feet of 14-inch diameter pipeline

Constant-head reservoir modeling JWPCP outfall

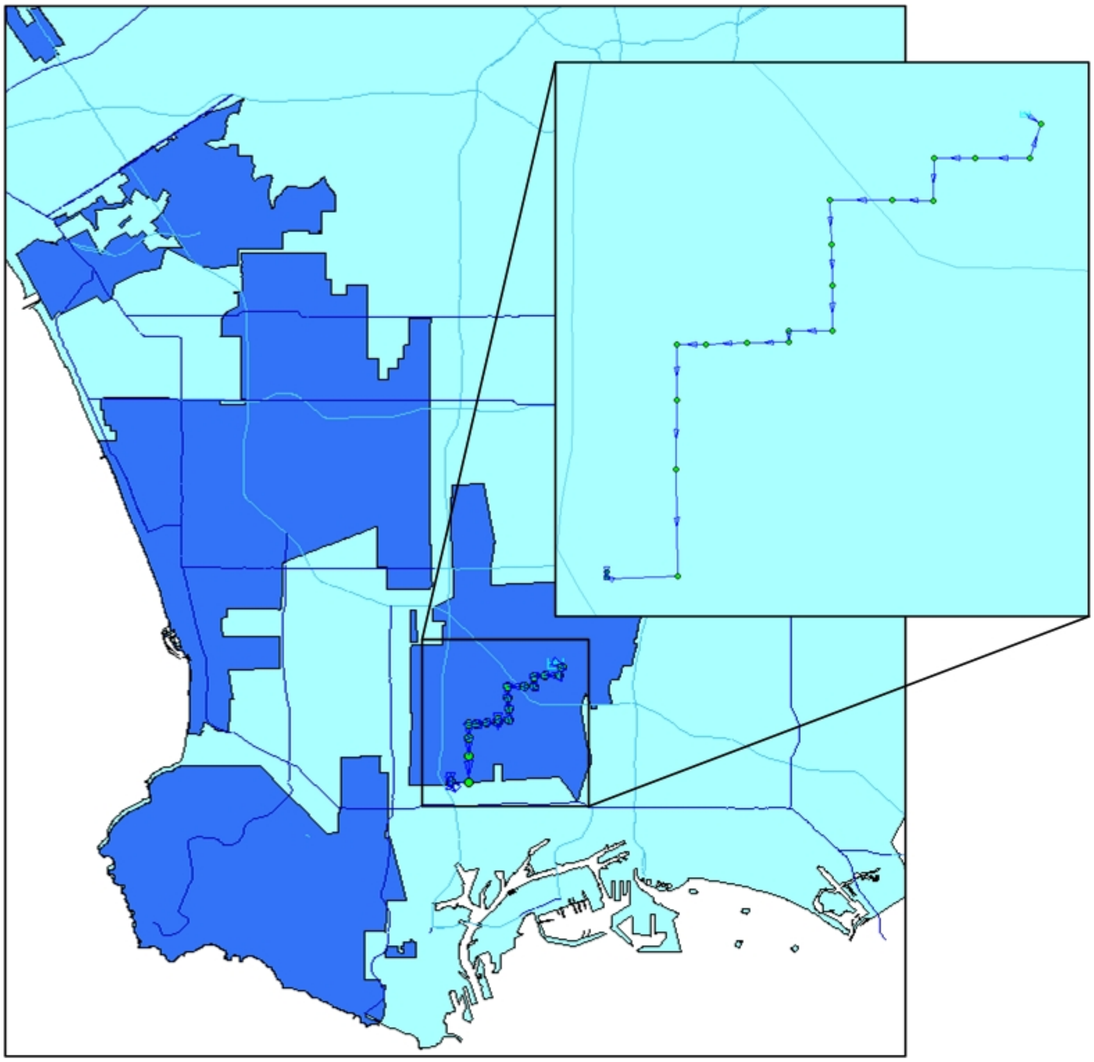
6.3 HYDRAULIC MODEL CALIBRATION

6.3.1 Calibration Methodology

The general calibration methodology was to gather as much system information as possible from customer sites and West Basin facilities for each model, from either DCS information or flow and pressure measuring equipment temporarily installed in the field. Generally, information gathered included the following:

- Tank levels
- Pump station flows
- Pump station discharge pressures
- Individual pump on/off settings
- Individual pump speeds
- Pressures at key locations where tanks do not exist
- Flows and pressures for all satellite plants, refineries, and other high water users

Figure 6.10
Carson Regional Water Recycling Facility Brine Line Hydraulic Model



The data was recorded in 5-minute intervals. Based on the data gathered, a time period was selected where the information gathered indicated flows and pressures without significant variation. The dates and times varied for each model and are discussed further in Section 6.3.2. Demands, tank levels, pump speeds, and pump on/off times were inputted exactly as the recorded DCS information, where available. Flows and pressures were also verified with the provided DCS information. Several pressure measurements were compared at the downstream end of the system to validate the data collected in the field. The friction factors for the distribution system were adjusted until pressures matched within reason.

6.3.2 Field Data Gathering

Field data was gathered over a two-week period from October 3, 2008 through October 19, 2008. Due to equipment malfunction, some data was recollected from November 4, 2008 to November 14, 2008. The data collected in the field included flows, pressures, tank levels, pump on/off times, and pump speeds for the various system models discussed in Section 6.2.2. West Basin's DCS system data was utilized as much as possible for accuracy. Some additional equipment was installed in the field to obtain specific customer flow and pressure information.

All equipment (pressure data loggers and flowmeters) was calibrated prior to installation in the field and synchronized to West Basin's DCS system so that all data collected was on the same time basis. The time interval selected for the models was 5 minutes.

Most of the equipment installed in the field was on the Title 22 distribution system. Brainard Meter Master equipment (FSBC, 2008) was installed at 15 customer meters to record flows as listed in Table 6.1. The customer sites were selected for flow metering purposes based on highest water use and representing different types of recycled water usages. The flow information was used to develop usage patterns (diurnal curves). Dickson pressure loggers were installed at 19 locations in the Title 22 distribution system, the Barrier blend station vault, the Barrier pump station discharge at ELWRF, the ELWRF brine line, the CRWRF brine line, and the RO and Nitrified water lines providing service to bp Carson Refinery. Specific information regarding the flowmeter and pressure gauge locations and field data collected can be found in Appendix E, the Model Calibration Results.

6.3.3 Calibration Process and Results

The calibration process and results are briefly described here. For more detailed information, please refer to Appendix E, Model Calibration Results.

6.3.3.1 Hyperion Secondary Effluent Pumping System

The Hyperion Secondary Effluent Pumping System was calibrated over a 24-hour period. The DCS and field information used in the calibration process correlates to October 14, 2008. The pump station flow and discharge pressure, the pump on/off status, pump speeds, and the pressure at ELWRF were utilized in calibrating the model.

The hydraulic model was run and the friction factor within the 60-inch Hyperion Secondary Effluent Force Main was adjusted until the pressures at ELWRF matched within reason. The selected C-factor for the Hyperion Secondary Effluent Force Main is 150, which is reasonable for this size pipe. The pressure at ELWRF was approximately 23.0 psi. The average difference in pressures at ELWRF between the model and the field data was 1.2 psi.

6.3.3.2 Title 22 Distribution System

The Title 22 Distribution System was calibrated over a 24-hour period. The DCS and field information used in the calibration process correlates to October 14, 2008.

Initially, it was attempted to model the Title 22 tanks and pump stations. Upon running the hydraulic model, a large discrepancy was found between the combined Title 22 pump station flow and the estimated demands of the Title 22 users. DCS data recorded an average pump station flow of 14,283 gpm on October 24, 2008. The estimated average demand for the same time period is 12,673 gpm. Although the total average flow and demand differs by only 534 gpm (14,238 gpm – 12,673 gpm), the difference in demand over the 24-hour model simulation averaged 1,611 gpm.

The measured flows versus the estimated demand for the Title 22 system were looked at for the time period October 7, 2008 through October 19, 2008. The measured flows per the District's DCS system were consistently higher than the estimated demands. The average difference each day ranged from 900 gpm to 1,650 gpm. With the total demand ranging from 13,000 gpm to 15,000 gpm, the percentage difference ranged from 7 to 12 percent. This is a significant difference in flow for calibration of a hydraulic model.

In order to balance the flows in the hydraulic model, the discrepancy in measured flow versus estimated demands would have to be reconciled. Significant effort was made to explain the discrepancy and adjust the demands. Ultimately, a reasonable conclusion was not found.

It is also suspected that the flowmeter on the discharge pipe of the Title 22 pump station may not be calibrated. As a check, the flowmeter records were compared to the monthly billing records. The difference in volume ranged from 9 MG to 154 MG (193 gpm to 3,565 gpm) with the flowmeter volume being higher.

Since, the flow discrepancy could not be reconciled without additional investigation, an alternative modeling methodology was utilized to model pressure delivered by the Title 22 pump station while establishing demands through the satellite flow information and field measured flow data, which was assumed to be more reliable than the Title 22 pump station flowmeter data. Therefore, the calibrated model was set up using an average demand of 12,673 gpm and the Title 22 pump station is modeled as an equivalent variable-head reservoir with associated water levels that provide the recorded DCS discharge pressures.

The DCS data collected at the three satellite facilities and the field pressure data collected throughout the distribution system were compared to the model pressures at the same locations. The model was deemed calibrated when the pressures matched within reason. C-factor values within the calibrated model range from 120 to 140. Detailed calibration results are shown in Appendix E.

6.3.3.2 West Coast Barrier Water System

The West Coast Barrier Water System was calibrated over a 12-hour period. The DCS and field information used in the calibration process correlates to November 4, 2008 from 5 am to 5 pm. The pump station flows, pump on/off controls, clearwell levels, the flow control valve setting of 73 psi, and the pressures at the blend station were utilized in calibrating the model.

The hydraulic model was run and the friction factor within the 30-inch diameter distribution pipeline for barrier water was adjusted until the pressure at the blend station matched within reason. A C-factor value of 140 was selected for the West Coast Barrier Water System. The pressure at the blend station was approximately 76.4 psi. The average difference in pressures at the blend station between the model and the field data was 0.50 psi.

6.3.3.3 Chevron High Pressure Boiler Feed System

The Chevron High Pressure Boiler Feed system was calibrated over a 24-hour period. The DCS and field information used in the calibration process correlates to October 10, 2008. The clearwell level, pump station flow and discharge pressure, the pump on/off status, pump speeds, and the Chevron product storage tank percentage full were utilized to calibrate the model.

The hydraulic model was run and the friction factor within the 16-inch diameter HPBF pipe was adjusted until the product storage tank percentage full matched field conditions within reason. A C-factor value of 120 was selected for the HPBF system.

6.3.3.4 Chevron Low Pressure Boiler Feed System

The Chevron Low Pressure Boiler Feed system was calibrated over a 24-hour period. The DCS and field information used in the calibration process correlates to October 10, 2008. The clearwell level, pump station flow and discharge pressure, the pump on/off status, pump speeds, and the Chevron product storage tank percentage full were utilized to calibrate the model.

The hydraulic model was run and the friction factor within the 12-inch diameter LPBF distribution pipe was adjusted until the product storage tank percentage full matched field conditions within reason. A C-factor value of 120 was selected for the 12-inch diameter LPBF distribution system.

6.3.3.5 Chevron Nitrified Water System

The Chevron Nitrified Water system was calibrated over a 24-hour period. The DCS and field information used in the calibration process correlates to October 14, 2008. The product storage tank level, pump station flow and discharge pressure, pump on/off status, pump speeds, and the pressure at Chevron's El Segundo Refinery were utilized to calibrate the model.

The hydraulic model was run and the friction factor within the 20-inch Chevron Nitrified Water System pipe was adjusted until the pressure at the Chevron El Segundo Refinery matched within reason. A C-factor value of 140 was selected for this system. The resulting average delivery pressure at the entrance to the Chevron El Segundo Refinery was 73.6 psi in the model. The reported field measured pressure is between 78 and 80 psi.

6.3.3.6 ELWRF Brine Line

Because ELWRF Brine Line has several high points, and reported low pressure at the outlet, it was modeled utilizing the Los Angeles County Department of Public Works' WSPG program. Pressure data loggers were installed at the ELWRF and at five locations along the brine line alignment from November 20, 2008 to November 23, 2008. Pressures to the brine line are provided off the ELWRF RO concentrate trains and average about 22 psi. The ground surface elevation at ELWRF is approximately 100.5 feet. The five other pressure locations are as follows:

1. Station 32+00 - Vista Del Mar north of Grand Avenue, approximate ground elevation = 34 feet
2. Station 56+95 – Grand Avenue east of Vista Del Mar, approximate ground elevation = 138 feet
3. Station 71+65 – Grand Avenue at Concord Avenue, approximate ground elevation = 128 feet
4. Station 100+65 – Sierra Street at Grand Avenue, approximate ground elevation = 160 feet
5. Station 124+25 - El Segundo Boulevard at Center Street, approximate ground elevation = 151 feet

Each of these locations recorded atmospheric pressure at some period indicating open channel flow within the brine line. The only exception was at Station 71+65, which recorded pressures ranging from 0.5 psi to 4.0 psi. The brine system was analyzed with Manning roughness coefficients (Manning's "n" values) of 0.009, 0.011, and 0.013 to test the sensitivity of the internal condition of the pipe.

6.3.3.7 bp Reverse Osmosis System

The bp Reverse Osmosis system was calibrated over a 24-hour period. The DCS and field information used in the calibration process correlates to November 22, 2008. The RO product water storage tank level, pump station flow and discharge pressure, pump on/off status, pump speed, and pressure at the bp meter vault were utilized in calibrating the model.

The hydraulic model was run and the friction factor within the 24-inch and 30-inch diameter reverse osmosis distribution pipeline was adjusted to match the pressures. It was found that the change in C-factor did not change the results significantly. A C-factor value of 140 was selected for the bp Reverse Osmosis system. The average difference in pressures at the pump station between the model and the field data was less than 1 psi.

6.3.3.8 bp Nitrified Water System

The bp Nitrified Water system was calibrated over a 24-hour period. The DCS and field information used in the calibration process correlates to November 22, 2008. The Nitrified product water storage tank level, pump station flow and discharge pressure, pump on/off status, pump speed, and pressure at the bp meter vault were utilized in calibrating the model.

The hydraulic model was run and the friction factor within the 12-inch diameter nitrified water distribution pipeline was adjusted to match the pressures. It was found that the change in C-factor did not change the results significantly. A C-factor value of 120 was selected for the bp Nitrified Water System. The average difference in pressures at the pump station between the model and the field data was less than 1 psi.

6.3.3.9 CRWRF Brine Line

The CRWRF Brine Line system was calibrated over a 24-hour period. The DCS and field information used in the calibration process correlates to November 10, 2008. The RO train concentrate flow, the pressure at CRWRF, and the pressure on the brine line riser at the surge tower at LACSD's JWPCP in Carson were utilized to calibrate the model.

The hydraulic model was run and the friction factor within the 14-inch CRWRF brine line was adjusted until the pressure at LACSD's JWPCP matched within reason. A C-factor value of 120 was selected for this system. The model results in pressures at LACSD's JWPCP ranging from 10.4 psi to 15.1 psi.