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EXECUTIVE SUMMARY

This Water Master Plan Update for the City of Stockton Municipal Utilities Department's (COS MUD) North and South Stockton Service Areas, provides the City of Stockton (City) with the tools and the insight required to address important water system planning and associated funding issues facing the City as a result of the City's 2035 General Plan Update. These issues include the following:

- The need for supplemental water supplies to meet existing and future water demands and to increase supply reliability;
- The continued use of groundwater as a supply source;
- The need for additional transmission mains, distribution pipelines, interconnections, pumping capacity, wells and storage facilities to meet the needs of existing customers and future development; and
- The need to implement a planned capital improvement program to meet the needs of the existing water system and to accommodate future growth.

The associated analyses and assessments related to these issues and their recommendations are summarized below. Complete descriptions of the analyses and assessments are provided in the chapters and appendices of this Water Master Plan Update.

OVERVIEW OF THE EXISTING SERVICE AREAS

The City of Stockton Metropolitan Area (COSMA) corresponds to the general plan boundary adopted on January 22, 1990 as shown in Figure ES-1. Currently, three water service areas exist within the COSMA. These service areas, and the corresponding water purveyor serving them, are shown in Figure ES-2. COS MUD and the San Joaquin County Maintenance Districts serve the North Stockton, South Stockton, and Walnut Plant Area (WPA); California Water Services Company (CWSC) serves Central Stockton. This Water Master Plan Update only addresses the service areas served by the COS MUD in North and South Stockton.

The North Stockton Service Area, which is primarily residential, is bounded by Eight Mile Road to the north, Cascade and Columbia Railroad to the east, the Calaveras River to the south, and the City limits to the west. The South Stockton Service Area, which contains significant agricultural land uses, is bounded by French Camp Slough to the north, the City limits to the east and south, and the San Joaquin River to the west.

DESCRIPTION OF THE COS MUD WATER SERVICE AREA

The COS MUD currently provides water service to a portion of the City, which is located along the San Joaquin Delta waterway, approximately 90 miles east of San Francisco. Areas within the City Limits not currently served by either the COS MUD or CWSC are served by San Joaquin County (i.e., the County Maintenance Districts). Figure ES-3 presents the location of the COS MUD service area relative to other water purveyors in the area, and the adopted 2035 General Plan Update Urban Services Boundary.

As shown in Figure ES-3, the COS MUD service area encompasses portions of the City generally located north of Calaveras River (North Stockton), generally located south of French Camp Slough and Zephyr Road (South Stockton), and the WPA. The WPA is a stand alone water system that receives a majority of its water supply through two connections with CWSC.

EXISTING AND FUTURE WATER DEMANDS

As described in Chapter 3 of this Water Master Plan Update, existing water demands for the COS MUD were determined based on historical water production data, historical consumption data, and an estimation of unaccounted-for water (UAFW). Peaking factors for maximum day demand and peak hour demand were estimated based on historical water consumption records.

Future water demands were projected through 2035 buildout of the COS MUD North and South Service Areas using a unit demand method based on the 2035 General Plan Update land use designations. A land use based methodology was used, because per capita water demand projections uniformly distribute water use over the entire water service area and, therefore, do not account for specific land uses and locations. Additionally, per capita water demands do not accurately predict buildout, because there is normally a weak link to land use and the timing of development.

Existing and future demands by land use designation are summarized in Table ES-1.

EXISTING SOURCES OF WATER SUPPLY

The COS MUD currently receives water from two sources: groundwater pumped from the underlying groundwater basin and treated surface water from the Stockton East Water District Water Treatment Plant (SEWD WTP).

Existing Local Groundwater Supplies

The groundwater basin underlying the COS MUD service area is part of the contiguous Central Valley aquifer system.[1] The thickness of the unconfined alluvial aquifer ranges from around 100 feet on the eastern end of the county to over 3,000 feet on the southwestern end; the thickness underlying the COS MUD service area is approximately 1,000 feet.[2]

For the City, adverse impacts of a lowered water table include increasing saline intrusion, increasing pumping depths (higher pumping costs, reduced well yields, and the need to deepen some wells), and potentially land subsidence. The most current estimate of groundwater availability appears in the 2006 Water Supply Evaluation (WSE) at 0.75- to 1.0-acre feet per acre per year (af/ac/yr).

The quantity of groundwater pumped from the basin will increase dramatically as the City's demands increase; however, as will be discussed in Chapter 4, the City has been and will continue to implement a conjunctive use program that will assist the COS MUD in meeting the targets presented in the 2006 WSE.

Table ES-1. Projected Water Demands for the COS MUD Service Area

Landuse Designation	Unit Demand Factor, af/ac/yr	North Stockton[a]		South Stockton		COS MUD	
		Additional Development, acres[b]	Additional Consumption, af/year[c]	Additional Development, acres[b]	Additional Consumption, af/year[c]	Additional Development, acres[b]	Additional Consumption, af/year[c]
Residential Estate	1.5	990	1,490	0	0	990	1,490
Low Density Residential	2.5	6,260	15,650	1,640	4,100	7,900	19,750
Medium Density Residential	3.7	1,650	6,110	450	1,670	2,100	7,780
High Density Residential	5.2	540	2,810	80	420	620	3,230
Commercial	2.3	890	2,050	620	1,430	1,510	3,480
Administrative Professional	2.4	100	240	500	1,200	600	1,440
Industrial	2.0	70	140	8,030	16,060	8,100	16,200
Institutional	1.1	1,290	1,420	1,590	1,750	2,880	3,170
Parks and Recreation	2.4	820	1,970	170	410	990	2,380
Mixed Use	2.6	860	2,240	0	0	860	2,240
Village	2.6	3,380	8,790	4,680	12,170	8,060	20,960
Total		16,850	42,910	17,760	39,210	34,610	82,120
Conservation (10%) [c]			*(4,290)*		*(3,920)*		*(8,210)*
UAFW (@ 4.8%) [c]			*1,950*		*1,780*		*3,730*
Total Additional Production (includes UAFW @ 4.8%) [c]			40,570		37,070		77,640
Existing Production (average of 2004 and 2005) [c]			30,380		6,000		36,380
Existing Conservation (10%) [c]			*(3,040)*		*(600)*		*(3,640)*
Future Existing Production [c]			27,340		5,400		32,740
Total Future Water Demand[d]			**68,000**		**42,000**		**110,000**
Percentage Increase			*124%*		*600%*		*202%*

[a] Includes WPA and County Maintenance Districts.

[b] Rounded to the nearest 10 acres.

[c] Rounded to the nearest 10 acre-feet/year.

[d] Rounded to the nearest 1,000 acre-feet/year.

Existing Surface Water Supply

Currently, all surface water used in the COS MUD is produced by the SEWD WTP. The current capacity of the SEWD WTP is 50 mgd (approximately 56,000 afa). As previously shown in Chapter 3 (see Table 3-4), the SEWD WTP has provided the COS MUD with approximately 60 percent (21,707 af in 2005) of its total supply from 1993 to 2005.

The SEWD WTP currently receives Calaveras River and Stanislaus River water under five separate agreements that currently total approximately 104,100 af, but will decrease to approximately 94,100 af at buildout (see Table ES-2). Actual existing availability varies from 104,100 afa in a wet year, to approximately 48,000 afa in a critically dry year (see Table ES-2).

Table ES-2. Current and Future SEWD Water Sources and Critical Year Availability[(a)]

Source	Annual Contract Amount, thousand acre-feet (TAF)	Projected "Critical Year" Annual Availability, af/yr			
		Planning Year			
		2000	2010	2020	2035
Current and Future "Firm" Sources of Supply					
Reclamation – New Hogan Water Supplies, CACWD and SEWD	Total yield 84.1 TAF SEWD Entitled to M&I or Ag 40.171 TAF	20,000	12,000	12,000	12,000
CACWD Appropriate Water Rights	Unused CACWD Rights (currently at approximately M&I 24 TAF initially to 10 TAF at buildout)	20,000	10,000	10,000	10,000
Reclamation – New Melones Interim Water Contract and Section 215 "Spill" Water	Total contract 75 TAF (M&I 40 TAF) Ag & Recharge 20 TAF) Losses 15 TAF)	Not Available in Dry Years			
SSJID Transfer – Stanislaus River	(Interim M&I 15 TAF)	4,000	4,000	0	0
OID Transfer – Stanislaus River (includes contract renewal to 2025)	(Interim M&I 15 TAF)	4,000	4,000	4,000	0
Future Appropriate Water Rights on the Calaveras River	(Not yet determined, assumed to be M&I 50 TAF in wet and above normal years only)	Not Available in Dry Years			
Total	(Firm M&I 104.1 TAF initially to 94.1 TAF at buildout) (Approximate Max Future M&I 180 TAF)	48,000	30,000	26,000	22,000

(a) Table is an exact copy of Table 3 of the 2006 WSE.

The minimum amount of water available from SSJID/OID is 8,000 afa during critical years, increasing incrementally as the inflow increases.[3] Additionally, the current agreements expire in 2009, with optional extensions for up to 10 additional years.[4] Contract extension negotiations are currently underway, and the 2006 WSE assumed, for water supply planning purposes, that only one of these contracts will be extended through 2019, and neither will be available after 2025.

Future Local Groundwater Supplies

Currently and in the future, the COS MUD will be improving conditions in the groundwater basin through a conjunctive use program.[5] The conjunctive use program assumes that groundwater will be preserved as the last source of supply, and used only if surface water supplies are insufficient to meet demands; the 2006 WSE further discusses the COS MUD's program.

The analysis conducted as a part of the 2006 WSE indicated that the groundwater extraction would begin to exceed the long-term operational goal of 0.6 af/ac/yr at buildout even with the groundwater banking and agricultural credits unless additional surface water sources can be developed for the COS MUD.

Future Surface Water Supplies

The 2006 WSE included two projects for the COS MUD: Expansion of the SEWD WTP and the Delta Water Supply Project (DWSP).

Expansion of the SEWD WTP

SEWD potable water deliveries to the COS MUD and CWSC are limited by raw water contracts and availability, and the design capacity of the WTP. The WTP's current design capacity is 50 mgd.[6] The 2006 WSE assumed that the WTP capacity would be expanded to 60 mgd by 2015. The 2006 WSE also assumed that the COS MUD and CWSC would split the total supplies from the SEWD 50/50 after considerations for San Joaquin County.

Delta Water Supply Project (DWSP)

In March 2006, the State Water Resources Control Board (SWRCB) granted a permit (#21176) for diversion and use of water by the COS MUD from the Delta to the maximum of 33,600 afa.[7] Design-build procurement of 30 mgd capacity water treatment plant is underway at the west side of Lower Sacramento Road, about 0.5-mile north of Eight Mile Road with the target startup in 2011.[8] The three main objectives of the DWSP are to:

- Replace expected surface water supply reductions to the COS MUD; specifically from the SEWD;
- Meet expected future water demands due to planned growth; and
- Protect and restore groundwater.

HYDRAULIC MODEL UPDATE AND DEVELOPMENT

One of the objectives of this Water Master Plan Update was the development of a reliable, representative hydraulic model of the COS MUD's water system which could be used with confidence to conduct detailed hydraulic analysis of pump station locations, transmission and distribution pipeline alignments and overall system configuration. Since the last model update in 2000, there has been new developments and several CIP projects which have been constructed. Therefore, WYA developed an updated water system hydraulic model using H_2ONET. The updated model was then calibrated using actual field data and verified using data from the COS MUD's SCADA system. A detailed description of the model development, calibration, and verification is provided in Chapter 6 of this Water Master Plan Update. Also, additional data related to the verification of the updated model is provided in Appendix B.

WATER DISTRIBUTION SYSTEM EVALUATION

The existing and future water system was analyzed using the updated and verified steady state hydraulic model that integrated facilities required to fix existing deficiencies and facilities required to serve projected demands in 2035. This steady state analysis identified areas of the COS MUD's existing and future water system that could not maintain the performance and design criteria while supplying existing and projected water demands in 2035. Additional model simulations were conducted to evaluate the need for other system improvements and/or enhancements, including new pipeline connections, parallel pipelines or replacement mains, in those areas not meeting the performance criteria.

Recommended Improvements for the Existing Water System

The recommended improvements for pipelines, wells and storage following the analysis of the existing distribution system in North and South Stockton are discussed below. Figures ES-4 and ES-5 illustrate the recommended improvements based on this analysis. These figures also illustrate the near term improvements that are proposed by the COS MUD. The capital costs associated with these improvements are detailed in Chapter 9.

North Stockton Service Area

Pipelines. Because the 10-inch diameter main on Swain Road is a critical pipeline and violates both the head loss and the velocity criteria stated in Chapter 5 for a peak hour condition, it is recommended that a new 12-inch diameter main be installed in parallel to reduce the head loss and velocity.

Wells. The existing system analysis indicated that North Stockton does not currently have a groundwater pumping capacity deficit. However, the COS MUD is currently designing Well #33, #2-2 and #10-2 to improve the groundwater pumping supply reliability.

Storage. To improve peak hour design pressures in the northeastern part of the service area, two (2) storage tanks each with a capacity of 3 MG, complete with pumping facilities, are recommended near the area south of Morada Lane and west of Glacier Point Drive. In addition, the COS MUD is planning an additional 3.4 MG tank at the Northwest tank site[9].

South Stockton Service Area

Pipelines. The County Jail and Hospital area observed pressures below the performance criterion during a peak hour demand condition. Therefore, new pipeline facilities were evaluated and recommended to improve flows in the service area. An 18-inch diameter pipeline looping the WR area to the County Jail and Hospital areas is recommended to improve the peak hour pressures within the County Jail area. The new pipeline recommended for improvement is shown in Figure 7-8. In addition, WYA recommends that the COS MUD confirm the existing pipeline configuration in the Airport, County Jail, and Hospital areas for possible near term pipeline improvements. For example, increasing the diameter of the existing 6-inch and 8-inch diameter pipelines within the Airport and the 8-inch diameter pipelines leading into the County Jail would reduce head losses and velocities during peak hour demand and maximum day demand plus fire flow conditions.

Wells. Potential additional well locations are scarce due to the salinity front in the western portion of the service area, and the landfill proximity in the southeast. Preferred locations for new wells are immediately north or south of SSS #3. According to the current system analysis, no new wells are required; however, as future development occurs, this is subject to change.

Storage. In order to meet the pressure criterion during a maximum day demand plus fire flow condition in the French Camp area, a new storage tank must be built. In addition, the COS MUD is planning an additional 3 MG tank at the existing WR tank site. These new storage tanks will allow South Stockton meet its required storage capacity.

Recommended Improvements for the Future Water System

The recommended improvements for pipelines, wells and storage, following the analysis of the future distribution system in North and South Stockton, are discussed below. Figures ES-6 and ES-7 illustrate the recommended improvements based on this analysis. These figures also illustrate the proposed pipelines in the 2035 water distribution system. The capital costs associated with these improvements are detailed in Chapter 9.

North Stockton Service Area

Pipelines. In order to meet the performance criteria during a peak hour demand condition, the following pipeline improvements are recommended for the 2035 water distribution system:

- Install pipelines of various diameters and lengths as shown in Figure ES-6.
- Install an 18-inch diameter parallel pipeline west of the proposed Southeast booster pump station.
- Install a 12-inch diameter parallel pipeline west of the proposed Southeast booster pump station.
- Install a 16-inch diameter parallel pipeline south of the proposed Southeast booster pump station.

Wells. Fifteen (15) new production wells are proposed for the 2035 water distribution system.

Storage. The following storage tanks are proposed for the 2035 water distribution system:

- North Central Tank (1) = 3.0 MG
- Southeast Tanks (2) = 6.0 MG
- DWSP Tank (1) = 10.0 MG

South Stockton Service Area

Pipelines. In order to meet the performance criteria during a peak hour demand condition, the following pipeline improvements are recommended for the 2035 water distribution system:

- Install pipelines of various diameters and lengths as shown in Figure ES-7.
- Install a 12-inch diameter parallel pipeline on Harty Lane inside the County Jail area.

The proposal of an additional tank at the French Camp booster pump station removes the velocity violations for the 8-inch diameter pipeline connecting the Hospital and the County Jail and the 16-inch diameter pipeline on Arch Airport Road toward Alitalia Avenue during a peak hour demand condition.

In order to meet the performance criteria during a maximum day plus fire flow condition, the following pipeline improvements are recommended for the 2035 water distribution system:

- Replace the existing 12-inch diameter pipeline along I-5 and north of E. Roth Road with a 16-inch diameter pipeline.

As recommended in Chapter 7, WYA suggests that the COS MUD should confirm the existing pipeline configuration in the Airport, County Jail and Hospital area for possible pipeline improvements to reduce velocities and head losses during peak hour demand and maximum day demand plus fire flow conditions.

Wells. Five (5) new production wells are proposed for the 2035 water distribution system.

Storage. The following storage tanks are proposed for the 2035 water distribution system:

- Additional French Camp Tank (1) = 3.0 MG
- East Area Tanks (2) = 6.0 MG
- Terminal Reservoir (1) = 8.0 MG
- Far East Area Tanks (2) = 6.0 MG

CAPITAL IMPROVEMENT PROGRAM

As described in Chapters 7 and 8 of this Water Master Plan Update, the COS MUD's water system was evaluated to determine its ability to meet operational and design criteria related to water storage, pumping capacity and distribution system operations under both existing and

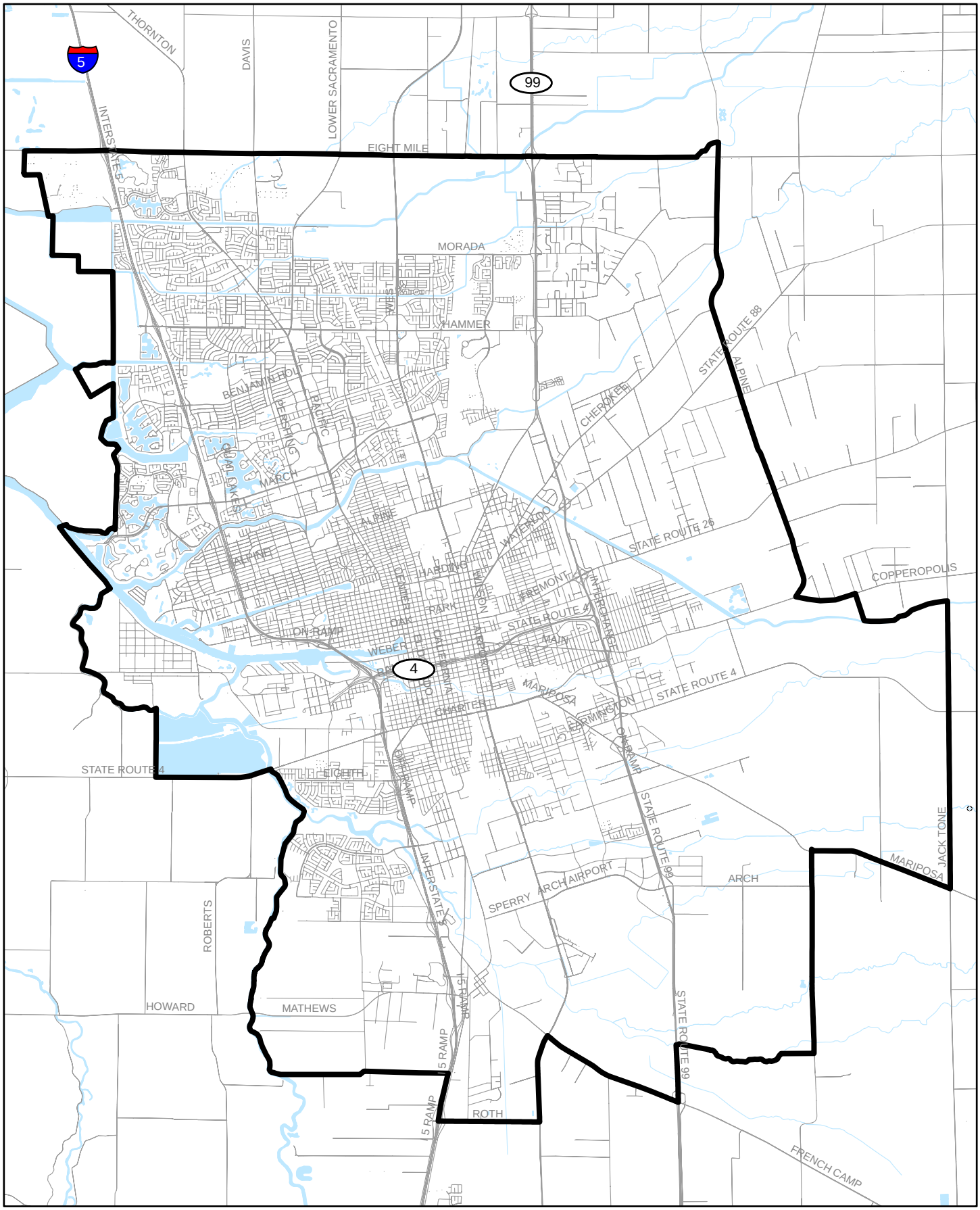
buildout conditions. Water storage facilities were evaluated based on their ability to meet water storage needs for operational, fire flow and emergency needs. Pump stations were evaluated based on their ability to meet pumping requirements under maximum day demand plus fire flow conditions and peak hour conditions. The water distribution system was evaluated based on its ability to meet maximum day demand plus fire flow and peak hour demands, while meeting established operations criteria for minimum and maximum pressures, maximum head losses, and maximum velocities.

Based on these evaluations, several deficiencies were identified. Table ES-3 summarizes the costs for the recommended improvements for the existing and buildout system CIP to address the identified deficiencies. The locations of the recommended improvements are shown on Figures ES-8 and ES-9, and the estimated timing for these facilities is shown on Figures ES-10 and ES-11.

Table ES-3. Summary of CIP Costs for North and South Stockton[a,b,c]

Area	Near Term, dollars	2035, dollars	Total, dollars
North Stockton	380,194,000	272,645,000	652,839,000
South Stockton	47,470,000	302,586,000	350,056,000
Total	427,664,000	575,231,000	1,002,895,000

(a) Includes 35 percent contingency and 35 percent other project costs.
(b) Based on the July 2008 ENR index of 8293.
(c) Rounded to the nearest $1,000.



LEGEND:

- 1990 General Plan Boundary
- Street
- Water Feature

N

0 0.45 0.9 1.8

Scale in Miles

FIGURE ES-1

City of Stockton
Municipal Utilities Department
Water Master Plan Update

EXISTING COSMA AREA

WEST YOST ASSOCIATES Consulting Engineers

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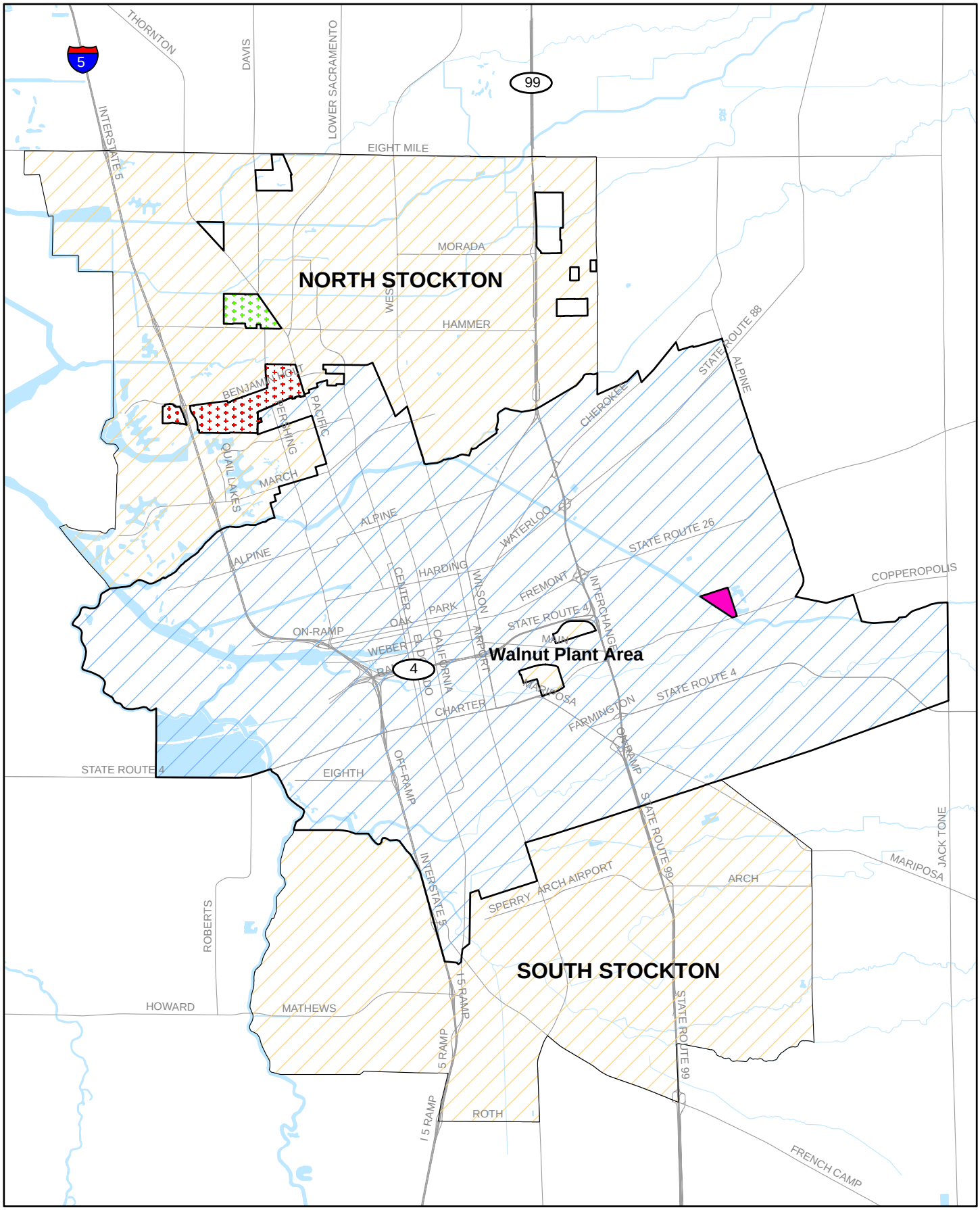

LEGEND:

- Major Street
- COS MUD
- Lincoln Village
- Colonial Heights
- Cal Water
- County Area
- SEWD WTP
- Water Feature

N

0 0.45 0.9 1.8

Scale in Miles

FIGURE ES-2

City of Stockton
Municipal Utilities Department
Water Master Plan Update

EXISTING SERVICE AREAS

WEST YOST ASSOCIATES Consulting Engineers

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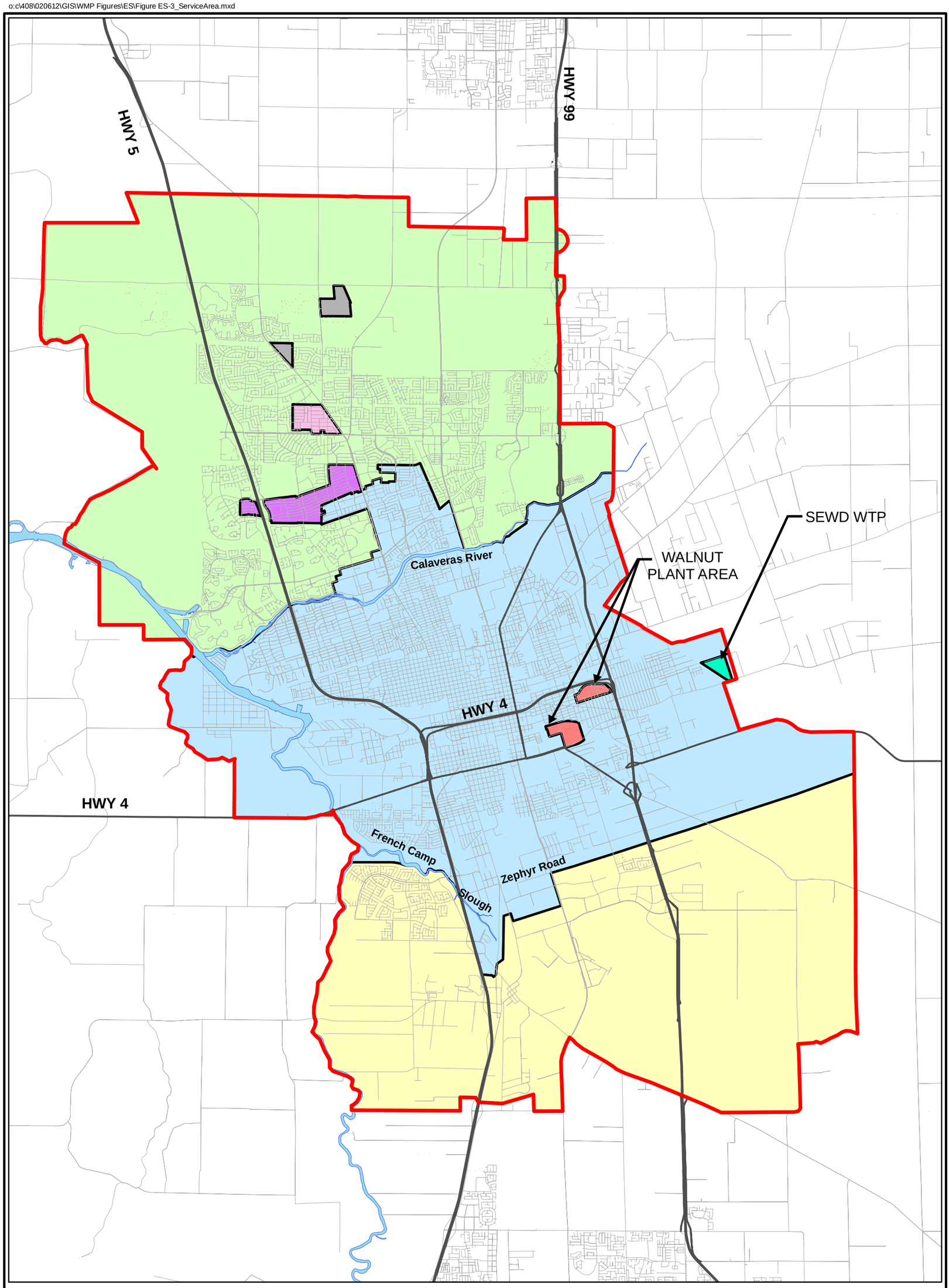

LEGEND:

- 2035 Urban Services Boundary
- Major Freeway
- Street
- Colonial Heights
- Lincoln Village
- County Island
- CWSC
- COS MUD - North Stockton
- COS MUD - South Stockton
- COS MUD - Walnut Plant
- SEWD WTP
- Major Water Feature

N

0 0.45 0.9 1.8

Scale in Miles

FIGURE ES-3

City of Stockton
Municipal Utilities Department
Water Master Plan Update

SERVICE AREAS

WEST YOST ASSOCIATES
Consulting Engineers

O\C\408\020612\GIS\WMP Figures\ES\Figure ES-4_NS Near Term.mxd

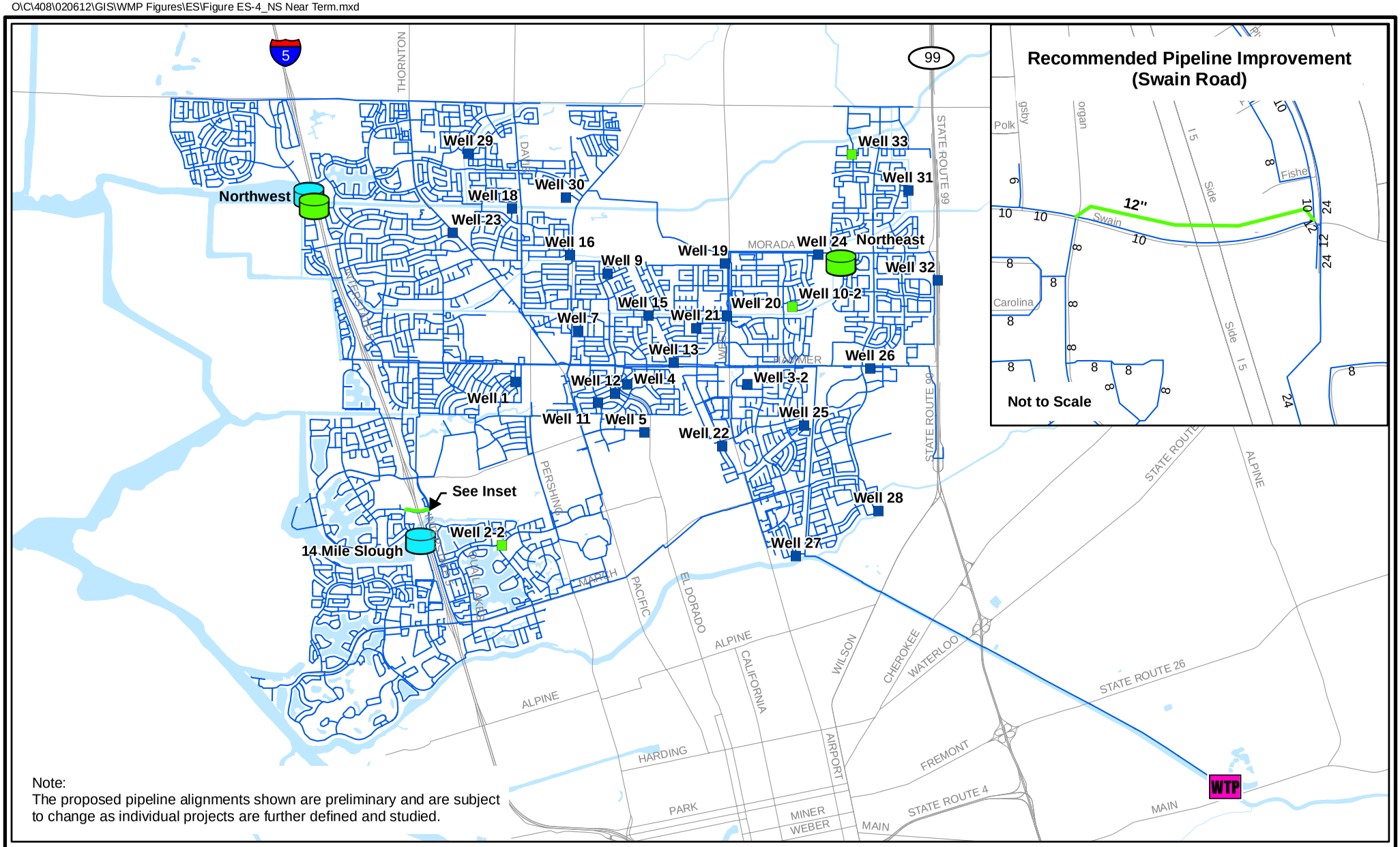

FIGURE ES-4

City of Stockton
Municipal Utilities Department
Water Master Plan Update

NORTH STOCKTON NEAR TERM IMPROVEMENTS

WEST YOST ASSOCIATES Consulting Engineers

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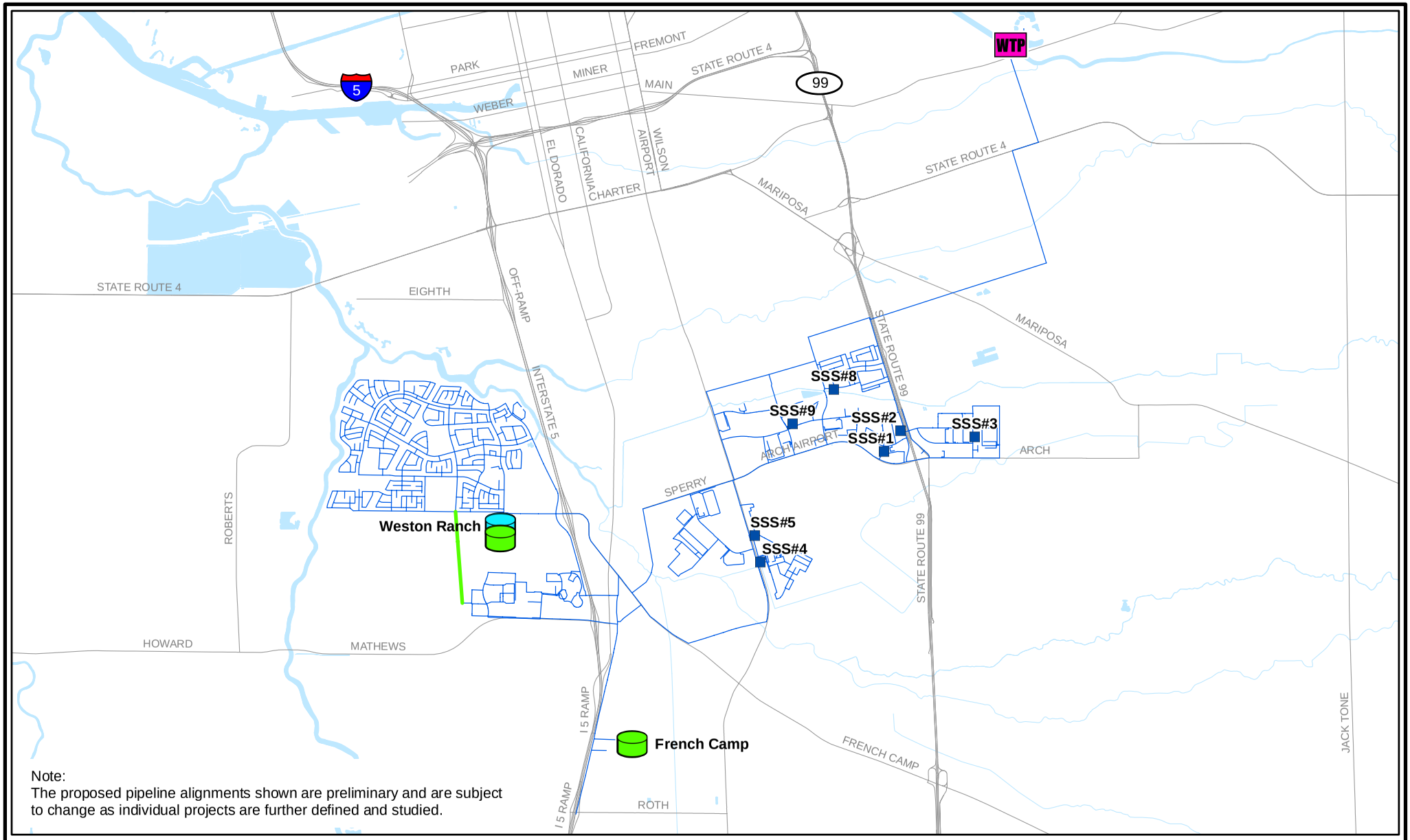

Note:
The proposed pipeline alignments shown are preliminary and are subject to change as individual projects are further defined and studied.

LEGEND:

- Existing Well
- Near Term Water Tank
- Existing Water Tank
- SEWD WTP
- Proposed 18-inch Diameter Pipeline
- Existing Pipeline
- Major Street
- Water Feature

N

0 0.5 1 2

Scale in Miles

FIGURE ES-5

City of Stockton
Municipal Utilities Department
Water Master Plan Update

SOUTH STOCKTON NEAR TERM IMPROVEMENTS

WEST YOST ASSOCIATES Consulting Engineers

Note:
- As of December 2007, the Empire Ranch development has been removed from the 2035 General Plan Update Urban Services Boundary. The decision was made to show that the Empire Ranch development was removed from the City's system; however, no additional analysis was performed to evaluate what infrastructure was required without the development. WYA recommends that the COS MUD evaluate the effects of removing the Empire Ranch development within the water distribution system in the near future.
- The proposed pipeline alignments shown are preliminary and are subject to change as individual projects are further defined and studied.

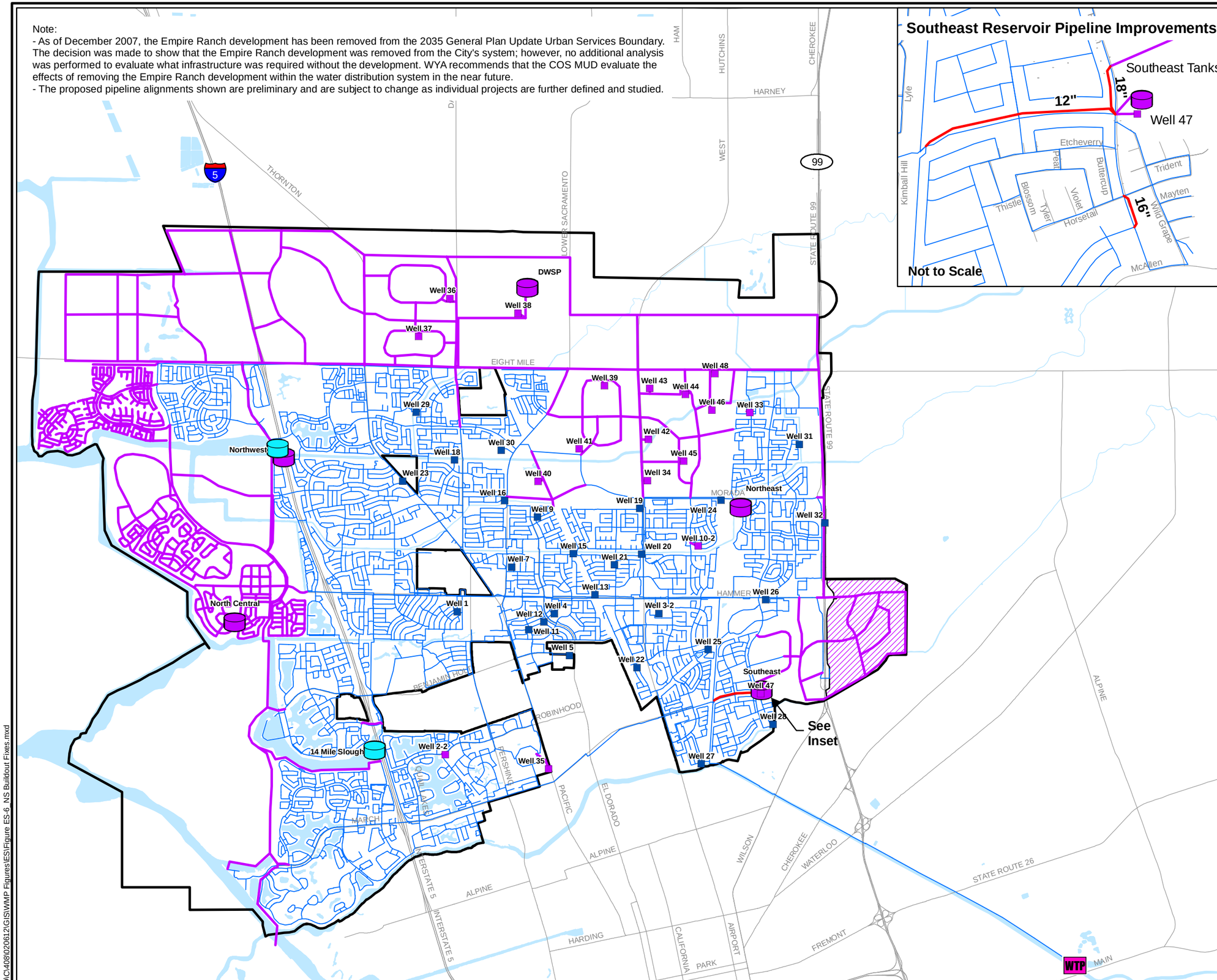

FIGURE ES-6

City of Stockton
Municipal Utilities Department
Water Master Plan Update

NORTH STOCKTON
2035 IMPROVEMENTS

N

0 0.4 0.8 1.6

Scale in Miles

LEGEND:

- Existing Well
- Proposed Well
- Existing Water Tank
- Proposed Water Tank
- Pipeline Improvement
- Existing Pipeline
- Proposed Pipeline
- SEWD WTP
- Empire Ranch Development
- Service Area
- Major Street
- Water Feature

WEST YOST ASSOCIATES
Consulting Engineers

O:\C408\020612\GIS\WMP Figures\ES\Figure ES-6_NS Buildout Fixes.mxd

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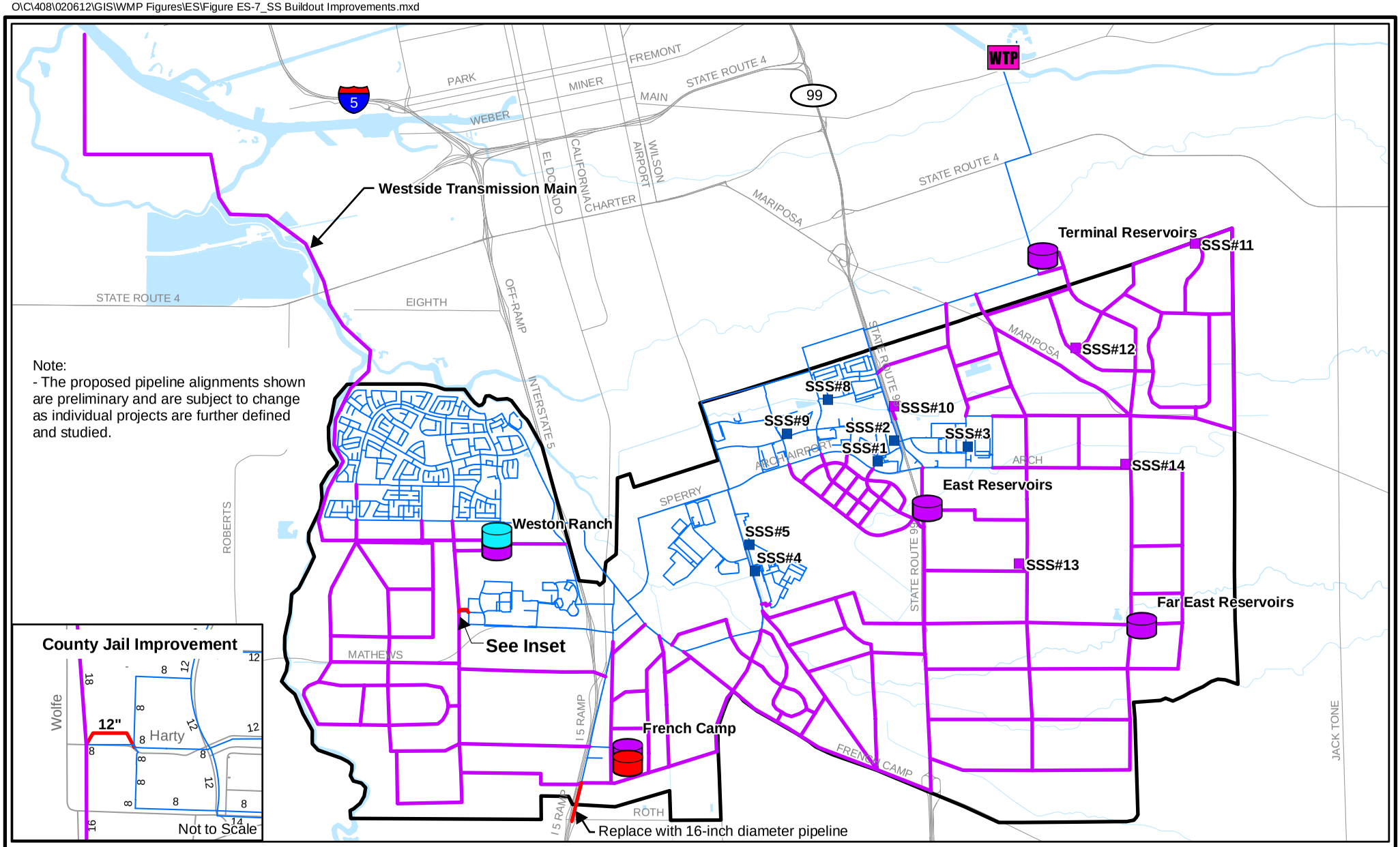


FIGURE ES-7

City of Stockton
Municipal Utilities Department
Water Master Plan Update

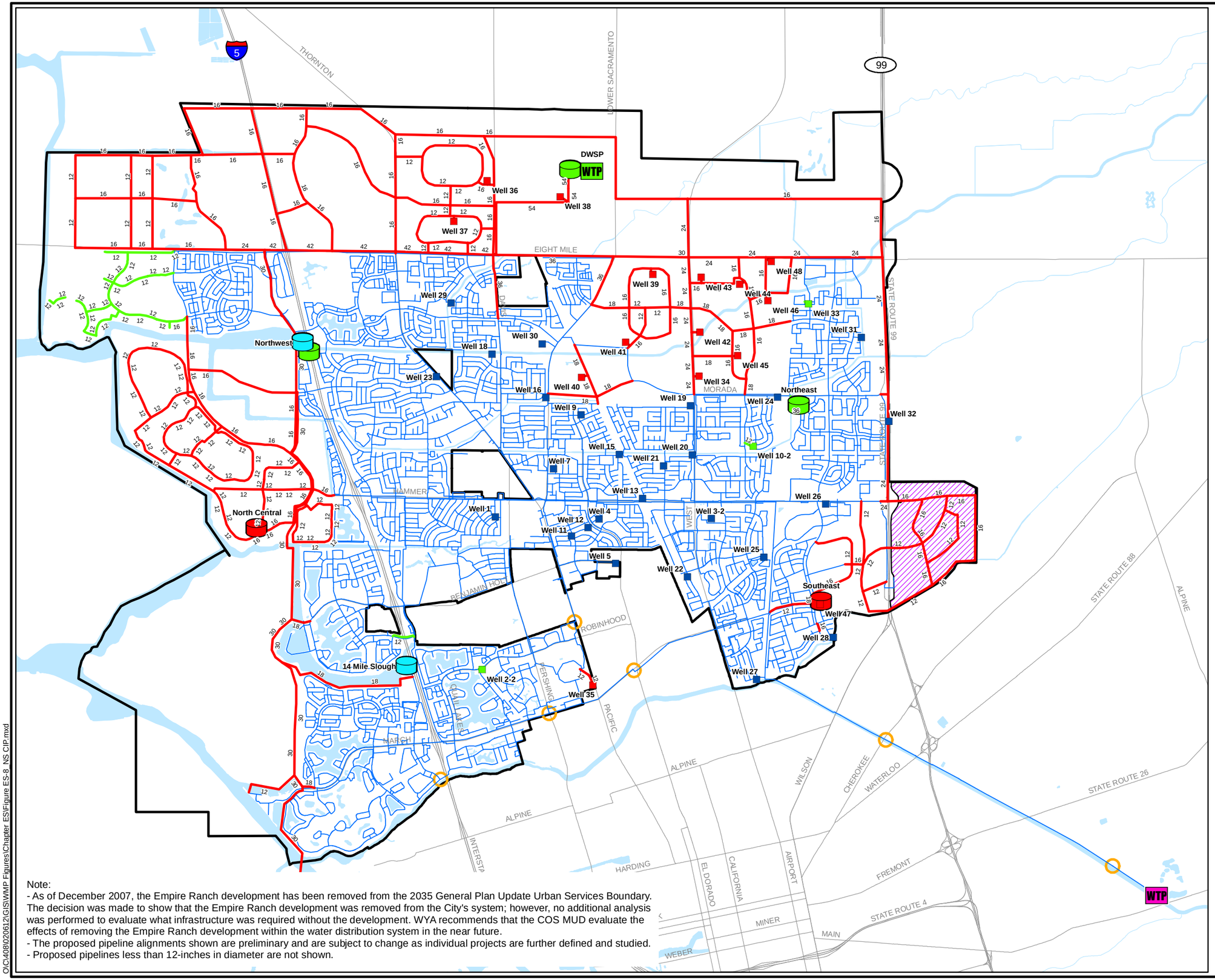
SOUTH STOCKTON 2035 IMPROVEMENTS

WEST YOST ASSOCIATES Consulting Engineers

FIGURE ES-8

City of Stockton
Municipal Utilities Department
Water Master Plan Update

NORTH STOCKTON EXISTING AND BUILDOUT CIP RECOMMENDATIONS



Note:
- As of December 2007, the Empire Ranch development has been removed from the 2035 General Plan Update Urban Services Boundary. The decision was made to show that the Empire Ranch development was removed from the City's system; however, no additional analysis was performed to evaluate what infrastructure was required without the development. WYA recommends that the COS MUD evaluate the effects of removing the Empire Ranch development within the water distribution system in the near future.
- The proposed pipeline alignments shown are preliminary and are subject to change as individual projects are further defined and studied.
- Proposed pipelines less than 12-inches in diameter are not shown.

N

0 0.375 0.75 1.5
Scale in Miles

LEGEND:

- Existing Well
- Near Term Well
- 2035 Well
- Existing Water Tank
- Near Term Water Tank
- 2035 Water Tank
- Existing Pipeline
- Near Term Pipeline
- 2035 Pipeline
- DWSP WTP (Near Term)
- SEWD WTP (Near Term Expansion)
- Empire Ranch Development
- Potential Turnout to Serve CWSC
- Service Area
- Major Street
- Water Feature

WEST YOST ASSOCIATES
Consulting Engineers

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Note:
- The proposed pipeline alignments shown are preliminary and are subject to change as individual projects are further defined and studied.
- Proposed pipelines less than 12-inches in diameter are not shown.

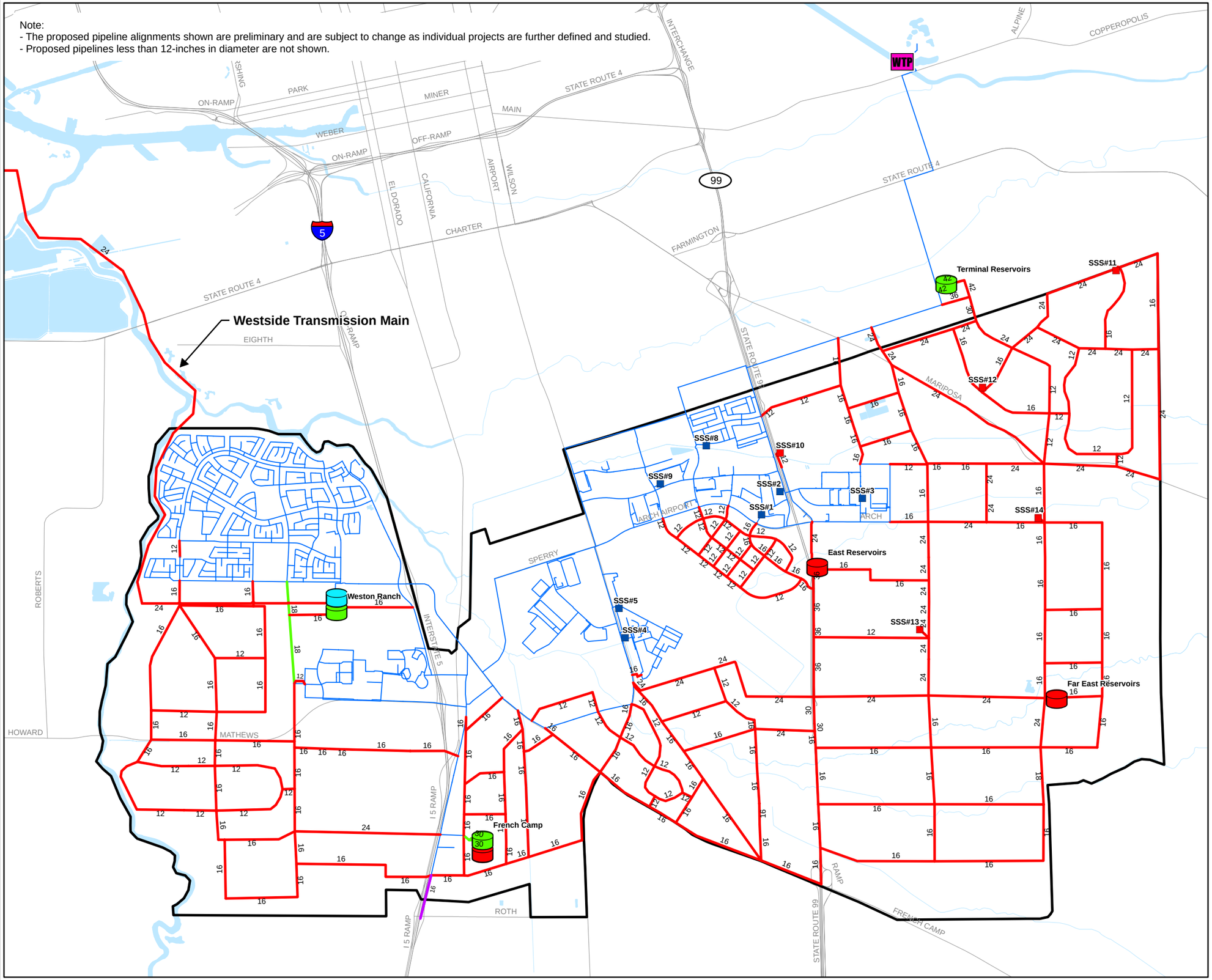

FIGURE ES-9

City of Stockton
Municipal Utilities Department
Water Master Plan Update

SOUTH STOCKTON EXISTING AND BUILDOUT CIP RECOMMENDATIONS

N

0 0.3 0.6 1.2

Scale in Miles

LEGEND:

- Existing Well
- 2035 Well
- Existing Water Tank
- Near Term Water Tank
- 2035 Water Tank
- Existing Pipeline
- Near Term Pipeline
- 2035 Pipeline
- 2035 Pipeline Replacement
- SEWD WTP (Near Term Expansion)
- Service Area
- Major Street
- Water Feature

WEST YOST ASSOCIATES Consulting Engineers

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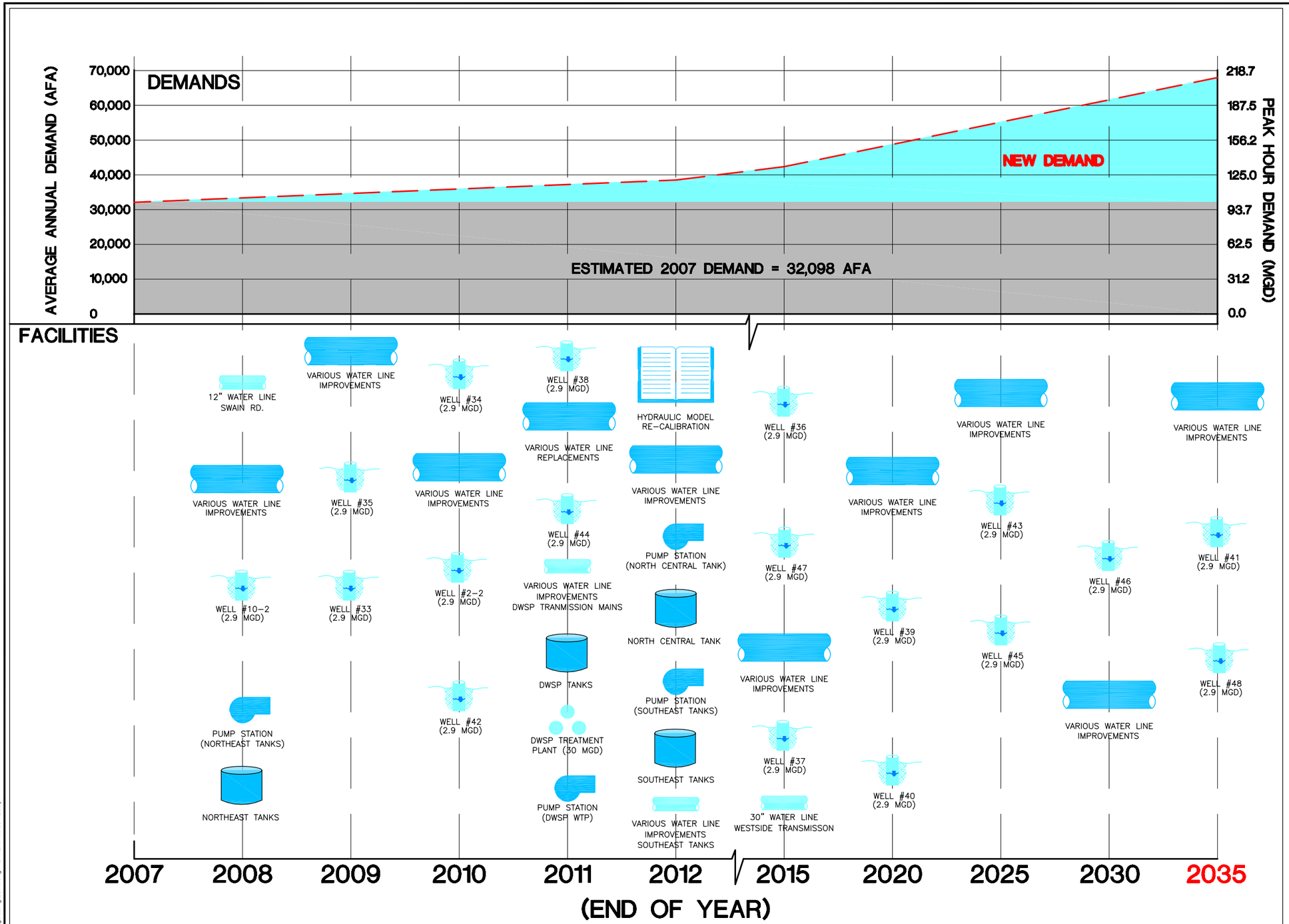

FIGURE ES-10

City of Stockton
Municipal Utilities Department
Water Master Plan Update

TIMING OF MAJOR WATER SUPPLY AND DISTRIBUTION FACILITIES IN NORTH STOCKTON

N

0 NO SCALE

NOTES:

LEGEND:

WEST YOST ASSOCIATES
Consulting Engineers

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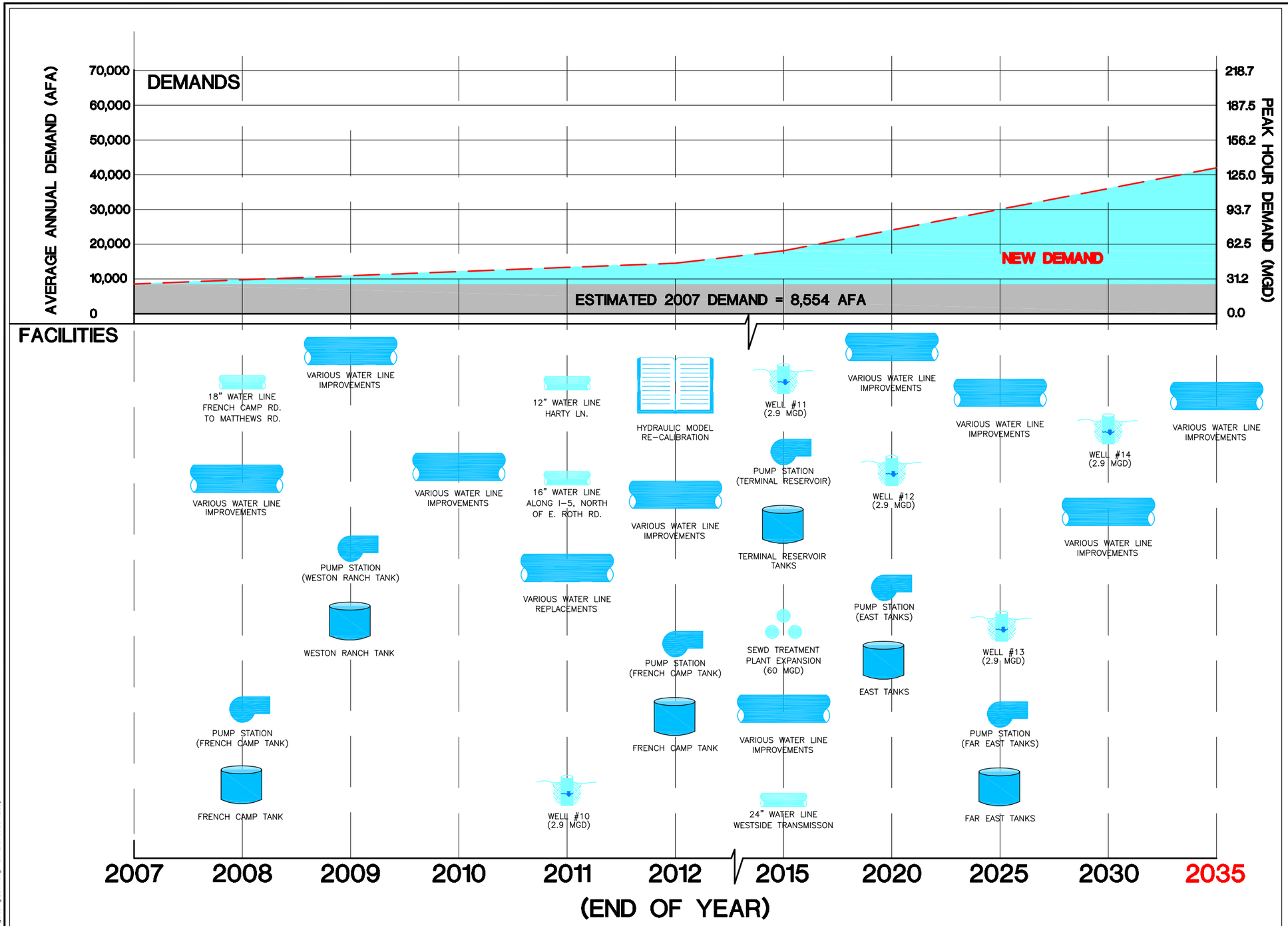

FIGURE ES-11

City of Stockton
Municipal Utilities Department
Water Master Plan Update

TIMING OF MAJOR WATER SUPPLY AND DISTRIBUTION FACILITIES IN SOUTH STOCKTON

N

0 – –
NO SCALE

NOTES:

LEGEND:

WEST YOST ASSOCIATES
Consulting Engineers

CAD FILE: O:\C408\02-06-12\CAD\Figures\Fig ES-11.dwg DATE: 07-03-08 12:50 pm

REFERENCES

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[1] Montgomery Watson Harza, 2006. Water Supply Evaluation for the General Plan Update Preferred Alternative. December 30, 2005. Amended May 12, 2006.

[2] Montgomery Watson Harza, 2006. Water Supply Evaluation for the General Plan Update Preferred Alternative. December 30, 2005. Amended May 12, 2006.

[3] Montgomery Watson Harza, 2006. Water Supply Evaluation for the General Plan Update Preferred Alternative. December 30, 2005. Amended May 12, 2006.

[4] Montgomery Watson Harza, 2006. Water Supply Evaluation for the General Plan Update Preferred Alternative. December 30, 2005. Amended May 12, 2006.

[5] Montgomery Watson Harza, 2006. Water Supply Evaluation for the General Plan Update Preferred Alternative. December 30, 2005. Amended May 12, 2006.

[6] Montgomery Watson Harza, 2006. Water Supply Evaluation for the General Plan Update Preferred Alternative. December 30, 2005. Amended May 12, 2006.

[7] Montgomery Watson Harza, 2006. Water Supply Evaluation for the General Plan Update Preferred Alternative. December 30, 2005. Amended May 12, 2006.

[8] Montgomery Watson Harza, 2006. Water Supply Evaluation for the General Plan Update Preferred Alternative. December 30, 2005. Amended May 12, 2006.

[9] This tank has been completed as confirmed by the City in May 2008. However, this additional tank was not considered in the existing storage and pumping capacity analyses presented in Chapter 7.

CHAPTER 1. INTRODUCTION

This Water Master Plan Update for the City of Stockton Municipal Utilities Department's (COS MUD) North and South Stockton Service Areas, provides the City of Stockton (City) with the tools and the insight required to address important water system planning and associated funding issues facing the City as a result of the City's 2035 General Plan Update. These issues include the following:

- The need for supplemental water supplies to meet existing and future water demands and to increase supply reliability;
- The continued use of groundwater as a supply source;
- The need for additional transmission mains, distribution pipelines, interconnections, pumping capacity, wells and storage facilities to meet the needs of existing customers and future development; and
- The need to implement a planned capital improvement program to meet the needs of the existing water system and to accommodate future growth.

A comprehensive Water Master Plan Update provides the City with the appropriate tool to formally develop and implement water system and supply strategies to serve existing customers and support future growth. In addition, it will also provide the City with a tool to identify and evaluate City-wide capital improvements for the COS MUD's North and South Stockton Service Areas in an efficient and cost-effective manner.

GOAL

The City requires a Water Master Plan Update that includes recent and projected changes in infrastructure and integrates them into a revised hydraulic model, allowing for more effective water system management and planning. The goal of this work product is a single water master plan document, including an updated system hydraulic model, which the COS MUD can use to assess the impacts of system expansion. The General Plan was updated under a separate effort and was completed in 2007.

Although the primary focus of this Water Master Plan Update is on planning the COS MUD portions of the water systems serving the City of Stockton Metropolitan Area (COSMA), water demands and supplies for the California Water Service Company's (CWSC) service area are also discussed briefly. Projecting water demands and supplies for the COSMA, rather than only the COS MUD service area, was required to help support the 2035 General Plan Update, and identify the infrastructure required for expansion of the COS MUD Service Area.

This Water Maser Plan Update supports the City's overall mission of providing timely, efficient, and effective service to existing customers and future development. Moreover, this planning effort recognizes and incorporates the City's strategic goal of maintaining competitive water rates through the efficient use of available water resources.

OBJECTIVES

To meet the City's objective of updating the water master plan to identify existing system deficiencies in the North and South Stockton Service Areas, and to guide its future water system expansion and operation, the following tasks were completed:

- Reanalyze historic water consumption by user type, and use the updated information to recalculate buildout water demand projections for the COSMA.
- Identify available water supplies for the COSMA required to meet projected demands in 2035 for wet and critically dry year conditions.
- Update the existing hydraulic model for both the North and South Stockton Service Areas using data from the City's Geographical Information System (GIS).
- Develop a new hydraulic buildout model of the COS MUD's North and South systems using the updated model and projected land use plans developed from the 2035 General Plan Update process.
- Use the model to evaluate the ability of the City's existing and future water system infrastructure to meet system performance standards.
- Develop a long range, prioritized Capital Improvement Program (CIP).
- Using previously developed estimates of the groundwater safe yield developed by others, estimate whether annually sustainable groundwater supplies are available to meet the buildout demands of the Stockton area, and if not, estimate approximately when supplemental supplies will be required.
- Prepare a draft and final Water Master Plan Update Report.

AUTHORIZATION

In July 2006, the City authorized West Yost Associates (WYA) to provide engineering services to develop the Water Master Plan Update.

REPORT ORGANIZATION

Following this introductory Chapter 1, this Water Master Plan Update includes the following chapters:

- **Chapter 2. Existing Water System** – background information on the COS MUD's water system including water supply, storage and transmission/distribution facilities.
- **Chapter 3. Water Demands** – historical, current and projected water demands which correspond to the growth projections of the City's 2035 General Plan Update.
- **Chapter 4. Water Supply –** evaluation of the groundwater and surface water supplies necessary to support the City's 2035 General Plan Update.
- **Chapter 5. Design/System Performance Criteria** – identification of the performance and design criteria used in the evaluation of the COS MUD's existing and future water distribution system.

- **Chapter 6. Hydraulic Model Update and Development –** explanation of the development of the computer based hydraulic model used to analyze the COS MUD's distribution system performance.
- **Chapter 7. Evaluation of Existing Water System** – description and presentation of the analysis of the COS MUD's existing distribution system pipelines and treated water storage facilities in comparison to the criteria developed in Chapter 5, and identification of recommended improvements.
- **Chapter 8. Evaluation of Future Water System** – description and presentation of the COS MUD's recommended future distribution system pipelines and treated water storage facilities in comparison to the criteria developed in Chapter 5, and identification of recommended improvements.
- **Chapter 9. Recommended Water System Capital Improvement Plan** – detailed listing of the proposed capital improvements recommended for the COS MUD's water system to meet existing and future demands while complying with drinking water regulations and industry standards for operational criteria.

The following appendices to this Water Master Plan Update contain additional technical information and assumptions:

- **Appendix A. March 2005 UAFW Analysis** – Unaccounted-for Water within the City of Stockton Water Utility Service Area Technical Memorandum, March 21, 2005.
- **Appendix B. Verification Results** – Results of model verification by individual facility.
- **Appendix C. Construction Costs for Planning and Design** – Basis of cost estimates.

ACRONYMS AND ABBREVIATIONS

The following acronyms and abbreviations have been used throughout this Water Master Plan Update to improve document clarity and readability.

2003 DWSP FR	2003 Delta Water Supply Feasibility Report
2006 WSE	May 2006 Water Supply Evaluation for the General Plan Updated Preferred Alternative
af	Acre-Feet
af/ac/yr	Acre-Feet Per Acre Per Year
afa	Acre Feet Annually
APN	Assessors Parcel Number
AWWA	American Water Works Association
CCI	Construction Cost Index
CCWD	Calaveras County Water District
CDOF	California Department of Finance
C-factors	Roughness Factors

CIP	Capital Improvement Program
City	City of Stockton
COS MUD	City of Stockton Municipal Utilities Department
COSMA	City of Stockton Metropolitan Area
CVPIA	Central Valley Project Improvement Act
CWSC	California Water Service Company
DPH	Department of Public Health
DWSP	Delta Water Supply Project
EIR	Environmental Impact Report
ENR	Engineering New Record
EPS	Extended Period Simulation
FMS	Fourteen-Mile Slough
fps	Feet Per Second
ft/kft	Feet Per Thousand Feet
GAC	Granular Activated Carbon
GBA	Groundwater Baking Authority
GIS	Geographical Information System
gpcd	Gallon Per Capita Per Day
gpd	Gallons Per Day
gpm	Gallon Per Minute
Hp	Horse Power
HPR	Hydrant Pressure Recorder
IRWMP	Integrated Regional Water Management Plan
ISO	Insurance Service Office
M&I	Municipal and Industrial
MG	Million Gallons
mgd	Million Gallons Per Day
NFPA	National Fire Protection Association
NW	Northwest
OID	Oakdale Irrigation District
PHG	Public Health Goal
ppb	Parts Per Billion
psi	Pounds Per Square Inch
PVC	Polyvinyl Chloride
SCADA	Supervisory Control and Data Acquisition
SEWD WTP	Stockton East Water District Water Treatment Plant
SSA	South Stockton Aqueduct
SSJID	South San Joaquin Irrigation District
SWRCB	State Water Resources Control Board
TAF	Thousand Acre Feet
UAFW	Unaccounted-for Water
UFC/CFC	Uniform/California Fire Code

US EPA	United States Environmental Protection Agency
VFD	Variable Frequency Drive
WPA	Walnut Plant Area
WR	Weston Ranch
WYA	West Yost Associates

CHAPTER 2. EXISTING WATER SYSTEM

This chapter describes the COS MUD's existing water system which is located in North and South Stockton. This description provides the background for identifying existing water system deficiencies, and water system improvements to address these deficiencies. It is based on previous studies, design reports, maps, plans, operating records, and discussions with the COS MUD staff. Key sections of this chapter include:

- Existing Service Areas
- Water Supply and Treatment Facilities
- Water Distribution and Storage

EXISTING SERVICE AREAS

The COSMA corresponds to the general plan boundary adopted on January 22, 1990 as shown in Figure 2-1. Currently, three water service areas exist within the COSMA. These service areas, and the corresponding water purveyor serving them, are shown in Figure 2-2. COS MUD and the San Joaquin County Maintenance Districts serve the North Stockton, South Stockton, and Walnut Plant Area (WPA); CWSC serves Central Stockton. This Water Master Plan Update only addresses the service areas served by the COS MUD in North and South Stockton.

The North Stockton Service Area, which is primarily residential, is bounded by Eight Mile Road to the north, Cascade and Columbia Railroad to the east, the Calaveras River to the south, and the City limits to the west. The South Stockton Service Area, which contains significant agricultural land uses, is bounded by French Camp Slough to the north, the City limits to the east and south, and the San Joaquin River to the west.

WATER SUPPLY AND TREATMENT FACILITIES

The COS MUD water service areas receive groundwater from wells and treated surface water from the Stockton East Water District Water Treatment Plant (SEWD WTP). The water supply and treatment facilities are described as follows.

Existing Water Treatment Plant

The SEWD, which is a public agency founded in 1948, operates the only water treatment plant in the COSMA. The SEWD WTP has been upgraded within the last two years from 45 million gallons per day (mgd) to 50 mgd treatment capacity. The treated water is shared by the North, South and Central Stockton Service Areas.

The SEWD diverts water from the Calaveras and Stanislaus Rivers to three raw water reservoirs at the WTP as shown in Figure 2-3. The South, North and Intake raw water reservoirs contain 30, 24, and 26 million gallons (MG) of water when full, respectively. The treatment process comprises of coagulation, flocculation, sedimentation, filtration, and disinfection. Granular activated carbon (GAC) is used for removing organic contaminants and controlling taste and odor

problems, while chlorine gas is used for disinfection. The treated water is initially stored in a 10 MG underground finished water reservoir before being pumped to a manifold which splits the flow into the South Stockton Aqueduct, the CWSC distribution system, and North Stockton Aqueduct.

Due to water quality issues, CWSC had to increase their water system pressure by approximately 10 psi, making the common manifold a very inefficient method of flow splitting. The SEWD has recently completed a project to replace the common manifold method with individual pumps for the three service areas. This operation will maintain a preferred system pressure utilizing variable frequency drives (VFD).

Existing Groundwater Wells

The COS MUD operates wells in both the North and South Stockton Service Areas. These are described as follows.

North Stockton Service Area

There are currently approximately 25 operational groundwater wells in North Stockton with design capacities from 540 to 3,200 gallons per minute (gpm). These wells have a total production capacity of approximately 58 mgd, but pump an average of 8 mgd. Four of these wells (Wells #30, #31, #32, and #3-2) were constructed within the past two years. Well #3-2 is a replacement for Well #3 which was abandoned due to poor water quality. Three wells (Wells #2-2, #10-2, and #33) are at various stages of construction. Table 2-1 summarizes the information on the North Stockton wells.

South Stockton Service Area

There are currently seven operational groundwater wells in South Stockton as shown in Table 2-2. The design capacities range from 700 to 2,800 gpm. These wells have a total production capacity of approximately 18 mgd, but pump an average of 4 mgd. Two of these wells (SSS #4 and SSS #5) are planned for fire support only and therefore, are on stand-by. Well SSS #8 underwent well casing modifications to address water quality concerns.

WATER DISTRIBUTION AND STORAGE

The COS MUD operates a water storage and distribution system that contains two service areas: North Stockton and South Stockton. Each service area is an individual pressure zone with the lowest ground surface elevation (at mean sea level) on the western side of the system and the highest elevation (36 feet above mean sea level) on the eastern side of the system.

Water System Pipelines

The water transmission system consists of 16- to 48-inch diameter pipelines. The North Stockton Service Area is connected to the SEWD WTP via a 48-inch diameter pipeline. The South Stockton Service Area is connected to the SEWD WTP by the recently completed 42-inch diameter South Stockton Aqueduct (SSA). The water distribution system consists of pipelines

Table 2-1. North Stockton Wells

Well No.	Name	Location	Installed HP	Production Capacity, gpm	Year Drilled	Depth, ft	Well Status	Updated Well Priority[a,b]
1	Parkwoods	Rivara Road	40	648	1954	268	Active	Secondary
2	Swenson	Swenson Golf Course	75	924	1950	252	Abandoned	--
2-2	-	Atherton Park	200	2,000	-	-	Future Replacement	--
3	Lincoln Village	Greeley Way	75	932	1957	312	Abandoned	--
3-2	-	West Lane	200	2,000	-	-	Active (Replacement)	--
4	Villa Dorado	Villa Dorado Park	75	1,050	1965	602	Active[c]	Secondary
5	Anderson Park	Benjamin Holt Drive	40	480	1957	344	Active	Secondary
7	Loch Lomond	Galloway Drive	40	550	1963	238	Active	No Action
9	San Ramon	Don Carlos Drive	50	540	1955	290	Active	No Action
10-2	-	Valverde Park	200	2,000	--	--	Future Replacement	--
11	Pacific Oaks	Inglewood	75	1,100	1958	317	Active	Secondary
12	Pacific Oaks	Leslie Avenue	60	760	1963	410	Active	Secondary
13	Tiffany park	Hammer and WPRR	200 (gas)	2,000	1970	440	Active	No Action
15	Stonehaven	Mosher Slough and WPRR	150	2,000	1975	600	Active	Secondary
16	Royal Oaks	Lower Sacramento Road	200 (gas)	2,000	1976	600	Active	Secondary
18	Western Valley	Hickock Drive	60	800	1956	211	Active	No Action
19	Morada	1233 Sutherland	200	2,000	1978	500	Active	High Priority
20	Park North	West Lane/Summerview Drive	200 (gas)	2,000	1978	545	Active	Secondary
21	Cortez	Cortez Park	200	2,000	1978	500	Active	No Action
22	Tam O'shanter	Tam O'shanter Drive	200	1,900	1981	600	Active (Standby)	--
23	Otto Drive	Otto and Thornton Road	60	900	1980	260	Active	Secondary
24	Morada	Saffron Way	150	1,040	1982	495	Active[d]	No Action
25	Panella Park	Panella Park	200 (gas)	2,200	1984	570	Active	High Priority
26	Auto Center	Hammer and EBMUD	N/A	2,400	1987	450	Active	High Priority
27	-	Bonaire Circle	200	2,000	1985	575	Active	No Action
28	-	Wild Grape Dr	120	1,400	1997	560	Active	No Action
29	-	Autumn Oak Pl.	200	3,200	2000	500	Active	No Action
30	-	Grider Way	200	2,200	2003	540	Active	No Action
31	-	Ivano Lane	200	2,000	2004	410	Active	No Action
32	-	North State Route 99 (West Frontage Road)	200	2,000	2004	480	Active	No Action
33	-	Cannery Park		2,000	--		Future	--
Total Active Now[e]				40,128				
Total Active within 5 Years[e]				46,128				

(a) Updated well priority provided by COS MUD staff in July 2007 (WellOperationsStatus.xls).

(b) "High Priority" wells are inactive and mostly have mechanical/operational issues, "Secondary Priority" wells are inactive and mostly have water quality issues, and "No Action" wells are active.

(c) Well status was recently converted from active/stand-by to active status by the City in May 2008. This well was considered on active/stand-by status in all subsequent analyses presented in this Water Master Plan Update.

(d) Well status was recently converted from out of service to active status by the City in May 2008. This well was considered out of service in all subsequent analyses presented in this Water Master Plan Update.

(e) Total does not include Well No. 24, which was recently converted to active status by the City in May 2008.

Table 2-2. South Stockton Wells

Well No.	Name	Location	Installed HP	Production Capacity, gpm	Year Drilled	Depth, ft	Well Status	Updated Well Priority[a,b]
SSS #1	Quantas	4728 Quantas Lane	200	1,800	1984	600	Active	No Action
SSS #2	Highway 99 Frontage	4605 W. Highway 99 Frontage Road	100	1,400	1953	172	Active	No Action
SSS #3	Frontier	4748 Frontier Way	200	2,000	1989	625	Active	No Action
SSS #4	Airport South	5000 South Airport Way	75	700	1978	429	Stand-By	--
SSS #5	Airport North	5000 South Airport Way	75	800	1980	-	Active[c]	Secondary
SSS #8	Pock Park	4120 Pock Lane	250	2,800	2000	410	Active	No Action
SSS #9	-	B Street	200	2,800	2004	372	Active	No Action
Total				12,300				

(a) Updated well priority provided by COS MUD staff in July 2007 (WellOperationsStatus.xls).

(b) "High Priority" wells are inactive and mostly have mechanical/operational issues, "Secondary Priority" wells are inactive and mostly have water quality issues, and "No Action" wells are active.

(c) Well status was recently converted from stand-by to active status by the City in May 2008. This well was considered on stand-by status in all subsequent analyses presented in this Water Master Plan Update.

with diameters less than 16 inches. Most of the service laterals branch off of 8-inch and 10-inch diameter pipelines.

Pipeline materials consist of asbestos cement, ductile iron, cast iron, steel, and polyvinyl chloride (PVC). Pipelines less than 8 inches are primarily PVC. Figure 2-4 shows the North Stockton water distribution system, and Figure 2-5 shows the South Stockton water distribution system.

Storage Tanks and Booster Pump Stations

The North Stockton water system has two 3 MG storage tanks near Fourteen-Mile Slough (FMS) and two 3.43 MG storage tanks at the Northwest (NW) Reservoir site. A third 3.43 MG storage tank at the NW Reservoir site is now online[1]. The South Stockton water system has one 3 MG storage tank near Weston Ranch (WR). The second storage tank near Weston Ranch is currently under design. The FMS tanks deliver water through a 24-inch diameter pipeline, the NW tanks deliver water through a 36-inch diameter pipeline, and the WR tank through a 30-inch diameter pipeline. Table 2-3 summarizes the information for each storage facility.

Table 2-3. COS MUD Storage Tanks

Reservoir	Tank	Volume, MG	Overflow Elevation, ft	Bottom Elevation, ft
Northwest	1	3.4	45.9	4.9
	2	3.4	45.9	4.9
	3[1]	3.4	36.4	4.9
Fourteen-Mile Slough	1	3	35	0
	2	3	35	0
Weston Ranch	1	3	44	15

Each tank has an altitude valve which opens to fill the tank when the pressure in the distribution system exceeds a set-point and closes when the tank level exceeds a set-point. There are booster pump stations at each reservoir site to pump the stored water from the tanks into the distribution system during higher system demands. Each booster pump station has 4 to 5 pumps that are operated sequentially based on water system pressure. Table 2-4 summarizes the information for each booster pump station.

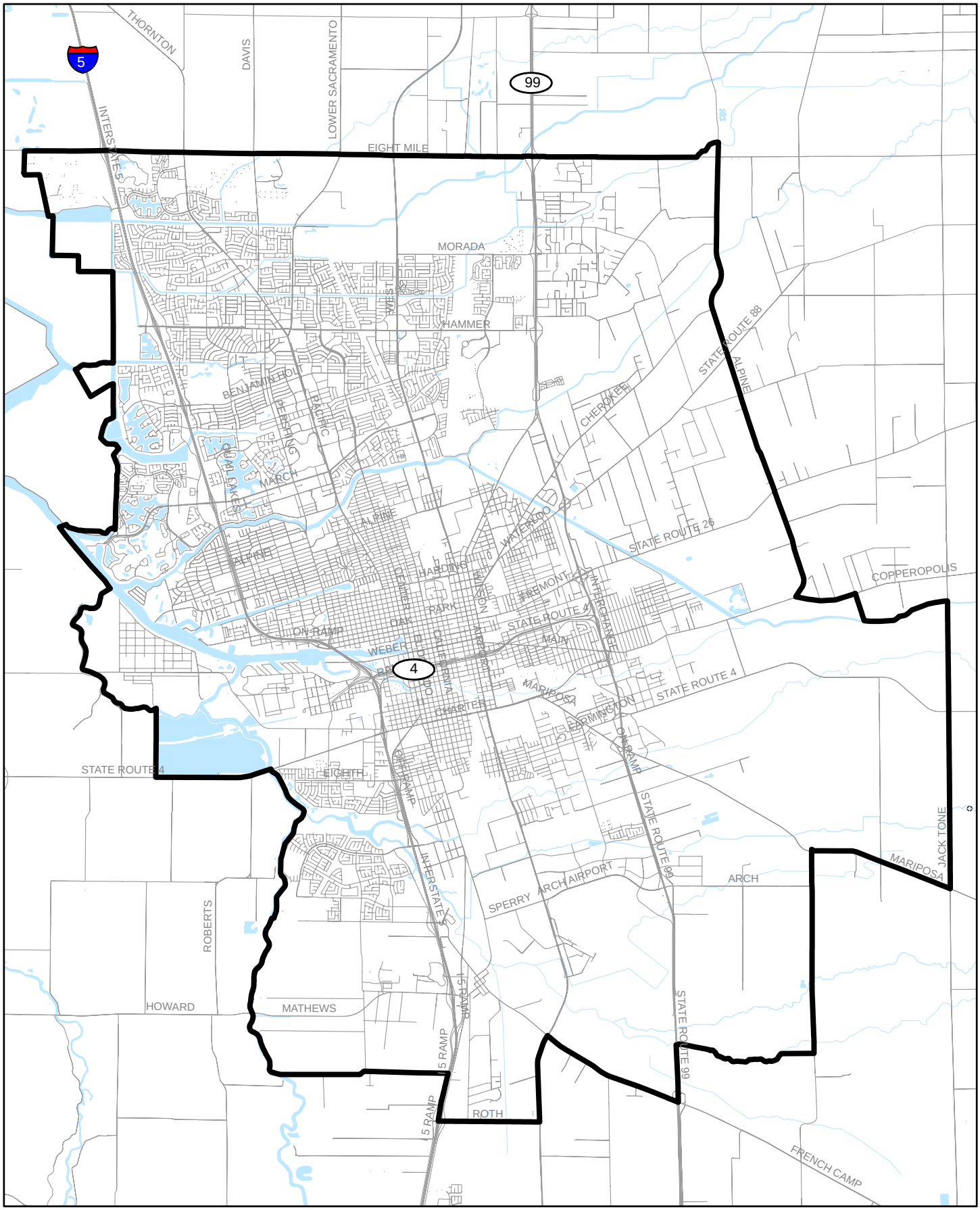
[1] This was confirmed by the City in May 2008. This additional tank was not considered in the existing storage and pumping capacity analyses presented in Chapter 7.

Table 2-4. COS MUD Booster Pump Stations

Supply Source/Location	Rated Capacity, mgd	Pumps [Capacity, gpm/Power, Hp]					
		Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6
Northwest Tanks/ 10001 North I-5 Frontage Road	29.1[2]	5,000/200	3,800/150	3,800/127[2]	3,800/127[2]	3,800/150	5,000/200
Fourteen-Mile Slough Tanks/ 5656 Feather River Drive	16.2	3,300/150	3,300/150	2,650/125	2,650/125	2,650/125	NA
Weston Ranch Tank/ 750 French Camp Road	13.0	3,000/125	3,000/125	3,000/125	3,000/125	NA	NA

NA = Not Applicable
Hp = Horsepower

[2] This was confirmed by the City in May 2008. This additional booster pump was not considered in the existing storage and pumping capacity analyses presented in Chapter 7.



LEGEND:

- 1990 General Plan Boundary
- Street
- Water Feature

N

0 0.45 0.9 1.8

Scale in Miles

FIGURE 2-1

City of Stockton
Municipal Utilities Department
Water Master Plan Update

EXISTING COSMA AREA

WEST YOST ASSOCIATES Consulting Engineers

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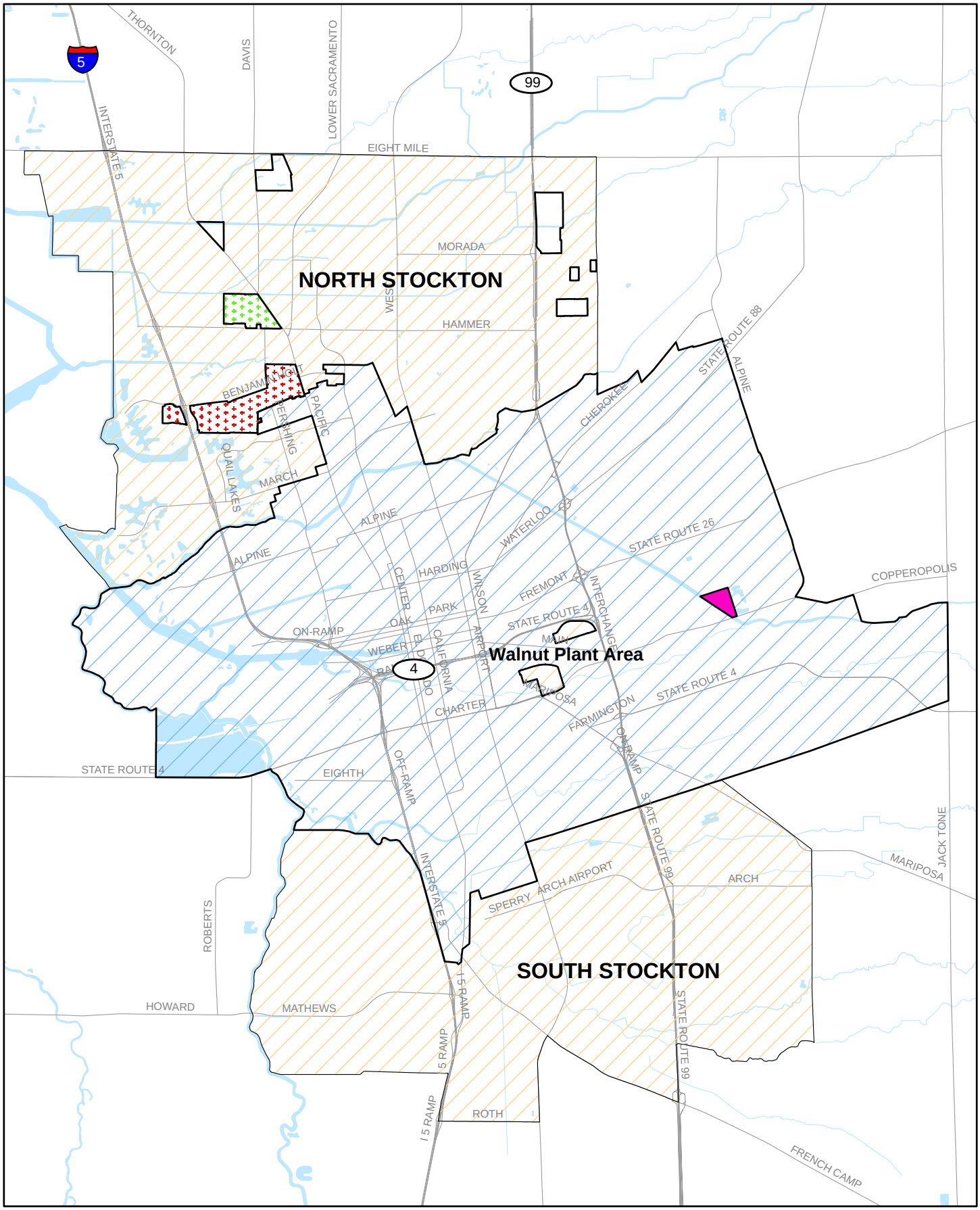

LEGEND:

- Major Street
- COS MUD
- Lincoln Village
- Colonial Heights
- Cal Water
- County Area
- SEWD WTP
- Water Feature

N

0 0.45 0.9 1.8

Scale in Miles

FIGURE 2-2

City of Stockton
Municipal Utilities Department
Water Master Plan Update

EXISTING SERVICE AREAS

WEST YOST ASSOCIATES Consulting Engineers

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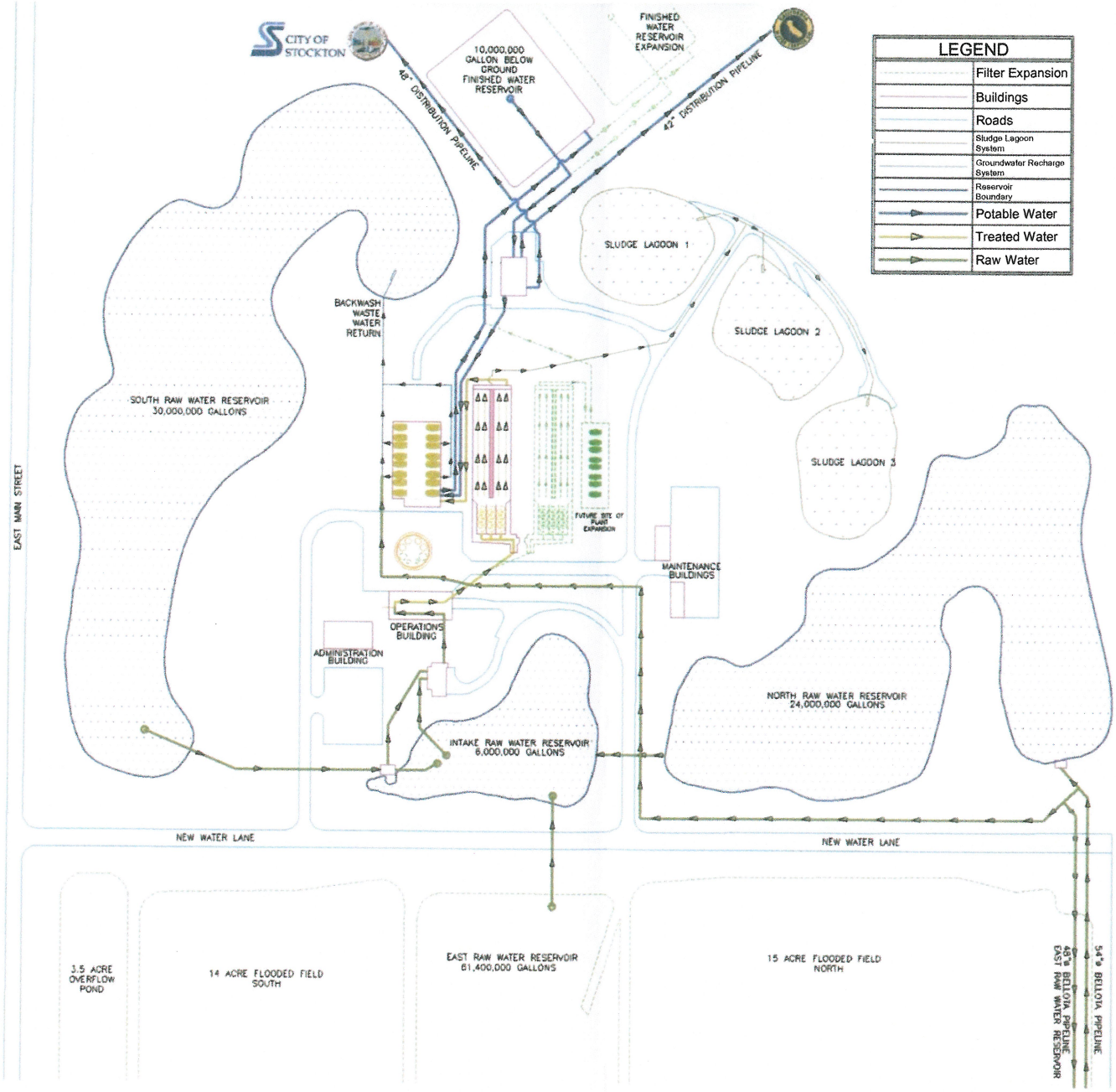

LEGEND:
see above

N

FIGURE 2-3

City of Stockton
Municipal Utilities Department
Water Master Plan Update

SEWD WTP

WEST YOST ASSOCIATES
Consulting Engineers

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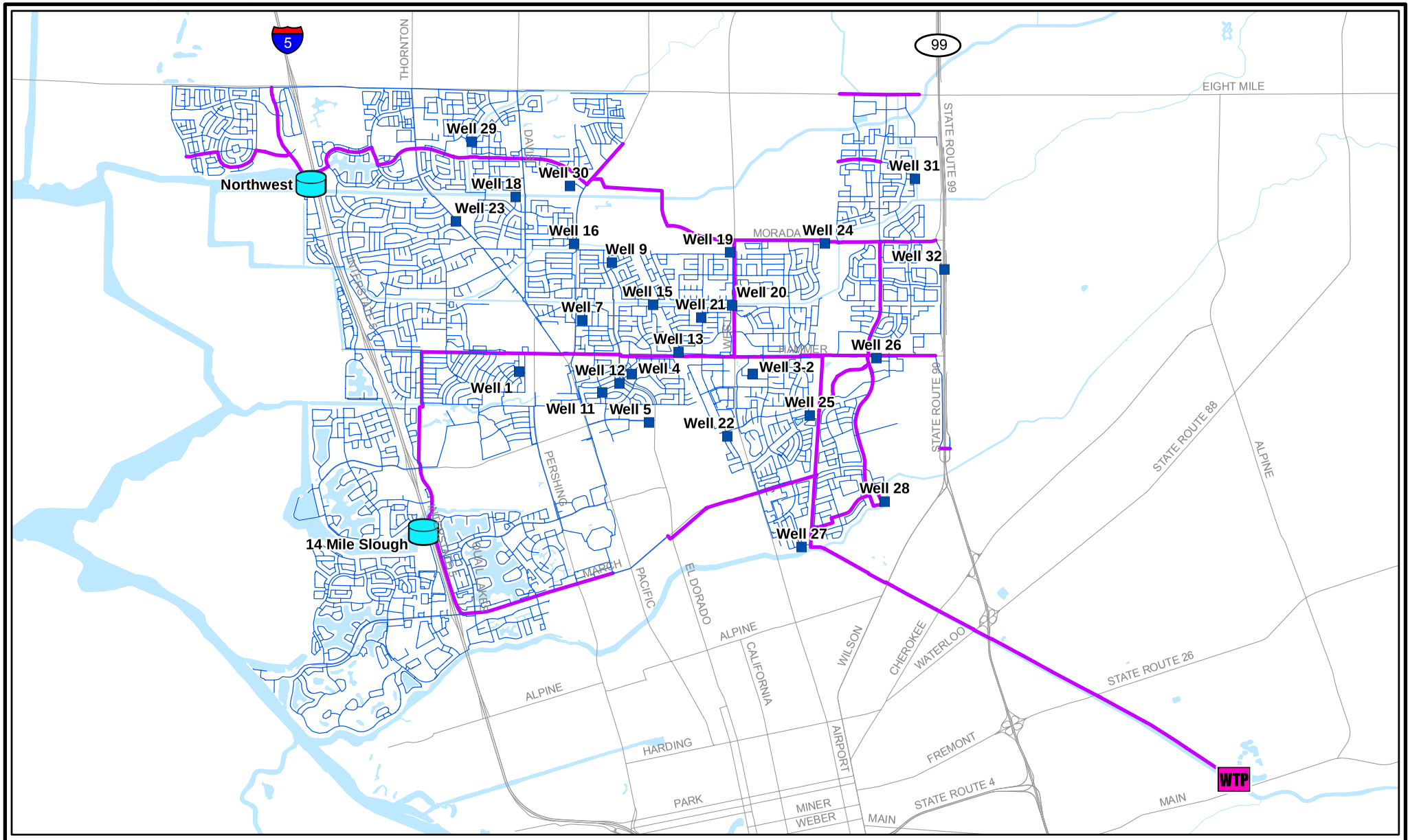

LEGEND:

- Existing Well
- Existing Water Tank
- WTP SEWD WTP
- Pipeline Diameter < 18-inches
- Pipeline Diameter ≥ 18-inches
- Major Street
- Water Feature

N

0 0.5 1 2

Scale in Miles

FIGURE 2-4

City of Stockton
Municipal Utilities Department
Water Master Plan Update

NORTH STOCKTON EXISTING WATER SYSTEM

WEST YOST ASSOCIATES Consulting Engineers

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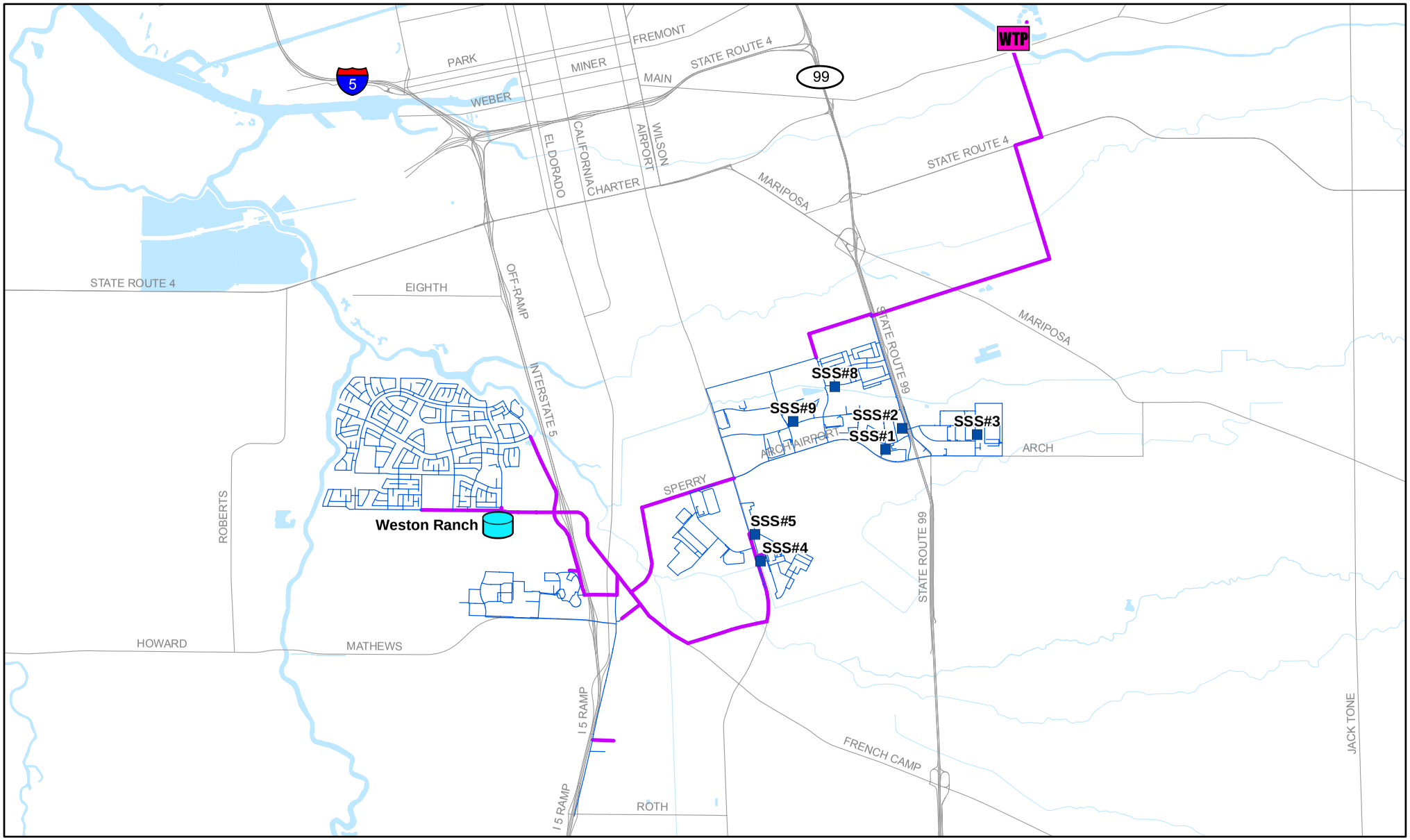


LEGEND:

- Existing Well
- Existing Water Tank
- SEWD WTP
- Pipeline Diameter <18-inches
- Pipeline Diameter ≥18-inches
- Major Street
- Water Feature

N

0 0.5 1 2

Scale in Miles

FIGURE 2-5

City of Stockton
Municipal Utilities Department
Water Master Plan Update

SOUTH STOCKTON EXISTING WATER SYSTEM

WEST YOST ASSOCIATES Consulting Engineers

CHAPTER 3. WATER DEMANDS

The purpose of this chapter is to present the current and projected potable water demands served by the COS MUD. Accurate and detailed potable water demand estimates are required to develop and calibrate the potable water system hydraulic model, help identify deficiencies in the existing potable water system, and assist in the assessment of future system capacity and future capital improvements based on planned development. Future water demand projections also play a key role in helping the COS MUD identify and secure sufficient water supplies to serve their customers under various hydrologic conditions.

The following sections of this chapter describe the data and methodology utilized to determine the COS MUD's potable water system demands:

- Description of the COS MUD Water Service Area
- Historical Water Production, UAFW, and Per Capita Demands
- Adopted Peaking Factors
- Projected Water Demands

DESCRIPTION OF THE COS MUD WATER SERVICE AREA

The COS MUD currently provides potable water service to a portion of the City, which is located along the San Joaquin Delta waterway, approximately 90 miles east of San Francisco. Areas within the City Limits not currently served by either the COS MUD or CWSC are served by San Joaquin County (i.e., the County Maintenance Districts). Figure 3-1 presents the location of the COS MUD service area relative to other water purveyors in the area, and the adopted 2035 General Plan Update Urban Services Boundary.

As shown in Figure 3-1, the COS MUD service area encompasses portions of the City generally located north of Calaveras River (North Stockton), generally located south of French Camp Slough and Zephyr Road (South Stockton), and the WPA. The WPA is a stand alone water system that receives a majority of its water supply through two connections with CWSC.

Subsequent sections describe the existing population served, existing and projected land use served water by the COS MUD, and adopted timing of future development.

Historical Population Served within the City of Stockton

Estimates of historical population served were developed so that historical per capita demands could be determined in subsequent sections of this chapter. Historical per capita demands typically provide a long-term trend in water use that can be used to evaluate the effects of water conservation or other influencing factors.

Population estimates for the City were provided by the City's Planning Department for years 1990 and 2000 through 2005; population estimates for years 1991 through 1999 were obtained from the California Department of Finance (CDOF). As shown in Table 3-1 below, the City's

total population has increased by approximately 69,300 people (about 33 percent) between 1990 and 2005, and has grown at an annual rate of approximately 2.6 percent between 2000 and 2005.

Table 3-1. Historical Population within the City of Stockton

Year	Population[a,b]	Annual % Increase
1990	210,943	--
1991	213,400	1.2%
1992	219,800	3.0%
1993	221,800	0.9%
1994	223,400	0.7%
1995	227,400	1.8%
1996	230,700	1.5%
1997	233,900	1.4%
1998	237,300	1.5%
1999	239,600	1.0%
2000	243,771	1.7%
2001	248,024	1.7%
2002	254,260	2.5%
2003	262,553	3.3%
2004	271,712	3.5%
2005	280,249	3.1%
Historical Average		1.9%
Average from 2000 to 2005		2.6%

(a) Population estimates for the City were provided by the City's Planning Department for years 1990 and 2000 through 2005, while population estimates for years 1991 through 1999 were obtained from the CDOF, Report E-4 Revised, downloaded on November 17, 2006.

(b) Includes the entire City.

Existing and Projected Land Use Served Water

WYA obtained the 2035 General Plan Update land use map from the City's Planning Department, which was adopted at the end of 2007. The 2035 General Plan Update land use map was then further refined to include more detailed information on specific development projects currently being reviewed by the City's Planning Department. Actual information from each of the developers was obtained and confirmed during a meeting held between the development community and the COS MUD staff on September 29, 2006.

The refinements provided by the development community were included in this Water Master Plan Update, so that future demand and supply projections would reflect the most current data available. Figure 3-2 compares the 2035 General Plan Update land use map to the refined land use map used in this Water Master Plan Update.

Water served to existing land uses was estimated by spatially locating metered water demand data by either linking the data to individual parcels using an address or by geocoding. A detailed discussion of this process is provided in subsequent sections of this chapter.

For planning purposes in this Water Master Plan Update, it was assumed that any parcel receiving water from either the COS MUD, CWSC, or the County Maintenance Districts, or known to have private water use, was already developed from a water supply planning perspective (i.e., currently using water). Table 3-2 summarizes the water served to existing and projected land uses by the COS MUD within the adopted 2035 General Plan Update Urban Services Boundary.

As shown in Table 3-2, the North and South Stockton Service Areas are approximately 44 percent and 19 percent developed, respectively, while the entire COS MUD service area is only 34 percent developed. Additionally, the total acreage reported at buildout includes areas currently served by private water wells so that the COS MUD's distribution system will have sufficient capacity to serve these areas if requested in the future.

Figure 3-3 presents existing and projected land use to be served water by the COS MUD within the 2035 General Plan Update Urban Services Boundary. As shown in Figure 3-3, a majority of future development is within the COS MUD service area, and the southeast portion of the South Stockton Service Area will more than double due to the quantity of industrial development projected by the 2035 General Plan Update.

Estimated Timing of Future Development

During the meeting with the development community on September 29, 2006, WYA also solicited input regarding the timing of future development in the City. Table 3-3 summarizes the projected start time and duration provided by each developer, while Figure 3-4 illustrates the projected start time.

The information presented in Table 3-3 and Figure 3-4 was also reviewed by the City's Planning Department, which indicated that the duration of these projects was likely unrealistic. Consequently, the start date provided by the developer and the planning horizon of the general plan (2035) was used to project demands for those areas on an annual basis. The adopted growth rate is much higher than the assumed population growth rate in the general plan (2.5%) because of the large amount of non-residential development in the City's general plan.

Additionally, those areas not currently represented by a developer, or within the City Limits (i.e., Urban Boundary Growth), were assumed to start in 2011, while those areas within the City Limits not currently represented by a developer (i.e., Infill) were used to supplement the developed acres to make sure the City would buildout by 2035. The Urban Boundary Growth was assumed to start in 2011, because these are large areas that will require several years beyond known development before they will start using water.

Table 3-2. Land Use Served Water by the COS MUD within the 2035 Urban Services Boundary

Land Use Designation	North Stockon[a]			South Stockton			Total COS MUD		
	Existing Acreage Served Water[b]	Total 2035 Acreage Served Water[c]	% Served Water	Existing Acreage Served Water[b]	Total 2035 Acreage Served Water[c]	% Served Water	Existing Acreage Served Water[b]	Total 2035 Acreage Served Water[c]	% Served Water
Residential Estate	0	990	0%	0	0	0%	0	990	0%
Low Density	8,400	14,660	57%	1,550	3,190	49%	9,950	17,850	56%
Medium Density	1,060	2,710	39%	1	450	0%	1,060	3,160	34%
High Density	400	940	43%	5	90	6%	410	1,030	40%
Commercial	1,070	1,960	55%	240	860	28%	1,310	2,820	46%
Administrative Professional	240	340	71%	20	520	4%	260	860	30%
Industrial	180	250	72%	1,110	9,140	12%	1,290	9,390	14%
Institutional	850	2,140	40%	1,210	2,800	43%	2,060	4,940	42%
Parks and Recreation	960	1,780	54%	110	280	39%	1,070	2,060	52%
Mixed Use	130	990	13%	0	0	0%	130	990	13%
Village	0	3,380	0%	0	4,680	0%	0	8,060	0%
Total	13,290	30,140	44%	4,250	22,010	19%	17,540	52,150	34%

[a] Acreage includes Walnut Plant and County Islands served by the COS MUD.

[b] Acreage obtained from WYA's GIS, and does not include runway, water, open space/agriculture, areas served off private wells, or areas outside of the 2035 Urban Services Boundary. Rounded to the nearest 10 acres.

[c] Acreage obtained from WYA's GIS, and includes areas currently served off private water wells, but does not include runway, water, or open space/agriculture. Private users were included in this evaluation so that the COS MUD's water system would have sufficient capacity to serve these areas if these users request service in the future. Rounded to the nearest 10 acres.

Table 3-3. Timing of Known Development in the City of Stockton[a,b]

Development		Development Community			
		Company	Start	Duration	End
1	Bear Creek West	Wayne LeBaron	2008	10	2018
2	Mariposa Lakes	Verner	2007	20	2027
3	Bear Creek South	HD Arnaiz	2008	8	2016
4	Cannery Park	HD Arnaiz	Under Construction	8	2014
5	NS-Lauchland	HD Arnaiz	2008	10	2018
6	Tidewater Crossing	HD Arnaiz	2008	10	2018
7	Thompson SOI	Thompson Group	2009	10	2019
8	Shima Track/Sanctuary	Grupe	2007	15	2022
9	Oakmore Gateway	Oakmore Gateway Group	2008	7	2015
10	North Stockton Project III	AR Sanguinetti	Under Construction	6	2012
11	Riverbend	KB Homes	2005	4	2009
12	Duck Creek Estates	Lamphier-Gregory	2007	5	2012
13	River Run	Lamphier-Gregory	2008	10	2018
14	Origone Ranch	DK Associates	2008	6	2014
15	Atlas Tract	AG Spanos	2007	5	2012
16	Crystal Bay	AG Spanos	2007	5	2012
17	Gateway	AG Spanos	2008	12	2020
18	Westlake Village	AG Spanos	Under Construction	6	2012
19	Bear Creek East	Wood-Rodgers	2008	8	2016
20	Empire Ranch	Empire Land NC	2007	9	2016
21	French Camp (Weston) Retail	Vestar	2008	10	2018
22	Silver Springs	DR Horton	Under Construction	2	2008
23	South of Tidewater	HD Arnaiz	2010	10	2020
24	Pacific Mountain Partners	Pacific Mountain Partners	2008	3	2011

[a] All data obtained from developers during a meeting on 9/29/2006 between the development community and the COS MUD staff.

[b] Timing shown is for planning purposes only.

HISTORICAL WATER PRODUCTION, UAFW, AND PER CAPITA DEMANDS

Water production is the combined quantity of water purchased from SEWD and produced by the COS MUD's groundwater wells, while water consumption is the quantity of water actually consumed or used by the COS MUD customers. The difference between production and consumption is unaccounted-for water (UAFW).

Both water production and UAFW are discussed in more detail below, along with a discussion of the COS MUD's historical per capita demands.

Historical Water Production in the COS MUD Service Area

The COS MUD meets its customers' water demands with a combination of water purchased from the SEWD and groundwater pumped from its own groundwater wells. Table 3-4 presents the historical water production for the COS MUD, by source and by area, from 1990 to 2005. The production data presented in Table 3-4 accounts for water wheeled by the COS MUD to the County Maintenance Districts to ensure that the COS MUD water distribution system has sufficient capacity in the future to accommodate these county areas.

As shown in Table 3-4, the COS MUD's total production has increased by approximately 76 percent (from 20,631 to 36,259 acre-feet) between 1990 and 2005. Table 3-4 also indicates that the COS MUD has maintained a 30 percent to 70 percent mix of groundwater to surface water in its North Stockton Service Area, while nearly all of the demand is met with groundwater in the South Stockton Service Area, and nearly all of the demand is met with surface water in the WPA (via a connection with CWSC).

Additionally, the COS MUD started providing surface water to its South Stockton Service Area via the South Stockton Aqueduct in December 2005; consequently, the COS MUD will likely increase the total quantity of surface water it uses.

Figure 3-5 compares total historical water production and historical average annual rainfall. As shown in Figure 3-5, the COS MUD water demands had a slight decrease between 1990 and 1991, increased at a relatively steady rate from 1991 to 1997, decreased sharply from 1997 to 1998, increased at a relatively steady rate from 1998 to 2004, and then stabilized from 2004 to 2005.

The sharp decrease in 1991 is likely the result of regional drought awareness measures at the time, while the sharp decrease in 1998 water production may be the result of above average rainfall that year, or regional water conservation efforts, of which the COS MUD has participated.

Table 3-4. Historical Water Production[a]

Year	City of Stockton Municipal Utilities Department																			
	North Stockton[b]					South Stockton					Walnut Plant Area					Total				
	Groundwater, afa	Surface Water, afa	Total, afa	Percent of Groundwater Used	Percent of Surface Water Used	Groundwater, afa	Surface Water, afa	Total, afa	Percent of Groundwater Used	Percent of Surface Water Used	Groundwater, afa	Surface Water, afa[c]	Total, afa	Percent of Groundwater Used	Percent of Surface Water Used[b]	Groundwater, afa	Surface Water[b], afa	Total, afa	Percent of Groundwater Used	Percent of Surface Water Used[b]
1990	14,087	5,067	19,154	74%	26%	999	0	999	100%	0%	116	362	478	24%	76%	15,203	5,428	20,631	74%	26%
1991	9,239	8,152	17,391	53%	47%	950	0	950	100%	0%	38	377	415	9%	91%	10,227	8,529	18,756	55%	45%
1992	10,217	8,526	18,743	55%	45%	1,217	0	1,217	100%	0%	59	387	446	13%	87%	11,494	8,912	20,406	56%	44%
1993	6,845	13,385	20,230	34%	66%	1,262	0	1,262	100%	0%	14	443	456	3%	97%	8,120	13,828	21,948	37%	63%
1994	7,930	14,298	22,228	36%	64%	1,531	0	1,531	100%	0%	3	422	425	1%	99%	9,464	14,720	24,184	39%	61%
1995	6,398	16,253	22,651	28%	72%	1,763	0	1,763	100%	0%	8	429	437	2%	98%	8,168	16,683	24,851	33%	67%
1996	6,979	16,869	23,848	29%	71%	2,009	0	2,009	100%	0%	3	451	455	1%	99%	8,991	17,320	26,312	34%	66%
1997	6,660	19,352	26,012	26%	74%	2,324	0	2,324	100%	0%	10	435	445	2%	98%	8,994	19,787	28,781	31%	69%
1998	6,454	16,960	23,415	28%	72%	2,420	0	2,420	100%	0%	49	392	441	11%	89%	8,923	17,352	26,275	34%	66%
1999	7,037	17,365	24,403	29%	71%	3,215	0	3,215	100%	0%	69	448	517	13%	87%	10,321	17,813	28,134	37%	63%
2000	6,422	17,394	23,816	27%	73%	3,822	0	3,822	100%	0%	46	461	507	9%	91%	10,290	17,855	28,145	37%	63%
2001	8,366	17,367	25,732	33%	67%	4,322	0	4,322	100%	0%	16	503	519	3%	97%	12,703	17,869	30,573	42%	58%
2002	8,082	18,764	26,846	30%	70%	4,857	0	4,857	100%	0%	34	450	484	7%	93%	12,973	19,214	32,187	40%	60%
2003	8,149	18,857	27,007	30%	70%	5,338	0	5,338	100%	0%	63	433	496	13%	87%	13,550	19,291	32,840	41%	59%
2004	8,865	21,260	30,125	29%	71%	5,847	0	5,847	100%	0%	2	543	545	0%	100%	14,714	21,803	36,517	40%	60%
2005	8,510	21,024	29,534	29%	71%	6,042	123	6,165	98%	2%	0	559	559	0%	100%	14,553	21,707	36,259	40%	60%
Average																			42%	58%
5-Year Average																			41%	59%

[a] Data obtained from water production records provided by the COS MUD.

[b] Water for North Stockton includes water wheeled by the COS MUD to the County Maintenance Districts so that the COS MUD water distribution system will have sufficient capacity in the future to accomodate their wheeling agreements.

[b] Surface Water includes WPA Intertie

Historical Unaccounted-for Water

UAFW within the COS MUD is the difference between the recorded production and metered consumption. On March 21, 2005, WYA completed a Technical Memorandum (TM) that thoroughly examined recorded production and metered consumption to estimate the COS MUD's UAFW percentage from 1999 to 2004. This TM is provided as Appendix A.

As shown in Appendix A, the COS MUD's unaccounted-for water averaged 4.8 percent between 1999 and 2004. For planning purposes in this Water Master Plan Update, a UAFW percentage of 4.8 percent was used to project the COS MUD's future water production needs.

Historical Per Capita Water Demand

Historical per capita water demands are determined by dividing historical water production by the historical population. Population information specific to the COS MUD service area is not available and therefore, per capita demands were calculated for the entire City and used as a surrogate for per capita demands within the COS MUD service area.

As discussed previously, historical water production presented in Table 3-4 was representative of only the COS MUD; consequently, the water production was adjusted to account for CWSC before dividing it by the population. Table 3-5 presents the historical production (with CWSC), the historical population, and the resulting per capita demand.

As shown in Table 3-5, the per capita demand for the entire City (including CWSC) averaged 220 gallons per capita per day (gpcd) between 1990 and 2005, and averaged 228 gpcd over the past five years. Table 3-5 also indicates that the maximum per capita demand (240 gpcd) occurred in 1997 and the minimum per capita demand occurred in 1991 (189 gpcd).

Figure 3-6 compares historical per capita demands and historical average annual rainfall. As shown in Figure 3-6, per capita demands had a slight decrease between 1990 and 1991, increased at a relatively steady rate from 1991 to 1997, decreased sharply from 1997 to 1998, increased at a relatively steady rate from 1998 to 2002, and then stabilized from 2003 to 2005.

The sharp decrease in 1991 is likely the result of regional drought awareness measures at the time, while the sharp decrease in 1998 water production may be the result of above average rainfall that year, or regional water conservation efforts.

Table 3-5. Historical Per Capita Demands for the City of Stockton[(a)]

Year	Total Production, af	Total Production, gpd	Population	Per Capita Demand, gpcd
1990	52,524	46,887,233	210,943	222
1991	45,243	40,387,446	213,400	189
1992	48,588	43,373,456	219,800	197
1993	51,087	45,604,845	221,800	206
1994	54,493	48,644,832	223,400	218
1995	55,512	49,554,612	227,400	218
1996	59,125	52,780,042	230,700	229
1997	62,873	56,125,175	233,900	240
1998	57,030	50,909,545	237,300	215
1999	59,371	52,999,234	239,600	221
2000	61,932	55,285,114	243,771	227
2001	64,548	57,620,798	248,024	232
2002	67,483	60,240,712	254,260	237
2003	65,664	58,617,018	262,553	223
2004	69,411	61,961,824	271,712	228
2005	68,217	60,895,685	280,249	217
Average from 1990 to 2005				220
Average from 2001 to 2005				228

[(a)] Production includes CWSC
gpd = gallons per day.
af = acre feet

Water Conservation

The COS MUD is committed to preserving California's water resources through water conservation, and through metering or other conservation measures; currently, the COS MUD has saved 18 percent over 1983 water use.[1]

The COS MUD has recently commissioned a study that will determine the steps necessary for the COS MUD to implement additional water conservation savings. Estimated conservation savings from this study will not be available in time to incorporate into this Water Master Plan Update; however, City staff has indicated that the additional savings could be from 5 to 15 percent of total projected demands (i.e., both existing and future).

For planning purposes in this Water Master Plan Update, it was assumed that the City would achieve an additional 10 percent water conservation savings between 2007 and buildout. Although the City could save more or less than 10 percent, it provides a planning goal that accounts for the large water conservation effort that the COS MUD is about to begin.

ADOPTED PEAKING FACTORS

Peaking factors are used to calculate water demands expected under high demand conditions (i.e., Maximum Day and Peak Hour Demand). The resulting demand conditions for maximum day and peak hour periods are then used to evaluate and size transmission/distribution pipelines and storage facilities, and to define water supply needs and capacity requirements. This section describes the methodology used to develop the peaking factors for the maximum day and peak hour demand conditions within the COS MUD service area.

Table 3-6 summarizes the average and maximum day demands, and the corresponding peaking factor between 1994 and 2005. As shown in Table 3-6, the maximum day peaking factor for the COS MUD has ranged from a low of 1.4 in 1994 and 1997 to a high of 1.8 in 1998. For planning purposes in this Water Master Plan Update, a maximum day peaking factor of 1.7 was adopted. Although, this peaking factor is not the maximum factor (1.8), which occurred only once over the past 11-years, it is the highest peaking factor which occurred most frequently (3 times) during the historical period reviewed.

Insufficient data was available to determine a historical peak hour demand factor by year; however, peak hour data was available for 2006. Data provided by the COS MUD indicated that the peak hour demand (113 mgd or 78,472 gpm) occurred on July 24, 2006, from 6 to 7 am. Consequently, an estimate of the peak hour peaking factor was determined by dividing the 2006 peak hour demand (113 mgd) by the average day production in 2006 (32.0 mgd), which equals 3.5 (113 mgd divided by 32.0 mgd).

The calculated peak hour peaking factor (3.5) is nearly identical to the historical factor (3.4) used by the COS MUD. For planning purposes, a peak hour factor of 3.5 was used to size water system infrastructure.

Table 3-6. Maximum Day Peaking Factor[a,b]

Year	Average Day, mgd	Maximum Day, mgd	Peaking Factor[c]
1994	21.6	30.1	1.4
1995	22.2	35.0	1.6
1996	23.5	37.9	1.6
1997	25.7	36.4	1.4
1998	23.5	43.3	1.8
1999	25.1	40.3	1.6
2000	25.1	42.0	1.7
2001	27.3	43.0	1.6
2002	28.7	44.8	1.6
2003	29.3	46.8	1.6
2004	32.6	55.4	1.7
2005	32.4	55.6	1.7
Average			1.6
5-Year Average			1.6

(a) All data based on total production data for the COS MUD.
(b) All data provided by the COS MUD.
(c) Maximum Day peaking factor is the Maximum Day divided by the Average Day.

PROJECTED WATER DEMANDS

Water demands were projected through buildout of the COS MUD service area using a unit demand methodology based on land uses assigned in the 2035 General Plan Update. A land use based methodology was used, because per capita water demand projections uniformly distribute water use over the entire water service area and therefore, do not account for specific land uses and locations.

Subsequent sections describe the land use based methodology used, followed by a discussion of total projected water demands.

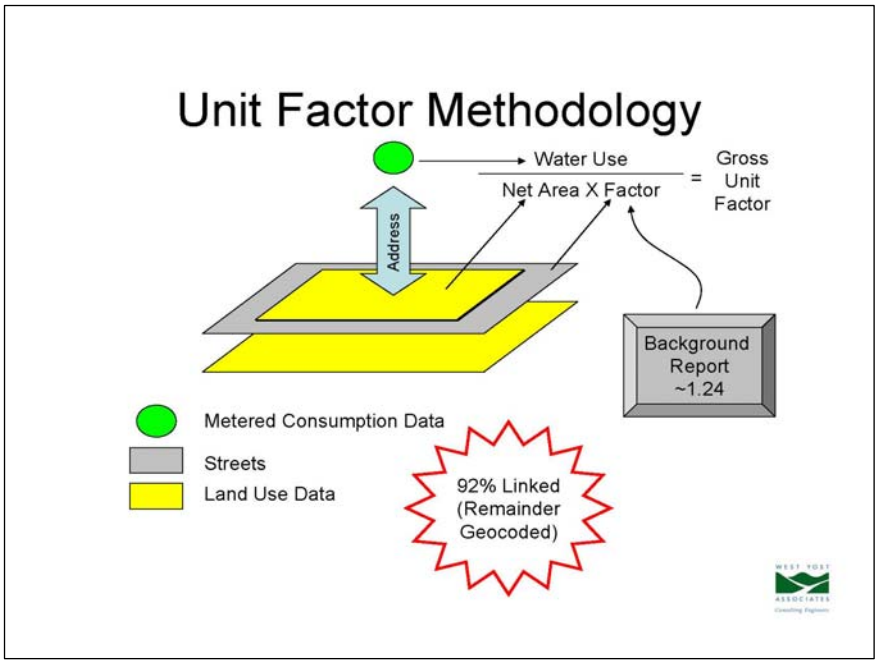
Unit Demand Factors Adopted for the Water Master Plan Update

Unit demand factors from 2001 to 2005 were determined using meter data obtained from the COS MUD and CWSC, and parcel data obtained from the City's Planning Department. Individual water use (by meter) was linked to individual parcels using addresses (see green dot on Figure 3-7); 92 percent of all available water meter data was linked to a parcel. An additional 6 percent was spatially located by geocoding addresses.

The unit demand factor for each land use designation was calculated by dividing the total water use by the total parcel area for which it was linked; however, the parcel area used in this initial calculation did not include streets (see grey area on Figure 3-7) and therefore, represented net area. Accordingly, the unit demand factors calculated were net unit demand factors.

The land use map that was used to project future water demands provided gross area. Consequently, the net unit demand factors were converted into gross unit demand factors using the net to gross area percentage presented in the General Plan Background report, or 24 percent (see 1.24 factor on Figure 3-7).[2] Figure 3-7 provides an illustration of the methodology used to calculate the gross unit demand factors.

Figure 3-7. Illustration of Unit Demand Factor Methodology



Additionally, unit demand factors were developed for the COS MUD and CWSC separately, because almost all new development within the City has occurred within the COS MUD service area. Subsequent sections present the calculated unit demand factors for each land use designation.

Unit Demand Factor: Low Density Residential

Figure 3-8 illustrates the Low Density Residential unit demand factor between 2001 and 2005 calculated for the COS MUD and CWSC service areas. As shown in Figure 3-8, the COS MUD Low Density unit demand factor is approximately 0.4 acre-feet per acre per year (af/ac/yr) higher, on average, than the CWSC Low Density factor. Both factors appear relatively stable. Figure 3-8 also indicates that the combined factor (i.e., data from COS MUD and CWSC combined) is between the two, which implies that the quantity of Low Density land use is fairly even, currently, in the two service areas.

A review of data provided by both the COS MUD and CWSC indicates that the number of residential services (Low and Medium Density) in the COS MUD service area has grown by 71 percent between 1994 and 2005, while the number of residential services in the CWSC service area has only grown by approximately 3.4 percent during the same period. Based on this observation, it appears that almost all of the new residential accounts are within the COS MUD service area and, therefore, the COS MUD Low Density unit demand factor is more likely representative of new homes. WYA has observed this phenomenon in other areas of California.

For planning purposes, it was assumed that all new Low Density development in the COS MUD service area would use the average COS MUD Low Density unit demand factor of 2.5 af/ac/yr.

Unit Demand Factor: Medium Density Residential

Figure 3-9 illustrates the Medium Density Residential unit demand factor between 2001 and 2005 calculated for the COS MUD and CWSC service areas. As shown in Figure 3-9, the COS MUD Medium Density unit demand factor is approximately 1.1 af/ac/yr higher, on average, than the CWSC Medium Density factor. Both factors appear relatively stable. Figure 3-9 also indicates that the combined factor (i.e., data from COS MUD and CWSC combined) is much closer to the COS MUD factor than the CWSC Water Factor, which implies that most of the data is within the COS MUD service area.

A review of data provided by both the COS MUD and CWSC indicates that the number of residential services (Low and Medium Density) in the COS MUD service area has grown by 71 percent, while the number of residential services in the CWSC service area has only grown by approximately 3.4 percent. Based on this observation, it appears that almost all of the new residential accounts are within the COS MUD service area and therefore, the COS MUD Medium Density unit demand factor is more likely representative of new homes. WYA has observed this phenomenon in other areas of California.

For planning purposes, it was assumed that all new Medium Density development in the COS MUD service area would use the average COS MUD Medium Density unit demand factor of 3.7 af/ac/yr.

Unit Demand Factor: High Density Residential

Figure 3-10 illustrates the High Density Residential unit demand factor between 2001 and 2005 calculated for the COS MUD and CWSC service areas. As shown in Figure 3-10, the COS MUD High Density unit demand factor is approximately 0.4 af/ac/yr higher, on average, than the CWSC High Density factor. Both factors appear relatively stable.

Figure 3-10 also indicates that the combined factor (i.e., data from COS MUD and CWSC combined) is slightly closer to the COS MUD factor than the CWSC Factor. This implies that a majority of the data is within the COS MUD service area.

A review of data provided by both the COS MUD and CWSC indicates that over 90 percent of all High Density services (i.e., Multiple Family) between 1994 and 2005 were within the COS MUD service area. Based on this observation, it appears that almost all of the High Density accounts are within the COS MUD service area and, therefore, the COS MUD High Density unit demand factor is more likely representative of typical High Density water use.

For planning purposes, it was assumed that all new High Density development in the COS MUD service area would use the average COS MUD High Density unit demand factor of 5.2 af/ac/yr.

Unit Demand Factor: Commercial

Figure 3-11 illustrates the Commercial unit demand factor between 2001 and 2005 calculated for the COS MUD and CWSC service areas. As shown in Figure 3-11, the CWSC Commercial unit demand factor is approximately 0.3 af/ac/yr higher, on average, than the COS MUD Commercial factor.

Both factors appear to have a slight drop between 2001 and 2003. Discussions with the COS MUD staff indicate that this drop might be the result of changes in the type of commercial use. A review of Figure 3-5 indicates that rainfall was slightly below average for 2002 and 2003, but normal for all other years.

Figure 3-11 also indicates that the combined factor (i.e., data from COS MUD and CWSC combined) is slightly closer to the CWSC factor than the COS MUD factor. This implies that a majority of the data is within the CWSC service area.

A review of data provided by both the COS MUD and CWSC indicates that over 75 percent of all Commercial and Industrial services between 1994 and 2005 were within the CWSC service area. Based on this observation, it appears that Commercial accounts within the CWSC service area are likely more representative of typical Commercial water use than the Commercial accounts within the COS MUD service area.

For planning purposes, it was assumed that all new Commercial development in the COS MUD service area would use the average CWSC Commercial unit demand factor of 2.3 af/ac/yr.

Unit Demand Factor: Administrative Professional

Figure 3-12 illustrates the Administrative Professional unit demand factor between 2001 and 2005 calculated for the COS MUD and CWSC service areas. As shown in Figure 3-12, the CWSC Administrative Professional unit demand factor is approximately 0.5 af/ac/yr higher, on average, than the COS MUD Administrative Professional factor. Both factors appear relatively stable.

Figure 3-12 also indicates that the combined factor (i.e., data from COS MUD and CWSC combined) is slightly closer to the COS MUD factor than the CWSC factor. This implies that a majority of the data is within the COS MUD service area.

A review of data provided by both the COS MUD and CWSC indicates that over 70 percent of all non-commercial/industrial, non-residential accounts between 1994 and 2005 were within the COS MUD service area. Based on this observation, it appears that Administrative Professional accounts within the COS MUD service area are likely more representative of typical Administrative Professional water use than the Administrative Professional accounts within the CWSC service area.

For planning purposes, it was assumed that all new Administrative Professional development in the COS MUD service area would use the average COS MUD Administrative Professional unit demand factor of 2.4 af/ac/yr.

Unit Demand Factor: Industrial

Figure 3-13 illustrates the Industrial unit demand factor between 2001 and 2005 calculated for the COS MUD and CWSC service areas. As shown in Figure 3-13, the CWSC Industrial unit demand factor is approximately 0.5 af/ac/yr higher, on average, than the COS MUD Industrial factor.

Both factors appear to have a slight drop between 2002 and 2004. Discussions with the COS MUD staff indicate that this drop might be the result of changes in the type of industrial use. A review of Figure 3-5 indicates that rainfall was slightly below average for 2002 and 2003, but normal for all other years.

Figure 3-13 also indicates that the combined factor (i.e., data from the COS MUD and CWSC combined) is extremely close to the CWSC factors. This implies that most of the data is within the CWSC service area.

A review of data provided by both the COS MUD and CWSC indicates that over 75 percent of all Commercial and Industrial services between 1994 and 2005 were within the CWSC service area. Based on this observation, it appears that Industrial accounts within the CWSC service area are likely more representative of typical Industrial water use than the Industrial accounts within the COS MUD service area.

Although the average Industrial unit factor within the CWSC service area is 1.7 af/ac/year, discussions with the COS MUD staff indicate that current Industrial water use may not be representative of future Industrial water use; the City may have high water use industries (e.g., bottling plants) in the future. Consequently, it was assumed that all new Industrial development in the COS MUD service area would use the 2001 CWSC Industrial unit demand factor of 2.0 af/ac/yr to provide the COS MUD with additional conservatism for planning purposes.

Unit Demand Factor: Institutional

Figure 3-14 illustrates the Institutional unit demand factor between 2001 and 2005 calculated for the COS MUD and CWSC service areas. As shown in Figure 3-14, the CWSC Institutional unit demand factor is approximately 0.2 af/ac/yr higher, on average, than the COS MUD Institutional factor.

Both factors appear to have a slight drop between 2002 and 2004. A review of Figure 3-5 indicates that rainfall was slightly below average for 2002 and 2003, but normal for all other years. Discussions with the COS MUD staff did not indicate anything unusual during this period.

Figure 3-14 also indicates that the combined factor (i.e., data from COS MUD and CWSC combined) is slightly closer to the COS MUD factor than the CWSC factor. This implies that a majority of the data is within the COS MUD service area.

A review of data provided by both the COS MUD and CWSC indicates that over 70 percent of all non-commercial/industrial, non-residential accounts between 1994 and 2005 were within the COS MUD service area. Based on this observation, it appears that Institutional accounts within the COS MUD service area are likely more representative of typical Institutional water use than the Institutional accounts within the CWSC service area.

For planning purposes, it was assumed that all new Institutional development in the COS MUD service area would use the average COS MUD Institutional unit demand factor of 1.1 af/ac/yr.

Unit Demand Factor: Parks and Recreation

Figure 3-15 illustrates the Parks and Recreation unit demand factor between 2001 and 2005 calculated for the COS MUD and CWSC service areas. As shown in Figure 3-15, the CWSC Parks and Recreation unit demand factor is only 0.1 af/ac/yr higher, on average, than the COS MUD Parks and Recreation factor.

Both factors appear to have a dramatic drop between 2001 and 2003, then the COS MUD factor stabilizes, while the CWSC factor continues to drop. A review of Figure 3-5 indicates that rainfall was slightly below average for 2002 and 2003, but normal for all other years. Discussions with the COS MUD staff did not indicate anything out of the ordinary during this period.

Figure 3-15 also indicates that the combined factor (i.e., data from COS MUD and CWSC combined) is slightly closer to the COS MUD factor than the CWSC factor. This implies that a majority of the data is within the COS MUD service area.

The average unit demand factor for both service areas is nearly identical; consequently, it was assumed that all new Parks and Recreation development in the COS MUD service area would use the average CWSC Parks and Recreation unit demand factor of 2.4 af/ac/yr. The higher CWSC factor was chosen to provide additional conservatism for planning purposes.

Unit Demand Factor: Mixed Use

Figure 3-16 illustrates the Mixed Use unit demand factor between 2001 and 2005 calculated for the COS MUD and CWSC service areas. As shown in Figure 3-16, the COS MUD Mixed Use unit demand factor is much higher, on average, than the CWSC factor.

The CWSC factor appears relatively stable, while the COS MUD factor increases from 0 to 1.7 af/ac/yr in only two years. Discussions with the COS MUD staff indicated that their service area did not have actual mixed use water demands until 2003.

Figure 3-16 also indicates that the combined factor (i.e., data from COS MUD and CWSC combined) starts off being equal to the CWSC factor, but then shifts to being nearly equal to the COS MUD factor. This implies that a majority of the new Mixed Use development has occurred within the COS MUD service area.

Further discussions with staff from both the COS MUD and CWSC indicate minimal existing mixed use land use within both service areas. Consequently, it was decided that insufficient data was available to use historical metered demands to calculate a unit factor for Mixed Use.

For planning purposes, it was assumed that all new Mixed Use development in the COS MUD service area would use the same factor developed for Village, 2.6 af/ac/yr. The unit factor for Village is discussed in subsequent sections.

Unit Demand Factor: Residential Estate

The City does not have an existing Residential Estate that could be used to estimate a unit demand factor; consequently, the unit demand factor (1.5 af/ac/yr) adopted in the COS MUD's Water Supply Evaluation for the General Plan Updated Preferred Alternative Report, dated May 12, 2006, was used.

Unit Demand Factor: Village

Areas designated as Village in the 2035 General Plan Update will eventually consist of a combination of all of the other land use designations. As previously discussed, a large portion of future Village was refined to include input from the development community (see Figure 3-2). Consequently, the unit demand factors already adopted for the other land use designations can be applied to those areas that were originally Village to estimate a unit demand factor for Village.

Table 3-7 presents the data used to estimate the unit demand factor for Village. As shown in Table 3-7, the unit demand factor for Village, based on data provided by the development community, is approximately 2.6 af/ac/yr.

Table 3-7. Estimated Unit Demand Factor for Village

Land Use Designation	Area, acre[(a)]	Unit Factor, af/acre	Water Demand, af
Residential Estate	94	1.5	140
Low Density Residential	7,599	2.5	18,997
Medium Density Residential	2,424	3.7	8,969
High Density Residential	591	5.2	3,073
Commercial	1,025	2.3	2,358
Administrative Professional	256	2.4	614
Industrial	1,134	2.0	2268
Institutional	1,203	1.1	1,323
Parks & Recreation	1,031	2.4	2,474
Total Village	15,357	**2.6**	40,216

(a) Acreage obtained from WYA's GIS.

Summary of Adopted Unit Demand Factors

Table 3-8 summarizes the unit demand factors adopted in this Water Master Plan Update for projecting future water demands. These unit demand factors are based on over 90 percent of 2005 meter data for the entire City.

Table 3-8. Adopted Unit Demand Factors

Landuse Designation	Unit Demand Factor, af/ac/yr
Residential Estate	1.5
Low Density Residential	2.5
Medium Density Residential	3.7
High Density Residential	5.2
Commercial	2.3
Administrative Professional	2.4
Industrial	2.0
Institutional	1.1
Parks and Recreation	2.4
Mixed Use	2.6
Village	2.6

Total Projected Water Demands and Timing

Projected water demands for the COS MUD service area were calculated by multiplying the adopted unit demand factors (see Table 3-8) by the additional development projected to occur (see Table 3-2) at buildout. The resulting projection was then added to existing water demands, followed by adjustments for unaccounted-for water and conservation. Existing water demands were assumed equal to the average water demands in 2004 and 2005.

Table 3-9 illustrates the projected water demands for the COS MUD service area. As shown in Table 3-9, the COS MUD water demands are projected to increase by 200 percent (from 36,380 af to 110,000 af), and the COS MUD's South Stockton Service Area is projected to grow by approximately 600 percent. The large increase in demand is attributable to the quantity of growth projected within the Urban Services Boundary in the adopted 2035 General Plan Update.

The COS MUD demands were then projected, on a yearly basis, using the timing previously discussed. Figure 3-17 illustrates projected water demands over time. As shown on Figure 3-17, water demands grow at a rate much higher than the growth rate assumed for population (2.5%) in the general plan. This difference is due to the large quantity of non-residential development incorporated into the City's general plan.

Table 3-9. Projected Water Demands for the COS MUD Service Area

Landuse Designation	Unit Demand Factor, af/ac/yr	North Stockton[a]		South Stockton		COS MUD	
		Additional Development, acres[b]	Additional Consumption, af/year[c]	Additional Development, acres[b]	Additional Consumption, af/year[c]	Additional Development, acres[b]	Additional Consumption, af/year[c]
Residential Estate	1.5	990	1,490	0	0	990	1,490
Low Density Residential	2.5	6,260	15,650	1,640	4,100	7,900	19,750
Medium Density Residential	3.7	1,650	6,110	450	1,670	2,100	7,780
High Density Residential	5.2	540	2,810	80	420	620	3,230
Commercial	2.3	890	2,050	620	1,430	1,510	3,480
Administrative Professional	2.4	100	240	500	1,200	600	1,440
Industrial	2.0	70	140	8,030	16,060	8,100	16,200
Institutional	1.1	1,290	1,420	1,590	1,750	2,880	3,170
Parks and Recreation	2.4	820	1,970	170	410	990	2,380
Mixed Use	2.6	860	2,240	0	0	860	2,240
Village	2.6	3,380	8,790	4,680	12,170	8,060	20,960
Total		16,850	42,910	17,760	39,210	34,610	82,120
Conservation (10%) [c]			*(4,290)*		*(3,920)*		*(8,210)*
UAFW (@ 4.8%) [c]			*1,950*		*1,780*		*3,730*
Total Additional Production (includes UAFW @ 4.8%) [c]			40,570		37,070		77,640
Existing Production (average of 2004 and 2005) [c]			30,380		6,000		36,380
Existing Conservation (10%) [c]			*(3,040)*		*(600)*		*(3,640)*
Future Existing Production [c]			27,340		5,400		32,740
Total Future Water Demand[d]			**68,000**		**42,000**		**110,000**
Percentage Increase			*124%*		*600%*		*202%*

[a] Includes WPA and County Maintenance Districts.

[b] Rounded to the nearest 10 acres.

[c] Rounded to the nearest 10 acre-feet/year.

[d] Rounded to the nearest 1,000 acre-feet/year.

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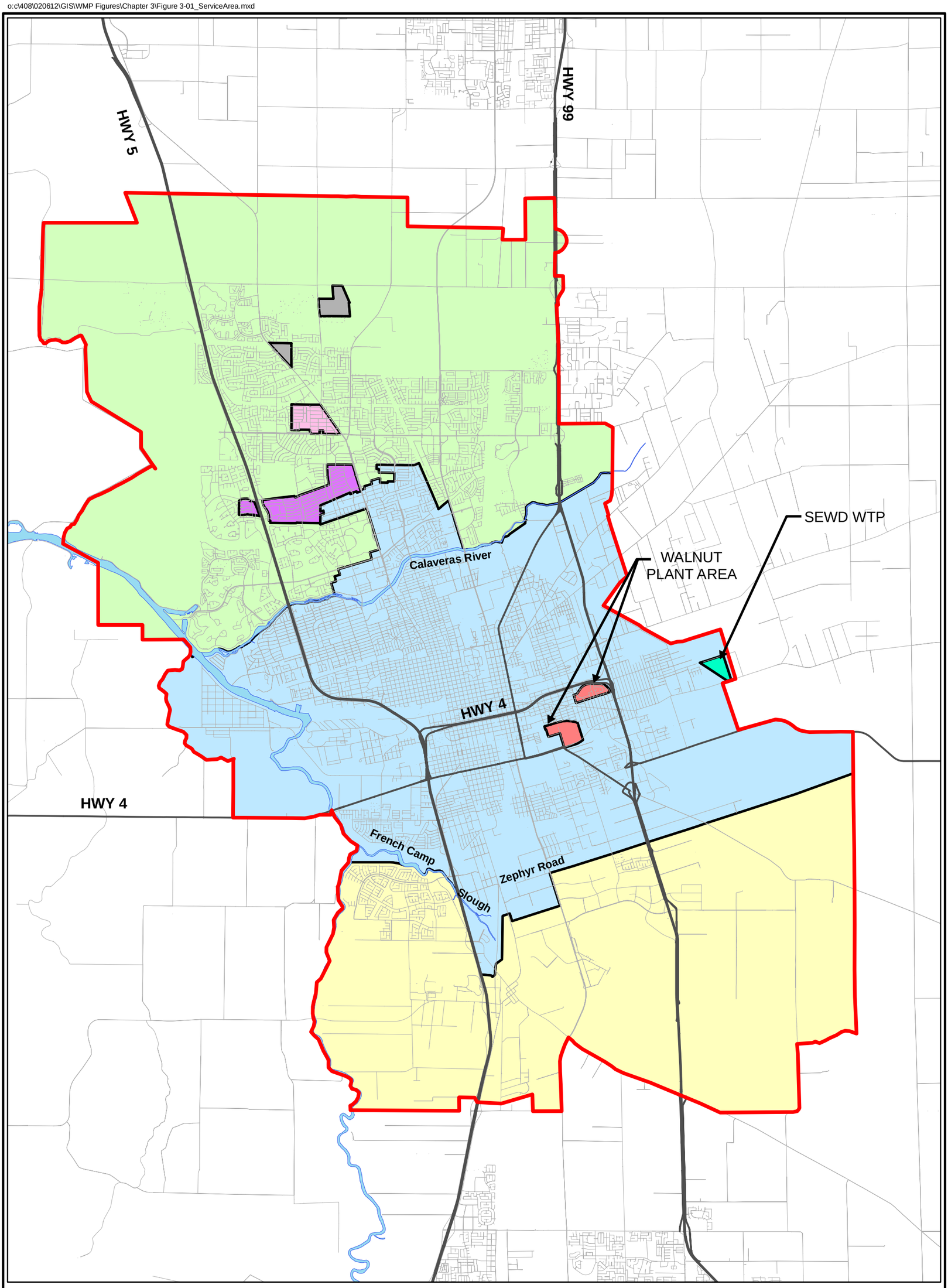


LEGEND:

- 2035 Urban Services Boundary
- Major Freeway
- Street
- Colonial Heights
- Lincoln Village
- County Island
- CWSC
- COS MUD - North Stockton
- COS MUD - South Stockton
- COS MUD - Walnut Plant
- SEWD WTP
- Major Water Feature

N

0 0.45 0.9 1.8

Scale in Miles

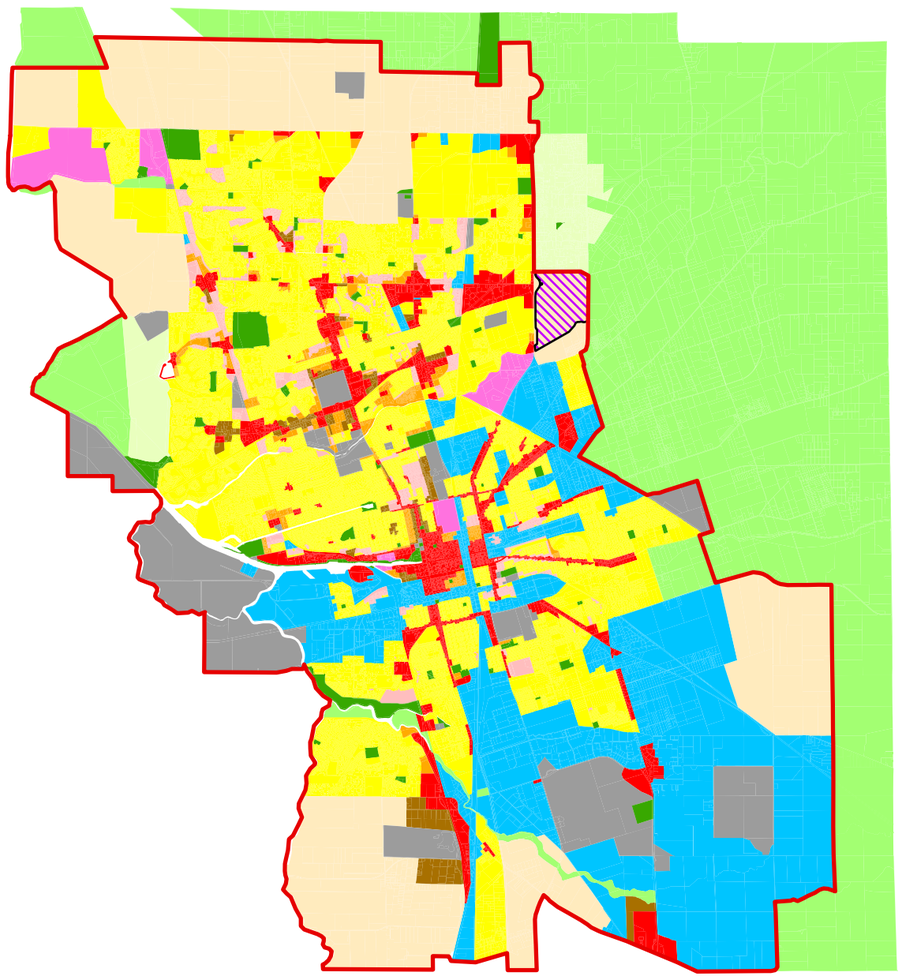
FIGURE 3-1

City of Stockton
Municipal Utilities Department
Water Master Plan Update

SERVICE AREAS

WEST YOST ASSOCIATES
Consulting Engineers

2035 General Plan Adopted Land Use Plan



Refined Land Use Map for the COS MUD Water Master Plan Update

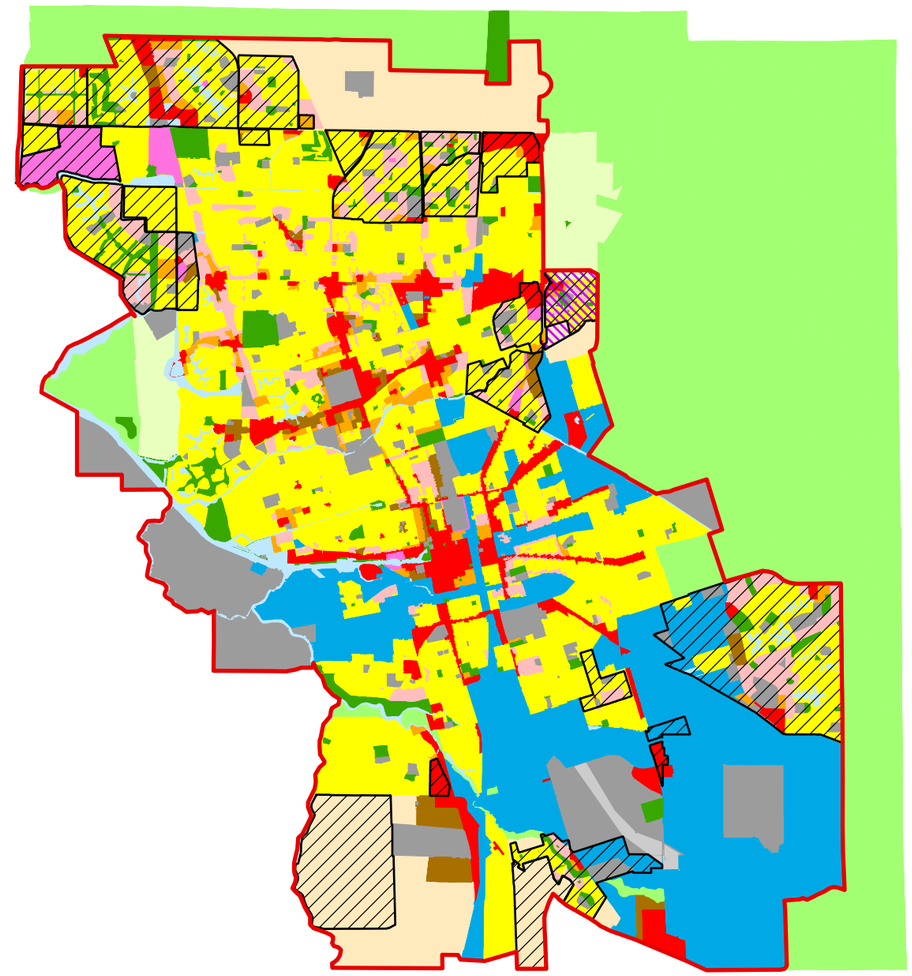


FIGURE 3-2

City of Stockton
Municipal Utilities Department
Water Master Plan Update

COMPARISON OF ADOPTED GENERAL PLAN TO LAND USE USED IN THE WATER MASTER PLAN UPDATE

N

0 1.25 2.5 5
Scale in Miles

NOTES:

- Refined map corrected to include existing Schools, Parks, Hospitals, and Golf Courses
- Refined map includes input from developers obtained on 9/29/2006 during a meeting between the development community and COS MUD staff
- Not all plans incorporated as they are still under review by the planning department

LEGEND:

- 2035 Urban Services Boundary
- Areas Represented by a Developer
- Empire Ranch Development
- Residential Estate
- Low Density Residential
- Medium Density Residential
- High Density Residential
- Commercial
- Administrative Professional
- Industrial
- Institutional
- Parks and Recreation
- Open Space/Agriculture
- Mixed Use
- Village
- Waterways
- Runway

WEST YOST ASSOCIATES
Consulting Engineers

Note:
As of December 2007, the Empire Ranch development has been removed from the 2035 General Plan Update Urban Services Boundary. The decision was made to show that the Empire Ranch development was removed from the City's system; however, no additional analysis was performed to evaluate what infrastructure was required without the development. WYA recommends that the COS MUD evaluate the effects of removing the Empire Ranch development within the water distribution system in the near future.

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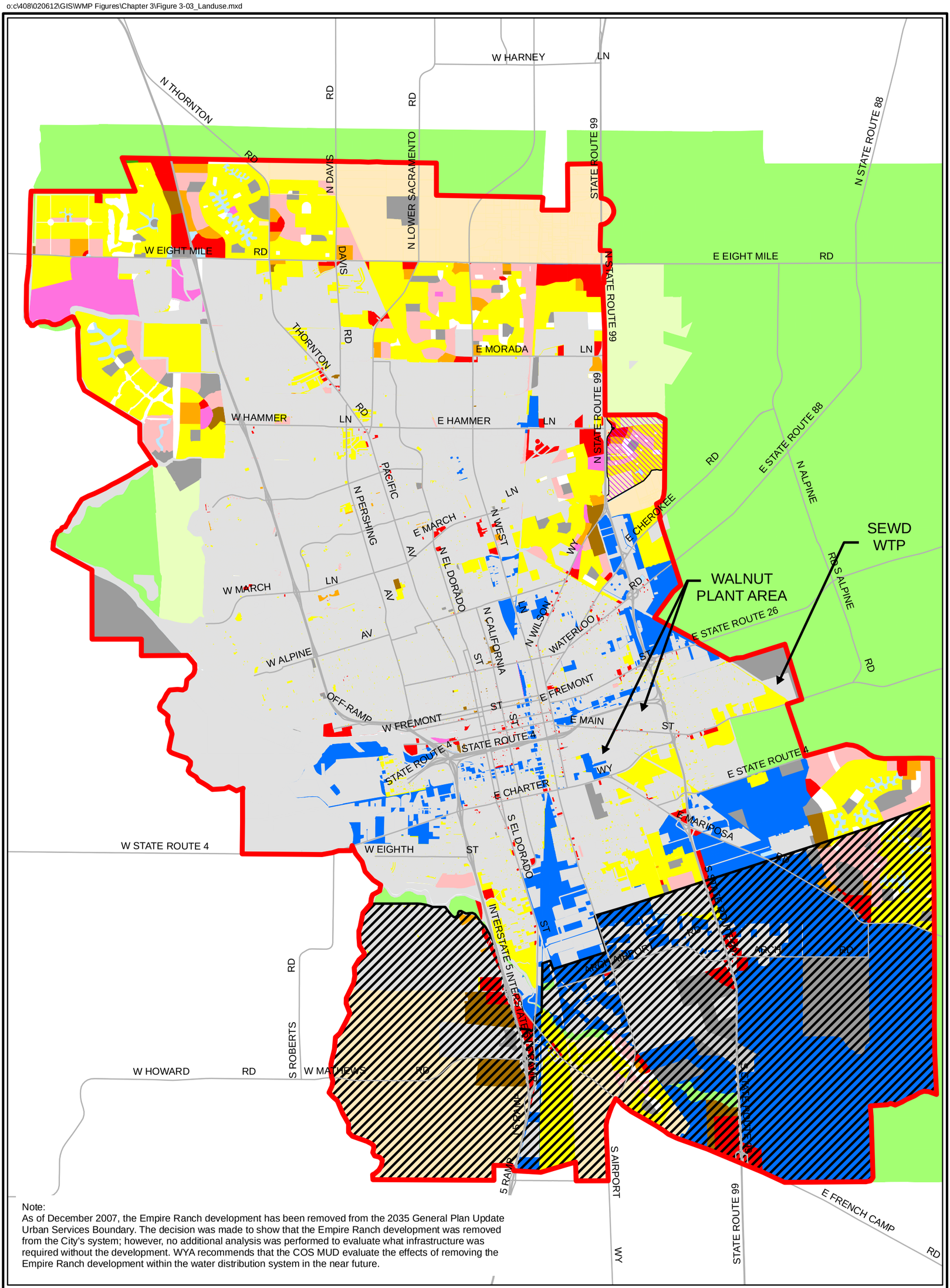


Note:
As of December 2007, the Empire Ranch development has been removed from the 2035 General Plan Update Urban Services Boundary. The decision was made to show that the Empire Ranch development was removed from the City's system; however, no additional analysis was performed to evaluate what infrastructure was required without the development. WYA recommends that the COS MUD evaluate the effects of removing the Empire Ranch development within the water distribution system in the near future.

LEGEND:

- 2035 Urban Services Boundary
- Major Street
- Area Served by CWSC
- Existing Areas Served Water
- Residential Estate
- Low Density Residential
- Medium Density Residential
- High Density Residential
- Commercial
- Administrative Professional
- Industrial
- Institutional
- Parks and Recreation
- Open Space/Agriculture
- Mixed Use
- Village
- Waterways
- Runway
- Empire Ranch Development

N

0 0.45 0.9 1.8

Scale in Miles

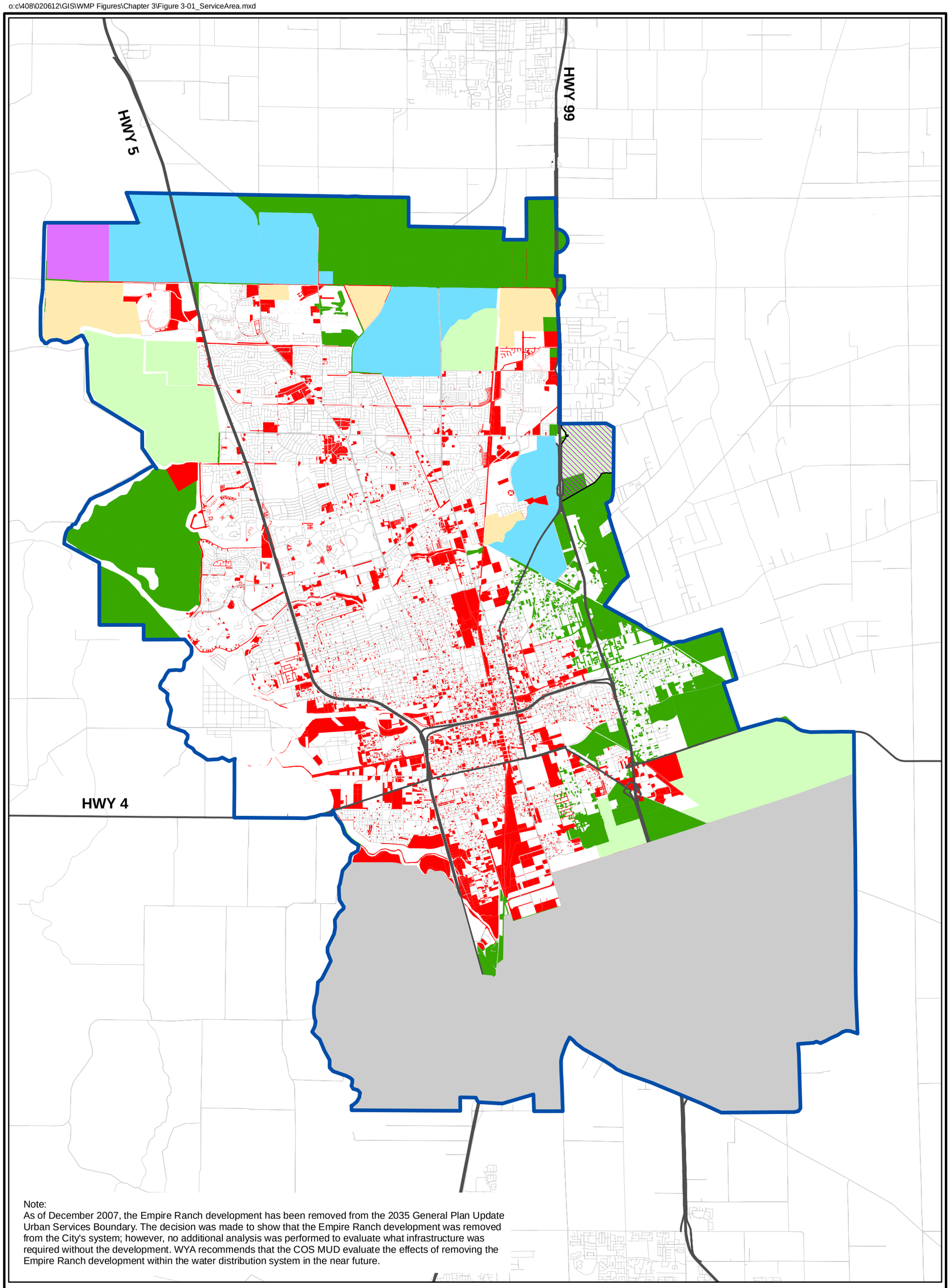
FIGURE 3-3

City of Stockton
Municipal Utilities Department
Water Master Plan Update

FUTURE LAND USE AREAS TO BE SERVED WATER

WEST YOST ASSOCIATES
Consulting Engineers

o:c\408\020612\GIS\WMP Figures\Chapter 3\Figure 3-01_ServiceArea.mxd



Note:
As of December 2007, the Empire Ranch development has been removed from the 2035 General Plan Update Urban Services Boundary. The decision was made to show that the Empire Ranch development was removed from the City's system; however, no additional analysis was performed to evaluate what infrastructure was required without the development. WYA recommends that the COS MUD evaluate the effects of removing the Empire Ranch development within the water distribution system in the near future.

LEGEND:

- 2035 Urban Services Boundary
- Area Served by CWSC
- Major Freeway
- Street
- USB Development (Starting in 2011)
- Infill (Starting in 2007)
- Started in 2006
- Starting in 2007
- Starting in 2008
- Starting in 2009
- Starting in 2010
- Empire Ranch Development

N

0 0.5 1 2

Scale in Miles

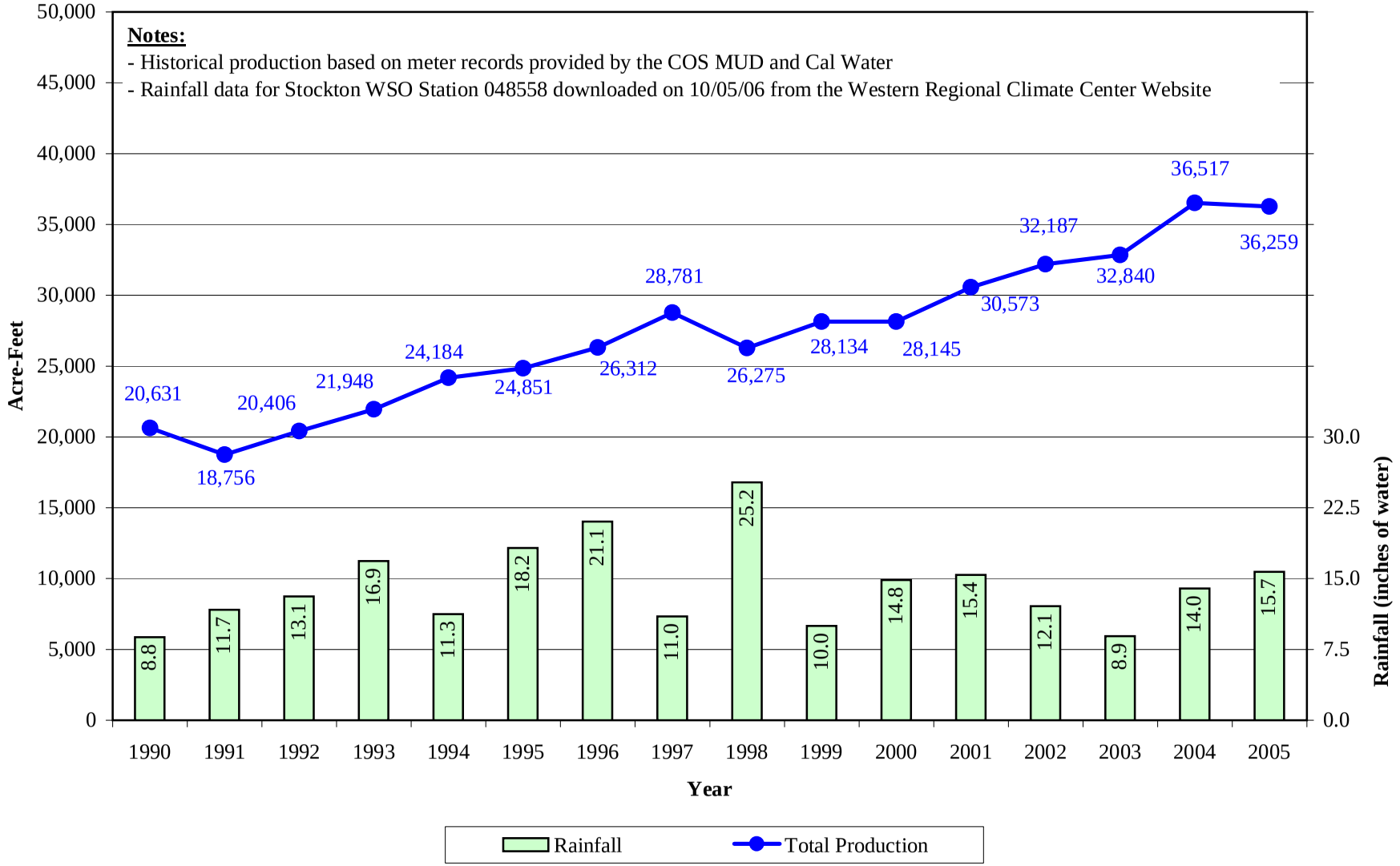
FIGURE 3-4

City of Stockton
Municipal Utilities Department
Water Master Plan Update

TIMING OF DEVELOPMENT

WEST YOST ASSOCIATES
Consulting Engineers

Figure 3-5. Historical Production in the COS MUD Service Area



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o:\c\408\02-06-12\EeT1\Production Data
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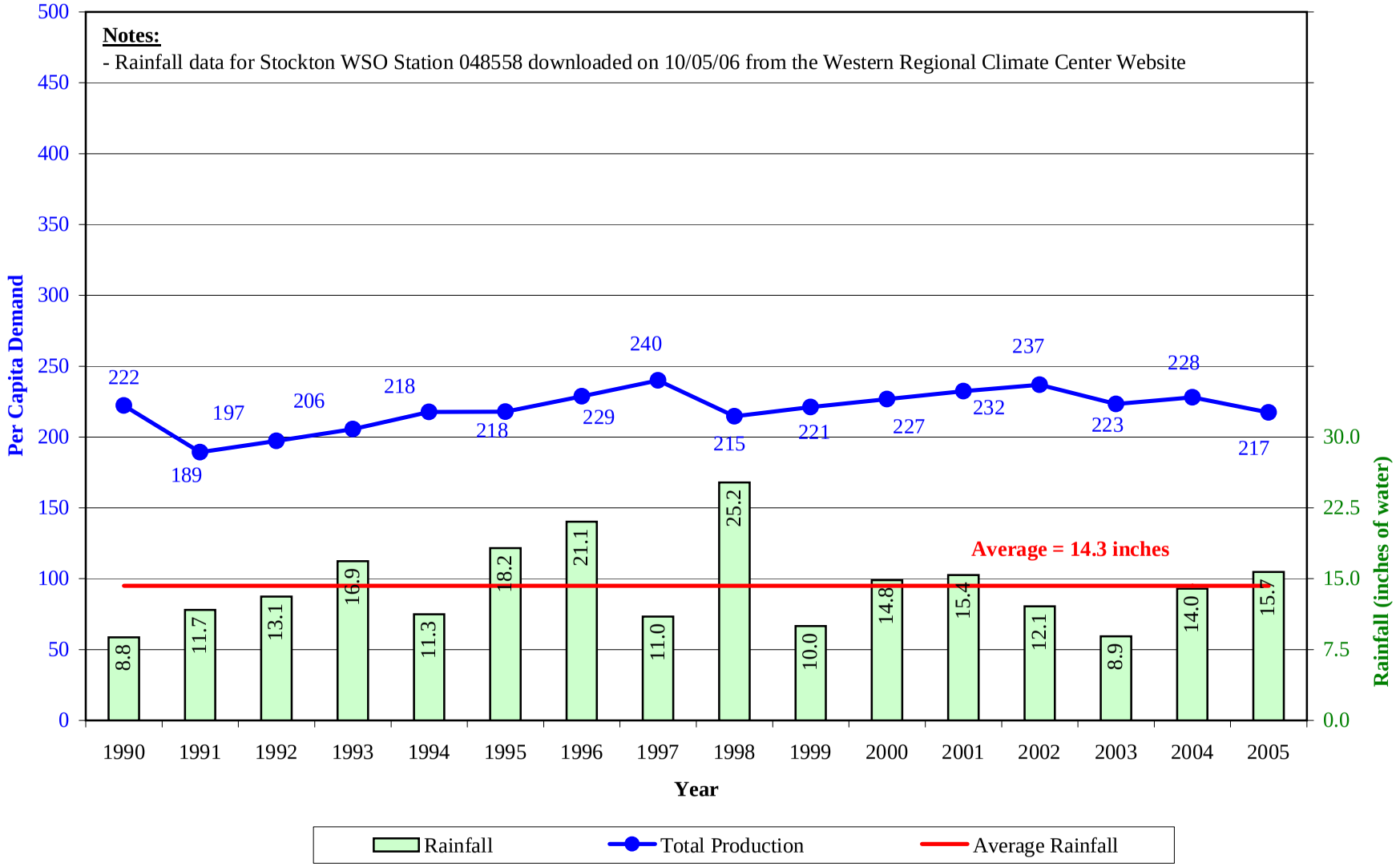
City of Stockton
Water Master Plan Update

Figure 3-6. Historical Per Capita Demands for the City of Stockton



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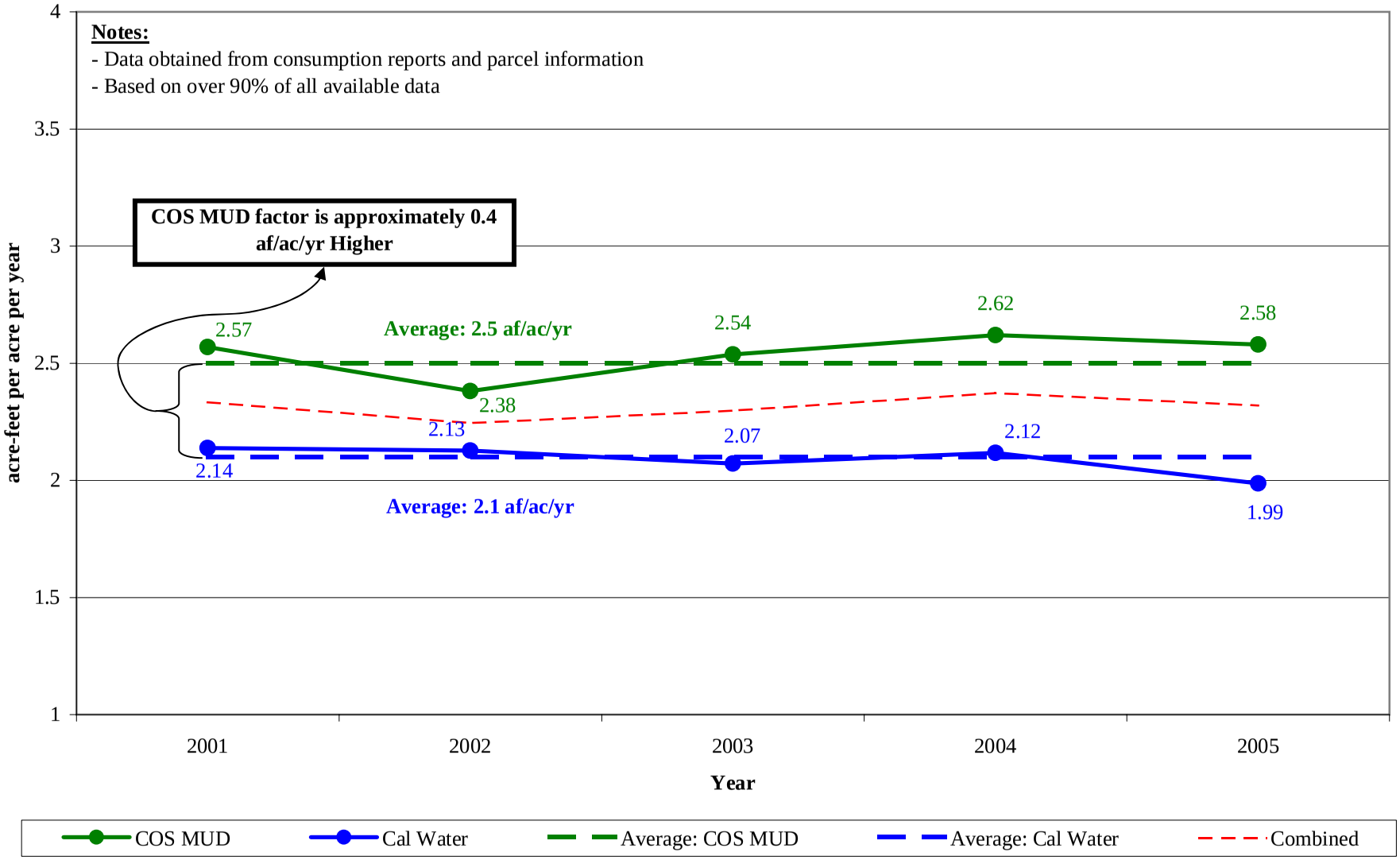
City of Stockton
Water Master Plan Update

Figure 3-8. Historical Unit Demand Factor: Low Density Residential



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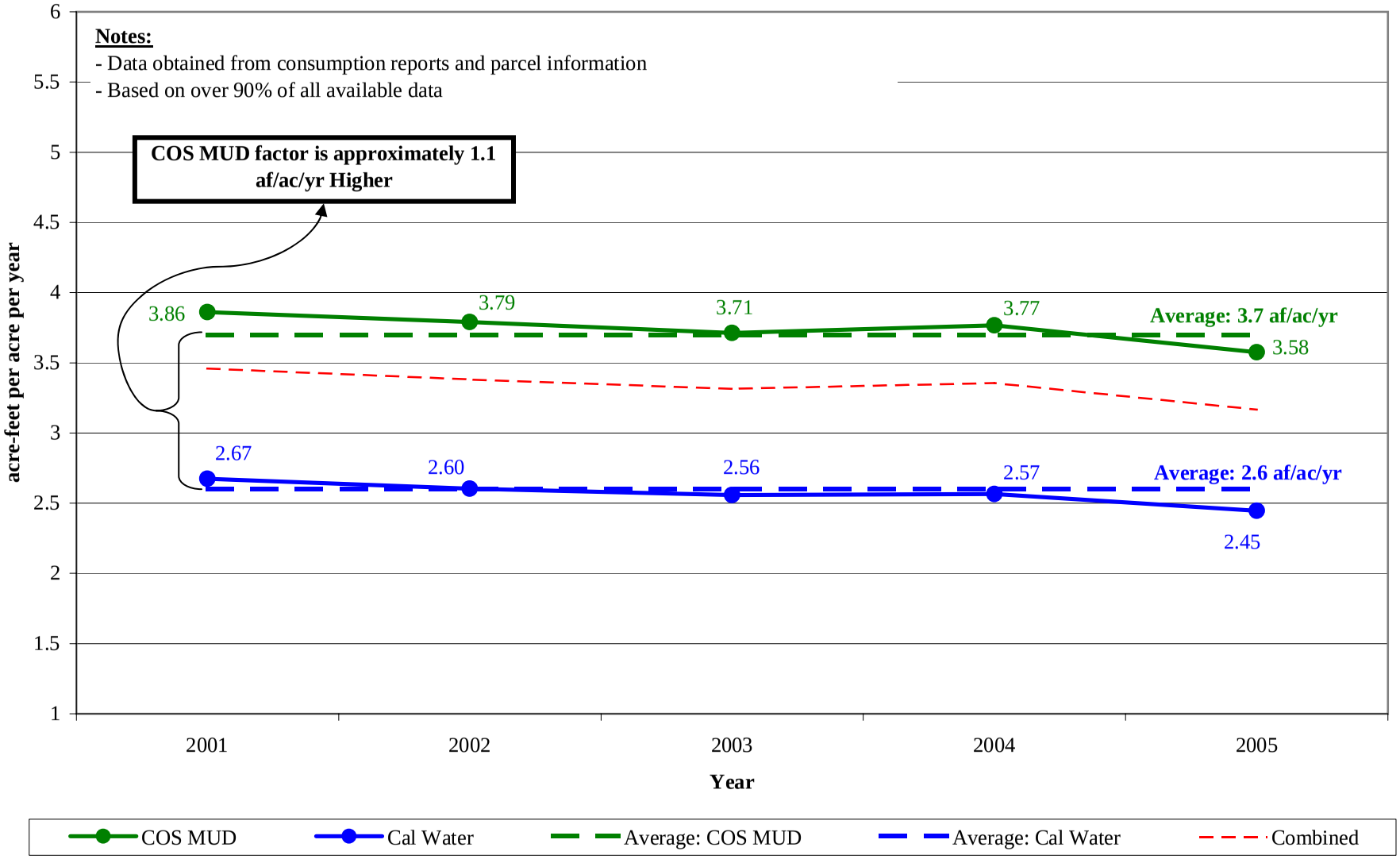
City of Stockton
Water Master Plan Update

Figure 3-9. Historical Unit Demand Factor: Medium Density Residential



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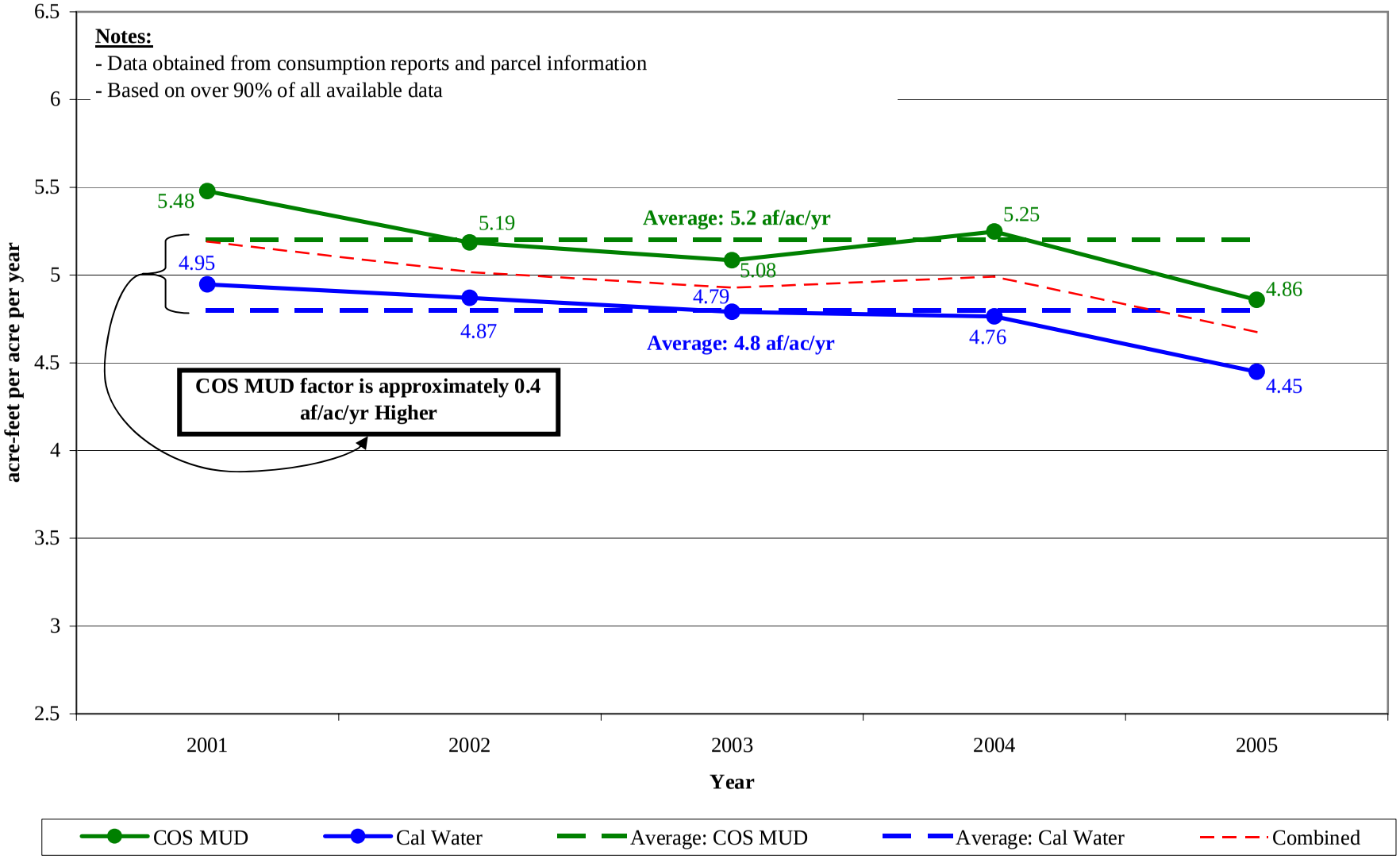
City of Stockton
Water Master Plan Update

Figure 3-10. Historical Unit Demand Factor: High Density Residential



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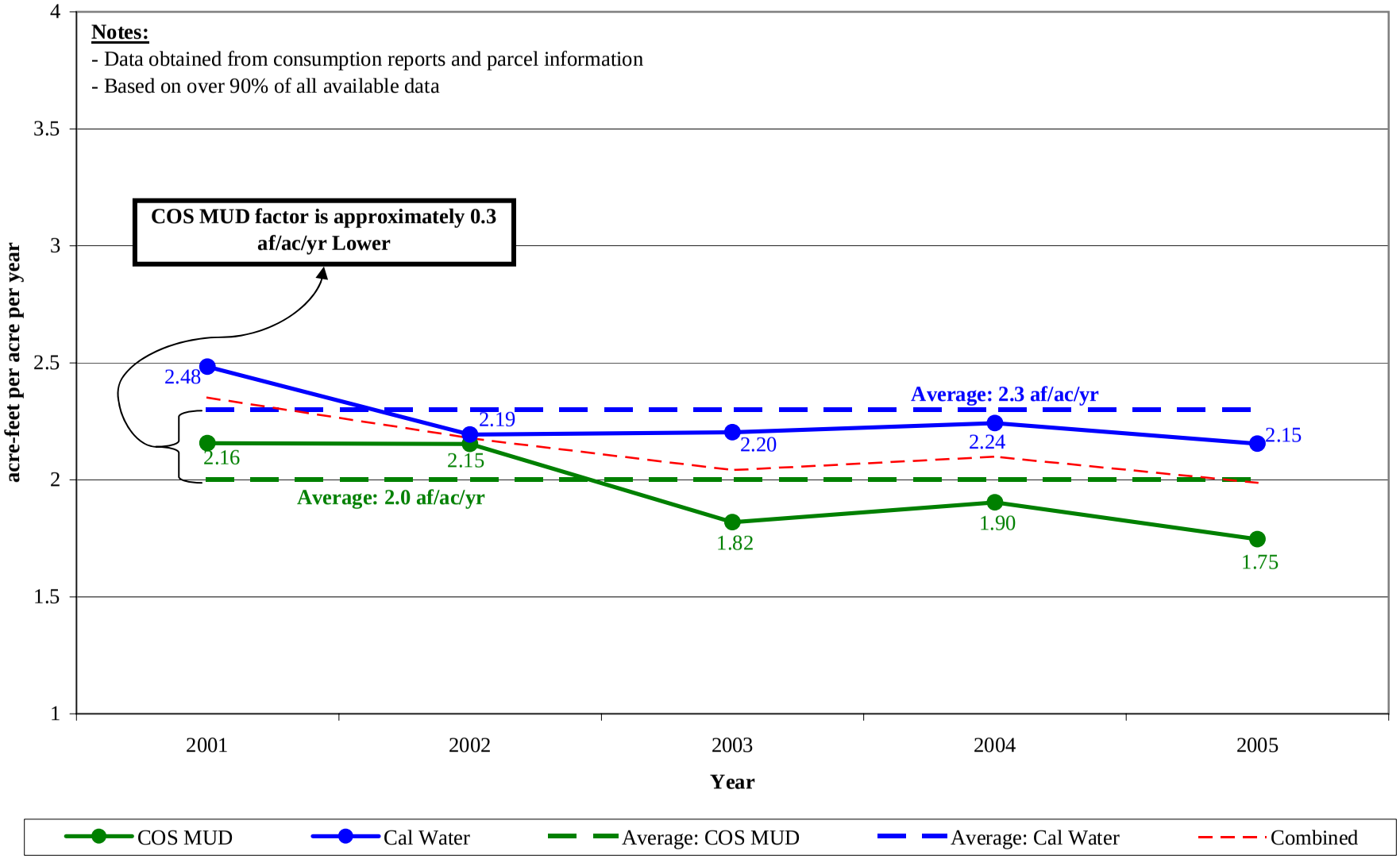
City of Stockton
Water Master Plan Update

Figure 3-11. Historical Unit Demand Factor: Commercial



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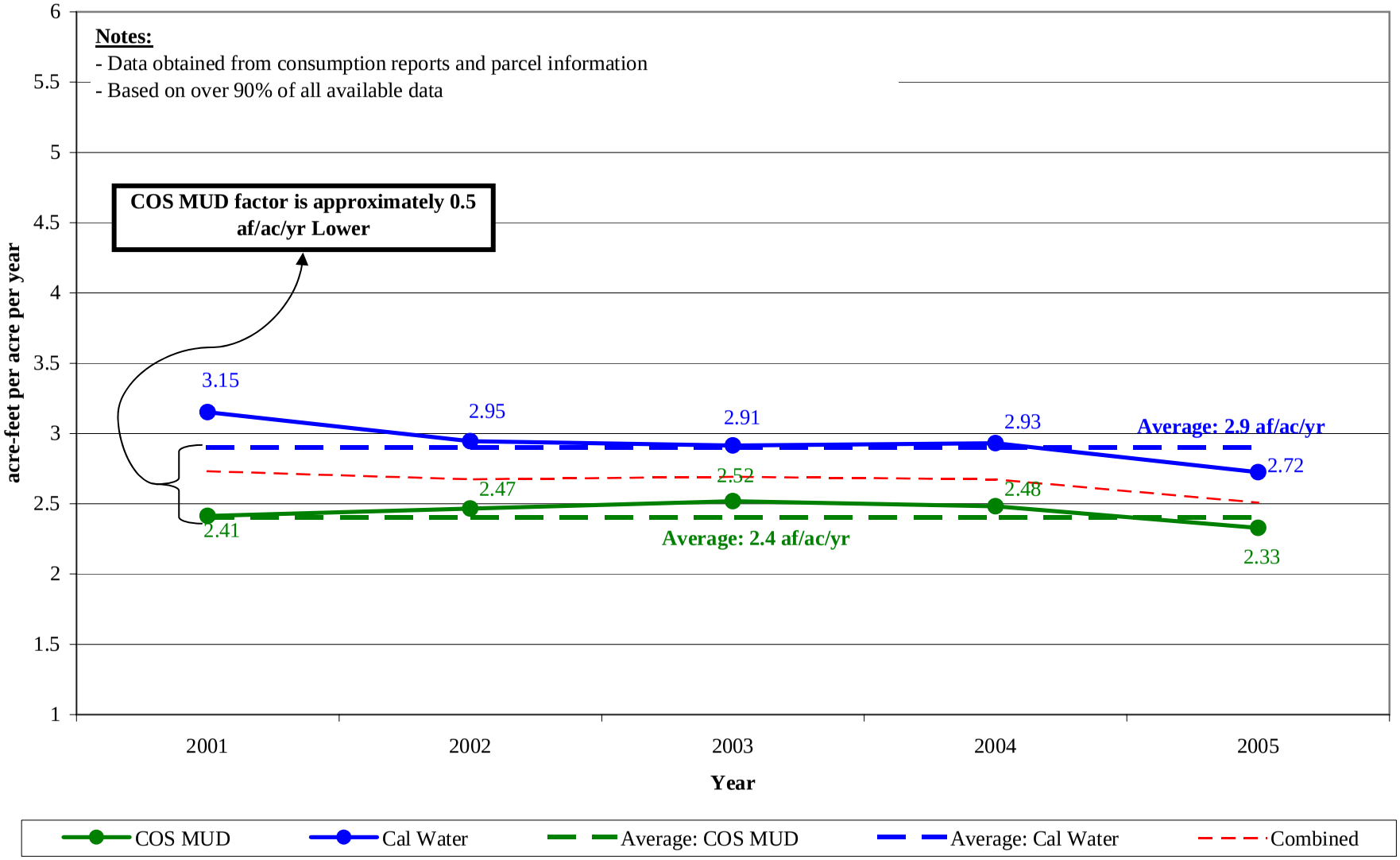
City of Stockton
Water Master Plan Update

Figure 3-12. Historical Unit Demand Factor: Administrative Professional



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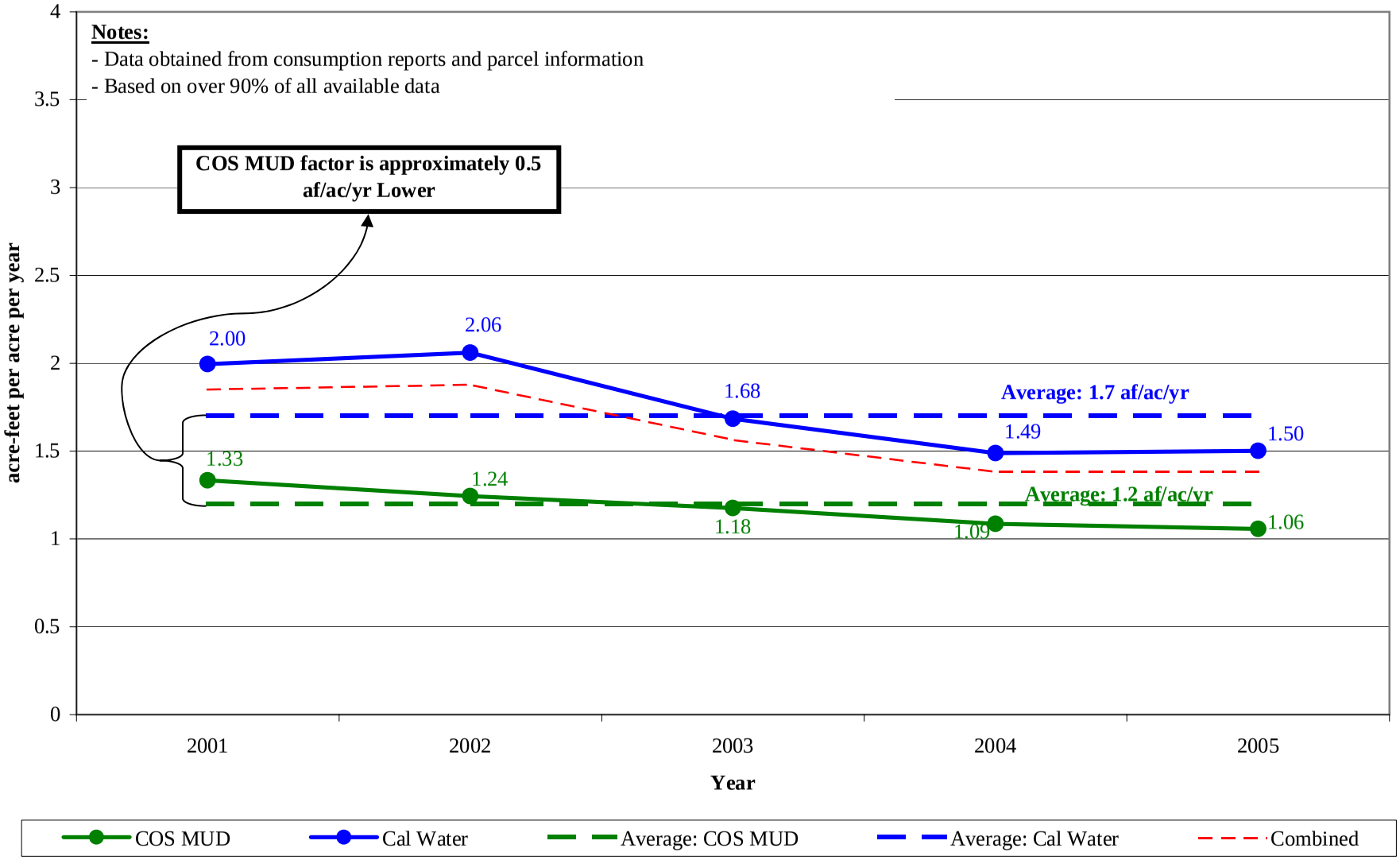
City of Stockton
Water Master Plan Update

Figure 3-13. Historical Unit Demand Factor: Industrial



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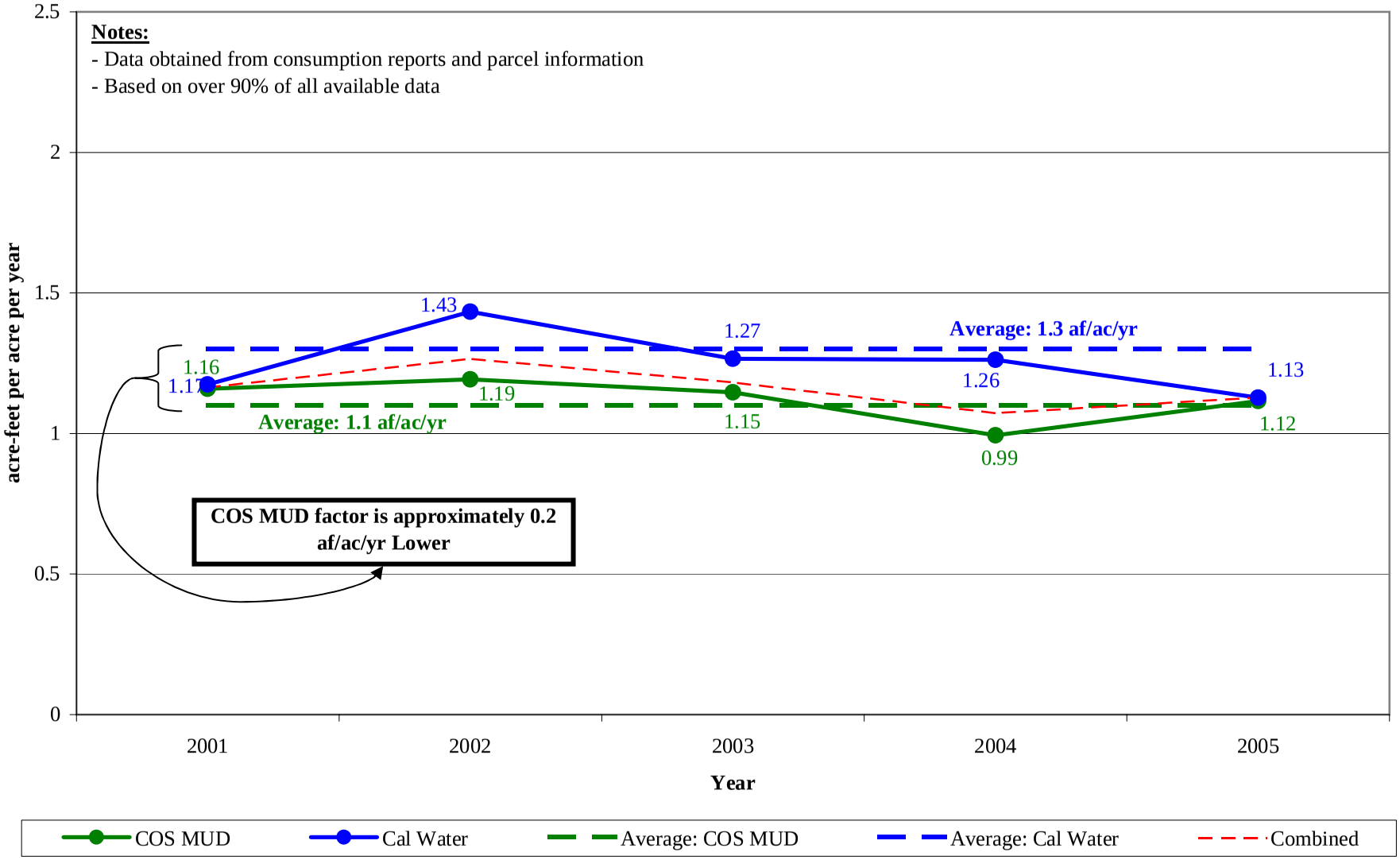
City of Stockton
Water Master Plan Update

Figure 3-14. Historical Unit Demand Factor: Institutional



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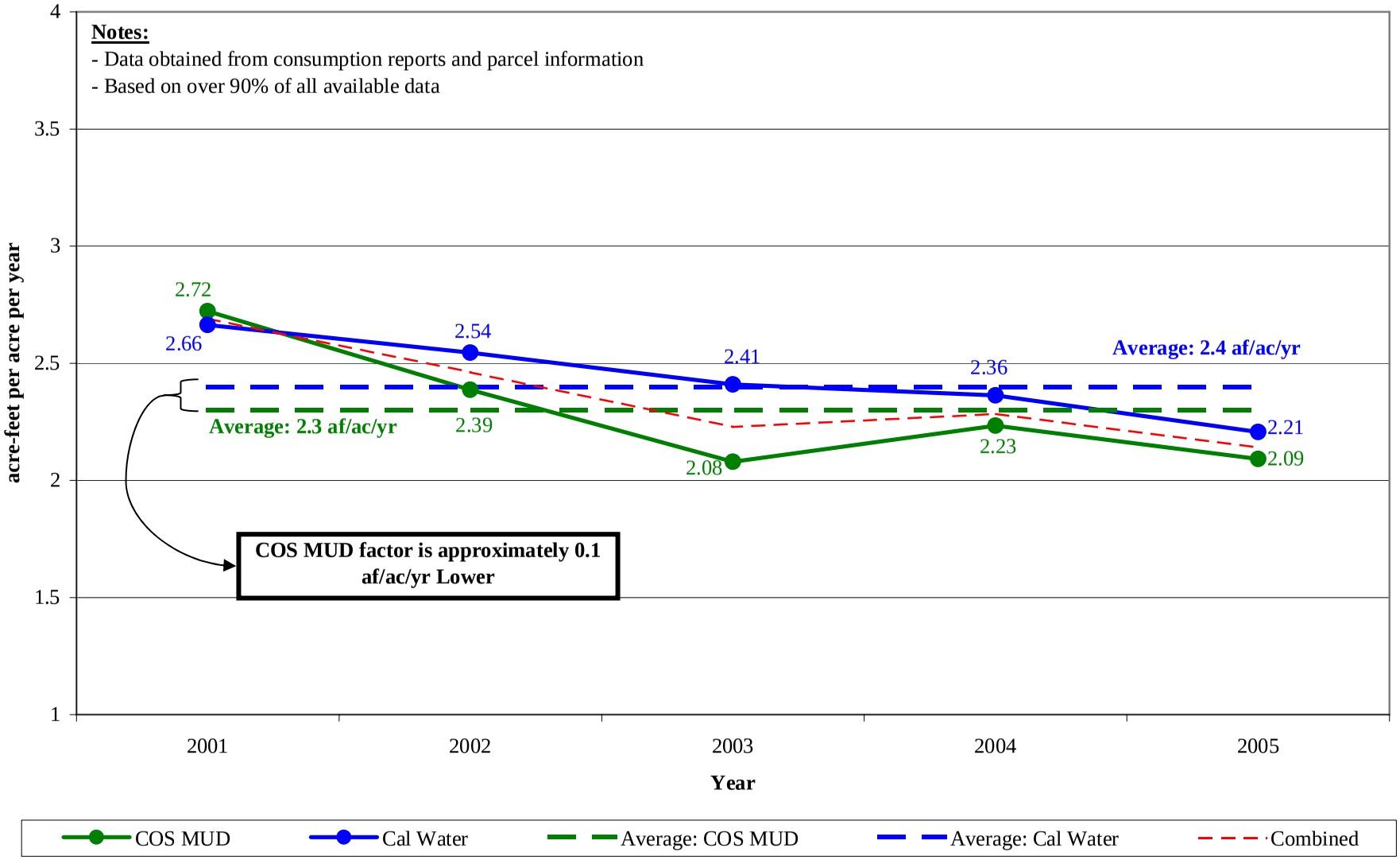
City of Stockton
Water Master Plan Update

Figure 3-15. Historical Unit Demand Factor: Parks & Recreation



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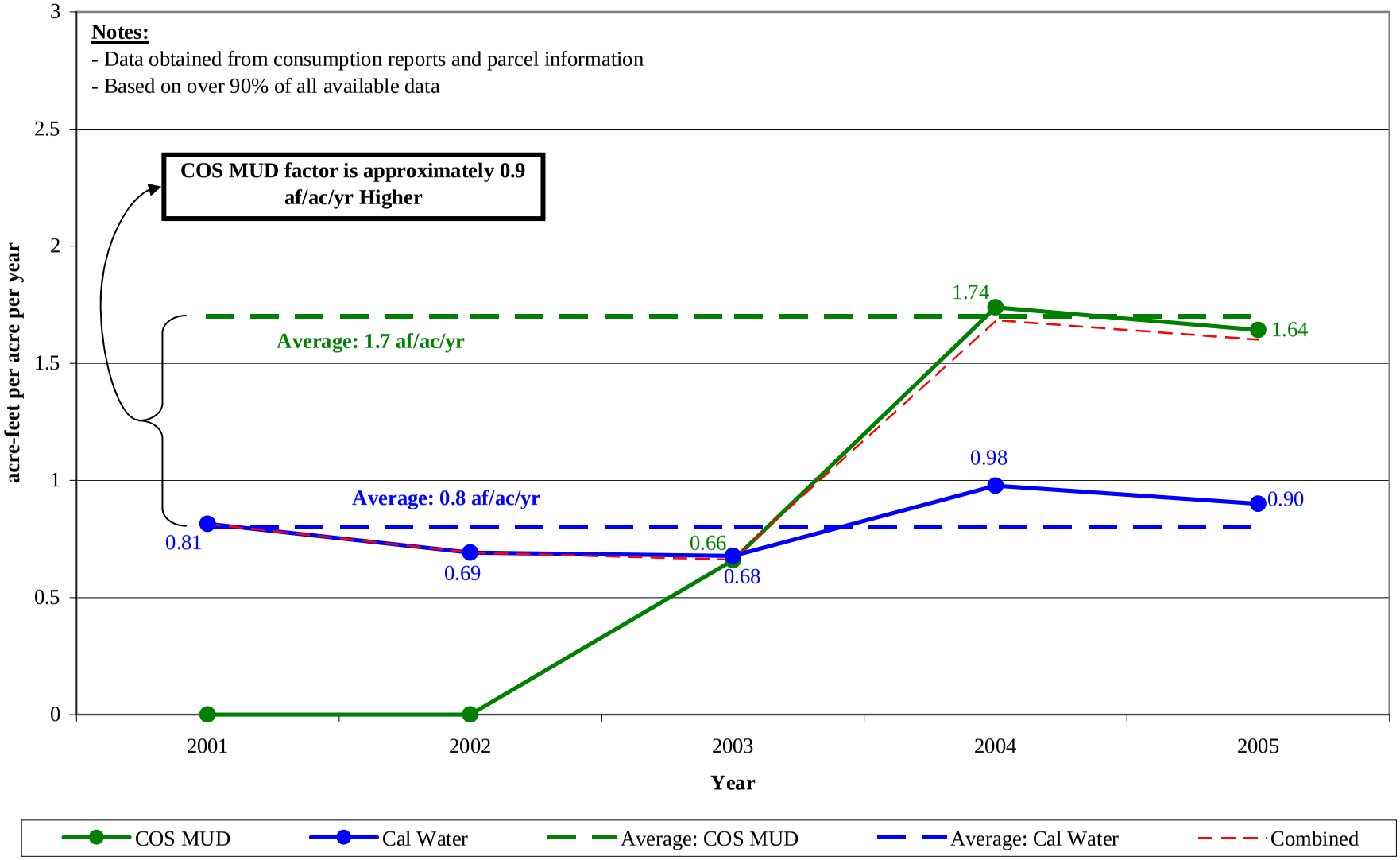
City of Stockton
Water Master Plan Update

Figure 3-16. Historical Unit Demand Factor: Mixed Use



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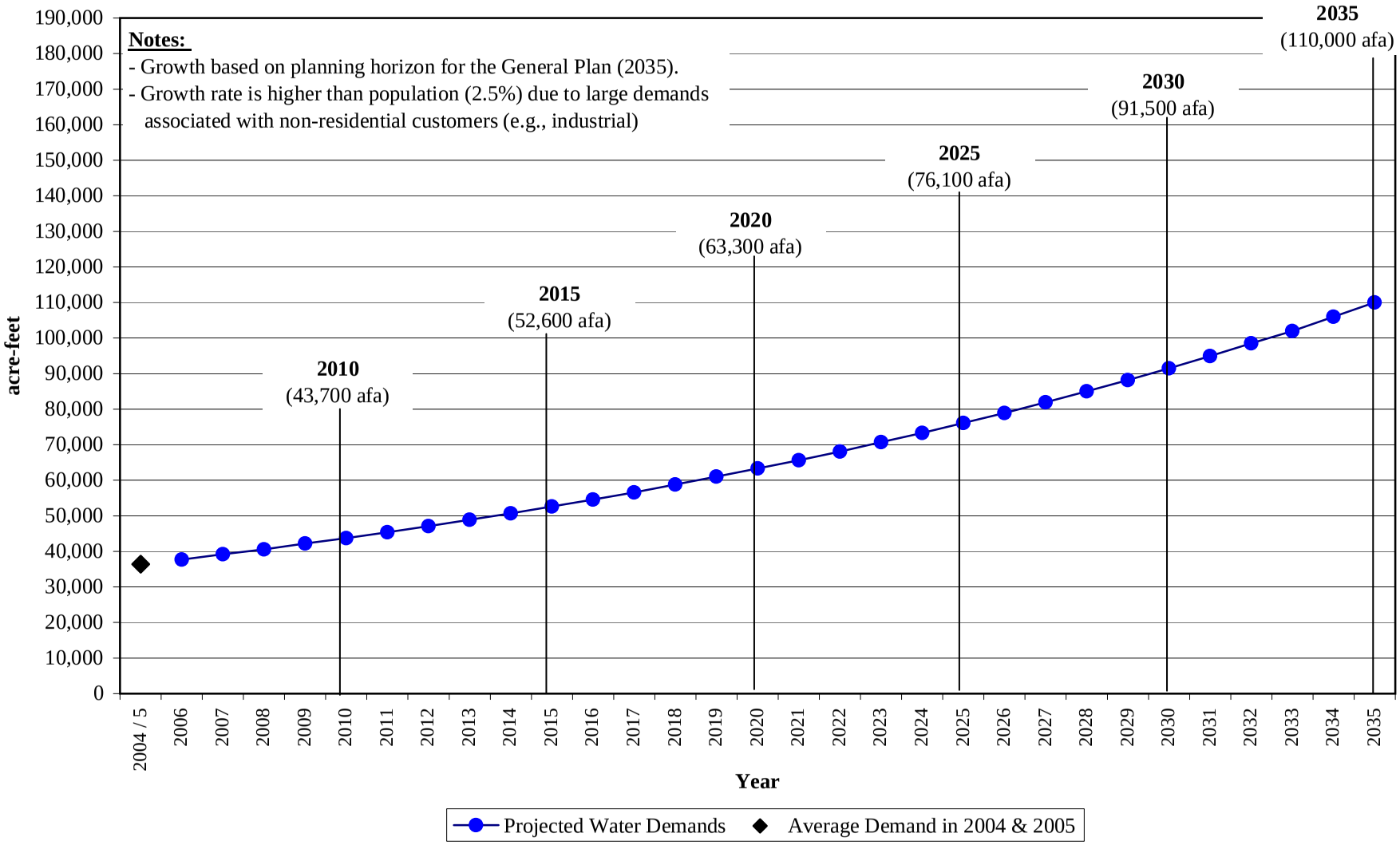
City of Stockton
Water Master Plan Update

Figure 3-17. Timing of Projected Water Demands



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o:\c\408\02-06-12\e\2035_Comparison.xls
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City of Stockton
Water Master Plan Update

REFERENCES

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[1] Estimated water conservation savings over 1983 water use provided by COS MUD staff.

[2] Mintier & Associates, URS, ADE, ESA, RACESTUDIO, Verranzza Wolfe Associates, West Yost & Associates. 2004. City of Stockton General Plan Background Report. February.

CHAPTER 4. WATER SUPPLY

The purpose of this chapter is to summarize the key conclusions from the May 2006 Water Supply Evaluation for the General Plan Updated Preferred Alternative (2006 WSE) and the 2003 Delta Water Supply Feasibility Report (2003 DWSP FR) adopted for this Water Master Plan Update, and used as the basis for estimating future water infrastructure needs for the COS MUD water system.

Assumptions made in the 2006 WSE for CWSC were also included in this summary; however, infrastructure planning for the CWSC water system is beyond the scope of this Water Master Plan Update. Only potential wholesale connections to the COS MUD water system will be identified.

Per the City's direction, an independent evaluation of water supplies was not conducted by WYA for this Water Master Plan Update.

Sections of this chapter include:

- Existing Sources of Water Supply
- Future Sources of Water Supply
- Summary of Water Supply Assumptions

EXISTING SOURCES OF WATER SUPPLY

Until the mid-1970's, the COS MUD used groundwater as its sole source of water supply, because it required minimal treatment, resulted in lower pumping and conveyance costs, and had a higher degree of reliability.[1] The SEWD WTP began supplying treated surface water in 1977 to help supplement the COS MUD groundwater supplies.[2] Consequently, the COS MUD currently receives water from two sources: groundwater pumped from the underlying groundwater basin and treated surface water from the SEWD WTP.

Existing Local Groundwater Supplies

The groundwater basin underlying the COS MUD service area is part of the contiguous Central Valley aquifer system.[3] The thickness of the unconfined alluvial aquifer ranges from around 100 feet on the eastern end of the county to over 3,000 feet on the southwestern end; the thickness underlying the COS MUD service area is approximately 1,000 feet.[4]

Figure 10 of the 2006 WSE indicates that groundwater elevations within the greater San Joaquin County area have declined; the 2006 WSE indicates that this decline is likely the result of groundwater pumping within this same area. The decline in groundwater elevations has created a cone of depression, allowing saltwater from the Delta region to intrude into the basin underlying the west side of the COS MUD's water system, diminishing groundwater quality.[5] Figure 11 of the 2006 WSE illustrates the location of the saltwater front. This saltwater front has been migrating in an easterly direction across the COS MUD service area at a rate of about 150-250 feet per year.[6]

Past studies have attempted to quantify the sustainable long-term yield ("safe yield") available from the groundwater aquifer.[7] The safe yield is the quantity of water that can be withdrawn on average over a long period without adverse impacts. As pumping is increased, groundwater levels drop, which increases the hydraulic gradient from surrounding areas, thus increasing the saltwater flow toward the depression.[8] In an ideal system, a new equilibrium will be reached for each level of pumping. Consequently, one must define the term "adverse impacts" to quantify the safe yield.

For the City, adverse impacts of a lowered water table include increasing saline intrusion, increasing pumping depths (higher pumping costs, reduced well yields, and the need to deepen some wells), and potentially land subsidence. The most current estimate of groundwater availability appears in the 2006 WSE at 0.75- to 1.0-af/ac/yr.

The Northeastern San Joaquin County Groundwater Banking Authority (GBA), of which the City and CWSC are members, has recently begun preparation of an Integrated Regional Water Management Plan (IRWMP). One of the early tasks of the IRWMP will be to set Basin Operating Criteria, including the groundwater safe yield. The work will be supported by state-of-the-art groundwater modeling.

In the 2006 WSE, the groundwater extraction is targeted not to exceed the long-term operational goal of the basin of 0.6 af/ac/yr or beyond the 0.75 af/ac/yr maximum in any given year before applying any groundwater banking or agricultural credits for future conjunctive management purposes.

As shown previously in Chapter 3 (Water Demands, Table 3-4), the COS MUD's water supplies have historically consisted of approximately 40 percent groundwater and 60 percent surface water, and the COS MUD pumped 14,553 af of groundwater in 2005. The total quantity of acres within the COS MUD's 2035 service area is approximately 55,100 acres at buildout; hence, the COS MUD's current groundwater yielded from the groundwater basin underlying its service area in 2005 was approximately 0.26 af/ac (14,553 af divided by 55,100 acres).

The quantity of groundwater pumped from the basin will increase dramatically as the City's demands increase; however, as will be discussed in subsequent sections, the City has been and will continue to implement a conjunctive use program that will assist the COS MUD in meeting the targets presented in the 2006 WSE.

Existing Surface Water Supply

Currently, all surface water used in the COS MUD is produced by the SEWD WTP. The current capacity of the SEWD WTP is 50 mgd (approximately 56,000 acre-feet annually (afa)). As previously shown in Chapter 3 (see Table 3-4), the SEWD WTP has provided the COS MUD with approximately 60 percent (21,707 af in 2005) of its total supply from 1993 to 2005.

The SEWD WTP currently receives Calaveras River and Stanislaus River water under five separate agreements that currently total approximately 104,100 af, but will decrease to approximately 94,100 af at buildout (see Table 4-1). Actual existing availability varies from 104,100 afa in a wet year, to approximately 48,000 afa in a critically dry year (see Table 4-1).

Table 4-1. Current and Future SEWD Water Sources and Critical Year Availability[(a)]

Source	Annual Contract Amount, thousand acre-feet (TAF)	Projected "Critical Year" Annual Availability, af/yr			
		Planning Year			
		2000	2010	2020	2035
Current and Future "Firm" Sources of Supply					
Reclamation – New Hogan Water Supplies, CACWD and SEWD	Total yield 84.1 TAF SEWD Entitled to M&I or Ag 40.171 TAF	20,000	12,000	12,000	12,000
CACWD Appropriate Water Rights	Unused CACWD Rights (currently at approximately M&I 24 TAF initially to 10 TAF at buildout)	20,000	10,000	10,000	10,000
Reclamation – New Melones Interim Water Contract and Section 215 "Spill" Water	Total contract 75 TAF (M&I 40 TAF) Ag & Recharge 20 TAF) Losses 15 TAF)	Not Available in Dry Years			
SSJID Transfer – Stanislaus River	(Interim M&I 15 TAF)	4,000	4,000	0	0
OID Transfer – Stanislaus River (includes contract renewal to 2025)	(Interim M&I 15 TAF)	4,000	4,000	4,000	0
Future Appropriate Water Rights on the Calaveras River	(Not yet determined, assumed to be M&I 50 TAF in wet and above normal years only)	Not Available in Dry Years			
Total	(Firm M&I 104.1 TAF initially to 94.1 TAF at buildout) (Approximate Max Future M&I 180 TAF)	48,000	30,000	26,000	22,000

(a) Table is an exact copy of Table 3 of the 2006 WSE.

As shown in Table 4-1, the quantity available for Municipal & Industrial (M&I) use from the SEWD's Calaveras River contracts is approximately 64,171 af (40,171 af plus 24,000 af).[9] This water includes surplus entitlements not currently being used by Calaveras County Water District (CCWD), who has priority rights to this supply source.[10] This source of surface water will diminish as Calaveras County continues to develop and requires additional water to meet demands in its service area.[11]

In 1983, the SEWD contracted with the United States Bureau of Reclamation for interim water supply from the New Melones Reservoir on the Stanislaus River. During years with below normal rainfall, dry years and critical years, SEWD would receive no water through this contract.[12] To access this supply, the SEWD constructed the Farmington Canal to connect Goodwin Dam to the SEWD WTP.[13] Although the Farmington Canal was completed in 1994, implementation of the Central Valley Project Improvement Act (CVPIA) and other regulatory actions have limited the amount of water SEWD obtains from this contract.[14]

Through water transfer agreements with Oakdale Irrigation District (OID) and South San Joaquin Irrigation District (SSJID), SEWD can receive up to 30,000 afa from the Stanislaus River.[15] However, the actual amount of water SEWD receives is dependent on the inflow to the New Melones Reservoir.

The minimum amount of water available is 8,000 afa during critical years, increasing incrementally as the inflow increases.[16] Additionally, the current agreements expire in 2009, with optional extensions for up to 10 additional years.[17] Contract extension negotiations are currently underway, and the 2006 WSE assumed, for water supply planning purposes, that only one of these contracts will be extended through 2019 and neither will be available after 2025.

FUTURE SOURCES OF WATER SUPPLY

Future water demand projections for 2035 are shown in Table 3-9 of Chapter 3. The overall COS MUD water demands are projected to increase from 36,259 af in 2005 to 110,000 afa by 2035, representing a 200 percent increase in water demand.

Future Local Groundwater Supplies

The occurrence of salts, arsenic, or other impurities would not necessarily rule out the use of groundwater, but would increase the cost due to treatment, and may trigger an economic necessity to switch to another supply source.

In 2001, the United States Environmental Protection Agency (US EPA) lowered the existing 50 parts per billion (ppb) arsenic standard to 10 ppb; all water systems needed to comply with this standard by 2006. The California Department of Public Health (DPH) is expected to adopt a new arsenic standard equal to or more stringent than the US EPA's standard, and set as close as economically feasible to the Public Health Goal (PHG). A PHG is the level of arsenic in drinking water that would not pose a significant health threat if consumed over a lifetime. The DPH arsenic PHG is 4 ppb. The DPH has discussed setting the arsenic standard somewhere between 4 ppb and 10 ppb.

In 2002, average arsenic concentrations in groundwater in the COS MUD service area ranged from 5.3 ppb to 11 ppb. Therefore, COSMA can expect minor impact to their future groundwater supplies if the DPH sets the new standard at 10 ppb. For this Water Master Plan Update, it was assumed that all of the projected groundwater supply would be available for use by the COS MUD without treatment for arsenic, although some blending may be required to meet the standard.

Currently and in the future, the COS MUD will be improving conditions in the groundwater basin through a conjunctive use program.[18] The conjunctive use program assumes that groundwater will be preserved as the last source of supply, and used only if surface water supplies are insufficient to meet demands; the 2006 WSE further discusses the COS MUD's program.

The analysis conducted as a part of the 2006 WSE indicated that the groundwater extraction would begin to exceed the long-term operational goal of 0.6 af/ac/yr at buildout even with the groundwater banking and agricultural credits unless additional surface water sources can be developed for the COS MUD.

Future Surface Water Supplies

The COS MUD, CWSC, and SEWD are in the process of either implementing or reviewing several projects that will augment surface water supplies. The 2006 WSE included two projects for the COS MUD: Expansion of the SEWD WTP and the Delta Water Supply Project (DWSP).

Expansion of the SEWD WTP

SEWD potable water deliveries to the COS MUD and CWSC are limited by raw water contracts and availability, and the design capacity of the WTP. The WTP's current design capacity is 50 mgd.[19] The 2006 WSE assumed that the WTP capacity would be expanded to 60 mgd by 2015. The 2006 WSE also assumed that the COS MUD and CWSC would split the total supplies from the SEWD 50/50 after considerations for San Joaquin County.

Delta Water Supply Project (DWSP)

In March 2006, the State Water Resources Control Board (SWRCB) granted a permit (#21176) for diversion and use of water by the COS MUD from the Delta to the maximum of 33,600 afa.[20] Design-build procurement of a 30 mgd capacity water treatment plant is underway at the west side of Lower Sacramento Road, about 1-mile north of Eight Mile Road with the target startup in 2011.[21] The three main objectives of the DWSP are to:

- Replace expected surface water supply reductions to the COS MUD; specifically from the SEWD;
- Meet expected future water demands due to planned growth; and
- Protect and restore groundwater.

The following two components were the basis for the COS MUD water right application:

- California Water Code Section 1485 (also referred to as "D-1485"). This allows a municipality discharging treated wastewater to the Delta to divert a like amount, less carriage losses, from a point downstream of the point of discharge. The DWSP Feasibility Study and Draft Environmental Impact Report (EIR) identify carriage losses to be negligible. Wastewater effluent discharge averages 79 percent of average dry weather inflows to the wastewater plant, based on records for 2002-2004.[22]
- California Water Code Section 11460 et seq. (area of origin water). This provision of the water code allows a water user to appropriate water and to have a senior priority to natural flows over the federal Central Valley Project and State Water Projects.[23]

The 2006 WSE assumed that the COS MUD would use 24 mgd of the DWSP, while the remaining supply would be provided to CWCS (5.7 mgd) and San Joaquin County (0.3 mgd).

Future Water Supply Analysis

Surface water availability varies by year type: wet, above normal, below normal, dry, and critically dry, as defined by the California Department of Water Resources. According to the analysis conducted in the 2006 WSE, the water supply for the COS MUD would consist of 72,703 af from surface water sources and 40,472 af from groundwater during a normal year with no rationing. In a critically dry year, the surface water supply would be reduced to 34,808 af due to reduced raw water deliveries to SEWD. This results in an increased groundwater extraction to 61,392 af and 15 percent rationing.

The 2006 WSE also assumed that only the first Phase of the DWSP would be implemented and the water supply delivered, less mandated curtailment to protect fish migration through San Joaquin River, would be 32,308 af regardless of the water year type. Although the curtailment schedule prohibits the DWSP diversions at the intake during spring season, the City has recently executed a water purchase agreement with the Woodbridge Irrigation District. This agreement has secured 6,500 acre-feet of Mokelumne River water for Municipal and Industrial use in the City of Stockton for a period of 40 years beginning in 2009. This water will be conveyed to the future DWSP WTP for treatment and pumping to the City's water distribution system.

Based on this water purchase agreement, COS MUD staff have directed WYA to assume that sufficient supplies would be provided to the DWSP WTP, so that it can operate all year long.

Future Water Supplies by Purveyor

Master planning of water infrastructure requires assumptions about sources of supply. For instance, large diameter transmission mains are needed to move water from the water treatment plants to the areas of use. Additionally, sizing and layout of water system infrastructure is controlled by maximum day and peak hour demands, rather than average annual demands.

The 2006 WSE indicated that the maximum month water supplies for the COS MUD consist of 30.9 mgd from SEWD and 24.3 mgd from DWSP, which includes supply for San Joaquin County. The remaining demands would be met with groundwater. However, the 2006 WSE water supply assumptions have been modified due to CWSC's increased participation in the DWSP.

During the meeting with the COS MUD staff on November 9, 2006, it was decided that these supplies should be allocated to South Stockton and North Stockton Service Areas. The South Stockton Service Area was assumed to receive first priority on the COS MUD's portion of SEWD water, because future development of groundwater wells is limited by saltwater intrusion and industrial contamination in that part of the City. All service areas were assumed to use groundwater, in proportion to their urbanized areas.

Assumptions for allocation of water supplies, as determined during the meeting with the COS MUD staff on November 9, 2006, are given below for maximum day demands and peak hour demands:

- *Maximum Day & Peak Hour Demands for South Stockton:* It was assumed that the COS MUD would use 100 percent of its allocation of SEWD WTP capacity to meet maximum day demands. Groundwater would be used to make up any difference that could not be met with the SEWD WTP capacity. Rationing would apply during any dry years. During peak hour demands, additional supply would be available from above ground storage and groundwater wells.
- *Maximum Day & Peak Hour Demands for North Stockton:* It was assumed that the COS MUD would use all COS MUD DWSP WTP capacity, and then the remaining portion of its SEWD WTP capacity, if available, to meet maximum day demands. Groundwater would be used to make up the difference. Rationing would apply during any dry years. During peak hour demands, additional supply would be available from above ground storage and groundwater wells.

Water facilities planning in this Water Master Plan Update will evaluate the ability of the COS MUD's water distribution system to meet wet and critically dry year peaking conditions.

Other Potential Sources of Water Supply

As stated previously, the sustainable water supply scenario presented in this chapter is the scenario developed and assumed in the 2006 WSE, which assumes the development of the DWSP at its initial phase (30 mgd), based on the City's current water diversion and use permit. In addition to DWSP, the City has been investigating additional water supplies through various partnerships with other San Joaquin County water agencies, joint powers authorities, and advisory boards. The City is participating in the recently initiated IRWMP, which is being sponsored by the GBA.

The IRWMP will identify regional water resources problems and solutions. A number of potential water supply solutions have been summarized in the GBA Eastern San Joaquin Groundwater Basin Groundwater Management Plan (September 2004) and the Mokelumne River Water and Power Authority document titled Mokelumne River Regional Water Storage and Conjunctive Use Project, Phase 1-Reconnaissance Study, May 2004. The IRWMP will prioritize these projects into a preferred program of actions, which will correct the groundwater overdraft in Eastern San Joaquin County, and its undesirable side effects.

SUMMARY OF WATER SUPPLY ASSUMPTIONS

The existing water supplies for the COS MUD consist of surface water purchased from the SEWD and groundwater pumped from the local groundwater basin. Per the 2006 WSE, this Water Master Plan Update assumes the following:

- The COS MUD will construct the DWSP WTP with a capacity of 30.0 mgd
- The COS MUD's portion of the DWSP WTP capacity will be 19.7 mgd
- San Joaquin County's portion of the DWSP WTP capacity will be 0.3 mgd
- CWSC's portion of the DWSP WTP capacity will be 10.0 mgd
- The COS MUD will help expand the SEWD WTP capacity to 60 mgd

- The COS MUD's portion of the SEWD WTP capacity will be 29.1 mgd
- San Joaquin County's portion of the SEWD WTP capacity will be 1.8 mgd
- CWSC's portion of the SEWD WTP capacity will be 29.1 mgd

Annual supply and demand is discussed and evaluated in the 2006 WSE.

In a meeting with the COS MUD Staff on November 9, 2006, additional assumptions were made regarding the allocation of surface water treatment capacity between the COS MUD's North and South Stockton Service Areas. These assumptions included:

- South Stockton has priority on all of the COS MUD's surface water treatment capacity from the SEWD WTP
- Both North and South Stockton will use all available surface water treatment capacity before using groundwater
- Groundwater will be used to make up reductions in surface water supply during dry years
- Peak hour demands will be met with above ground storage, treated surface water, and groundwater

REFERENCES

[1] Montgomery Watson Harza, 2006. Water Supply Evaluation for the General Plan Update Preferred Alternative. December 30, 2005. Amended May 12, 2006.

[2] Montgomery Watson Harza, 2006. Water Supply Evaluation for the General Plan Update Preferred Alternative. December 30, 2005. Amended May 12, 2006.

[3] Montgomery Watson Harza, 2006. Water Supply Evaluation for the General Plan Update Preferred Alternative. December 30, 2005. Amended May 12, 2006.

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[5] Montgomery Watson Harza, 2006. Water Supply Evaluation for the General Plan Update Preferred Alternative. December 30, 2005. Amended May 12, 2006.

[6] San Joaquin County, Eastern San Joaquin Groundwater Basin Groundwater Management Plan, September 2004

[7] San Joaquin County, Eastern San Joaquin Groundwater Basin Groundwater Management Plan, September 2004

[8] San Joaquin County, Eastern San Joaquin Groundwater Basin Groundwater Management Plan, September 2004

[9] Montgomery Watson Harza, 2006. Water Supply Evaluation for the General Plan Update Preferred Alternative. December 30, 2005. Amended May 12, 2006.

[10] Montgomery Watson Harza, 2006. Water Supply Evaluation for the General Plan Update Preferred Alternative. December 30, 2005. Amended May 12, 2006.

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[20] Montgomery Watson Harza, 2006. Water Supply Evaluation for the General Plan Update Preferred Alternative. December 30, 2005. Amended May 12, 2006.

[21] Montgomery Watson Harza, 2006. Water Supply Evaluation for the General Plan Update Preferred Alternative. December 30, 2005. Amended May 12, 2006.

[22] Montgomery Watson Harza, 2006. Water Supply Evaluation for the General Plan Update Preferred Alternative. December 30, 2005. Amended May 12, 2006.

[23] Montgomery Watson Harza, 2006. Water Supply Evaluation for the General Plan Update Preferred Alternative. December 30, 2005. Amended May 12, 2006.

CHAPTER 5. DESIGN/SYSTEM PERFORMANCE CRITERIA

The purpose of this chapter is to define the planning and design criteria for the performance of the COS MUD's water distribution system. These criteria include fire flow and duration, definition of high demand periods, pumping and storage capacity requirements, the desired minimum and maximum pressures, and the desired maximum velocity and head loss. The following sections of this chapter present these criteria:

- Fire Flow Requirements
- Water Supply Capacity
- Pumping Facility Capacity
- Water Storage Capacity
- Water Transmission and Distribution Pipeline Sizing

These criteria are summarized in Table 5-1, and reflect typical water system industry standards, including the California Safe Drinking Water Act and American Water Works Association standards.

FIRE FLOW REQUIREMENTS

The COS MUD is a water purveyor for a portion of the City, but the City's Fire Department (Fire Department) is also concerned with the availability of adequate water supply during fires. The COS MUD is responsible for supply and distribution; whereas, the Fire Department establishes minimum water flows required for fire fighting purposes.

The Fire Department uses the Uniform/California Fire Code (UFC/CFC) Table A-III-A-1 *Minimum Required Fire Flow and Flow Duration for Buildings* to assist them in establishing minimum fire flows and durations. The Stockton Municipal Code (Chapter 4 – Public Safety Code Division 1-Uniform Fire Code, Amended by Ordinance 007-03 C. S. Effective March 20, 2003), specifies the following additional requirements with respect to automatic sprinkler systems:

- <u>New Construction:</u> An approved automatic fire sprinkler system is required in all new buildings and structures constructed on or after the effective date of this ordinance, notwithstanding the use and occupancy thereof, when the total floor area exceeds six thousand (6,000) square feet. For the provisions of this section, area separation walls shall not apply to eliminate the installation of a sprinkler system.

  EXCEPTION: Buildings and structures classified as Group R Division III and Group U Occupancies.

Table 5-1. City of Stockton Municipal Utility Department's Planning and Design Criteria

Component	Criteria	Remarks / Issues
PERFORMANCE CRITERIA FOR PLANNING & DESIGN		
Fire Flow Requirements (flow [gpm] @ duration [hours])		
Single-Family Residential	2,000 gpm @ 2 hrs	Fire flows based on new development requirements. Existing development will be evaluated on a case by case basis, because of the historical varying standard.
Multi-Family Residential	3,000 gpm @ 3 hrs	
Commercial	2,500 gpm @ 4 hrs (with approved automatic sprinkler system)	
Institutional (schools, hospitals, etc.)	4,500 gpm @ 4 hrs (with approved automatic sprinkler system)	
Industrial / Business Park	4,500 gpm @ 4 hrs (with approved automatic sprinkler system)	
Water Supply Capacity		
Maximum Day Demand Plus Fire Flow	Provide capacity equal to maximum day demand plus fire flow	
Peak Hour Demand	Provide capacity to equal peak hour demand	
Pumping Facility Capacity		
Booster Pump Capacity	Equal to the maximum day demand plus fire flow or peak hour (whichever is larger) w/ the largest pump out of service.	Design for peak hour.
Backup Power	Equal to the maximum day or equal to maximum day demand plus fire flow, when fire storage is not located near service area.	On-site generator for large stations. Plug in portable for smaller stations. If wells are being counted on to provide emergency storage, onsite generator is required.
Water Storage and System Peaking Capacity		
Operational	25 percent of maximum day demand	
Fire	Varies (see requirements listed in remarks column)	Varies depending on required fire flow duration. Highest fire flow demand in any particular area controls size of required storage. Does not include volume associated with 500 gpm sprinkler flow. 2,000 gpm @ 2 hrs = 0.24 MG 2,500 gpm @ 4 hrs = 0.48 MG 3,000 gpm @ 3 hrs = 0.54 MG 4,500 gpm @ 4 hrs = 0.96 MG
Emergency	Average day demand	Based on DPH recommendations.
Groundwater Credit	60% of Reliable Pumping Capacity	Only includes those wells with backup power.
Redundant Water Treatment Plant Credit	19.7 MG	Based on COS MUD's portion of the DWSP, or 19.7 mgd for one day.
Total Water Storage Capacity	Operational + Fire + Emergency - GW Credit - Redundant Plant Credit	
Water Transmission Line Sizing		
Diameter	18-inches in diameter or larger	Criteria based on requirements for new development, existing transmissions mains will be evaluated on case-by-case basis. Evaluation will include age, material type, velocity, head loss, and pressure.
Average Day Demand Condition		
Minimum Pressure [psi]	45 psi	
Maximum Pressure [psi]	80 psi	
Maximum Head Loss [ft/kft]	1.5 to 2 ft/kft	
Maximum Velocity [ft/sec]	3 fps	
Maximum Day Demand Condition		
Minimum Pressure [psi]	45 psi	
Maximum Head Loss [ft/kft]	3 ft/kft	
Maximum Velocity [ft/sec]	5 fps	
Peak Hour Demand Condition		
Minimum Pressure [psi]	45 psi	
Maximum Head Loss [ft/kft]	3 ft/kft	
Maximum Velocity [ft/sec]	5 fps	
Hazen Williams "C" Factor	130	For consistency in hydraulic modeling.
Pipeline Material	Ductile Iron, Concrete Cylinder or Steel	
Water Distribution Line Sizing		
Diameter	Less than 18-inches in diameter	Must verify pipeline size with max day and fire flow analysis.
Maximum Day w/ Fire Flow Demand Condition		Criteria based on requirements for new development, existing distribution mains will be evaluated on case-by-case basis. Evaluation will include age, material type, velocity, head loss, and pressure.
Minimum Pressure [psi] (at fire node)	20 psi	
Maximum Head Loss [ft/kft]	10 ft/kft	
Maximum Velocity [ft/sec]	10 fps	
Peak Hour Demand Condition		
Minimum Pressure [psi]	45 psi	
Maximum Head Loss [ft/kft]	7 ft/kft	
Maximum Velocity [ft/sec]	7 fps	
Minimum Pipeline Sizes		
Low Density Residential	12" [sq mi grid], 8" [1/4 mi grid], 6" [other]	
Commercial	8" + 12" [sq mi grid]	
Industrial	12"	
Distribution to cul-de-sac / dead end street	8-inch	
Distribution to fire hydrants	8-inch	
Hazen Williams "C" Factor	130 (PVC)	For consistency in hydraulic modeling.
Pipeline Material	PVC	
OTHER CRITERIA		
Maximum Number of residential lots that can be served by a non-looped water pipeline	25 lots	If a non-looped water line goes out-of-service, all associated residences lose water service.

The recommended fire flow requirements based on land use type, presented in Table 5-2, integrate consideration of these requirements.

The criteria, as presented above, will be used for the evaluation of the existing and future water system. Minimum fire flows were assumed to be met concurrently with a maximum day demand condition, while maintaining a minimum residual system pressure of 20 pounds per square inch (psi). Additionally, as described below, fire flows and the expected duration are also used to establish treated water storage requirements.

WATER SUPPLY CAPACITY

Maximum day demand plus fire flow and peak hour demand should be used to assess the adequacy of the COS MUD's water supply during high demand periods. Each is discussed in more detail.

Maximum Day Demand plus Fire Flow

In accordance with typical industry standards, the COS MUD's water supply and distribution system should have the capability to meet a system demand condition equal to the occurrence of a maximum day demand condition concurrent with a fire flow event. Furthermore, the analysis of specific fire flow evaluations will be conducted assuming the largest booster pump is offline (i.e., firm capacity of the pump station). This ensures the reliability of these systems to provide sufficient flow during emergency fire flow conditions. For future system improvement analyses, pump stations with only one booster pump, or without back-up power capability (either an onsite generator or adaptor for a plug-in generator), will not be considered to be reliable during fire flow analysis.

For planning purposes, it is assumed that the maximum day plus fire flow demand condition will consist of a single fire flow event.

Peak Hour Demand

Peak hour demand should be met from a combination of supply sources and treated water storage reservoirs.

PUMPING FACILITY CAPACITY

Sufficient water system pumping capacity should be provided to meet the greater of a fire flow concurrent with the maximum day demand or peak hour demand (unless peak hour is met with gravity storage), with the largest pump at the pump station in stand-by mode. This maximum supply requirement sets the pumping capacity requirement.

All pumping facilities should also be equipped with an on-site, back-up power generator or a plug-in adapter to allow interconnection to a portable generator, which will be brought to the site by City staff during a prolonged power outage.

Table 5-2. Recommended Fire Flow Requirements[a,b]

Designation	Non-Sprinklered			Sprinklered[c,d]		
	Fire Flow, gpm	Duration, hours	Recommended Storage, MG	Fire Flow, gpm	Duration, hours	Recommended Storage, MG[j]
Single-Family Residential[e]	2,000	2	0.24	--	--	--
Multi-Family Residential[f]	3,000	3	0.54	--	--	--
Commercial[g]	4,000	4	0.96	2,500[i]	4	0.48
Institutional[h]	8,000	4	1.92	4,500[i]	4	0.96
Industrial	8,000	4	1.92	4,500[i]	4	0.96

(a) Construction type and fire area are not generally known during the development of a master plan; consequently, fire flow requirements set forth in this table are based on previous estimates for these land use types and similar communities.

(b) Unique projects or projects with alternate materials may require higher fire flows and will be reviewed by the Fire Marshal on a case-by-case basis (e.g., proposed commercial/industrial areas and schools).

(c) The City Fire Marshal normally allows up to a 50 percent reduction in fire flows if a building is sprinklered. However, the Fire Code also requires that no fire flow be less than 1,000 gpm for single family residential or 1,500 gpm for all other building types. For a more conservative fire flow estimate, Single Family and Multiple Family buildings were considered non-sprinklered for this Water Master Plan Update.

(d) Specific fire flows were determined from Table A-III-A-1 of the 2001 CFC, and depend on construction type and fire area. These fire flow requirements are based on buildings being fully sprinklered.

(e) Single Family includes Residential Estate and Low Density Residential.

(f) Multiple Family includes Medium and High Density Residential.

(g) Commercial includes Commercial and Administrative Professional.

(h) Institutional includes Schools, Hospitals, or other governmental buildings.

(i) Fire flow includes a 500 gpm demand for on-site sprinkler flow.

(j) Recommended storage volumes do not include volume associated with 500 gpm sprinkler flow.

The fire flow should be supplied with a National Fire Protection Association (NFPA) rated fire pump that is natural gas engine driven. If an NFPA rated fire pump is not used, then a pump(s) and motor(s) combination with a backup power source of sufficient capacity to meet the required maximum fire flow and pressure requirements, as determined by the Fire Department's Fire Marshal, will be required.

WATER STORAGE CAPACITY

The total treated water storage and system peaking capacity requirements will be evaluated based on Operational Storage, Fire Storage, and Emergency Storage requirements, along with credits for existing groundwater supplies and redundant surface water treatment plants. Each is discussed below.

Operational Storage

Over any 24-hour period, water demands will vary. Typically, higher water demands will occur during the early morning hours when people are irrigating landscape and getting ready to go to work and school. Water demands will then decline to some nominal baseline level (depending on the proximity to and water use patterns of adjacent commercial/industrial areas), and will then begin to increase again depending on outside water needs (and corresponding temperature), until it reaches a higher water demand in the early evening hours as people return home from work. Throughout the year, the peaks of this cycle will vary according to customer needs; thereby, creating a maximum day and peak hour demand.

Typically, water treatment plants are operated at a constant rate over a 24-hour period (baseline), augmented by flow from storage tanks during higher daily demand periods. The tanks are normally refilled when demands drop below the baseline water production flow rate. The storage volume used to meet these peak demand periods is called operational storage.

The operational storage requirements will be calculated based on the diurnal demand in a pressure zone or service area. If sufficient data is not available to develop a diurnal demand, then the recommended volume of water to be held in reserve for operational storage should be at least equal to 25 percent of the total volume of water used on a maximum day.

Fire Storage

Fire fighting flow requirements are identified in the Insurance Service Office, Inc. (ISO) guidelines and UFC. These requirements are based on flow (in gpm) for the building use type (*i.e.* commercial, residential, school, industrial *etc*.), size of building (in square feet), and type of construction (wood frame, metal, masonry, installation of sprinklers, *etc*.). After a fire flow requirement is established, it is multiplied by the required fire fighting duration to produce an estimate of the total volume of fire flow required. Table 5-2 presents the recommended fire flow criteria.

The highest ISO recommended fire flow requirement in the City (see Table 5-2) is 4,500 gpm for four hours for industrial areas (if sprinklered). The resulting volume needed for fire flow storage is 0.96 MG. The resulting fire flow volume determined for the City, where feasible, should be stored in reservoirs located within the closest service area.

Emergency Storage

A reserve of stored water is also required to meet demands during an emergency. An emergency is defined as an unforeseen or unplanned event that may degrade the quality or quantity of potable water supplies available to serve customers. There are three types of emergency events that a water utility typically prepares for:

- Minor emergency. A fairly routine, normal, or localized event that affects few customers, such as a pipeline break, malfunctioning valve, hydrant break, or a brief power loss. Utilities plan for minor emergencies and typically have staff and materials available to correct them.
- Major emergency. A disaster that affects an entire, and/or large, portion of a water system, lowers the quality and quantity of the water, or places the health and safety of a community at risk. Examples include water treatment plant failures, raw water contamination or major power grid outages. Water utilities infrequently experience major emergencies.
- Natural disaster. A disaster caused by natural forces or events that create water utility emergencies. Examples include earthquakes, forest or brush fires, hurricanes, tornados or high winds, floods, and other severe weather conditions such as freezing or drought.

Determination of the volume of emergency storage is a policy decision based on the assessment of the risk of failures and the desired degree of system reliability. The amount of required emergency storage is a function of several factors including the diversity of the supply sources, redundancy and reliability of the production facilities, and the anticipated length of the emergency outage. In general, a vulnerability analysis, as described in the American Water Works Association (AWWA) Manual M19, *Emergency Planning for Water Utility Management*, should be used to identify the emergency storage requirements. However, because a vulnerability analysis was not completed as a part of this Water Master Plan Update, typical industry standards were used and the recommended criteria and assumptions are described in the following paragraphs.

The treated water emergency supply requirements, as published by the DPH in Title 22 Chapter 16, call for a minimum emergency supply in each pressure zone equivalent to the average day demand. However, the AWWA guidelines call for a more conservative assumption that is equal to twice the average day demand in summer months plus fire flows.

For this Water Master Plan Update, it has been assumed that the emergency storage requirement will be based on minor emergencies and *specific* major emergency criteria. It is recommended that the COS MUD use DPH's suggested guideline of having a minimum quantity of emergency storage volume equivalent to the COS MUD's average day demand.

Credits for Existing Groundwater Supply

Because of the COS MUD's available wells, groundwater storage can account for a portion of the recommended water storage and system peaking capacity. The following must be true to use the groundwater supply to offset the need to provide surface storage:

- The groundwater supply is of potable water quality and can be reliably accessed (wells are equipped with onsite emergency generators);
- The water extracted is not already being relied upon to meet the COS MUD's average day demand requirements; and
- Sufficient water transmission facilities are available to distribute this water to demand areas.

For planning purposes in this Water Master Plan Update, it was assumed that 60 percent of the COS MUD's reliable groundwater pumping capacity (i.e., that capacity with onsite generators) is available to supplement required storage for one day. This conservative assumption (60 percent) accounts for wells lost for reasons other than power loss (e.g., well maintenance or water quality). Criteria for backup power were specified in previous sections.

Credits for Future Redundant Treated Surface Water Supply

Because it is anticipated that COS MUD will eventually be supplied water from two surface water treatment plants, and these sources are independent of one another (Delta vs. Calaveras and Stanislaus Rivers), water treatment plant capacity can account for a portion of recommended emergency storage. For this Water Master Plan Update, it has been assumed that the smaller of the two water treatment plants, which is the COS MUD's portion of the DWSP (19.7 mgd), will be available to offset a portion of the ultimate emergency storage requirement.

Total System Storage

The COS MUD's minimum treated water storage capacity should be determined as follows:

- Operational: Volume of water necessary to meet diurnal peaks observed throughout the day, usually designed to be equivalent to at least 25 percent of the maximum day demand; plus
- Fire Flow: Volume of water necessary to provide the maximum fire flow in the service area multiplied by the duration the flow rate that must be maintained; plus
- Emergency: Volume of water necessary to provide an average day demand; minus
- Groundwater Credit: Equal to 60 percent of the groundwater well capacity for one day; minus
- Redundant Treated Surface Water Supply Credit: 19.7 mgd for one day.

The actual amount of total supply and system peaking capacity required to meet these criteria will change over time as the City continues to grow; this timing will be used in subsequent chapters to help develop the City's CIP.

WATER TRANSMISSION AND DISTRIBUTION PIPELINE SIZING

The following criteria are to be used as guidelines for new transmission and distribution pipeline sizing. The COS MUDS's existing system will be evaluated on a case–by-case basis using this criteria. For example, if an existing pipeline experiences velocities in excess of the criteria

described below during a maximum day plus fire flow event, this condition, by itself, does not necessarily indicate a problem as long as the minimum pressure criterion is satisfied.

Although these criteria and guidelines have been established, and will be used to size new pipelines, the COS MUD's existing system will be evaluated using pressure as the primary criterion and secondary criteria, such as velocity, head loss, age, and material type, will be used as indicators for where water system improvements may be needed.

Water Transmission System

Transmission pipelines are generally 18 inches in diameter or larger, and should be designed based on the criteria described below for average day, maximum day plus fire flow, and peak hour demand conditions. The criteria reflect industry standards and WYA's experience working with the COS MUD's existing water system.

Average Day Demand

- Pressures should be maintained between a maximum of 80 psi and a minimum of 45 psi.
- Maximum velocity within transmission pipelines should be 3 feet per second (fps).
- The maximum head loss within transmission pipelines should be 3 feet per thousand feet (ft/kft).

Maximum Day Demand

- The minimum allowable service pressure in the water transmission main should be 45 psi.
- The maximum velocity within the transmission system pipelines should be 5 fps.
- The maximum head loss within the transmission system pipelines should be 3 ft/kft.

Peak Hour Demand

- The minimum residual pressure during a peak hour demand should be 45 psi.
- The maximum pipeline velocity should be 5 fps.
- The maximum pipeline head loss should be 3 ft/kft.

Water Distribution System

Distribution pipelines are generally less than 18 inches in diameter, and should be sized based on the criteria described below for maximum day plus fire flow, and peak hour demand conditions. The criteria reflect industry standards and WYA's experience working with the COS MUD's existing water system.

Maximum Day Demand plus Fire Flow

- The minimum allowable service pressure should be 20 psi at the flowing fire hydrant.
- The maximum velocity within the distribution system pipelines should be 10 fps.
- The maximum head loss within the distribution system pipelines should be 10 ft/kft.

Peak Hour Demand

- The minimum residual pressure during a peak hour demand should be 45 psi.
- The maximum pipeline velocity should be 7 fps.
- The maximum pipeline head loss should be 7 ft/kft.

CHAPTER 6. HYDRAULIC MODEL UPDATE AND DEVELOPMENT

This chapter describes the update, refinement, and dynamic calibration of the COS MUD's existing water distribution system hydraulic model.

To refine and enhance the COS MUD's existing hydraulic network model, WYA completed the following steps:

- Used the City's existing water distribution system maps (exported from the City's GIS) to update the existing hydraulic model;
- Incorporated new facilities that were constructed and operating as of January 2006;
- Verified that the existing (up to 2006) hydraulic model system configuration (pipeline sizes, alignments, connections, and other facility sizes and locations) is representative of the COS MUD's current water system;
- Allocated existing water demands by using the COS MUD's water meter information to properly distribute demands within the hydraulic model; and
- Dynamically calibrated the COS MUD's water system hydraulic model to simulate pressures, levels and flows observed in the field and recorded on the City's Supervisory Control and Data Acquisition (SCADA) system.

To accomplish these tasks, WYA worked closely with the COS MUD staff to obtain and review:

- Available information regarding new transmission mains, reservoirs, treatment facilities, and other water facilities;
- As-built drawings and maps detailing older and newer sections and facilities of the water system to confirm pipeline sizes, material type, age, locations and alignments, and general facility configuration; and
- Available water meter data.

The water distribution model was then dynamically calibrated using pressure and flow data observed in the field in September 2006. The model update and dynamic calibration is described below.

UPDATE AND REFINEMENT OF THE HYDRAULIC MODEL

WYA updated the hydraulic model of the COS MUD's water system using a series of steps that included the following:

- Model Pipeline Configuration Update;
- Roughness Factors Assigned in H_2ONET;
- Water Use Accounts Spatially Located in GIS;

- Water Demands Allocated in H_2OMAP;
- Elevations Allocated for New Areas in H_2OMAP; and
- Naming Scheme Used in H_2ONET.

Each of these steps is discussed in more detail below.

Model Pipeline Configuration Update

The COS MUD's computerized hydraulic model was originally developed in 1999 using the H_2ONET software. This computerized hydraulic model was completed in 1999 (1999 Model) and was not dynamically calibrated. Since the completion of the 1999 Model, new service areas have continued to be constructed and developed within the City's service area. Although there have been minor updates to the hydraulic model since 1999, with the number of significant changes to the service area and advancements in hydraulic modeling, an updated model was required. As part of this model update, WYA was asked to dynamically calibrate the 1999 Model and to ultimately develop an Extended Period Simulation (EPS) model for the COS MUD to use as a planning tool.

WYA compared the latest hydraulic model with the GIS geodatabase file provided by the COS MUD staff. Figures 6-1 and 6-2 show the new service areas which were not included in the COS MUD's hydraulic model. These new service areas were added into the existing (2007) model. WYA also verified and updated pipeline configurations of the existing model to be consistent with the City's GIS geodatabase file.

Roughness Factors Assigned in H_2ONET

The 1999 Model had roughness factors (C-factors) assigned for the existing pipelines. However, since the City's GIS geodatabase and existing water system map books do not list material type and/or age for the recently constructed pipelines (after 1999), WYA had to assume a global C-factor of 130. In addition, for any future pipelines added to the hydraulic model, WYA assigned a preliminary C-factor of 130. These C-factors were then validated during verification of the hydraulic model.

Water Use Accounts Spatially Located in GIS

The COS MUD provided WYA with a database file (waterconsumption.MDB) containing water use account data by address (including the zip code) for each month of 2005. Two separate methods were used to spatially locate the water use account data: linking addresses to a GIS parcel shapefile, and then geocoding any remaining data using a special GIS street file map. City staff provided an Assessors Parcel Number (APN) parcel shapefile and a APN-Address table containing APNs and their corresponding parcel addresses. First, the parcel addresses were linked to the APN parcel shapefile by APN using the APN-Address table. Then the water use account data was spatially linked to the APN parcel shapefile by address. Figure 6-3 illustrates the methodology used to link the addresses associated with the water use account data to the addresses in the GIS parcel shapefile.

Using these two methodologies, WYA was able to spatially locate 99 percent (43,742 out of 43,820 accounts) of the total number of accounts present in the water use account data provided by the COS MUD staff. This represented approximately 98 percent of the total "metered" water demand within the COS MUD.

The remaining accounts, not spatially located in the COS MUD, were either irrigation meters located in areas that did not have an address, construction meters without proper addresses, or located in new developments whose streets were not yet available in the GIS parcel shapefile or street file. Table 6-1 presents the percentage of total accounts and metered demand spatially located for the COS MUD.

Figure 6-3. Illustration of Methodology for Locating Accounts Using a Parcel File

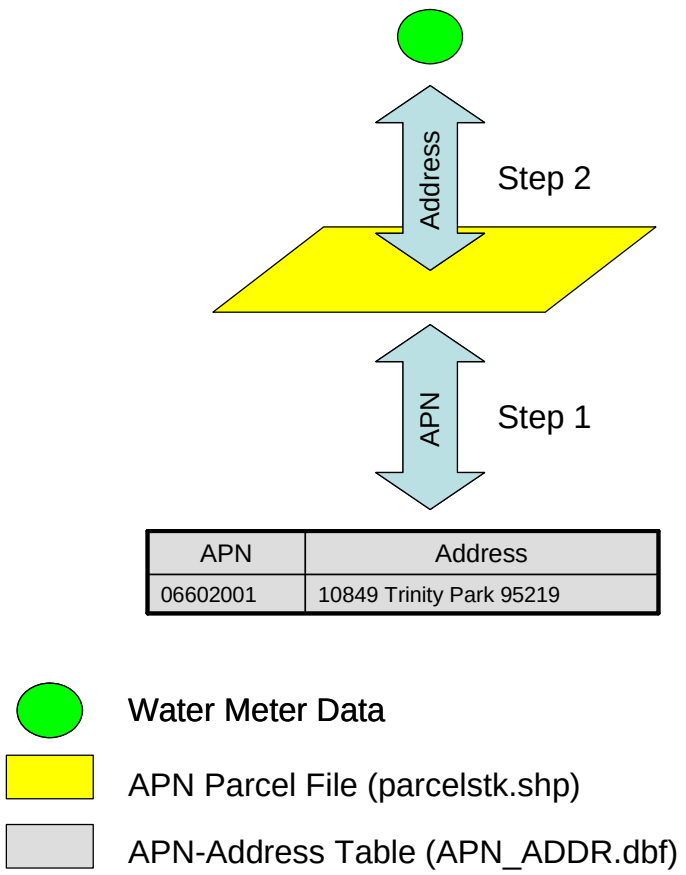


Table 6-1. Spatially Located Accounts for the COS MUD

Category	Number of Accounts	Total "Metered" Demand, afa	Average Day Demand, gpm
Actual[(a)]	43,820	32,973	20,441
Spatially Located using parcelstk.shp File[(b)]	*43,455*	*31,310*	*19,410*
Spatially Located by Geocoding	*287*	*1,135*	*704*
Spatially Located Total[(c)]	43,742	32,445	20,114[(d)]
Percent of Actual	99%	98%	98%

(a) Data obtained from "waterconsumption.MDB" provided by the City in September 2006, and does not include unaccounted-for water.
(b) Provided by the City.
(c) Based on WYA's GIS.
(d) After the deduction of the Walnut Plant demands (345 gpm), the 2005 average day demand of 19,769 gpm was allocated into the hydraulic model.

Figure 6-4 compares the spatially located water demand data with existing pipelines imported into H_2ONET for the City. As shown on Figure 6-4, all areas with spatially located accounts also had an existing pipeline, indicating that the GIS data used as the basis for the hydraulic model appears to have contained all existing pipelines.

Water Demands Allocated in H_2OMAP

For the COS MUD's water system, water demands were allocated into the hydraulic model using the spatially located water demand data developed in the previous section and the Demand Allocation/Pro module of H_2OMAP (Allocation Module). The Allocation Module automatically assigned the spatially located demand point to the pipeline closest to its position in the system.

Additionally, WYA was able to allocate water demands within the hydraulic model by land use designation, providing the COS MUD additional flexibility in the model. Table 6-2 presents the demand column assigned to each land use designation within the hydraulic model.

Table 6-2. Land Use Designation Assignment

Land Use Description[(a)]	Demand Column in Model[(b)]
Low Density Residential	1
Medium Density Residential	2
High Density Residential	3
Administrative Professional	4
Commercial	5
Industrial	6
Institutional	7
Mixed Use	8
Parks & Recreation	9
Large User[(c)]/Village[(d)]/Residential Estate[(e)]	10

(a) Data obtained from "Stockton_2035PrefAlt.shp" provided by the City in September 2006.
(b) Column number corresponds to Demand # Column in Junction database in the H_2ONET Model.
(c) Designation reserved for parcels with water use greater than 20 gpm.
(d) Designation reserved for parcels with Village land use in future demand allocation.
(e) Designation reserved for parcels with Residential Estate land use in future demand allocation.

Elevations Allocated for New Areas in H_2OMAP

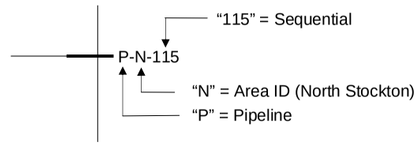
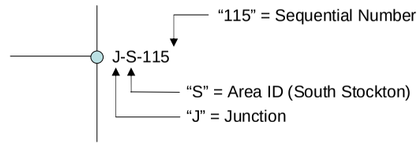
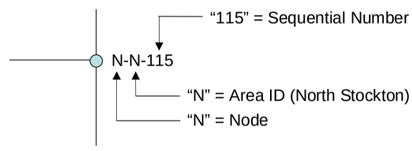
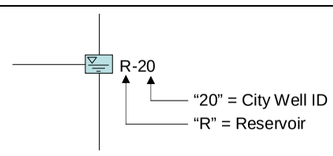
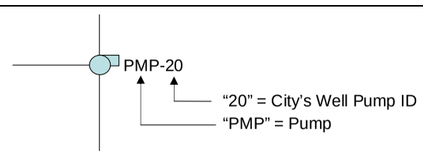
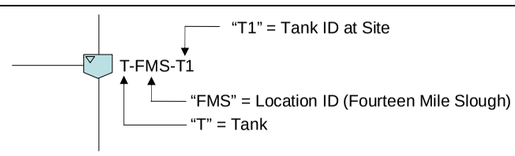
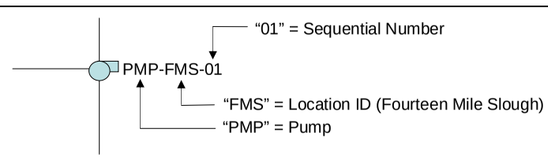
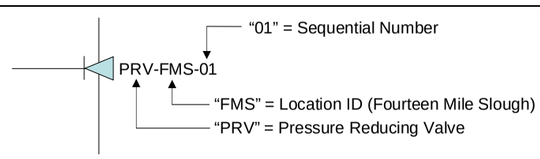
Digital topology information for the City was extracted as a GIS shapefile using TopoDepot®, a software program WYA uses to determine elevations for assignment in the hydraulic model. This shapefile was then used to assign elevation to new nodes, within the new service areas, in the updated model using H_2OMAP's Smart Topology feature.

Naming Scheme Used in H_2ONET

Once the model was updated and new facilities incorporated into the model, each model element was given a label which was then used to identify the type of model element, the element's purpose, and the element's location. Assigning each model element a specific label allows the modeler to easily locate specific elements or more readily identify potential problems during the verification process.

Based on WYA's experience and discussion with the COS MUD staff, the model was populated using the naming scheme presented in Table 6-3. As shown in Table 6-3, the naming scheme utilized the COS MUD's existing labeling scheme for the water system.

Table 6-3. Naming Scheme for Network Elements

Model Component	Naming Scheme
Pipelines	
Junctions	
Nodes	
Wells (Reservoir)	
Well Pumps	
Tanks	
Booster Pumps	
Control Valves	

DIURNAL CURVE DEVELOPMENT FOR DYNAMIC CALIBRATION

The COS MUD staff provided WYA with SCADA data in electronic format, on flows, tank levels and pump discharge pressures for most of the City's facilities during the period from September 22 to October 12, 2006. According to the COS MUD staff, SCADA data was not available from October 1 to October 7, 2006, because the system was out of service.

To add the time variable to the COS MUD's water system model and create a true EPS model to compare to the collected SCADA data, WYA developed realistic diurnal patterns for each of the COS MUD's North and South Stockton Service Areas. To create these diurnal patterns, hourly production data from all of the COS MUD's pump stations, wells, and tanks were summed using individual SCADA flow recordings. In addition, hourly flows from the SEWD WTP were also incorporated. Data was read from each of the electronic SCADA files during a 48-consecutive hour period for the North and South Stockton Service Areas as indicated in Table 6-4. The resulting diurnal patterns are discussed in the following section. By using these patterns, the model can more accurately represent fluctuations in demand over the indicated time period.

Table 6-4. Demand Diurnal Time Period

Service Area	Diurnal Pattern Time Period
North Stockton Service Area	September 25 to September 26, 2006
South Stockton Service Area	September 25 to September 26, 2006

In order to develop these patterns, certain assumptions were required. The tanks at each station in the North Stockton Service Area were combined and modeled as one tank. The tanks' water level data at each station were averaged to obtain a single combined water level for the modeled tank. In addition, it was assumed that as the water level in the tank declined, the booster pump(s) provided flow into the distribution system. This assumption was made due to lack of flow data at the COS MUD's booster pump stations. Table 6-5, provides a summary of the SCADA data that was available for the development of the diurnal curves. The following paragraphs provide the methodology used in the development of each diurnal curve for each service area within the COS MUD's distribution system.

<u>North Stockton Service Area</u>

The North Stockton Service Area is supplied water predominately from existing groundwater wells. However, this service area is also served by the SEWD WTP through the North Stockton Aqueduct. The following is a summary of the facilities that supply water to the North Stockton Service Area.

- SEWD WTP

Table 6-5. Available SCADA Information from the COS MUD Stations

Station	Facility	Service Area	SCADA		
			Discharge Pressure	Level	Flow
Northwest	Tank	North Stockton		✓	✓[a]
Northwest	Booster Pumps	North Stockton	✓		
Fourteen Mile Slough	Tank	North Stockton		✓	✓[a]
Fourteen Mile Slough	Booster Pumps	North Stockton	✓		
Well 1	Well	North Stockton	✓		✓
Well 4	Well	North Stockton	✓		✓
Well 5	Well	North Stockton	✓		✓
Well 7	Well	North Stockton	✓		✓
Well 9	Well	North Stockton	✓		✓
Well 11	Well	North Stockton	✓		✓
Well 12	Well	North Stockton	✓		✓
Well 13	Well	North Stockton	✓		✓
Well 15	Well	North Stockton	✓		✓
Well 16	Well	North Stockton	✓		✓
Well 18	Well	North Stockton	✓		✓
Well 19	Well	North Stockton	✓		✓
Well 20	Well	North Stockton	✓		✓
Well 21	Well	North Stockton	✓		✓
Well 22	Well	North Stockton	✓		✓
Well 23	Well	North Stockton	✓		✓
Well 24	Well	North Stockton	✓		✓
Well 25	Well	North Stockton	✓		✓
Well 26	Well	North Stockton	✓		✓
Well 27	Well	North Stockton	✓		✓
Well 28	Well	North Stockton	✓		✓
Well 29	Well	North Stockton	✓		✓
Well 30	Well	North Stockton	✓		✓
Well 31	Well	North Stockton	✓		✓
Well 32	Well	North Stockton	✓		✓
North Stockton Aqueduct	SEWD WTP	North Stockton	✓		✓
Weston Ranch	Tank	South Stockton		✓	✓[a]
Weston Ranch	Booster Pumps	South Stockton	✓		
Well SS1	Well	South Stockton	✓		✓
Well SS2	Well	South Stockton	✓		✓
Well SS3	Well	South Stockton	✓		✓
Well SS4	Well	South Stockton	✓		✓
Well SS5	Well	South Stockton	✓		✓
Well SS8	Well	South Stockton	✓		✓
Well SS9	Well	South Stockton	✓		✓
South Stockton Aqueduct	SEWD WTP	South Stockton	✓		✓

[a] Represents total change in volume into and out of tank.

- Tanks:
  - FMS Tanks (2)
  - NW Tanks (2)
- Booster Pump Stations:
  - FMS (5 Pumps)
  - NW (4 Pumps)
- Groundwater Wells:
  - Well 1, Well 4, Well 5, Well 7, Well 9, Well 11, Well 12, Well 13, Well 15, Well 16, Well 18, Well 19. Well 20, Well 21, Well 22, Well 23, Well 24, Well 25, Well 26, Well 27, Well 28, Well 29, Well 30, Well 31, and Well 32

Figure 6-5 presents the estimated diurnal (hourly flow rate) that is being assumed for the North Stockton Service Area.

South Stockton Service Area

The South Stockton Service Area is served from the South Stockton Aqueduct and existing groundwater wells. The following is a summary of the facilities that supply water to the South Stockton Service Area.

- SEWD WTP
- Tanks:
  - WR Tank (1)
- Booster Pump Station:
  - WR (4 Pumps)
- Groundwater Wells:
  - Well SS1, Well SS2, Well SS3, Well SS4, Well SS5, Well SS8, and Well SS9

Figure 6-6 presents the estimated diurnal (hourly flow rate) that is being assumed for the South Stockton Service Area.

These diurnal patterns were first normalized by dividing the hourly flows by the average day demand for each respective service area before they were integrated into the hydraulic model.

HYDRAULIC MODEL VERIFICATION

Verifying that a model replicates field conditions requires thorough knowledge of how the system performs over a wide range of operating conditions. To ensure that the hydraulic model was correctly configured and capable of producing results that are consistent with those observed in the field, a verification process was carried out. Hydrant pressure recorders (HPRs) were used to record pressures in the field. The data was then compared with model-predicted pressures at the same system locations. Other pressure points monitored by the COS MUD were also used in the

verification process. The description of the verification process, and the results, are described below.

Pressure Verification

Nineteen HPRs were placed in 19 different locations within the COS MUD's water distribution system over a 3-week period. Each HPR collected field-pressure data at a particular location for approximately three weeks (from September 22 to October 12, 2006). The locations were selected based on their proximity to the transmission mains and to extreme elevations (low and high) in each of the COS MUD's service areas. Figure 6-7 shows the locations where HPRs were installed and pressures monitored.

Following the integration of the normalized diurnal patterns into the hydraulic model, an EPS modeling run was performed, and the resulting pressures at each of the HPRs and the discharge pressures at each pump station were graphed. To verify whether the COS MUD's updated and refined hydraulic model was accurately predicting the hydraulics of the water system, flows, pressures and tank levels were compared to actual field data.

Verification Result

The COS MUD's distribution system was grouped into two service areas based on location. These service areas are North Stockton and South Stockton.

Comparisons between model-predicted and field-observed pressures, levels and flow are provided in Figures 6-8 through 6-16. Individual comparisons between model-predicted and field-observed pressures, flow and levels for each facility are provided in Appendix B.

The results of each of the service areas are further described below.

<u>North Stockton Service Area</u>

The northern portion of the COS MUD's distribution system is supplied from a combination of the SEWD WTP, groundwater wells, FMS, and the NW tanks.

The verification result in this pressure zone indicates that the model-simulated levels for FMS and NW tanks are similar to the recorded SCADA reading (see Figure 6-8). In addition, the flows and discharge pressures at the FMS and NW booster pumps also trend closely with the recorded SCADA reading.

The groundwater wells operating in the North Stockton Service Area also trend very well with the recorded SCADA readings (see Figures 6-9 through 6-11).

As illustrated in Figures 6-12 and 6-13, the simulated pressures for the pressure recorders in this service area also trend closely to the recorded field pressure readings. These results indicate that the demand in this service area is properly allocated.

South Stockton Service Area

The southern portion of the COS MUD's distribution system is supplied from a combination of the SEWD WTP, groundwater wells, and the WR tank. In order to verify the model, certain key adjustments were made in the South Stockton Service Area. These included:

- Using time controls for each station;
- Universally lowering C-factors by 10;
- Setting SEWD WTP discharge pressures to a maximum of 50 psi; and
- Adding minor losses at South Stockton Aqueduct turnouts.

The verification result in this service area indicates that the model-simulated levels for the WR tank are similar to the recorded SCADA reading (see Figure 6-14). In addition, the flows and discharge pressures at the WR booster pumps also trend closely with the recorded SCADA reading.

The groundwater wells operating in the South Stockton Service Area also trend very well with the recorded SCADA readings (see Figure 6-15).

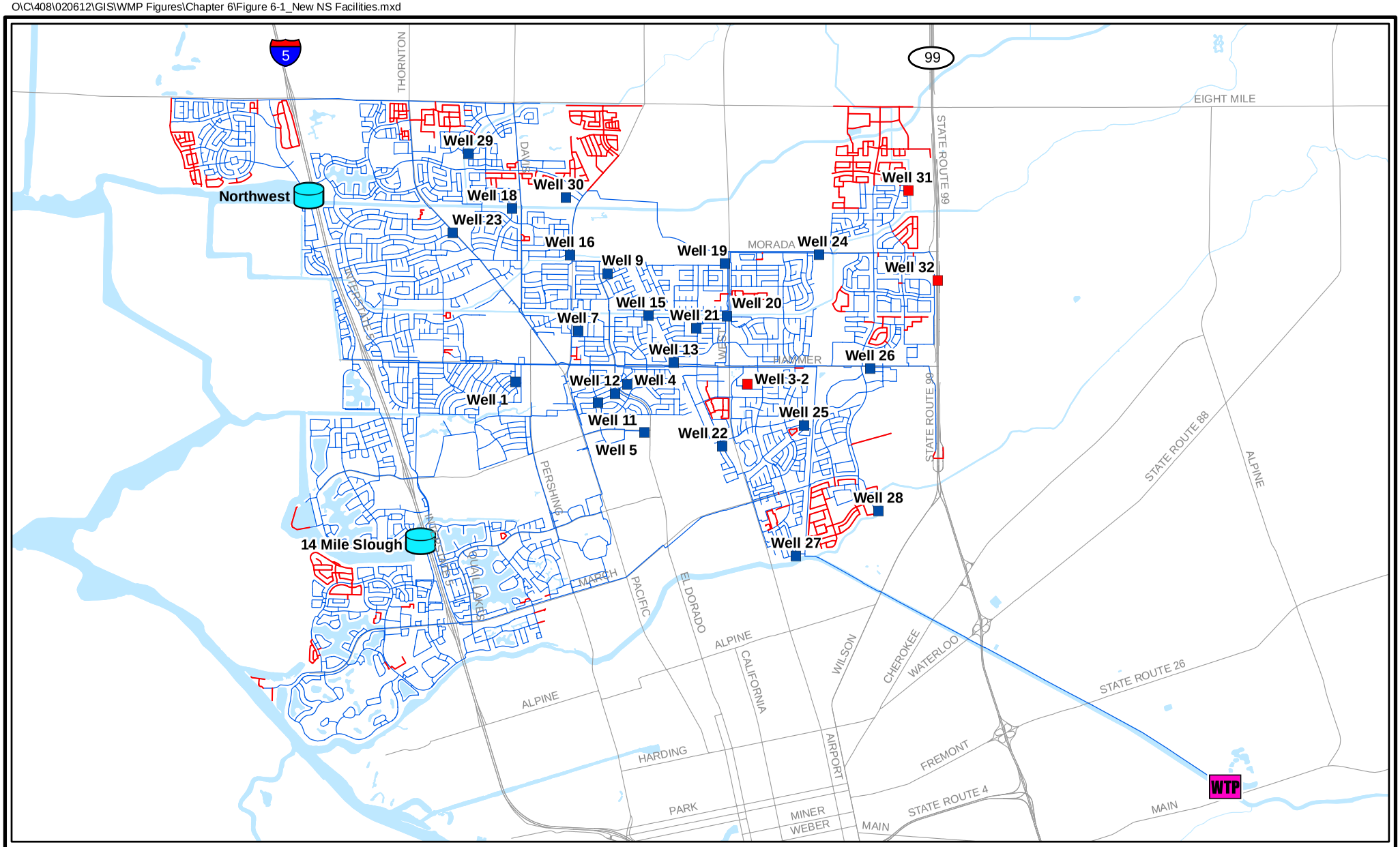
As illustrated in Figure 6-16, the simulated pressures for the pressure recorders in this service area also trend closely to the recorded field pressure readings. These results indicate that the demand in this service area is properly allocated.

Verification Findings and Conclusions

Overall, the results from the hydraulic model verification process validated the system configuration and demand allocation. Pump station flow rate comparisons at each of the COS MUD's operated facilities trended closely for both SCADA and field readings. Comparisons of HPR and model-simulated pressure data trended well. Most of the trends, though not exact, follow closely with the recorded HPR pressures. It is our recommendation that the COS MUD's continue to update/verify pipeline system configurations in the model as new facilities are constructed.

Based on the results of our verification, it can be concluded that the model provides an accurate operational representation of the COS MUD's water distribution system, and is more than adequate for use as a planning and operational tool.

O\C\408\020612\GIS\WMP Figures\Chapter 6\Figure 6-1_New NS Facilities.mxd



LEGEND:

- Existing Well
- New Well
- Existing Water Tank
- SEWD WTP
- New Model Element
- Previous Model Element
- Major Street
- Water Feature

N

0 0.5 1 2

Scale in Miles

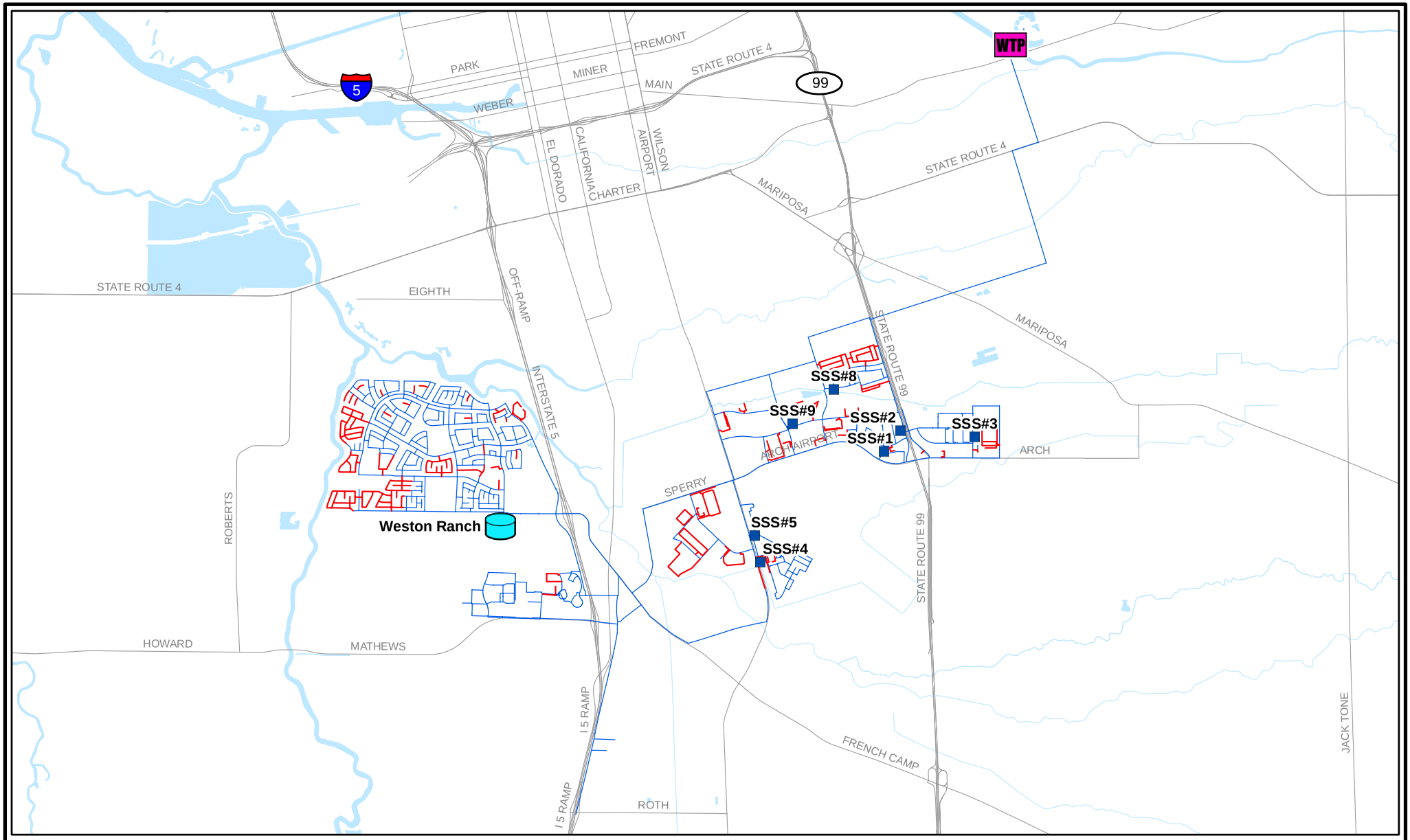
FIGURE 6-1

City of Stockton
Municipal Utilities Department
Water Master Plan Update

NEW FACILITIES IN THE NORTH STOCKTON MODEL

WEST YOST ASSOCIATES Consulting Engineers

O\C\408\020612\GIS\WMP Figures\Chapter 6\Figure 6-2_New SS Facilities.mxd



LEGEND:

- Existing Well
- Existing Water Tank
- SEWD WTP
- New Model Element
- Previous Model Element
- Major Street
- Water Feature

N

0 0.5 1 2

Scale in Miles

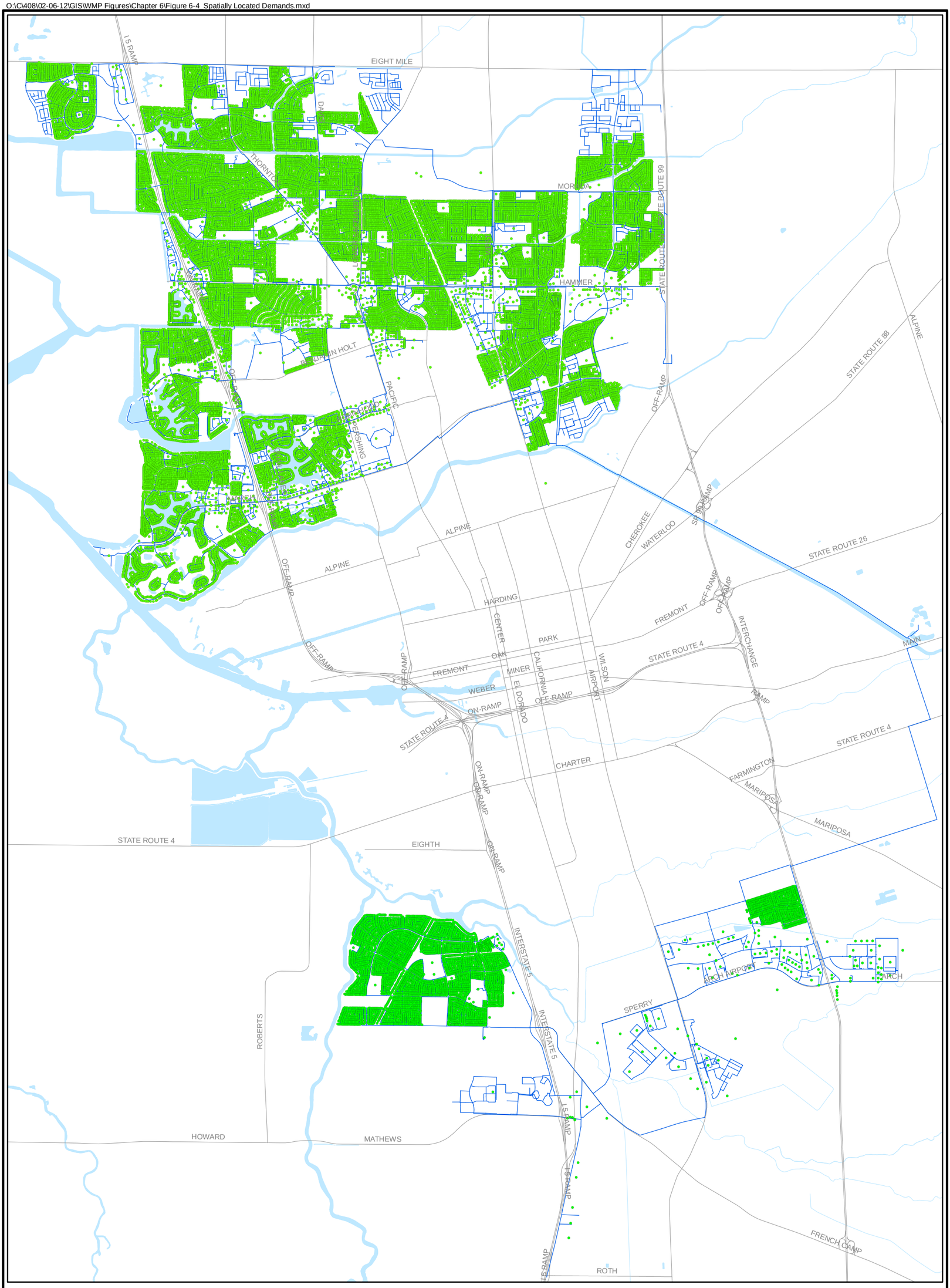
FIGURE 6-2

City of Stockton
Municipal Utilities Department
Water Master Plan Update

NEW FACILITIES IN THE SOUTH STOCKTON MODEL

WEST YOST ASSOCIATES Consulting Engineers

O:\C\408\02-06-12\GIS\WMP Figures\Chapter 6\Figure 6-4 Spatially Located Demands.mxd



LEGEND:

- Spatially Located Meter
- Pipeline
- Major Street
- Water Feature

N

0 0.3 0.6 1.2

Scale in Miles

FIGURE 6-4

City of Stockton
Municipal Utilities Department
Water Master Plan Update

SPATIALLY LOCATED DEMANDS

WEST YOST ASSOCIATES
Consulting Engineers

Figure 6-5. North Stockton Diurnal Demand Pattern
9/25/06 to 9/26/06

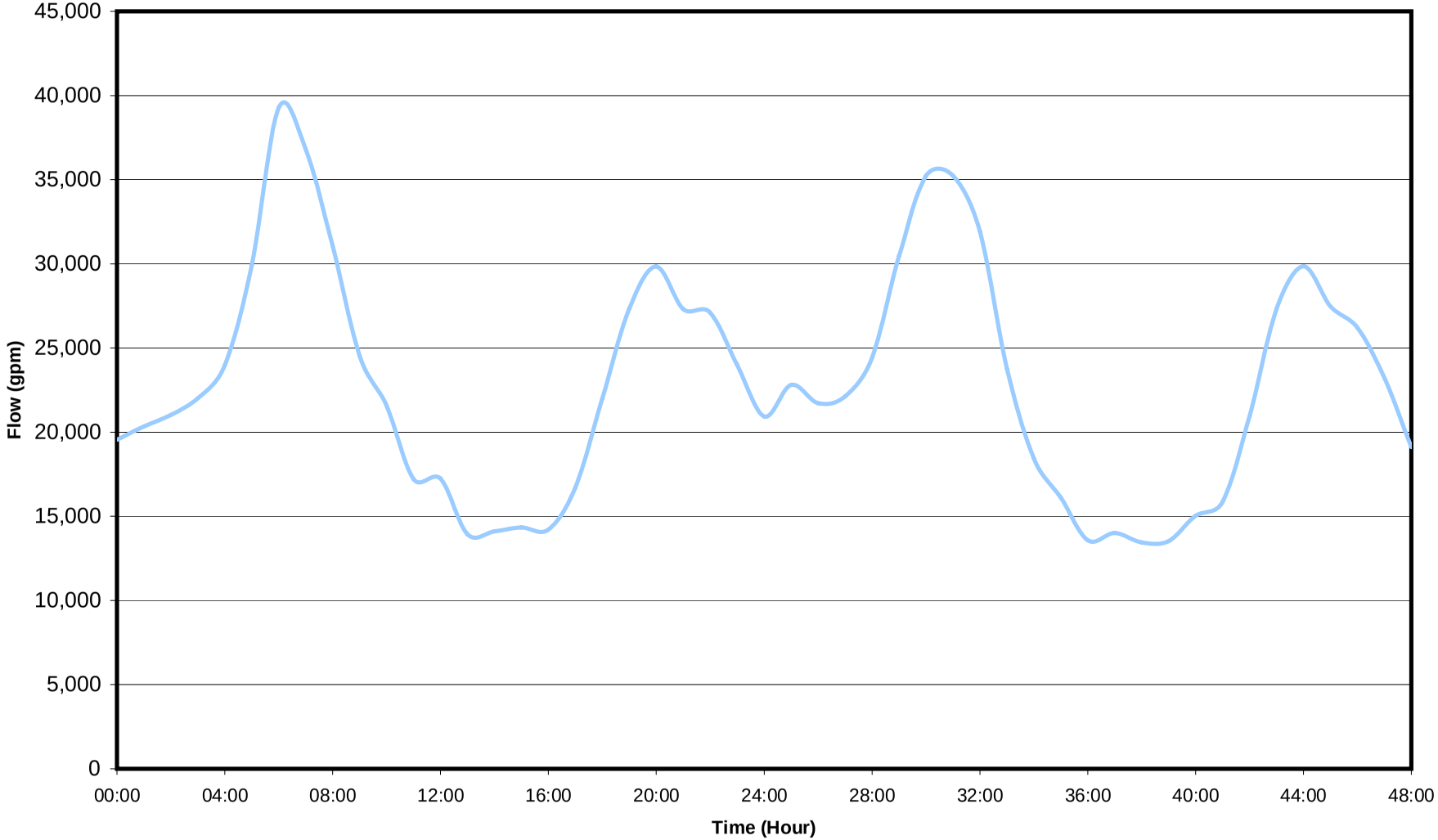
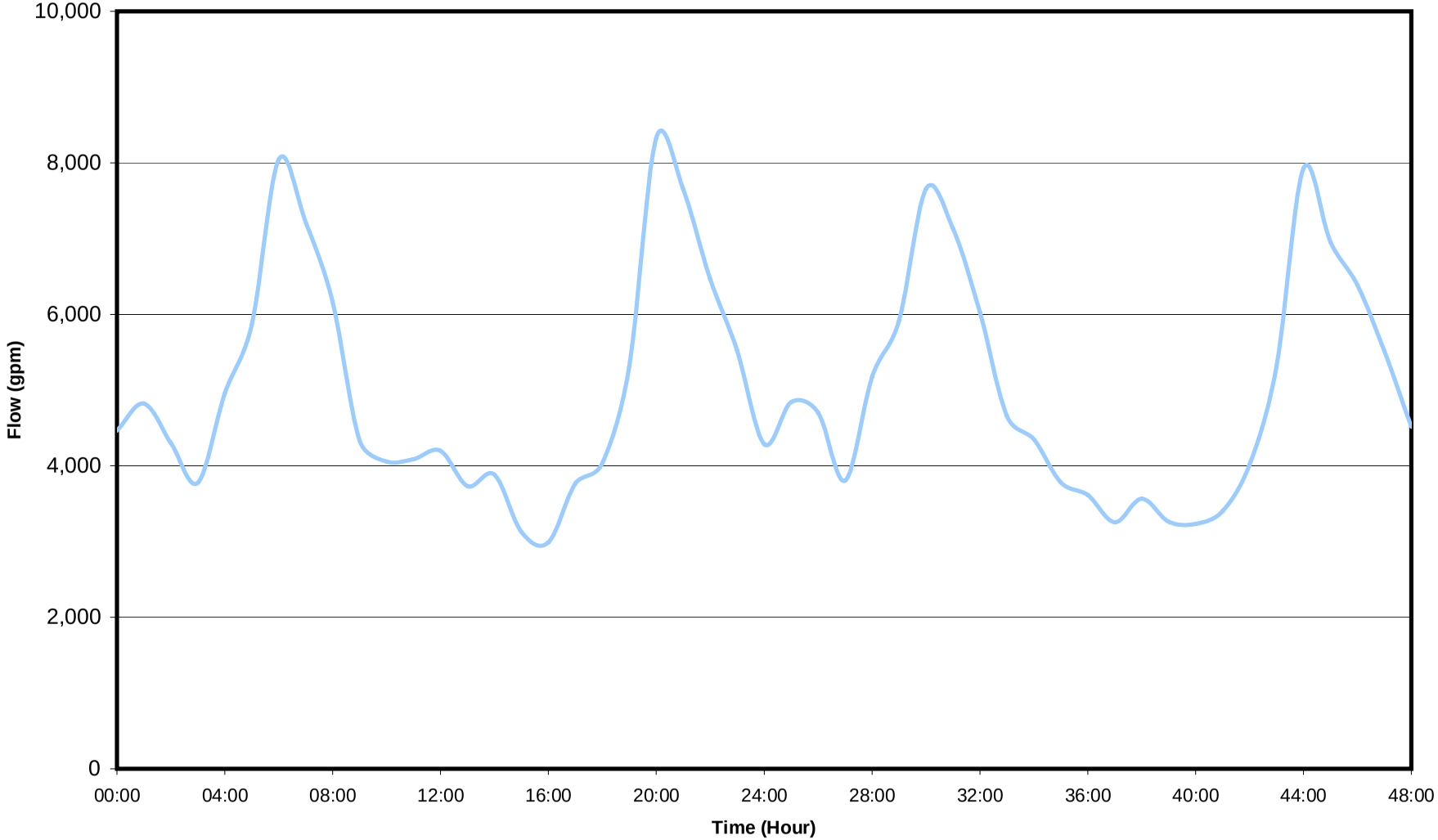
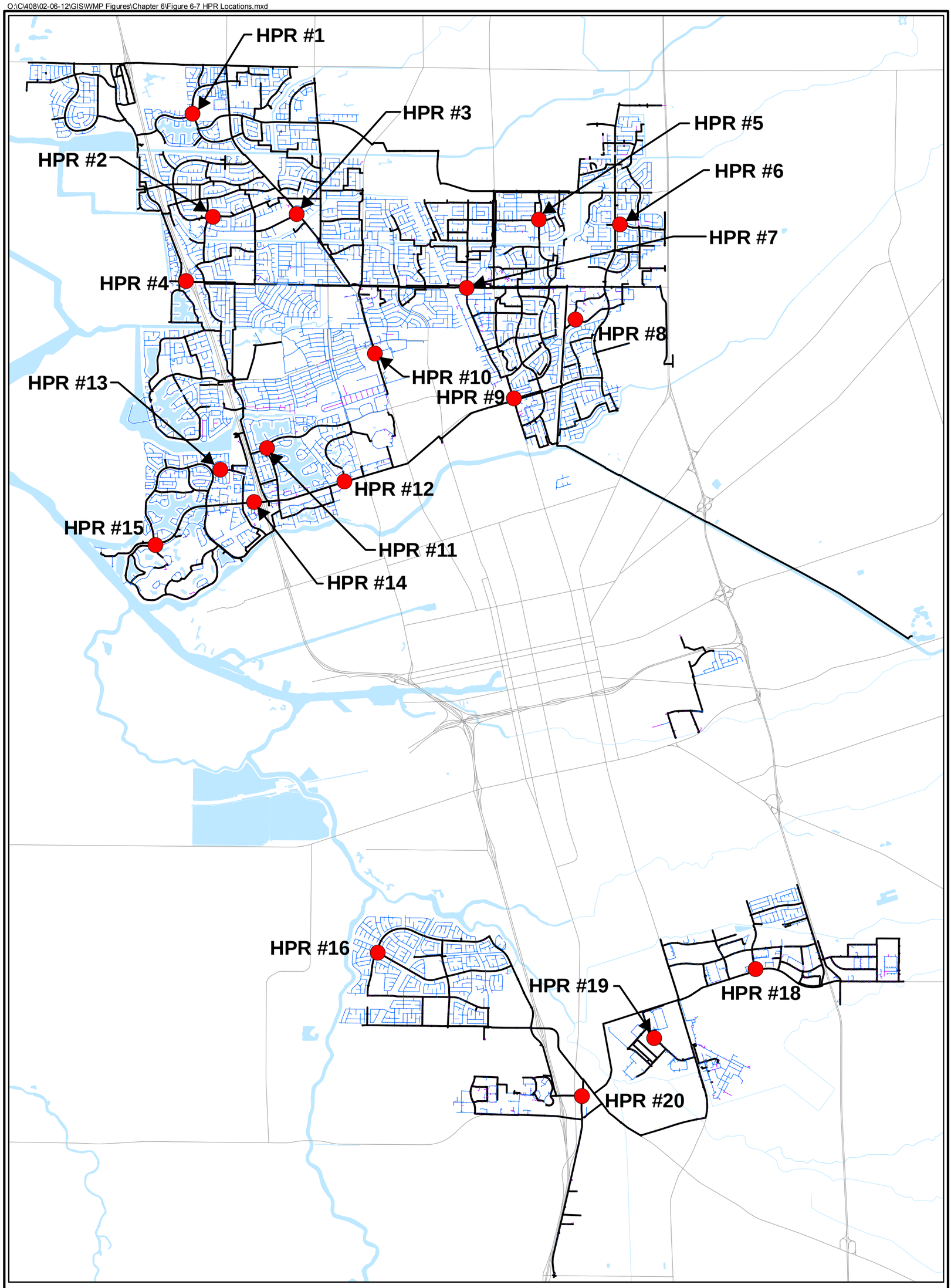


Figure 6-6. South Stockton Diurnal Demand Pattern
9/25/06 to 9/26/06



O:\C\408\02-06-12\GIS\WMP Figures\Chapter 6\Figure 6-7 HPR Locations.mxd



LEGEND:

- HPR Location
- No Diameter
- Pipelines < 12"
- Pipelines ≥ 12"
- Major Street
- Water Feature

N

0 0.375 0.75 1.5

Scale in Miles

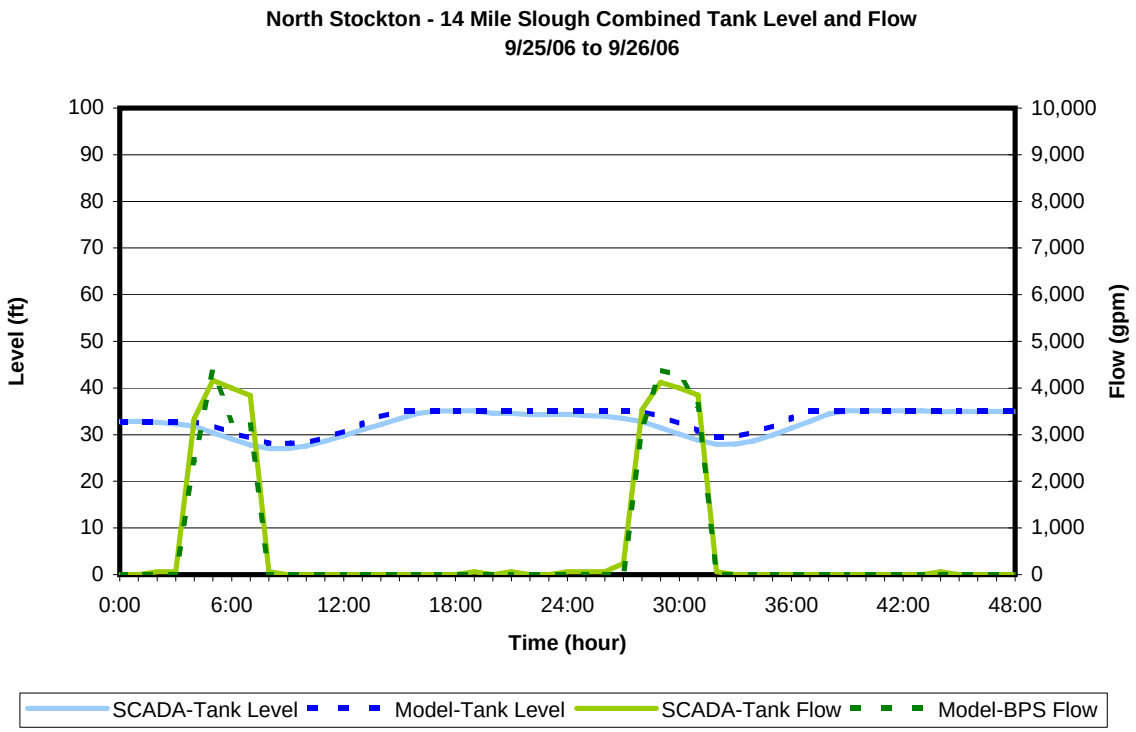
FIGURE 6-7

City of Stockton
Municipal Utilities Department
Water Master Plan Update

HPR LOCATIONS

WEST YOST ASSOCIATES
Consulting Engineers

Figure 6-8. Verification for North Stockton Service Area: 14 Mile Slough



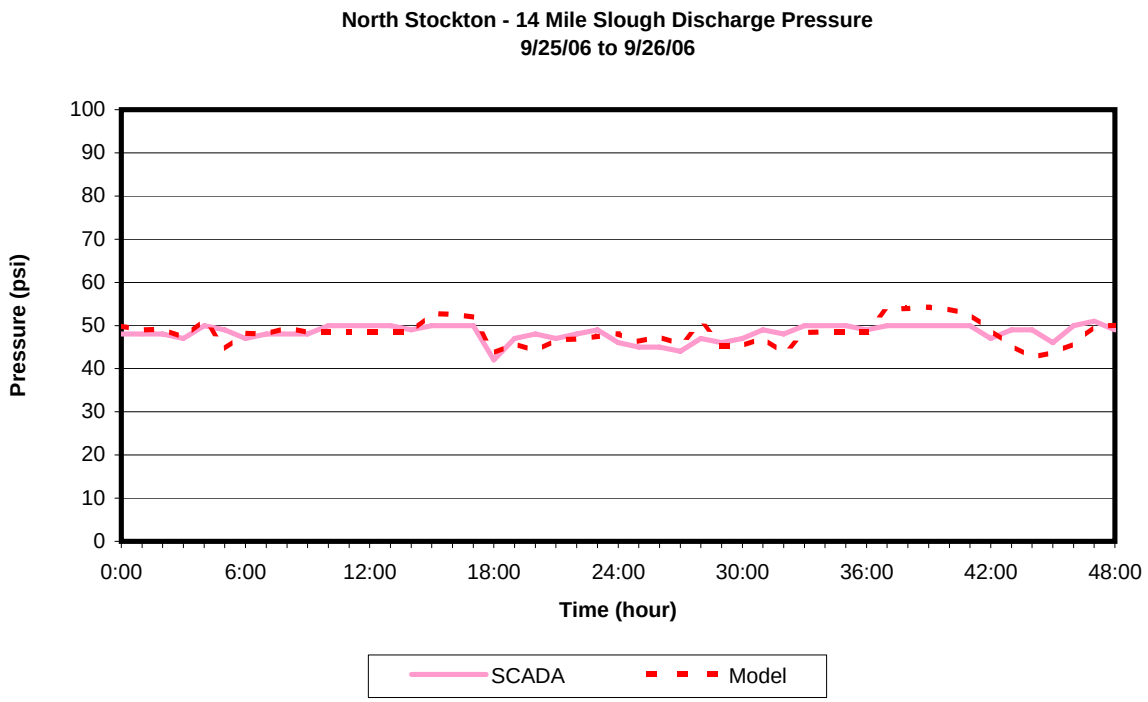
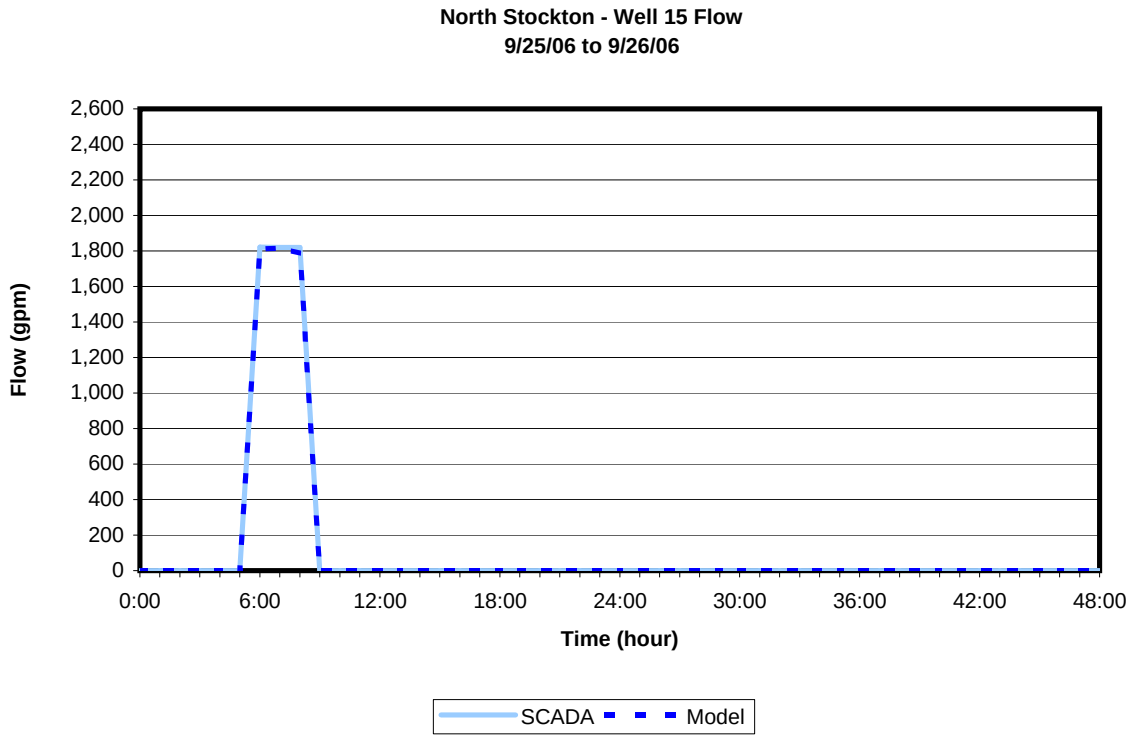


Figure 6-9. Verification for North Stockton Service Area: Well 15



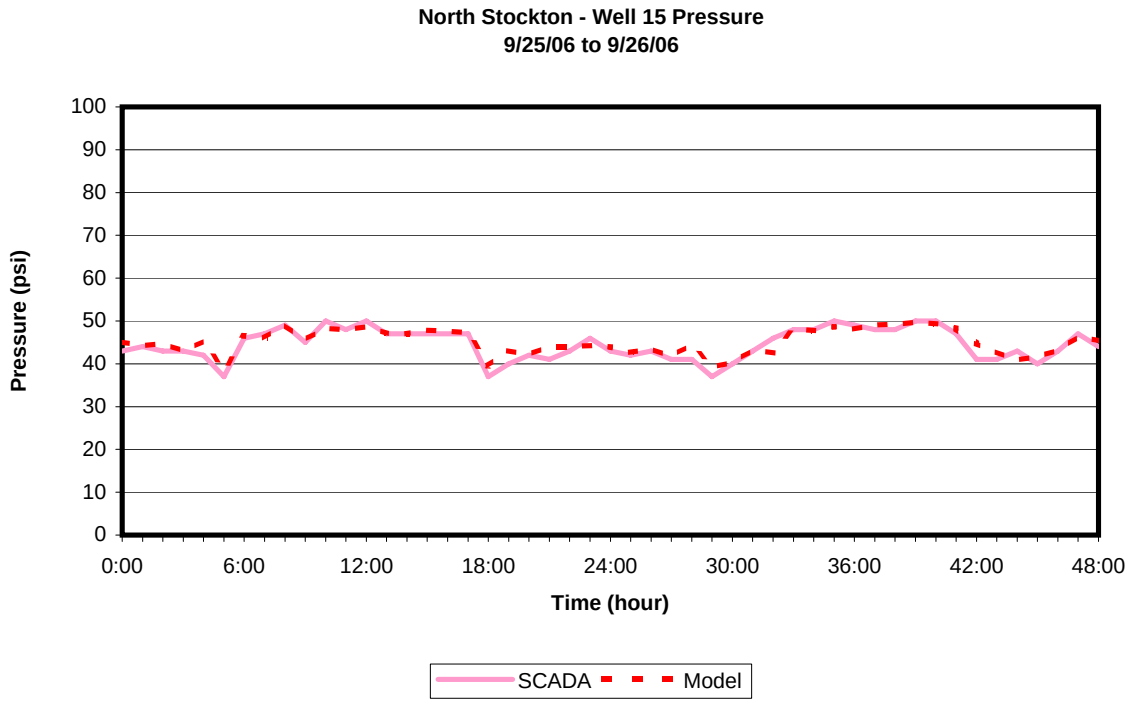
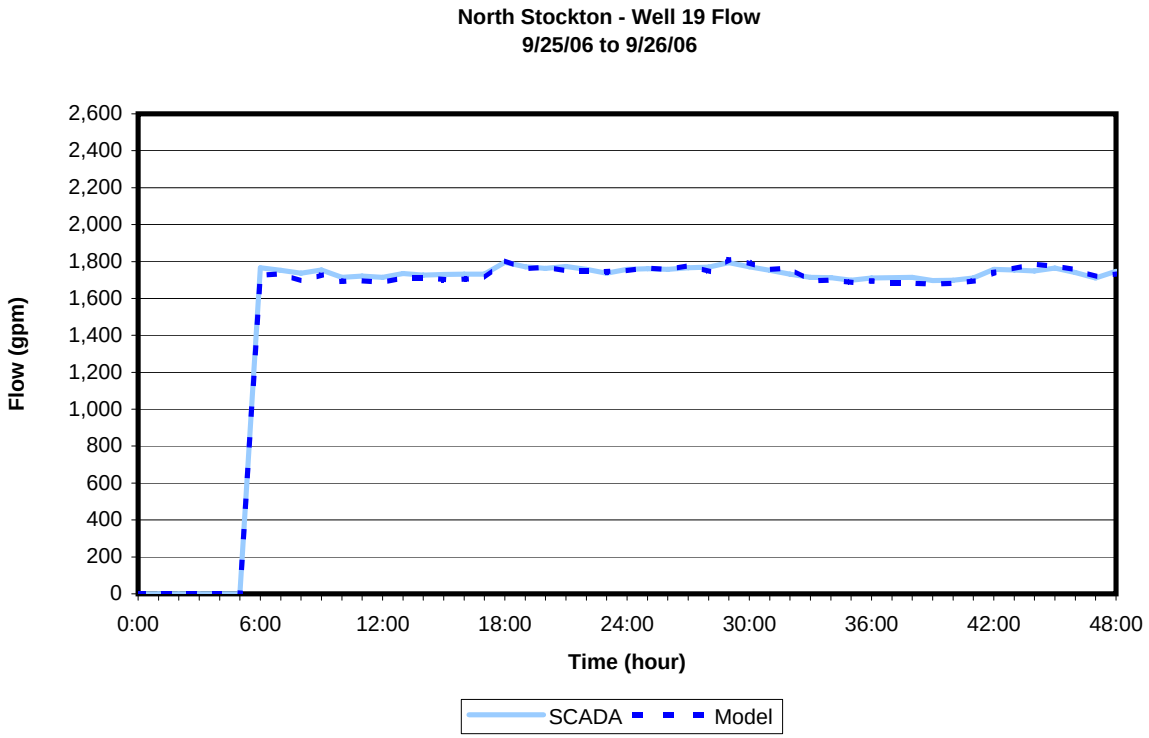


Figure 6-10. Verification for North Stockton Service Area: Well 19



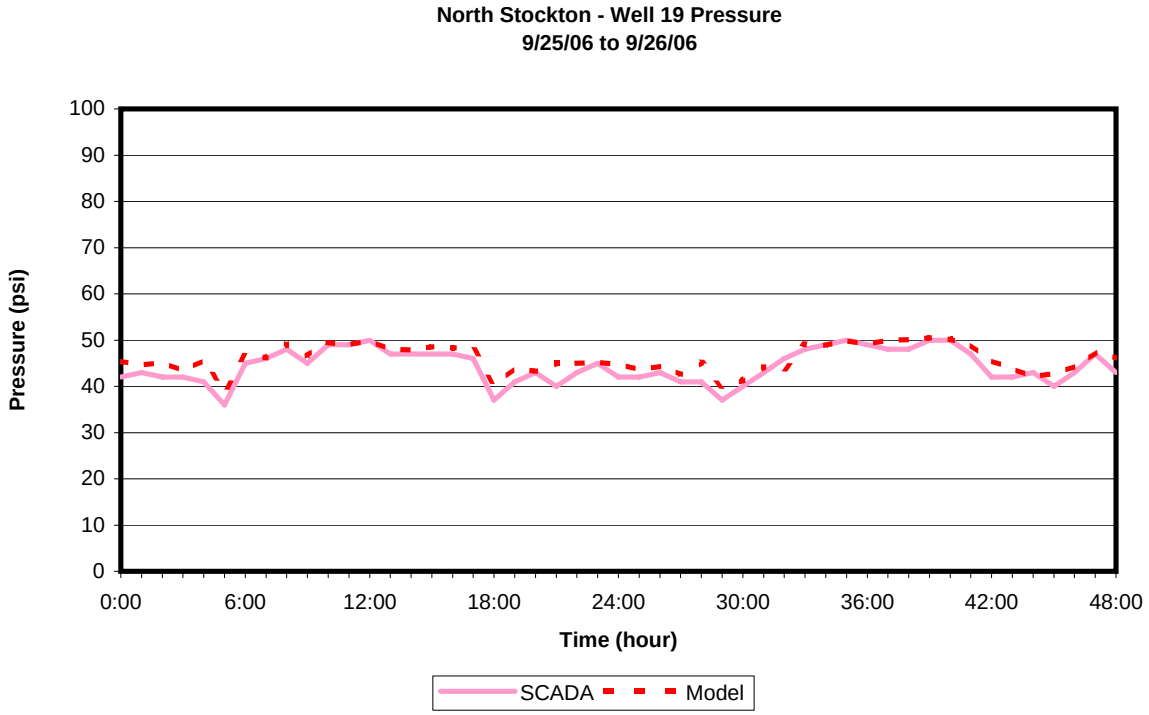
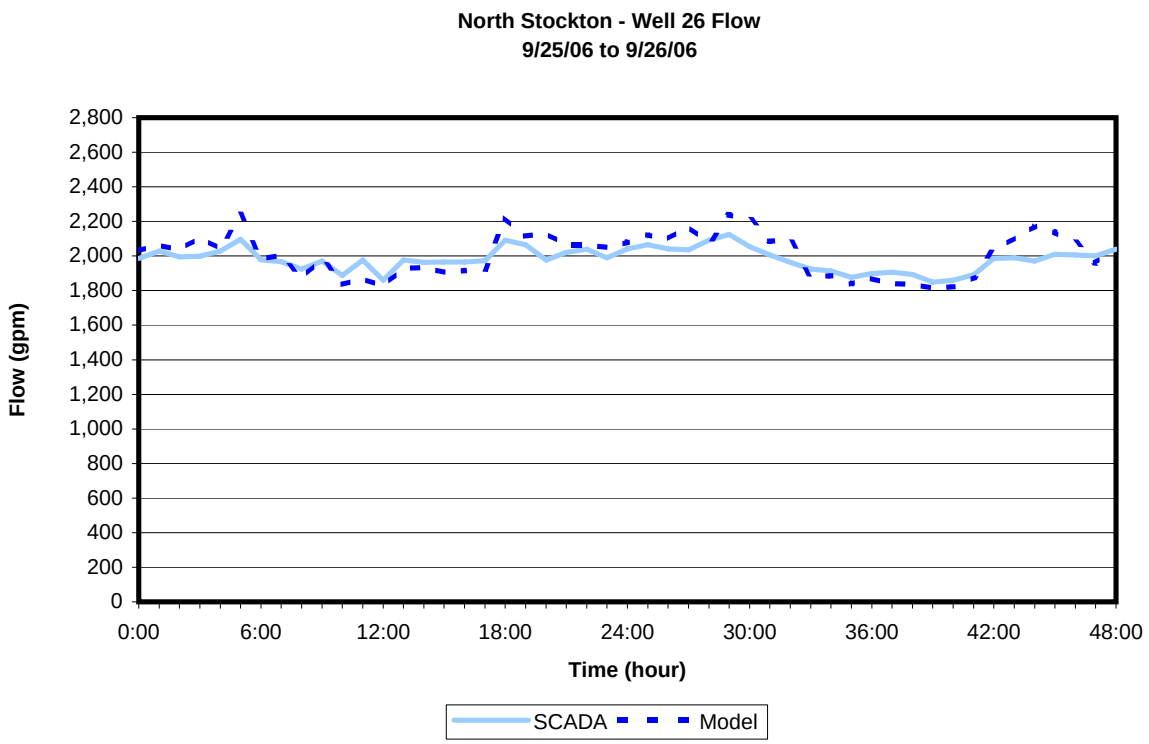


Figure 6-11. Verification for North Stockton Service Area: Well 26



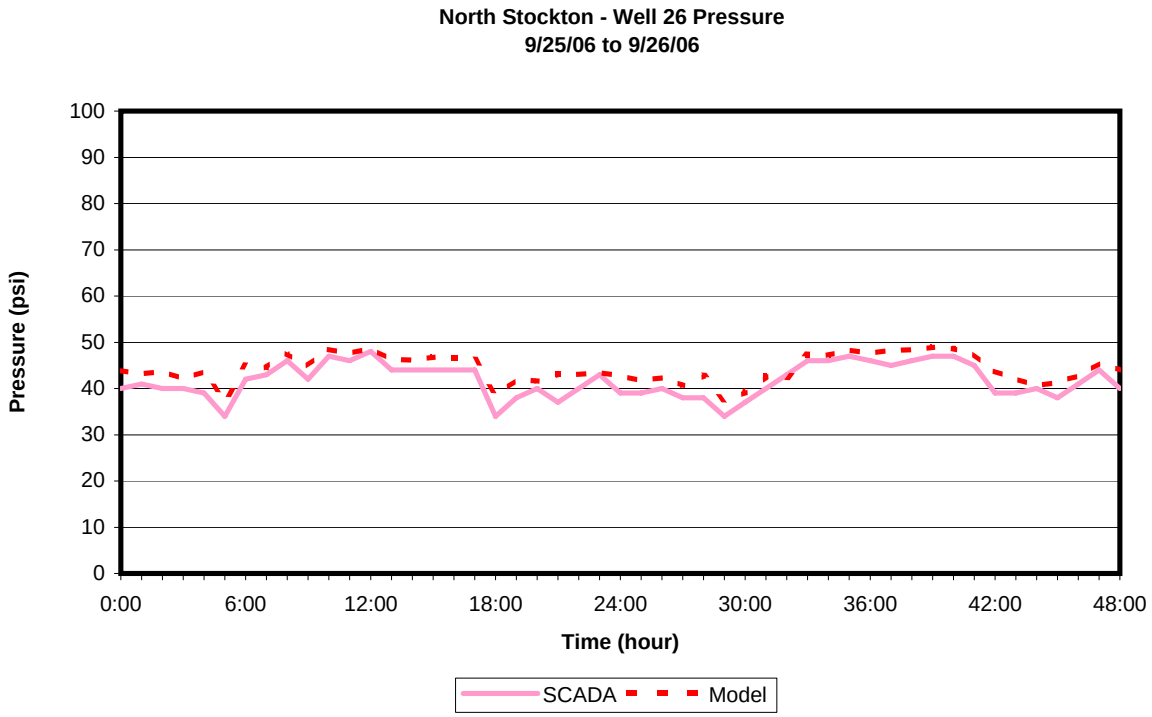
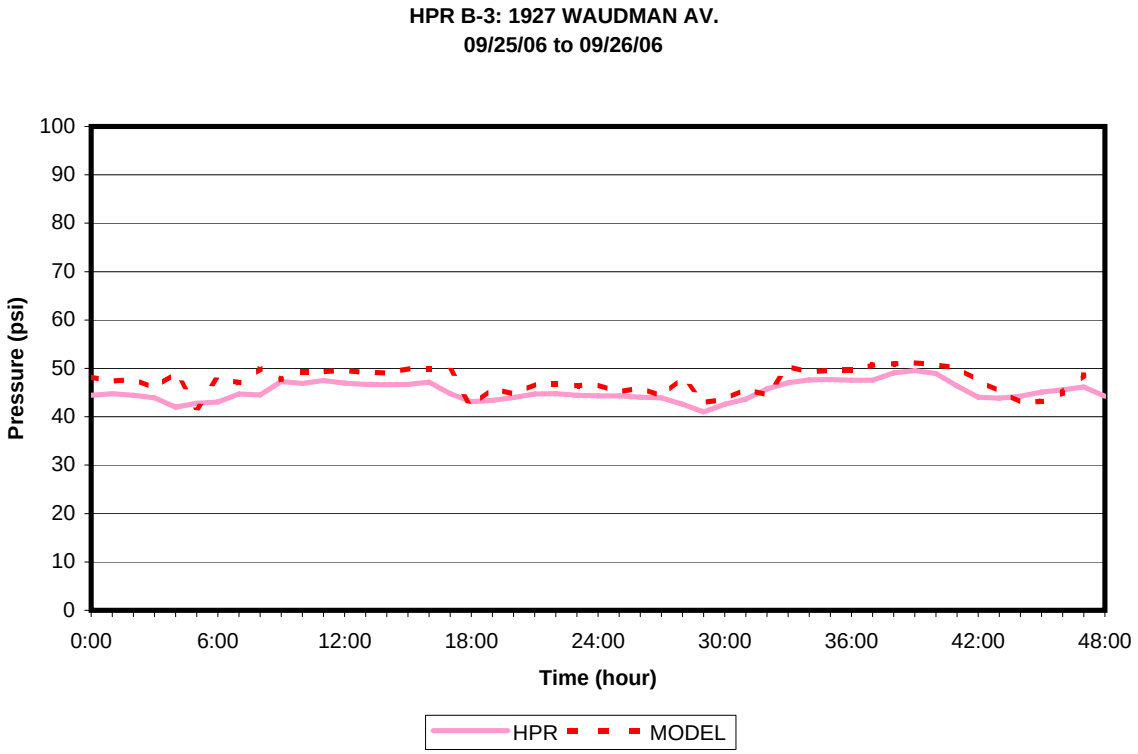


Figure 6-12. Verification for North Stockton Service Area: HPR 3 & HPR 7



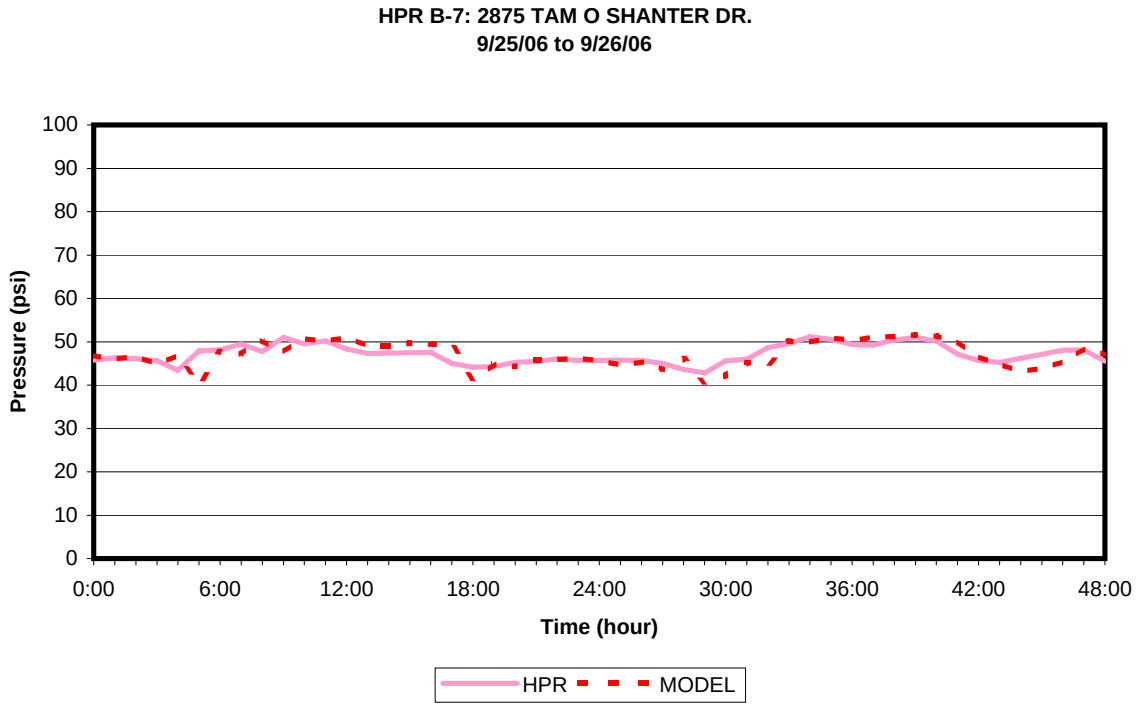
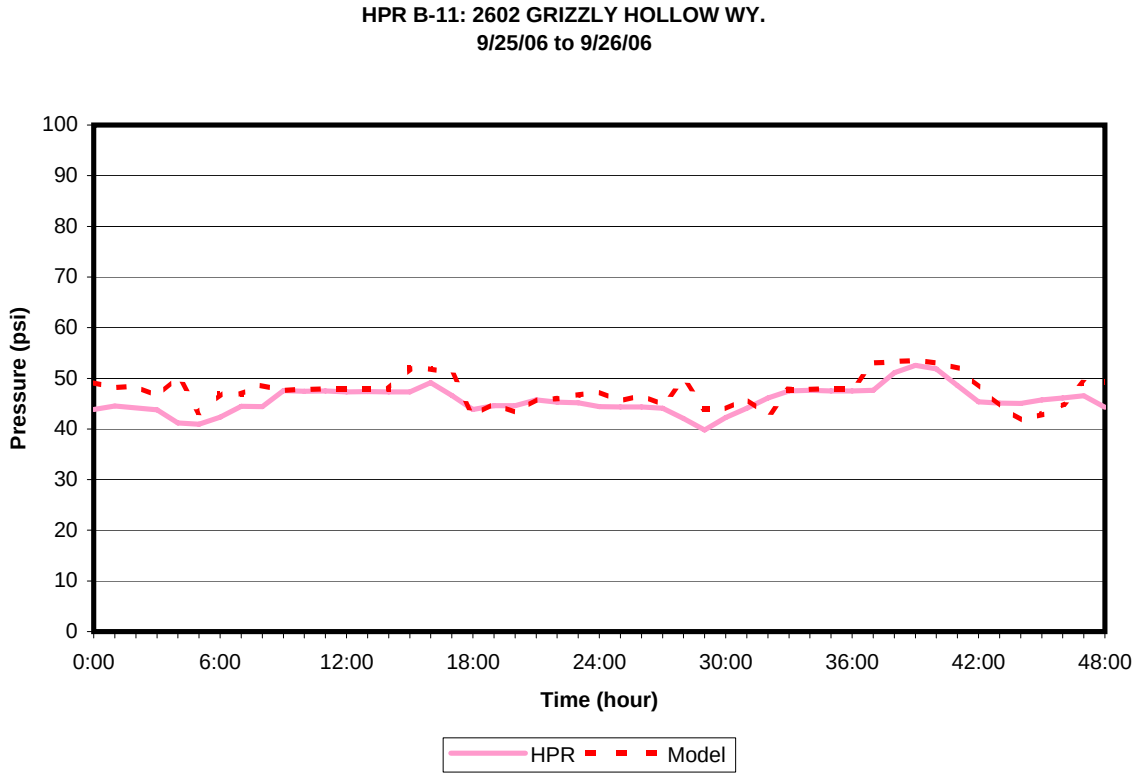


Figure 6-13. Verification for North Stockton Service Area: HPR 11 & HPR 12



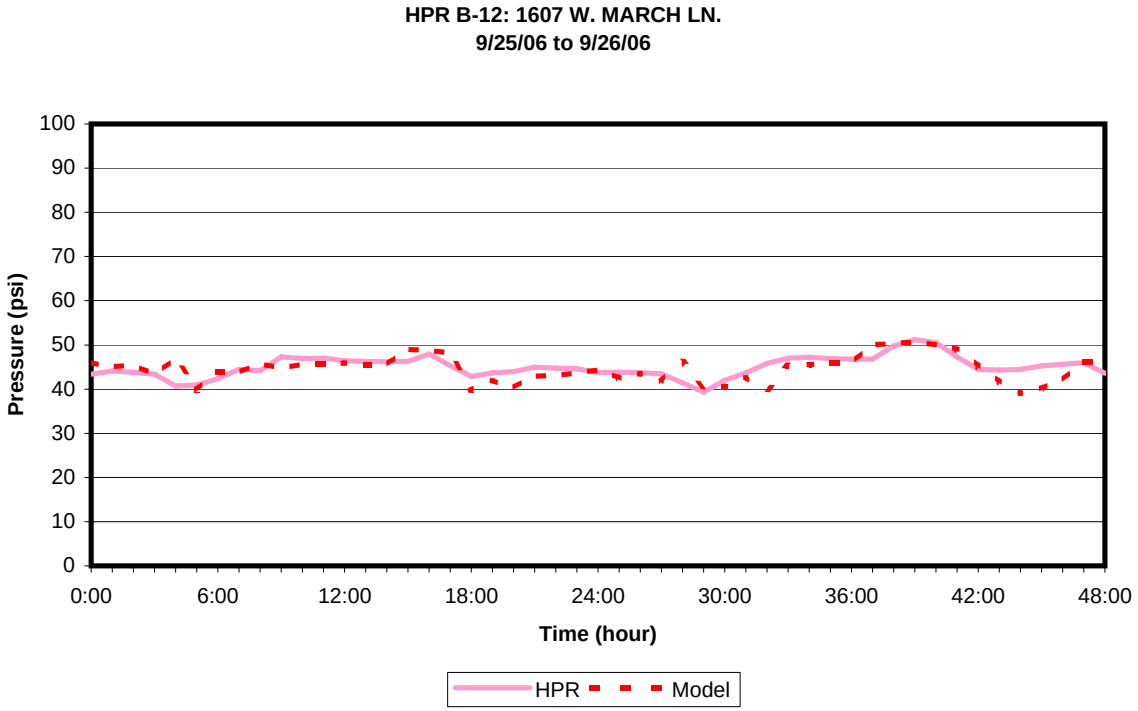
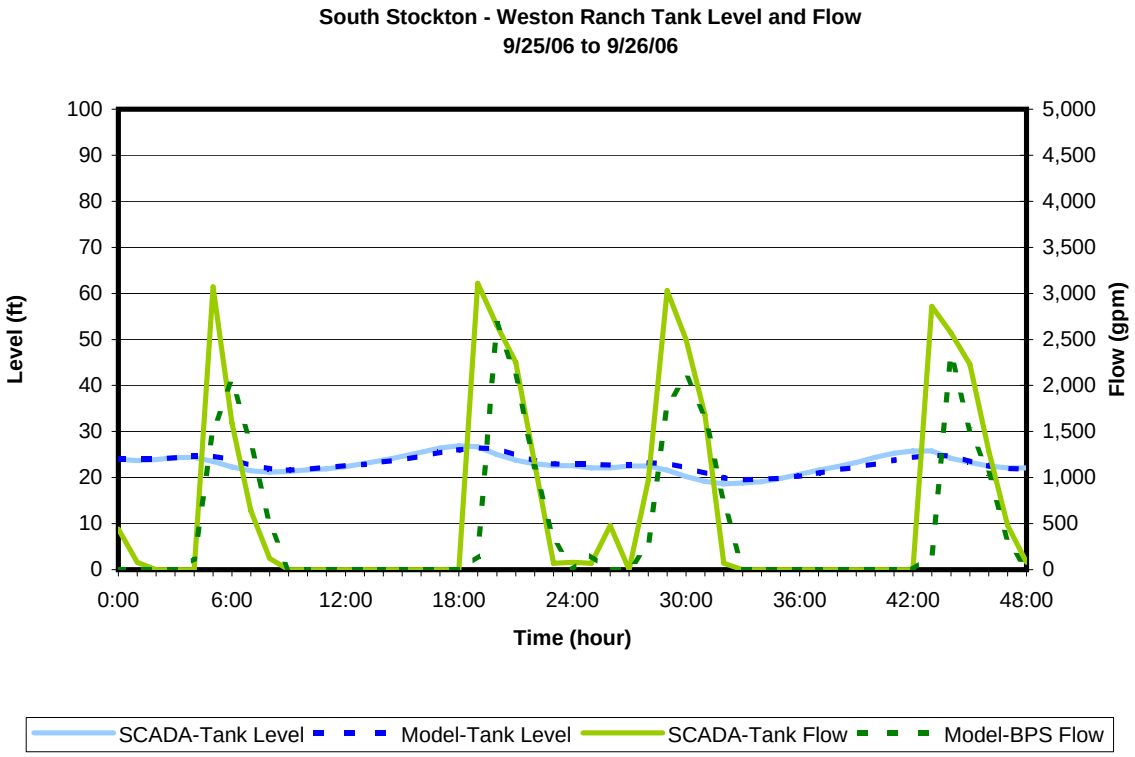


Figure 6-14. Verification for South Stockton Service Area: Weston Ranch



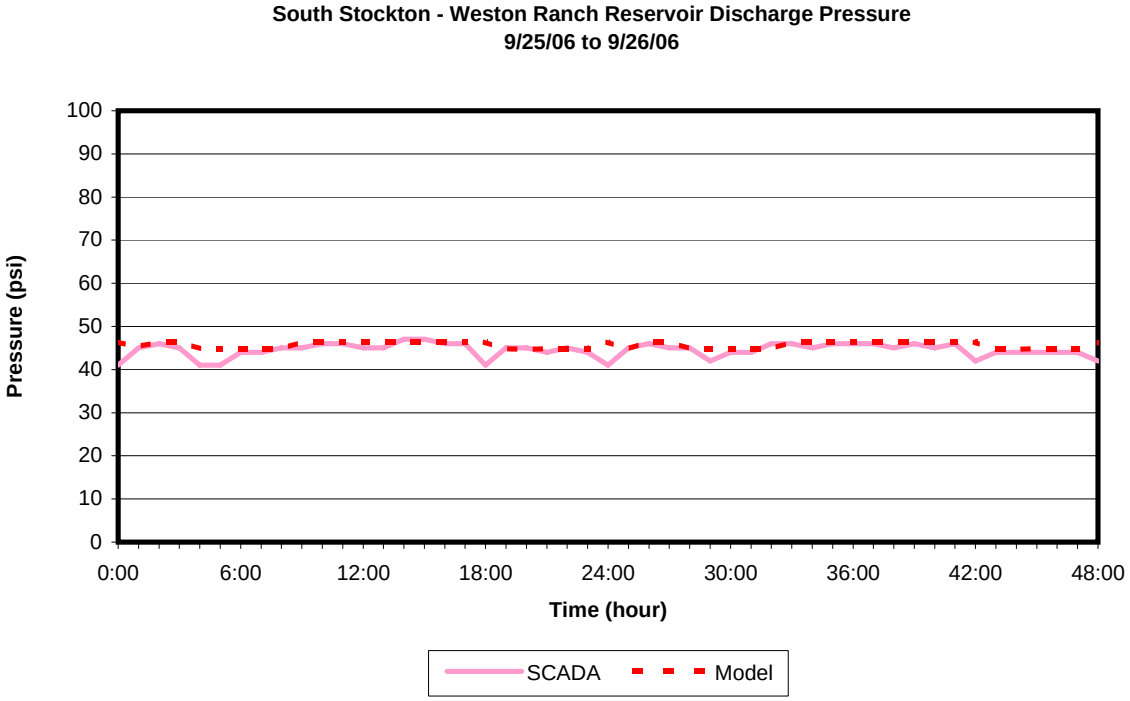
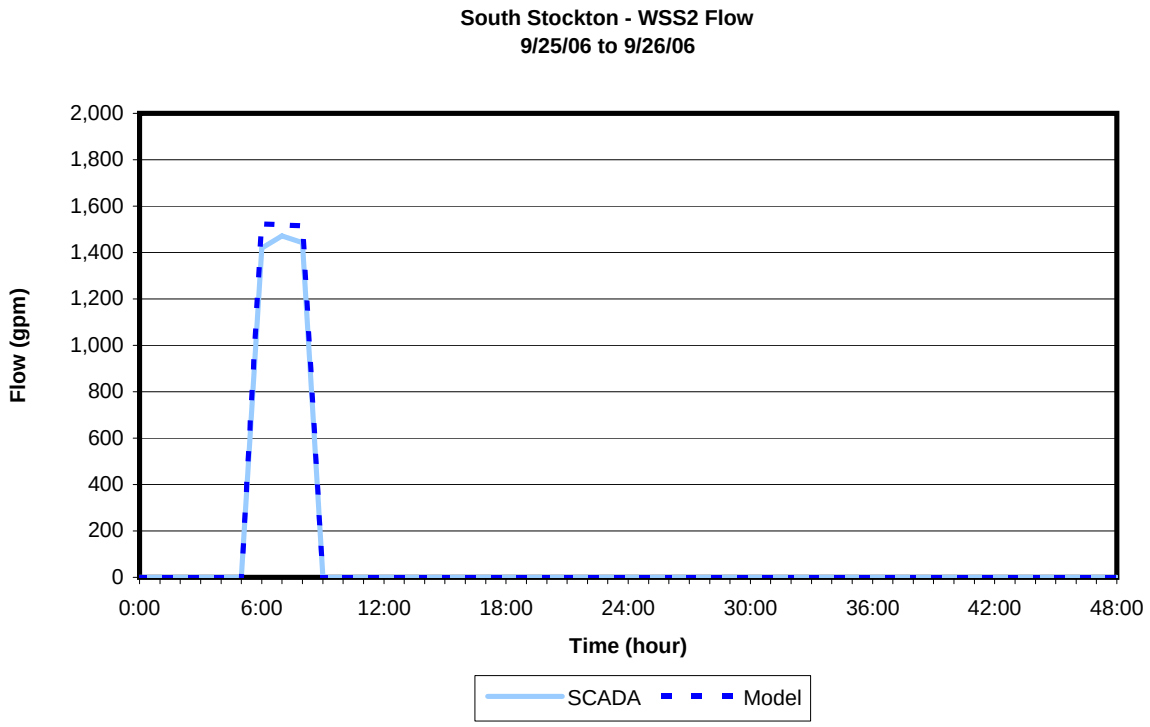


Figure 6-15. Verification for South Stockton Service Area: Well SS2



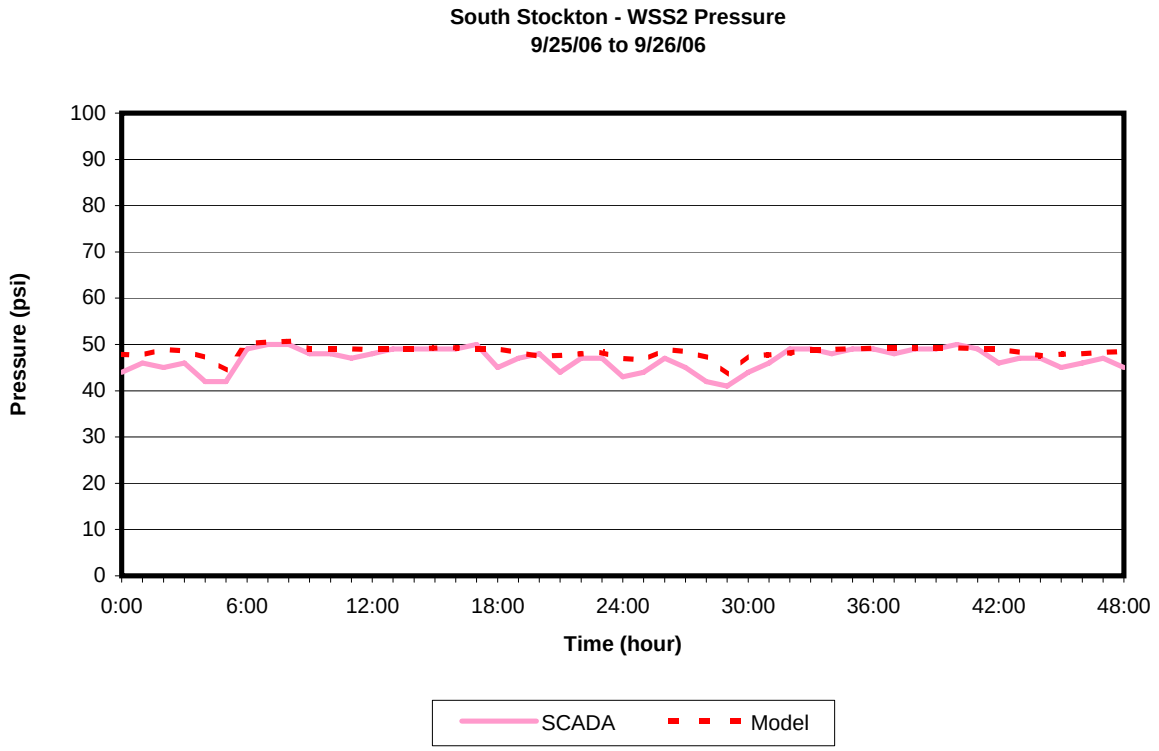
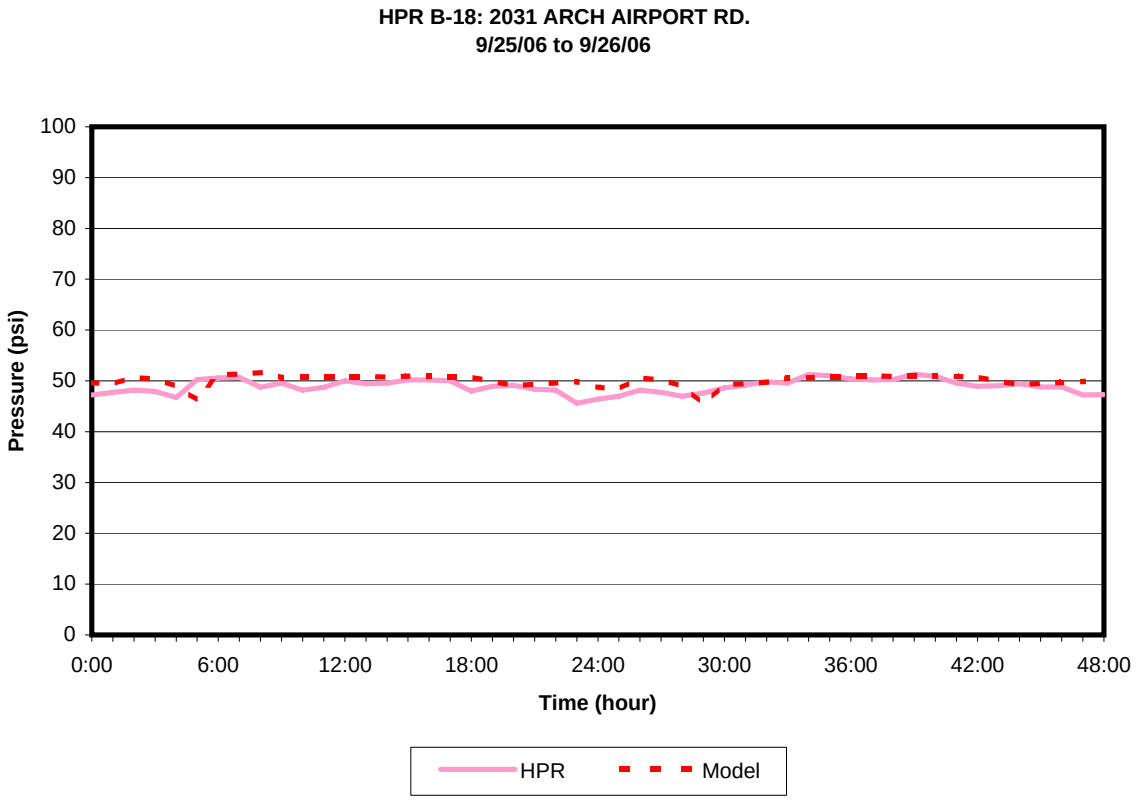
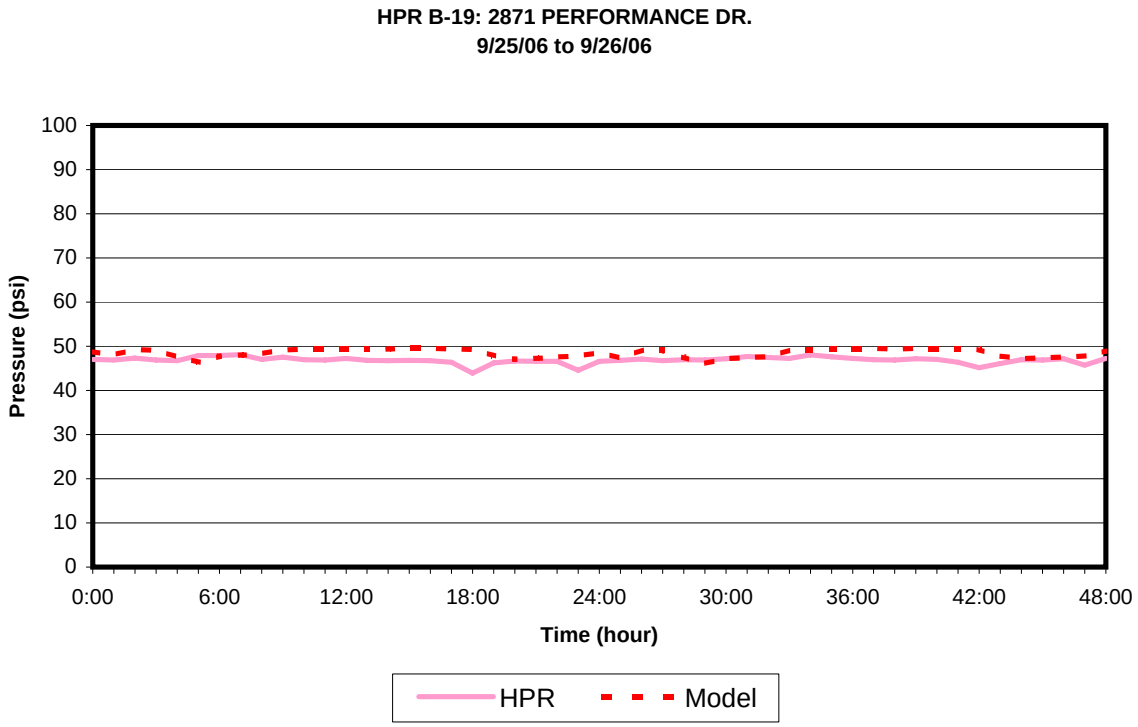


Figure 6-16. Verification for South Stockton Service Area: HPR 18 & HPR 19





CHAPTER 7. EXISTING WATER DISTRIBUTION SYSTEM ANALYSIS

The COS MUD's existing water distribution system (see Figures 7-1 and 7-2) was evaluated using the hydraulic model to determine its ability to meet the recommended operational performance and design criteria under existing demand conditions. This evaluation includes an analysis of water storage capacity, pumping capacity and the existing distribution system's ability to meet the recommended operational and design criteria under maximum day demand plus fire flow and peak hour demand conditions. This evaluation was conducted by WYA using the hydraulic model described in Chapter 6.

The following sections of this Chapter describe the methodology, analysis, and recommendations for the COS MUD's existing water system as follows:

- Water Demands
- Pumping Capacity Evaluation
- Groundwater Pumping Capacity Evaluation
- Water Storage Capacity Evaluation
- Evaluation of Existing Water Distribution System

WATER DEMANDS

Existing water demands for North and South Stockton were allocated based on metered water use data provided by the COS MUD. Existing demands by service area are summarized in Table 7-1.

Table 7-1. Existing Demands for North and South Stockton (2005)[a]

Service Area	Demand Condition	Demand	
		mgd	gpm
North Stockton	Average Day	26.4	18,310
	Maximum Day[b]	44.8	31,127
	Peak Hour[c]	92.3	64,085
South Stockton	Average Day	5.5	3,822
	Maximum Day[b]	9.4	6,497
	Peak Hour[c]	19.3	13,377

(a) Data based on geocoded meter data provided by the COS MUD and was scaled up to represent 2005 water production (see Table 3-4).
(b) Maximum day demand is 1.7 times the average day demand.
(c) Peak hour demand is 3.5 times the average day demand.

PUMPING CAPACITY EVALUATION

The COS MUD's pumping capacity consists of the combination of the following two categories: booster pump station capacity located at each tank and well pump capacity located at each groundwater production well. Each pump station was evaluated on its ability to deliver firm, reliable capacity to the service area. Therefore, pumping capacity was reduced to account for pumps that are out of service at any given time due to mechanical breakdowns, maintenance, water quality, or other operational issues. At each booster pump station, firm capacity was defined as the total booster pump station capacity with the largest pump out of service. For groundwater well pumps, the firm capacity was defined as the total pumping capacity of all the active wells minus 20 percent.

The pumping capacity criterion for the COS MUD (see Chapter 5), requires the COS MUD's system to have sufficient pumping capacity to meet the greater of either a maximum day demand concurrent with fire flow demand or a peak hour demand. The results of the pumping capacity evaluation are summarized in Table 7-2. Table 7-3 summarizes the pumping capacity of each station.

Table 7-2. Evaluation of Total Firm Pumping Capacity and Peak Hour Demand

Service Area	Pump Station	Existing Firm Pumping Capacity, gpm[a]	Existing Peak Hour Demand, gpm[b,c]
North Stockton	Northwest	12,600	64,085
	Fourteen Mile Slough	11,250	
	SEWD WTP[d]	17,360	
	Groundwater Wells	29,742	
Subtotal		*70,952*	
South Stockton	Weston Ranch	9,000	13,377
	Groundwater Wells	8,640	
Subtotal		*17,640*	
Total		88,592	77,462

(a) Defined as the total capacity of the individual pump station with the largest unit in the pump station out of service or the total capacity of active groundwater well pumps minus 20 percent. Well status defined as of February 2007.
(b) Based on 2005 water production data provided by the COS MUD.
(c) Peak hour demand is 3.5 times the average day demand.
(d) SEWD supply based on 17,360 gpm available, which is 50 percent of the existing 50 mgd WTP capacity.

This analysis indicated that the COS MUD's existing booster and groundwater pumping capacity meets the pumping capacity criteria for its entire service area during a peak hour demand condition. However, the volume of storage at the Northwest, Fourteen Mile Slough, and Weston Ranch tank sites would only allow the booster pumps to operate for 9, 8 and 5 hours, respectively. Therefore, the COS MUD must rely on their groundwater pumping capacity to meet maximum day demands. The COS MUD is currently designing three additional

Table 7-3. Summary of Existing Pumping Facilities

Service Area	Station	Status	Pump 1, gpm	Pump 2, gpm	Pump 3, gpm	Pump 4, gpm	Pump 5, gpm	Total Capacity, gpm	Firm Capacity[a], gpm
North Stockton	NW	Active	5,000	3,800	3,800	5,000	--	17,600	12,600
North Stockton	FMS	Active	3,300	3,300	2,650	2,650	2,650	14,550	11,250
North Stockton	SEWD WTP[b]	Active	17,360	--	--	--	--	17,360	17,360
							North Stockton Subtotal (Booster Pumps)	*49,510*	***41,210***
North Stockton	1	Active	648	--	--	--	--	648	29,742
North Stockton	3-2	Active	2,000	--	--	--	--	2,000	
North Stockton	4	Standby	1,050	--	--	--	--	0	
North Stockton	5	Active	480	--	--	--	--	480	
North Stockton	7	Active	550	--	--	--	--	550	
North Stockton	9	Active	540	--	--	--	--	540	
North Stockton	11	Active	1,100	--	--	--	--	1,100	
North Stockton	12	Active	760	--	--	--	--	760	
North Stockton	13	Active	2,000	--	--	--	--	2,000	
North Stockton	15	Active	2,000	--	--	--	--	2,000	
North Stockton	16	Active	2,000	--	--	--	--	2,000	
North Stockton	18	Active	800	--	--	--	--	800	
North Stockton	19	Active	2,000	--	--	--	--	2,000	
North Stockton	20	Active	2,000	--	--	--	--	2,000	
North Stockton	21	Active	2,000	--	--	--	--	2,000	
North Stockton	22	Standby	1,900	--	--	--	--	0	
North Stockton	23	Active	900	--	--	--	--	900	
North Stockton	24	Out of Service	1,040	--	--	--	--	0	
North Stockton	25	Active	2,200	--	--	--	--	2,200	
North Stockton	26	Active	2,400	--	--	--	--	2,400	
North Stockton	27	Active	2,000	--	--	--	--	2,000	
North Stockton	28	Active	1,400	--	--	--	--	1,400	
North Stockton	29	Active	3,200	--	--	--	--	3,200	
North Stockton	30	Active	2,200	--	--	--	--	2,200	
North Stockton	31	Active	2,000	--	--	--	--	2,000	
North Stockton	32	Active	2,000	--	--	--	--	2,000	
							North Stockton Subtotal (Groundwater Well Pumps)	*37,178*	***29,742***
South Stockton	WR	Active	3,000	3,000	3,000	3,000	--	12,000	9,000
							South Stockton Subtotal (Booster Pumps)	*12,000*	***9,000***
South Stockton	SSS #1	Active	1,800	--	--	--	--	1,800	8,640
South Stockton	SSS #2	Active	1,400	--	--	--	--	1,400	
South Stockton	SSS #3	Active	2,000	--	--	--	--	2,000	
South Stockton	SSS #4	Standby	700	--	--	--	--	0	
South Stockton	SSS #5	Standby	800	--	--	--	--	0	
South Stockton	SSS #8	Active	2,800	--	--	--	--	2,800	
South Stockton	SSS #9	Active	2,800	--	--	--	--	2,800	
							South Stockton Subtotal (Groundwater Well Pumps)	*10,800*	***8,640***
							Total Pumping Capacity		**88,592**

[a] Firm capacity is defined as the total booster pumping capacity with the largest pump out of service or the total active groundwater well pumping capacity minus 20 percent.

[b] SEWD supply based on 50 percent of the 50 mgd WTP capacity.

groundwater production wells (Well #33, #2-2 and #10-2) to improve the water supply reliability within the service area. Each of these wells was assumed to have a capacity of 2.9 mgd, providing the COS MUD with approximately 8.7 mgd (6,000 gpm) of additional pumping capacity in the future.

GROUNDWATER PUMPING CAPACITY EVALUATION

The COS MUD's current water supply consists of groundwater pumped from the COS MUD owned production wells and surface water provided by the SEWD WTP. In a critically dry year, the current maximum supply from the SEWD WTP is 30,000 afa (26.8 mgd). For planning purposes, it was assumed that half of this supply (15,000 af) would be available to the COS MUD and would provide supply for South Stockton; the remainder would supply CWSC. Therefore, the COS MUD should plan to have sufficient groundwater pumping capacity to pump the available groundwater supply in the event of a critically dry year.

Table 7-4 provides a summary of the developed acreage and groundwater supply for both North and South Stockton service areas. It was assumed that there is a perennial groundwater yield of at least 0.6 af/ac/yr. This is a target set as part of the DWSP, but actual groundwater pumpage may result in yields that can vary from 0 to much higher than 0.6 af/ac/yr, depending on the water year type (e.g., above normal or critically dry).

This analysis indicated that approximately 2.4 mgd of pumping capacity is required to pump the annual available groundwater yield in South Stockton; while in North Stockton, 7.8 mgd of pumping capacity is required to pump the annual available groundwater yield. The existing groundwater well pumping capacity is more than sufficient to extract the annual available groundwater yield.

Table 7-4. Summary of Existing Developed Acreage and Groundwater Supply

Service Area	Existing Developed Area, acres	Available Groundwater Supply, mgd[(a)]	Existing Firm Pumping Capacity of Wells, mgd[(b)]
North Stockton	14,550	7.8	42.8
South Stockton	4,460	2.4	12.4

(a) Based on target groundwater yield of 0.6 af/ac/yr and total existing developed acreage of 14,550 and 4,460 in North and South Stockton, respectively.

(b) Based on the total capacity of active groundwater well pumps minus 20 percent. Well status defined as of February 2007.

WATER STORAGE CAPACITY EVALUATION

The COS MUD storage capacity consists of the combination of the following two categories: above ground storage in tanks/reservoirs and below ground storage in the groundwater basin. Together, this storage must be of sufficient volume to meet the COS MUD's operational, fire flow and emergency storage criteria. The volumes required for each of these three storage components are:

- Operational Storage: 25 percent of a maximum day demand;
- Emergency Storage: An average day demand; and
- Fire flow Storage: The maximum fire flow multiplied by the fire flow duration period, as required by the City's Fire Marshal. However, two fire flow events were assumed for storage to provide a more conservative fire flow storage estimate. The largest fire flow of 4,500 gpm for the duration of 4 hours, and a smaller Multi-Family Residential fire flow of 3,000 gpm for the duration of 3 hours were assumed for this evaluation.

The existing storage facilities (and groundwater credits) were evaluated to determine whether there is currently sufficient capacity to provide the required operational, fire flow, and emergency storage. Groundwater credits assume that the smaller of either 60 percent of the total active groundwater pumping capacity or 100 percent of the total active groundwater pumping capacity of wells that are equipped with backup power will be available to supplement required water storage. Therefore, 60 percent of the total active groundwater pumping capacity is 32.1 MG and 9.3 MG for North and South Stockton, respectively and is also equal to the maximum available groundwater credit. However, the actual available groundwater credit from active wells equipped with backup power is 15.3 MG and 2.6 MG for North and South Stockton, respectively.

As presented in Table 7-5, the storage capacity in North Stockton is approximately 28.1 MG, while storage capacity in South Stockton is approximately 5.6 MG. Table 7-5 indicates that North Stockton has a storage deficiency of approximately 11.0 MG, while South Stockton has a storage deficiency of approximately 3.8 MG. Table 7-6 summarizes the existing available storage capacity, groundwater credits, and required storage capacity.

Table 7-5. Comparison of Existing and Required Storage Capacity/Groundwater Credits

Service Area	Available Storage Capacity, MG			Required Storage Capacity, MG				Additional Storage Capacity Required, MG[b]
	Reservoir Capacity	Groundwater Credits[a]	Total	Operational	Fire flow	Emergency	Total	
North Stockton	12.8	15.3	28.1	11.2	1.5	26.4	39.1	11.0
South Stockton	3.0	2.6	5.6	2.4	1.5	5.5	9.4	3.8

(a) Equal to the sum of the total groundwater pumping capacity of active wells with backup power.
(b) Calculated as required storage minus available storage.

WYA recommends a 3 MG storage tank located in the French Camp area. In addition, the COS MUD has designed another 3 MG tank at the Weston Ranch booster pump station to increase the storage capacity in South Stockton. With these two additional storage tanks, South Stockton will then meet the required storage capacity.

Table 7-6. Summary of Existing Storage Requirements

Service Area	Station	Status	Required Storage Capactiy, MG			Total Required Storage, MG	Reservoir Capacity, MG	Well Pump Capacity[d], MG	Groundwater Credit[e], MG	Storage Surplus (Deficit), MG
			Operational[a]	Fire Flow[b]	Emergency[c]					
North Stockton	NW	Active					6.8	--		
North Stockton	FMS	Active					6.0	--		
North Stockton	SEWD WTP	Active					--	--		
North Stockton	1	Active					--	--		
North Stockton	3-2	Active					--	--		
North Stockton	4	Standby					--	--		
North Stockton	5	Active					--	--		
North Stockton	7	Active					--	--		
North Stockton	9	Active					--	--		
North Stockton	11	Active					--	--		
North Stockton	12	Active					--	--		
North Stockton	13	Active					--	2.88		
North Stockton	15	Active					--	--		
North Stockton	16	Active					--	2.88		
North Stockton	18	Active	11.2	1.5	26.4	39.1	--	--	15.3	(11.0)
North Stockton	19	Active					--	--		
North Stockton	20	Active					--	2.88		
North Stockton	21	Active					--	--		
North Stockton	22	Standby					--	--		
North Stockton	23	Active					--	--		
North Stockton	24	Out of Service					--	--		
North Stockton	25	Active					--	3.17		
North Stockton	26	Active					--	3.46		
North Stockton	27	Active					--	--		
North Stockton	28	Active					--	--		
North Stockton	29	Active					--	--		
North Stockton	30	Active					--	--		
North Stockton	31	Active					--	--		
North Stockton	32	Active					--	--		
South Stockton	WR	Active					3.0	--		
South Stockton	SSS #1	Active					--	2.59		
South Stockton	SSS #2	Active					--	--		
South Stockton	SSS #3	Active	2.4	1.5	5.5	9.4	--	--	2.6	(3.8)
South Stockton	SSS #4	Standby					--	--		
South Stockton	SSS #5	Standby					--	--		
South Stockton	SSS #8	Active					--	--		
South Stockton	SSS #9	Active					--	--		
									Total Storage Capacity	**(14.8)**

[a] Based on 25 percent of maximum day demand.

[b] Based on a fire flow of 4,500 gpm multiplied by a 4 hour duration, and a fire flow of 3,000 gpm multiplied by a 3 hour duration.

[c] Based on an average day demand.

[d] Pump capacity of wells with backup power.

[e] Equal to the sum of the total groundwater pumping capacity of active wells with backup power.

The two previously proposed Northeast tanks will provide the North Stockton Service Area with an additional 6 MG of storage capacity. In addition, the COS MUD has designed another 3.4 MG tank at the Northwest tank site to increase the storage capacity in North Stockton. With these additional storage tanks, North Stockton still has a 1.6 MG storage capacity deficit. WYA recommends that the COS MUD install backup power on at least one existing well with a total production capacity above 1.6 mgd to obtain enough groundwater credit to meet the required storage capacity.

EVALUATION OF EXISTING WATER DISTRIBUTION SYSTEM

This section presents the analysis and conclusions of the evaluation completed on the COS MUD's existing water distribution system in North and South Stockton. The analysis evaluated the ability of the water system to meet recommended operational performance and design criteria (see Chapter 5) under existing demand conditions and the current system configuration. The existing water distribution system was evaluated under the following demand scenarios:

- Peak Hour Demand - A peak hour flow condition was simulated to evaluate the capability of the distribution facilities to meet a peak hour demand condition. Peak hour demands are met by the combined flows from the SEWD WTP, groundwater and storage reservoirs.
- Maximum Day Demand Plus Fire Flow - To evaluate the system under each maximum day plus fire flow condition, a two-step analysis was followed. The first step used the H_2ONET "Available Fire Flow Analysis" option to determine if the minimum pressure and required fire flow could be met with existing facilities. If the analysis indicated that the system failed to meet the minimum requirements for pressure and flow, a second analysis was performed. The second analysis involved running the model with pipeline improvements added to the distribution system to eliminate previously identified system constraints and/or deficiencies.

This analysis focused on steady state system runs to identify areas of the COS MUD's system in which minimum pressure, velocity and/or head loss could not be maintained. Pipelines should deliver peak hour demand and maximum day demand plus fire flow within the acceptable pressure, velocity, and head loss ranges as defined by the performance criteria (see Chapter 5), but the system will be evaluated using pressure as the primary criterion. Recommended improvements needed to comply with the performance criteria are also presented.

Peak Hour Demand

The current system demand for peak hour was calculated, using meter data provided by the COS MUD, as 77,462 gpm (111.6 mgd), representing 3.5 times the average day demand as stipulated in Chapter 3. It was assumed that approximately 17,360 gpm (25 mgd) would be available from the SEWD WTP.

Results for the North Stockton Service Area

The existing system demand for North Stockton during peak hour was calculated as 63,085 gpm (92.3 mgd). Currently, peak hour demands can be supplied using wells #1, #3-2, #13, #15, #18, #19, #20, #21, #23, #25, #26, #27, #28, #29, #30, #31, and #32 plus approximately 9,900 gpm from SEWD WTP and approximately 23,450 gpm from NW and FMS Reservoirs.

As shown on Figure 7-3, the majority of the North Stockton service area has pressures between 50 and 55 psi, while meeting peak hour demand. However, the pressures on the east and south side of the service area experience pressures between 45 and 50 psi.

Figure 7-3 also shows that, with the exception of the 10-inch diameter pipeline on Swain Road (head loss of about 18 ft/kft and velocity of about 7.4 fps) and the 6-inch diameter pipeline on Inglewood Avenue between Felton Avenue and Lincoln Road (head loss of about 16 ft/kft), the majority of the pipelines met the maximum head loss criterion of 7 ft/kft and the maximum velocity criterion of 7 fps.

The head loss analysis indicated that the capacity of individual pipelines is not a problem, but that the cumulative effect of head losses in the system and the configuration of the North Stockton system, lower the pressure within portions of the water distribution system, including the area around the FMS Reservoir.

Results for the South Stockton Service Area

The existing system demand for South Stockton during peak hour was calculated as 13,377 gpm (19.3 mgd). Currently, peak hour demands can be supplied using well SSS #9, plus approximately 2,950 gpm from SEWD WTP and approximately 7,600 gpm from WR Tank.

Figure 7-4 illustrates system pressures and velocities in South Stockton. As shown in Figure 7-4, only areas around the County Jail have pressures below 45 psi (approximately 44 psi). Pressures in the remaining portions of South Stockton are mostly above 60 psi. Figure 7-4 also shows that the majority of pipeline velocities remain below the specified criterion of 7 fps, except for the 8-inch diameter pipeline connecting the Hospital and the County Jail (velocity of approximately 8 fps and head loss of approximately 30 ft/kft). In addition, the 18-inch diameter pipeline leading out of the WR tank and a 10-inch diameter main within the County Jail did not meet the head loss criterion.

Maximum Day plus Fire Flow Demand

Figures 7-5 and 7-6 illustrate the locations of the fire flows simulated for North and South Stockton, respectively. Fire flow locations were chosen to represent the critical points in the distribution system, combining large demands and relatively isolated positions in the pipeline network. Fire flows were consistent with those defined in Chapter 5 and no sprinkler reductions were provided on the fire flows for residential land use. Pressures and velocities were not mapped as they were in the peak hour scenarios, but rather the locations of pipelines that exceed the performance criteria are described within the text.

Results for the North Stockton Service Area

Fire flow tests were modeled at six (6) locations in North Stockton. The results of each fire flow analysis are summarized below:

1. Northwest. A fire flow of 4,500 gpm was modeled at the intersection of A. G. Spanos Boulevard and Siskiyou Lane. All residual pressures remained above 20 psi, velocities below 10 fps, and head losses below 10 ft/kft, thus meeting the performance criteria.
2. Western side of Hammer Lane. A fire flow of 4,500 gpm was modeled at the intersection of Hammer Lane and Woodside Drive. All residual pressures remained above 20 psi, thus meeting the performance criterion. However, pipeline velocities and head losses near the fire flow ranged from 12 to 14 fps and 33 to 78 ft/kft, respectively; thus exceeding the performance criteria. Currently, no improvements are recommended for the pipelines exceeding the velocity and head loss criteria, because the pressures are above 20 psi and the pipelines are existing.
3. Southwest. A fire flow of 4,500 gpm was modeled at the intersection of Driftwood Place and Feather River Drive. All residual pressures remained above 20 psi and velocities below 10 fps, thus meeting the performance criteria. However, pipeline head losses near the fire flow ranged from 11 to 24 ft/kft, thus exceeding the performance criteria.
4. Central North Stockton. A fire flow of 3,000 gpm was modeled in the high density residential area close to the intersection of Iris Avenue and Strathaven Way. All residual pressures remained above 20 psi and velocities below 10 fps, thus meeting the performance criteria. However, pipeline head losses near the fire flow ranged from 13 to 48 ft/kft, thus exceeding the performance criteria. Currently, no improvements are recommended for the pipelines exceeding the head loss criterion, because the pressures are above 20 psi and the pipelines are existing.
5. Southeast. A fire flow of 2,000 gpm was modeled at the intersection of Mirasol Lane and Rayanna Drive. All residual pressures remained above 20 psi and velocities below 10 fps, thus meeting the performance criteria. However, pipeline head losses near the fire flow ranged from 16 to 25 ft/kft, thus exceeding the performance criteria. Currently, no improvements are recommended for the pipelines exceeding the head loss criterion, because the pressures are above 20 psi and the pipelines are existing.
6. Northeast. A fire flow of 4,500 gpm was modeled at the intersection of Bryant Drive and Wakeman Drive. All residual pressures remained above 20 psi, velocities below 10 fps, and head losses below 10 ft/kft, thus meeting the performance criteria.

The head loss criterion was not met for four out of the six fire flow tests. However, no improvements are recommended for these pipelines, because the pressure criterion has been met.

Results for the South Stockton Service Area

Fire flow tests were modeled at five (5) locations in South Stockton. The results of each fire flow analysis are summarized below:

1. East side. A fire flow of 4,500 gpm was modeled at the intersection of Arch Road and Fite Court. All residual pressures remained above 20 psi, velocities below 10 fps, and head losses below 10 ft/kft, thus meeting the performance criteria.
2. Airport. Combined fire flows of 2,250 gpm were sustainable at pressures that are slightly above the performance criterion (21 and 23 psi). However, head losses and velocities exceeded the performance criteria in many of the pipelines near the airport area (due to small, 8-inch and 6-inch diameter pipes and relative proximity to the fire flow). Some of the head losses observed in the airport piping were as high as 12 to 98 ft/kft. The highest pipeline velocity observed was 14 fps. In order to meet the pressure criterion for this fire flow test, all the facilities (including standby wells) in South Stockton had to be turned on.
3. French Camp. A fire flow of 4,500 gpm was modeled on the 12-inch diameter pipeline alongside I-5. Residual pressures in the French Camp area were far below performance criterion and demonstrated the need for a local storage tank. Without the tank, distances from other fire flow supplies (i.e. wells, SEWD WTP and WR) were simply too far and head losses too large to sustain an industrial fire flow of any duration. Using the new tank, pressures were maintained above the performance criteria. However, velocities reached 13 fps and head losses ranged from 41 to 48 ft/kft in the 12-inch diameter pipelines within close proximity to the fire flow. Currently, no improvements are recommended for the pipelines exceeding the velocity and head loss criteria because the pressures are above 20 psi.
4. County Jail. Combined fire flows of 2,250 gpm were not sustainable at pressures that were in compliance with the performance criterion. However, the minimum pressure requirement can be met by installing an 18-inch diameter pipeline looping WR and the County Jail area. All velocities then remained below the 10 fps, except for the 8-inch diameter pipeline connecting between the Hospital and the County Jail (17 fps), the 8-inch diameter pipeline connecting the proposed 18-inch diameter pipeline to the County Jail (11 fps) and the 8-inch diameter pipeline that connects the 12-inch and 14-inch diameter pipelines near the southern part of the County Jail (17 fps). Head losses also exceeded the 10 ft/kft limit due to the small 8-inch diameter pipelines within the vicinity of the fire flow. Some of the head losses observed in the pipelines were as high as 12 to 125 ft/kft. Currently, no improvements are recommended for the pipelines exceeding the velocity and head loss criteria, because the pressures are above 20 psi.
5. Weston Ranch. A fire flow of 2,000 gpm was modeled on an 8-inch diameter pipeline near the east end of WR. All residual pressures remained above 20 psi, and velocities below 10 fps were maintained. However, the 8-inch diameter pipelines in the vicinity of the fire flow exceeded the head loss criterion. These pipelines exhibited head losses ranging from 15 to 37 ft/kft.

The modeling results indicate that an industrial fire flow in the French Camp area cannot be supported without a new French Camp tank and pump station. Additionally, any proposed new wells on the east side would also be ineffective at supplying such a fire flow to the French Camp area due to its distance and relative isolation. Additionally, the head loss criterion was not met for four out of the five fire flow tests. However, no improvements are recommended for these pipelines, because the pressure criterion has been met. It is suggested that the COS MUD review

the pipelines in the Airport area for possible near term improvements to increase the fire flow into this area, because the simulated fire flow test constrained the existing system to operate all existing facilities.

Recommended Improvements for the Existing Water System

The recommended improvements for pipelines, wells and storage following the analysis of the existing distribution system in North and South Stockton are discussed below. Figures 7-7 and 7-8 illustrate the recommended improvements based on this analysis. These figures also illustrate the near term improvements that are proposed by the COS MUD. The capital costs associated with these improvements are detailed in Chapter 9.

North Stockton Service Area

Pipelines. Because the 10-inch diameter main on Swain Road is a critical pipeline and violates both the head loss and the velocity criteria stated in Chapter 5 for a peak hour condition, it is recommended that a new 12-inch diameter main be installed in parallel to reduce the head loss and velocity.

Wells. The existing system analysis indicated that North Stockton does not currently have a groundwater pumping capacity deficit. However, the COS MUD is currently designing Well #33, #2-2 and #10-2 to improve the groundwater pumping supply reliability.

Storage. To improve peak hour design pressures in the northeastern part of the service area, two (2) storage tanks each with a capacity of 3 MG, complete with pumping facilities, are recommended near the area south of Morada Lane and west of Glacier Point Drive. In addition, the COS MUD is planning an additional 3.4 MG tank at the Northwest tank site[1].

South Stockton Service Area

Pipelines. The County Jail and Hospital area observed pressures below the performance criterion during a peak hour demand condition. Therefore, new pipeline facilities were evaluated and recommended to improve flows in the service area. An 18-inch diameter pipeline looping the WR area to the County Jail and Hospital areas is recommended to improve the peak hour pressures within the County Jail area. The new pipeline recommended for improvement is shown in Figure 7-8. In addition, WYA recommends that the COS MUD confirm the existing pipeline configuration in the Airport, County Jail, and Hospital areas for possible near term pipeline improvements. For example, increasing the diameter of the existing 6-inch and 8-inch diameter pipelines within the Airport and the 8-inch diameter pipelines leading into the County Jail would reduce head losses and velocities during peak hour demand and maximum day demand plus fire flow conditions.

[1] This tank has been completed as confirmed by the City in May 2008. However, this additional tank was not considered in the existing storage and pumping capacity analyses presented in this Chapter.

Wells. Potential additional well locations are scarce due to the salinity front in the western portion of the service area, and the landfill proximity in the southeast. Preferred locations for new wells are immediately north or south of SSS #3. According to the current system analysis, no new wells are required; however, as future development occurs, this is subject to change.

Storage. In order to meet the pressure criterion during a maximum day demand plus fire flow condition in the French Camp area, a new storage tank must be built. In addition, the COS MUD is planning an additional 3 MG tank at the existing WR tank site. These new storage tanks will allow South Stockton meet its required storage capacity.

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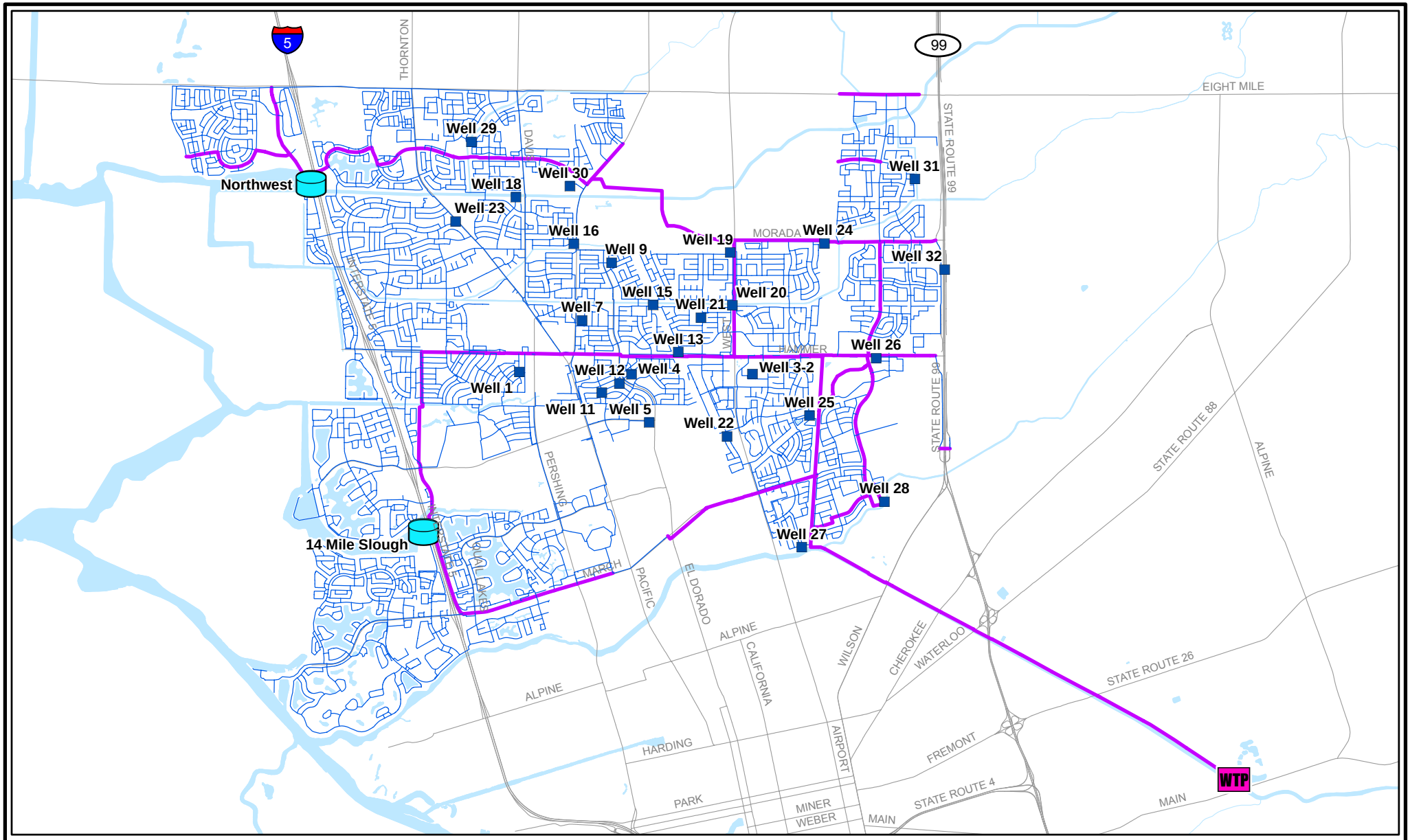

LEGEND:

- Existing Well
- Existing Water Tank
- SEWD WTP
- Pipeline Diameter < 18-inches
- Pipeline Diameter ≥ 18-inches
- Major Street
- Water Feature

N

0 0.5 1 2

Scale in Miles

FIGURE 7-1

City of Stockton
Municipal Utilities Department
Water Master Plan Update

NORTH STOCKTON EXISTING WATER SYSTEM

WEST YOST ASSOCIATES Consulting Engineers

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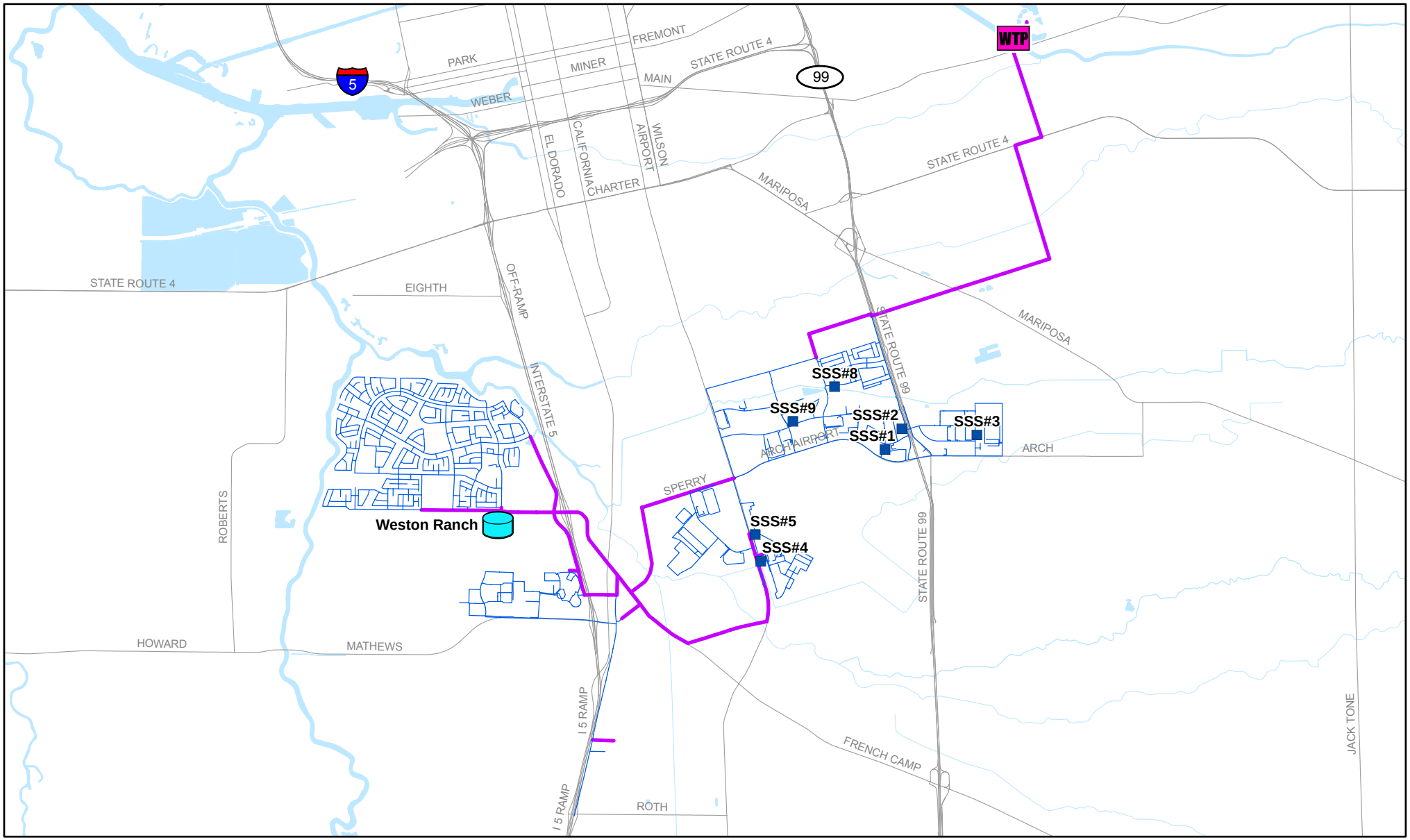

LEGEND:

- Existing Well
- Existing Water Tank
- SEWD WTP
- Pipeline Diameter <18-inches
- Pipeline Diameter ≥18-inches
- Major Street
- Water Feature

N

0 0.5 1 2

Scale in Miles

FIGURE 7-2

City of Stockton
Municipal Utilities Department
Water Master Plan Update

SOUTH STOCKTON EXISTING WATER SYSTEM

WEST YOST ASSOCIATES Consulting Engineers

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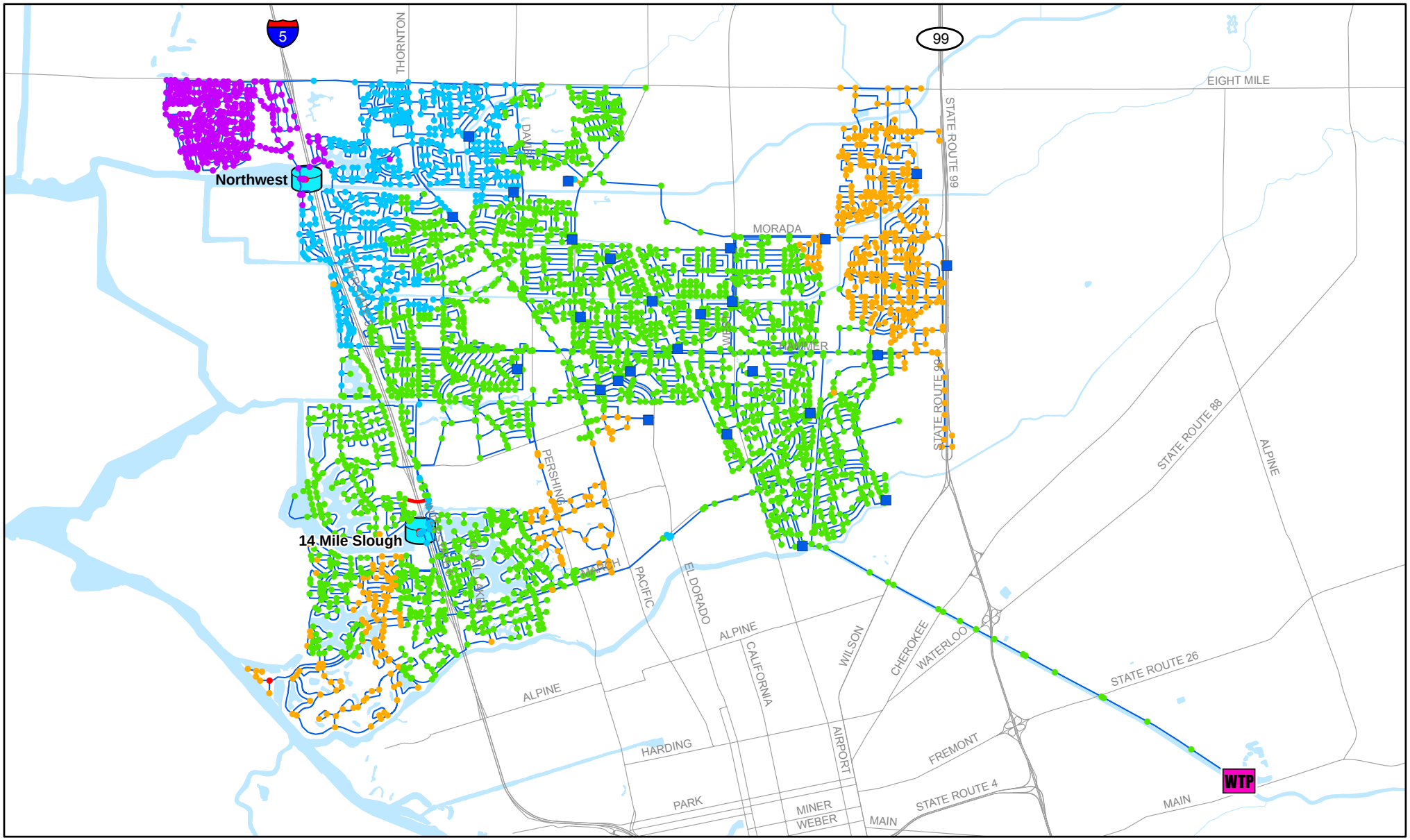

LEGEND:

- Existing Well
- Existing Water Tank
- SEWD WTP
- Water Feature
- Pressure ≤ 45 psi
- 45 < Pressure ≤ 50 psi
- 50 < Pressure ≤ 55 psi
- 55 < Pressure ≤ 60 psi
- Pressure > 60 psi
- Velocity ≤ 5 fps
- 5 fps < Velocity ≤ 7 fps
- Velocity > 7 fps
- Major Street

N

0 0.5 1 2

Scale in Miles

FIGURE 7-3

City of Stockton
Municipal Utilities Department
Water Master Plan Update

NORTH STOCKTON PEAK HOUR ANALYSIS

WEST YOST ASSOCIATES Consulting Engineers

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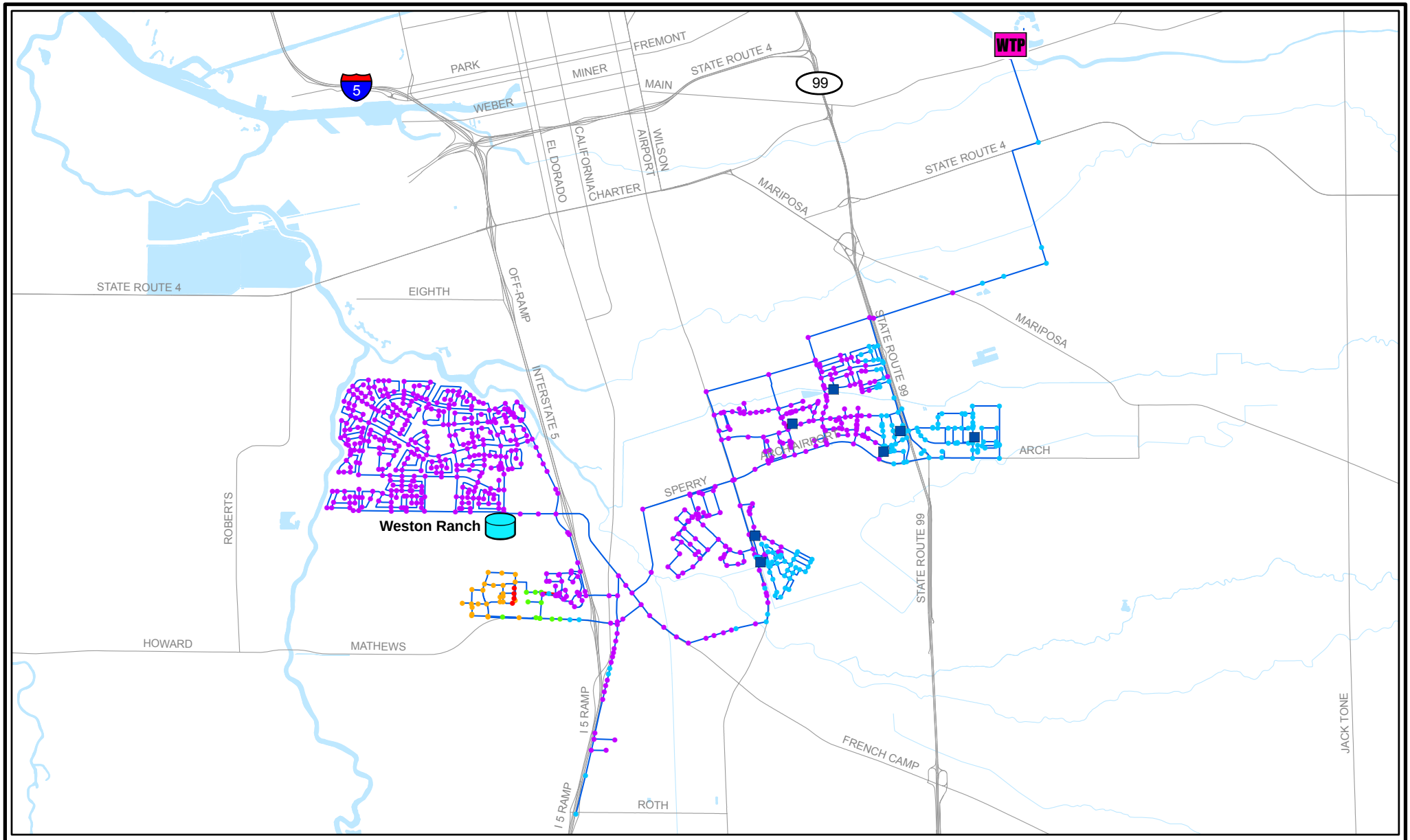

LEGEND:

- Existing Well
- Existing Water Tank
- SEWD WTP
- Water Feature
- Pressure ≤ 45 psi
- 45 < Pressure ≤ 50 psi
- 50 < Pressure ≤ 55 psi
- 55 < Pressure ≤ 60 psi
- Pressure > 60 psi
- Velocity ≤ 5 fps
- 5 fps < Velocity ≤ 7 fps
- Velocity > 7 fps
- Major Street

N

0 0.5 1 2

Scale in Miles

FIGURE 7-4

City of Stockton
Municipal Utilities Department
Water Master Plan Update

SOUTH STOCKTON PEAK HOUR ANALYSIS

WEST YOST ASSOCIATES Consulting Engineers

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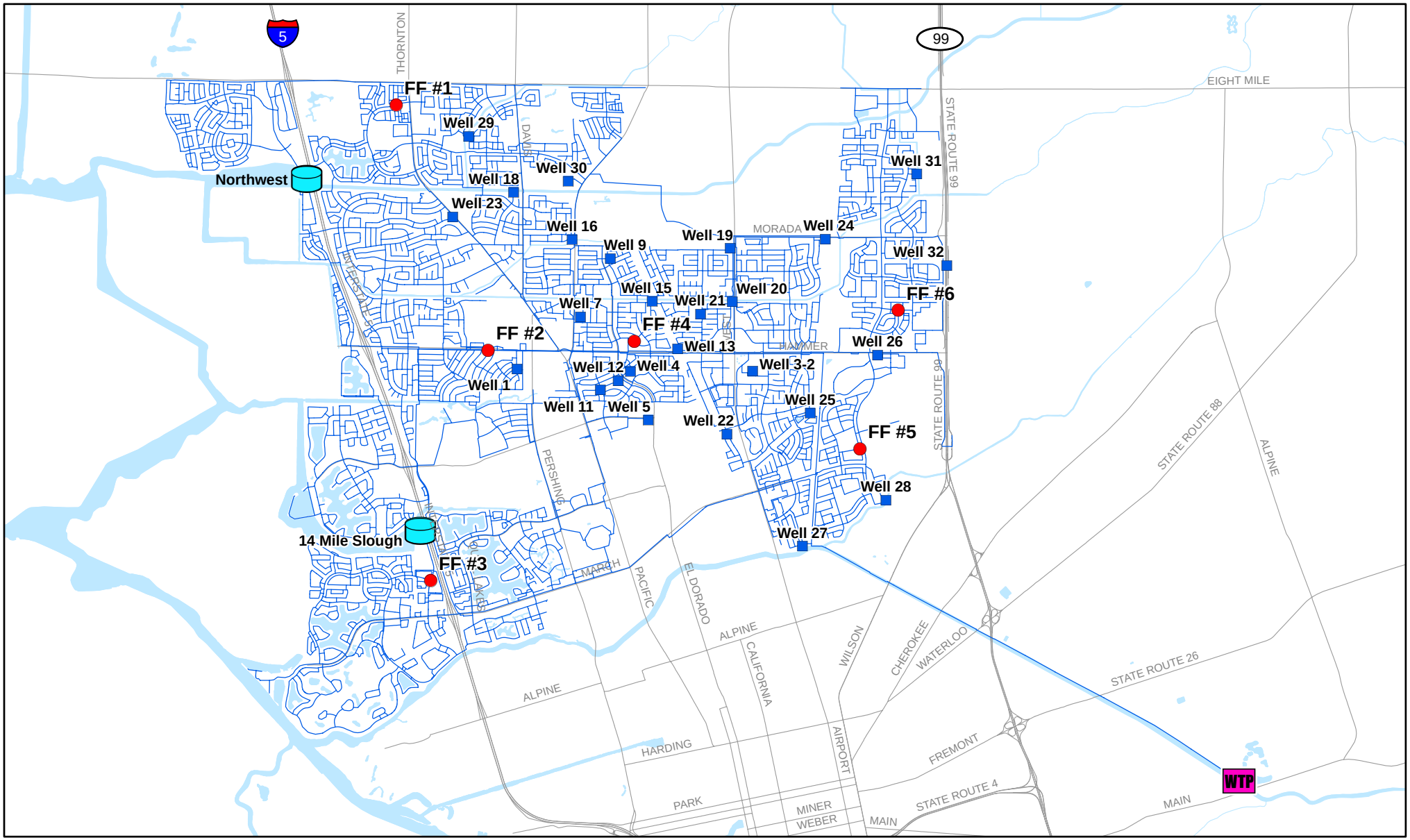


LEGEND:

- Fire Flow Location
- Existing Well
- Existing Water Tank
- SEWD WTP
- Pipeline
- Major Street
- Water Feature

N

0 0.5 1 2

Scale in Miles

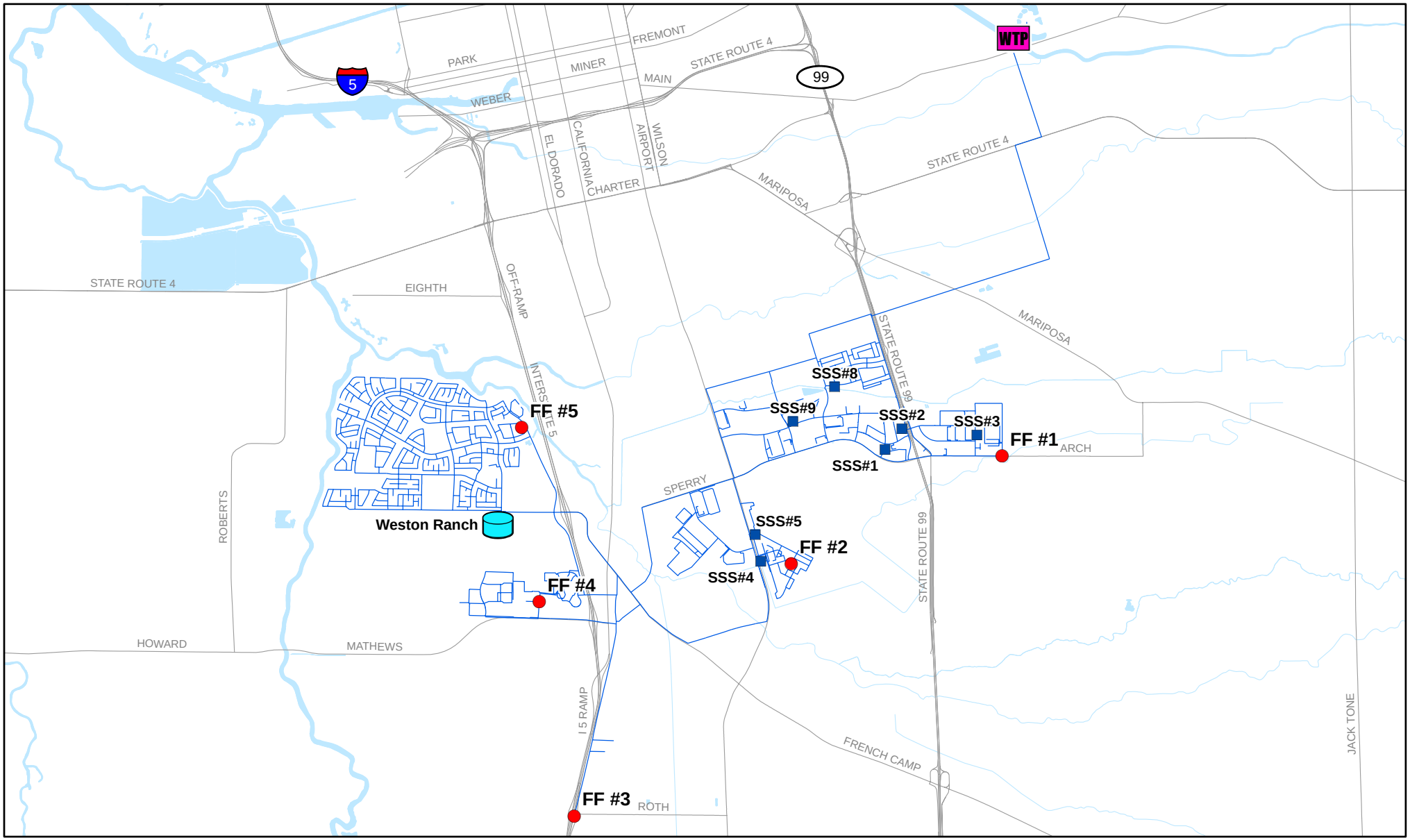
FIGURE 7-5

City of Stockton
Municipal Utilities Department
Water Master Plan Update

NORTH STOCKTON FIRE FLOW LOCATIONS

WEST YOST ASSOCIATES Consulting Engineers

O\C\408\020612\GIS\WMP Figures\Chapter 7\Figure 7-6_SS FF.mxd



LEGEND:

- Fire Flow Location
- Existing Well
- Existing Water Tank
- SEWD WTP
- Pipeline
- Major Street
- Water Feature

N

0 0.5 1 2

Scale in Miles

FIGURE 7-6

City of Stockton
Municipal Utilities Department
Water Master Plan Update

SOUTH STOCKTON FIRE FLOW LOCATIONS

WEST YOST ASSOCIATES Consulting Engineers

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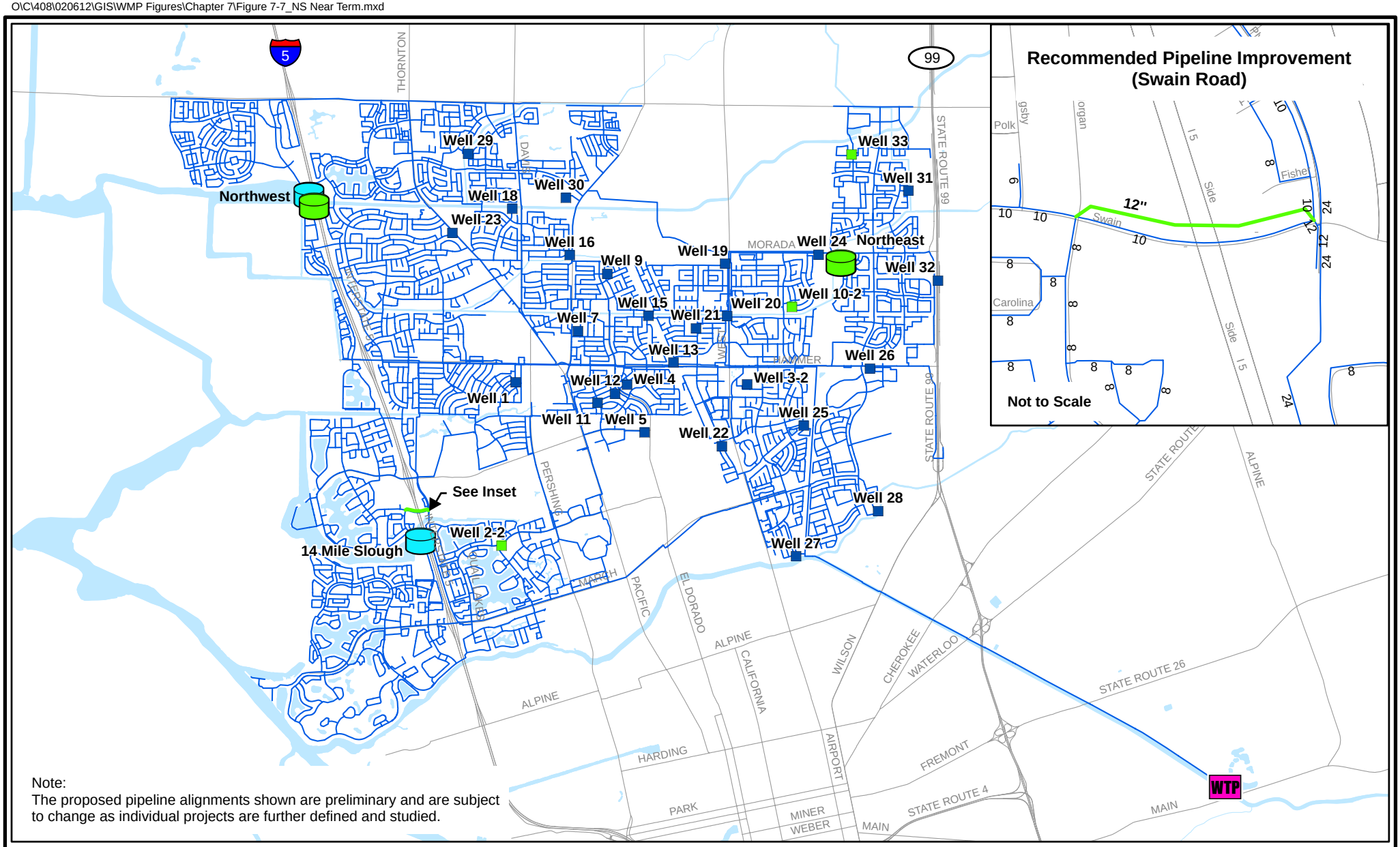

LEGEND:

- Existing Well
- Near Term Well
- Near Term Water Tank
- Existing Water Tank
- SEWD WTP
- Pipeline Improvement
- Existing Pipeline
- Major Street
- Water Feature

N

0 0.5 1 2

Scale in Miles

FIGURE 7-7

City of Stockton
Municipal Utilities Department
Water Master Plan Update

NORTH STOCKTON NEAR TERM IMPROVEMENTS

WEST YOST ASSOCIATES Consulting Engineers

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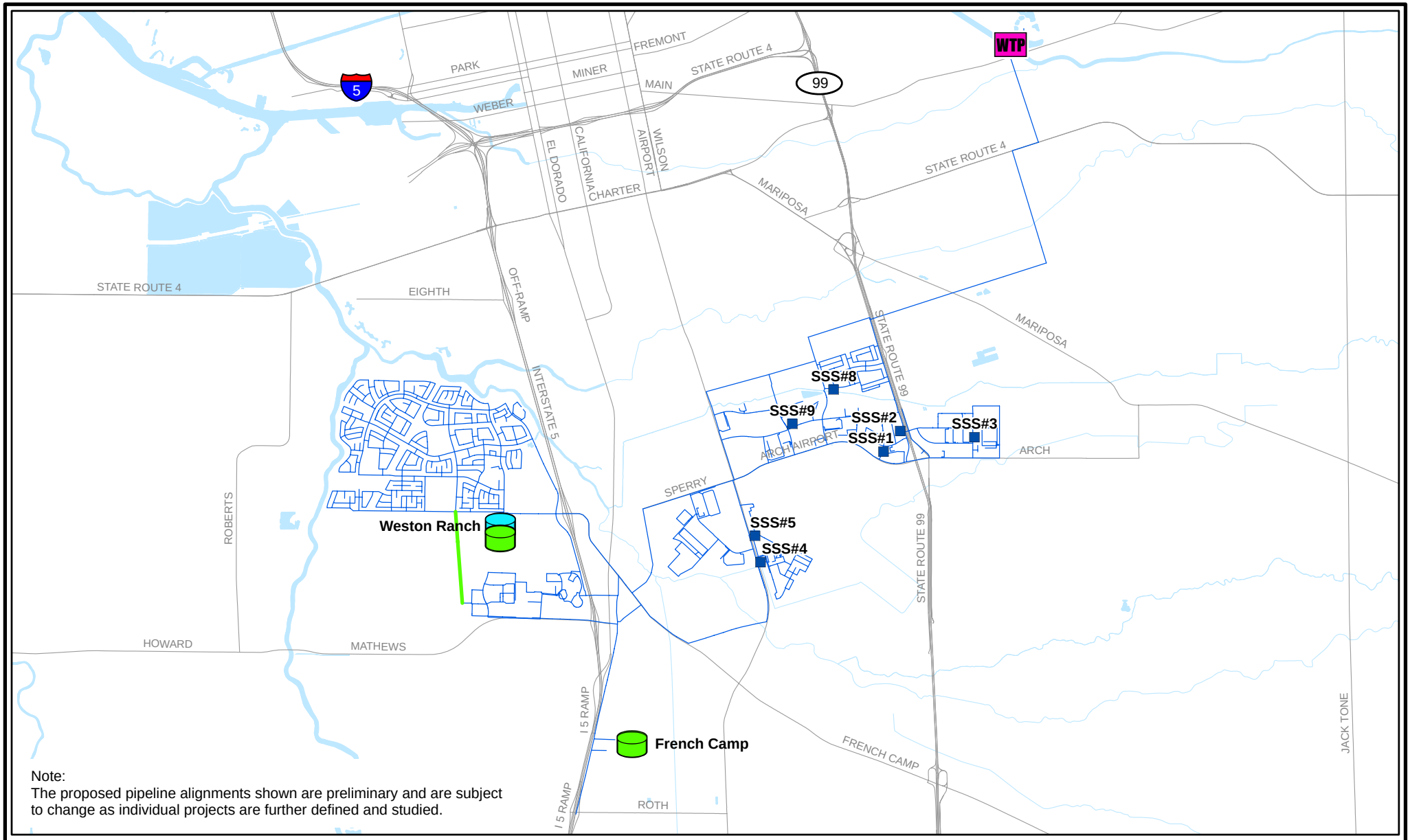


Note:
The proposed pipeline alignments shown are preliminary and are subject to change as individual projects are further defined and studied.

LEGEND:

- Existing Well
- Near Term Water Tank
- Existing Water Tank
- SEWD WTP
- Proposed 18-inch Diameter Pipeline
- Existing Pipeline
- Major Street
- Water Feature

N

0 0.5 1 2

Scale in Miles

FIGURE 7-8

City of Stockton
Municipal Utilities Department
Water Master Plan Update

SOUTH STOCKTON NEAR TERM IMPROVEMENTS

WEST YOST ASSOCIATES Consulting Engineers

CHAPTER 8. FUTURE WATER DISTRIBUTION SYSTEM ANALYSIS

This chapter presents the evaluation of the COS MUD's future water distribution system and its ability to meet the recommended performance and design criteria under future demand conditions. This evaluation includes an analysis of pumping capacity, water storage capacity and the future distribution system's ability to meet the recommended performance and design criteria under maximum day demand plus fire flow and peak hour demand conditions. The COS MUD's future water distribution system configuration is defined as the future network distribution system with all the existing operational facilities, plus any additional facilities required to meet the performance and design criteria in the new development areas as identified in Chapter 3. The evaluation is based on the operational performance and design criteria presented in Chapter 5 and any additional information provided to WYA by COS MUD staff.

The following sections of this Chapter describe the methodology, analysis, and recommendations for the COS MUD's future water system as follows:

- Projected Water Demands
- Water Supply and Treatment Facilities
- Pumping Capacity Evaluation
- Groundwater Pumping Capacity Evaluation
- Water Storage Capacity Evaluation
- Evaluation of Future Water Distribution System

The future system analysis was conducted using a hydraulic model that incorporated the improvements required to eliminate existing deficiencies and serve future growth. Projected water demands were then allocated into the future system model, and different demand conditions were simulated. Using the performance criteria in Chapter 5, new deficiencies were then identified in the future water distribution system as a result of future demands related to proposed development projects. Additional model simulations were also conducted to evaluate potential future system improvements. A summary of the future water distribution system analysis is presented in the following sections.

PROJECTED WATER DEMANDS

Water demands for North and South Stockton in 2035 have been projected based on future land use and the water duty factors established in Chapter 3. Future demands were allocated in the water distribution system model using H_2OMAP's *Demand Allocation/Pro*™. A summary of the future demands by service area is provided in Table 8-1.

Table 8-1. Projected Demands for North and South Stockton (2035)

Service Area	Demand Condition	Demand[a]	
		mgd	gpm
North Stockton	Average Day	60.7	42,157
	Maximum Day[b]	103.2	71,667
	Peak Hour[c]	212.5	147,550
South Stockton	Average Day	37.5	26,038
	Maximum Day[b]	63.7	44,265
	Peak Hour[c]	131.2	91,133

(a) Demand includes the existing demand and accounts for demand reduction due to conservation and demand increase due to UAFW (see Table 3-9).
(b) Maximum day demand is 1.7 times the average day demand.
(c) Peak hour demand is 3.5 times the average day demand.

WATER SUPPLY AND TREATMENT FACILITIES

North and South Stockton currently receive water supplies from SEWD WTP and groundwater wells as stated in Chapter 3. The projected supply availability of the SEWD WTP in a critically dry year in 2035 is 22,000 af (19.6 mgd). Of this amount, the COS MUD will receive half, while the remainder would supply CWSC. In a critically dry year, all the available SEWD treated surface water for the COS MUD (11,000 af) will go to South Stockton. It was also assumed that in this future analysis the groundwater yield would be increased to 1.1 af/ac/yr to help meet new demands in a critically dry year.

In addition, the COS MUD is expected to be supplied treated surface water from the DWSP by 2035. The total capacity of the DWSP is expected to be 30 mgd, and the COS MUD should normally receive 19.7 mgd (22,067 af) of capacity from the DWSP. However, the annual base supply of 32,308 af is available for the DWSP regardless of the water year type. Of this DWSP annual base supply, the COS MUD is expected to receive approximately 65 percent (21,000 af or 18.7 mgd). Using the annual base supply for the DWSP provides a more conservative estimate of supply availability. Based on these above conditions, Table 8-2 summarizes the average day demand and water supply availability for 2035 during a critically dry year.

Table 8-2. Comparison of Projected Average Day Demands in 2035 to Projected Water Supplies during a Critically Dry Year, af/yr, mgd

Service Area	Average Day Demand	Supply Available from SEWD WTP[(a)]	Supply Available from DWSP WTP[(b)]	Available Supply from Groundwater Basin[(c)]	Supply Deficit
North Stockton	68,000 (60.7)	-	21,000 (18.7)	35,279 (31.5)	11,721 (10.5)
South Stockton	42,000 (37.5)	11,000 (9.8)	-	25,331 (22.6)	5,669 (5.1)

(a) Based on critically dry year production of 22,000 af/yr and COS MUD's portion of 50 percent.
(b) Based on the annual base supply of 32,308 af and COS MUD's portion of 65 percent.
(c) Based on the estimated groundwater yield of 1.1 af/ac/yr and a total acreage of 32,072 and 23,028 for North and South Stockton, respectively for 2035.

It can be seen from Table 8-2 that, by 2035, there will be an average day supply deficit of approximately 10.5 mgd and 5.1 mgd in North and South Stockton, respectively in a critically dry year. This supply deficit in North and South Stockton will need to be met by either additional treated surface water supply or additional groundwater pumping at a groundwater yield of approximately 1.5 af/ac/yr. However, the future water supply deficit would improve if it was not a critically dry year, because the SEWD WTP is expected to expand to a capacity of 60 mgd, of which the COS MUD would receive approximately 29.1 mgd (32,596 af). This additional supply from SEWD WTP would allow the groundwater yield to maintain at approximately 1.1 af/ac/yr.

PUMPING CAPACITY EVALUATION

Sufficient pumping capacity must be provided to meet the greater of either a maximum day demand concurrent with fire flow demand or a peak hour demand. Each pump station was evaluated on its ability to deliver firm, reliable capacity to the service area. Therefore, pumping capacity was reduced to account for pumps that are out of service at any given time due to mechanical breakdowns, maintenance, water quality, or other operational issues. At each booster pump station, firm capacity was defined as the total booster pump station capacity with the largest pump out of service. For groundwater well pumps, the firm capacity was defined as the total pumping capacity of all the active wells minus 20 percent.

The existing pumping facilities in the North and South Stockton service areas were analyzed under 2035 peak hour demand conditions and the results are summarized in Table 8-3. In addition, Table 8-4 summarizes the pumping capacity of each station. As indicated on Table 8-3, the existing booster and groundwater pumping facilities will not be able to meet the pumping capacity criteria for a peak hour demand condition in 2035. An additional 91,571 gpm of booster and groundwater pumping capacity is required to meet a peak hour demand condition in 2035.

Table 8-3. Comparison of Firm Pumping Capacity to Projected Peak Hour Demands in 2035

Service Area	Pump Station	Existing/Proposed Pumping Capacity, gpm[a]	2035 Peak Hour Demand, gpm[b,c]
North Stockton	Northwest	19,800[f]	147,550
	Fourteen Mile Slough	11,250	
	Northeast	14,400[f]	
	DWSP[d]	13,680	
	Groundwater Wells	35,742	
Subtotal		*94,872*	
South Stockton	Weston Ranch	16,200[f]	91,133
	French Camp	7,200[f]	
	SEWD WTP[e]	20,200	
	Groundwater Wells	8,640	
Subtotal		*52,240*	
Total		147,112	238,683

(a) Defined as the total capacity of the individual pump station with the largest unit in the pump station out of service or the total capacity of active groundwater well pumps minus 20 percent. Well status defined as of February 2007 and includes near term wells.
(b) Based on existing and projected demand established in Chapter 3.
(c) Peak hour demand is 3.5 times the average day demand.
(d) DWSP supply based on 13,680 gpm available, which is 19.7 mgd of the 30 mgd WTP capacity.
(e) SEWD supply based on 20,200 gpm available, which is 29.1 mgd of the expanded 60 mgd WTP capacity.
(f) Proposed booster pumping capacity. Assumes that the proposed Northwest, Northeast, Weston Ranch, and French Camp tanks recommended as existing system improvements will be in service.

GROUNDWATER PUMPING CAPACITY EVALUATION

The pumps at the COS MUD's groundwater wells lift groundwater from the underlying groundwater basin into the distribution system. For this Water Master Plan Update, it was assumed that the COS MUD requires sufficient groundwater pumping capacity to lift available groundwater resources (i.e., 1.1 af/ac/yr) into its water distribution system.

This analysis, as shown in Table 8-5, indicates that the existing well pumps can meet the well pumping capacity requirement based on available groundwater resources in North Stockton by 2035. As for South Stockton, approximately four more wells may be required to pump the available groundwater by 2035.

Table 8-4. Summary of Existing and Near Term Pumping Facilities

Service Area	Station	Status	Pump 1, gpm	Pump 2, gpm	Pump 3, gpm	Pump 4, gpm	Pump 5, gpm	Total Capacity, gpm	Firm Capacity[a], gpm
North Stockton	NW	Active	5,000	3,800	3,800	5,000	--	17,600	12,600
North Stockton	NW	Proposed	3,600	3,600	3,600	--	--	10,800	7,200
North Stockton	FMS	Active	3,300	3,300	2,650	2,650	2,650	14,550	11,250
North Stockton	NE	Proposed	3,600	3,600	3,600	3,600	3,600	18,000	14,400
North Stockton	DWSP[b]	Proposed	13,680	--	--	--	--	13,680	13,680
							North Stockton Subtotal (Booster Pumps)	*74,630*	***59,130***
North Stockton	1	Active	648	--	--	--	--	648	29,742
North Stockton	3-2	Active	2,000	--	--	--	--	2,000	
North Stockton	4	Standby	1,050	--	--	--	--	0	
North Stockton	5	Active	480	--	--	--	--	480	
North Stockton	7	Active	550	--	--	--	--	550	
North Stockton	9	Active	540	--	--	--	--	540	
North Stockton	11	Active	1,100	--	--	--	--	1,100	
North Stockton	12	Active	760	--	--	--	--	760	
North Stockton	13	Active	2,000	--	--	--	--	2,000	
North Stockton	15	Active	2,000	--	--	--	--	2,000	
North Stockton	16	Active	2,000	--	--	--	--	2,000	
North Stockton	18	Active	800	--	--	--	--	800	
North Stockton	19	Active	2,000	--	--	--	--	2,000	
North Stockton	20	Active	2,000	--	--	--	--	2,000	
North Stockton	21	Active	2,000	--	--	--	--	2,000	
North Stockton	22	Standby	1,900	--	--	--	--	0	
North Stockton	23	Active	900	--	--	--	--	900	
North Stockton	24	Out of Service	1,040	--	--	--	--	0	
North Stockton	25	Active	2,200	--	--	--	--	2,200	
North Stockton	26	Active	2,400	--	--	--	--	2,400	
North Stockton	27	Active	2,000	--	--	--	--	2,000	
North Stockton	28	Active	1,400	--	--	--	--	1,400	
North Stockton	29	Active	3,200	--	--	--	--	3,200	
North Stockton	30	Active	2,200	--	--	--	--	2,200	
North Stockton	31	Active	2,000	--	--	--	--	2,000	
North Stockton	32	Active	2,000	--	--	--	--	2,000	
							North Stockton Subtotal (Groundwater Well Pumps)	*37,178*	***29,742***
North Stockton	33	Proposed	2,000	--	--	--	--	2,000	6,000
North Stockton	2-2	Proposed	2,000	--	--	--	--	2,000	
North Stockton	10-2	Proposed	2,000	--	--	--	--	2,000	
							North Stockton Subtotal (Proposed Groundwater Well Pumps)	*6,000*	***6,000***
South Stockton	WR	Active	3,000	3,000	3,000	3,000	--	12,000	9,000
South Stockton	WR	Proposed	3,600	3,600	3,600	--	--	10,800	7,200
South Stockton	FC	Proposed	3,600	3,600	3,600	--	--	10,800	7,200
South Stockton	SEWD WTP[c]	Proposed	20,200	--	--	--	--	20,200	20,200
							South Stockton Subtotal (Booster Pumps)	*53,800*	***43,600***
South Stockton	SSS #1	Active	1,800	--	--	--	--	1,800	8,640
South Stockton	SSS #2	Active	1,400	--	--	--	--	1,400	
South Stockton	SSS #3	Active	2,000	--	--	--	--	2,000	
South Stockton	SSS #4	Standby	700	--	--	--	--	0	
South Stockton	SSS #5	Standby	800	--	--	--	--	0	
South Stockton	SSS #8	Active	2,800	--	--	--	--	2,800	
South Stockton	SSS #9	Active	2,800	--	--	--	--	2,800	
							South Stockton Subtotal (Groundwater Well Pumps)	*10,800*	***8,640***
							Total Pumping Capacity		**147,112**

[a] Firm capacity is defined as the total booster pumping capacity with the largest pump out of service or the total active groundwater well pumping capacity minus 20 percent.

[b] DWSP supply based based on 13,680 gpm available, which is 19.7 mgd of the 30 mgd WTP capacity.

[c] SEWD supply based on 20,200 gpm available, which is 29.1 mgd of the expanded 60 mgd WTP capacity.

Table 8-5. Comparison of Existing Groundwater Pumping Capacity to Future Available Groundwater Supply

Service Area	2035 Area, acres	Available Groundwater Supply, mgd[(a)]	Existing Pumping Capacity of Wells, mgd[(b)]	Extra Pumping Capacity Required, mgd
North Stockton	32,072	31.5	42.8	--
South Stockton	23,028	22.6	12.4	10.2

(a) Based on target groundwater yield of 1.1 af/ac/yr and total 2035 acreage of 32,072 and 23,028 in North and South Stockton, respectively.

(b) Based on the total capacity of active groundwater well pumps minus 20 percent. Well status defined as of February 2007 and does not include near term wells.

WATER STORAGE CAPACITY EVALUATION

The required water storage capacity within the COS MUD service area must meet the operational, fire flow, and emergency storage criteria. Specific volume requirements for each of these storage components were defined in Chapter 5 as follows:

- Operational Storage: 25 percent of a maximum day demand;
- Emergency Storage: An average day demand; and
- Fire Flow Storage: The maximum fire flow multiplied by the fire flow duration period, as required by the City's Fire Marshal. However, two fire flow events were assumed for storage to provide a more conservative fire flow storage estimate. The largest fire flow of 4,500 gpm for the duration of 4 hours, and a smaller Multi-Family Residential fire flow of 3,000 gpm for the duration of 3 hours were assumed for this evaluation.

The existing storage facilities and credits from groundwater and WTPs were evaluated to determine whether there is sufficient capacity to provide the required operational, fire flow, and emergency storage. Groundwater credits assume that the smaller of either 60 percent of the total active groundwater pumping capacity or 100 percent of the total active groundwater pumping capacity of wells that are equipped with backup power will be available to supplement required water storage. Therefore, 60 percent of the total active groundwater pumping capacity is 37.3 MG (includes groundwater credit for near term wells) and 9.3 MG for North and South Stockton, respectively and is also equal to the maximum available groundwater credit. However, the actual available groundwater credit from active/near term wells equipped with backup power is 24.0 MG and 2.6 MG for North and South Stockton, respectively.

As presented in Table 8-6, the storage capacity in North Stockton is approximately 65.9 MG, while storage capacity in South Stockton is approximately 11.6 MG. Table 8-6 indicates that North Stockton has a storage deficiency of approximately 22.1 MG, while South Stockton has a storage deficiency of approximately 43.3 MG. Table 8-7 summarizes the existing available storage capacity, groundwater credits, and required storage capacity.

Table 8-6. Summary of Year 2035 Storage Capacity Deficiencies

Service Area	Available Storage Capacity, MG				Required Storage Capacity, MG				Additional Storage Capacity Required, MG[d]
	Reservoir Capacity[a]	Groundwater Credits[b]	WTP Credit[c]	Total	Operational	Fire flow	Emergency	Total	
North Stockton	22.2	24.0	19.7	65.9	25.8	1.5	60.7	88.0	22.1
South Stockton	9.0	2.6	--	11.6	15.9	1.5	37.5	54.9	43.3

(a) Assumes the proposed Northwest, Northeast, Weston Ranch and French Camp tanks recommended for existing system improvements will be in service.
(b) Equal to the total groundwater pumping capacity of active wells with backup power and assumes that the near term wells will have backup power installed.
(c) It was assumed that the smaller of the two surface WTPs will be available to offset storage.
(d) Calculated as required storage minus available storage.

This analysis shows that for 2035, an additional storage capacity of about 22.1 MG is needed for North Stockton. This can be met from the following additional storage facilities/credits:

- North Central Tank (1) = 3.0 MG
- Southeast Tanks (2) = 6.0 MG
- DWSP Tank (1) = 10.0 MG
- 2 Additional Wells with Backup Power (2.9 MGD each) = 5.8 MG groundwater credit

An additional storage of 43.3 MG will also be needed in South Stockton by 2035. This can be met from the following additional storage facilities/credits:

- East Area Tanks (2) = 6.0 MG
- Terminal Reservoir (1) = 8.0 MG
- Far East Area Tanks (2) = 6.0 MG
- 9 Additional Wells with Backup Power (2.9 MGD each) = 26.1 MG groundwater credit

The number of additional wells with backup power needed to provide groundwater storage credit can be reduced if backup power is installed at existing groundwater well facilities. This will reduce the amount of new wells with backup power required to meet the storage criteria. However, an additional 20 wells have already been proposed for construction in the future water distribution system to meet maximum day demands. Installing backup power on at least 11 of these proposed wells will ensure that the COS MUD will meet its required storage capacity.

Table 8-7. Summary of Future Storage Requirements

Service Area	Station	Status	Required Storage Capactiy, MG			Total Required Storage, MG	Reservoir Capacity, MG	Well Pump Capacity[d], MG	Groundwater Credit[e], MG	WTP Credit[f],	Storage Surplus (Deficit), MG
			Operational[a]	Fire Flow[b]	Emergency[c]						
North Stockton	NW	Active					6.8	--		--	
North Stockton	NW	Proposed					3.4	--		--	
North Stockton	FMS	Active					6.0	--		19.7	
North Stockton	NE	Proposed					6.0	--		--	
North Stockton	DWSP	Proposed					--	--		--	
North Stockton	1	Active					--	--		--	
North Stockton	3-2	Active					--	--		--	
North Stockton	4	Standby					--	--		--	
North Stockton	5	Active					--	--		--	
North Stockton	7	Active					--	--		--	
North Stockton	9	Active					--	--		--	
North Stockton	11	Active					--	--		--	
North Stockton	12	Active					--	--		--	
North Stockton	13	Active					--	2.88		--	
North Stockton	15	Active					--	--		--	
North Stockton	16	Active					--	2.88		--	
North Stockton	18	Active	25.8	1.5	60.7	88.0	--	--	24.0	--	(22.1)
North Stockton	19	Active					--	--		--	
North Stockton	20	Active					--	2.88		--	
North Stockton	21	Active					--	--		--	
North Stockton	22	Standby					--	--		--	
North Stockton	23	Active					--	--		--	
North Stockton	24	Out of Service					--	--		--	
North Stockton	25	Active					--	3.17		--	
North Stockton	26	Active					--	3.46		--	
North Stockton	27	Active					--	--		--	
North Stockton	28	Active					--	--		--	
North Stockton	29	Active					--	--		--	
North Stockton	30	Active					--	--		--	
North Stockton	31	Active					--	--		--	
North Stockton	32	Active					--	--		--	
North Stockton	33	Proposed					--	2.90		--	
North Stockton	2-2	Proposed					--	2.90		--	
North Stockton	10-2	Proposed					--	2.90		--	
South Stockton	WR	Active					3.0	--		--	
South Stockton	WR	Proposed					3.0	--		--	
South Stockton	FC	Proposed					3.0	--		--	
South Stockton	SEWD WTP	Proposed					--	--		--	
South Stockton	SSS #1	Active					--	2.59		--	
South Stockton	SSS #2	Active	15.9	1.5	37.5	54.9	--	--	2.6	--	(43.3)
South Stockton	SSS #3	Active					--	--		--	
South Stockton	SSS #4	Standby					--	--		--	
South Stockton	SSS #5	Standby					--	--		--	
South Stockton	SSS #8	Active					--	--		--	
South Stockton	SSS #9	Active					--	--		--	
										Total Storage Capacity	**(65.4)**

[a] Based on 25 percent of maximum day demand.
[b] Based on a fire flow of 4,500 gpm multiplied by a 4 hour duration, and a fire flow of 3,000 gpm multiplied by a 3 hour duration.
[c] Based on an average day demand.
[d] Pump capacity of wells with backup power.
[e] Equal to the sum of the total groundwater pumping capacity of active wells with backup power and assumes that the proposed wells will have backup power installed.
[e] Equal to 19.7 mgd at the DWSP WTP to offset storage requirement.

EVALUATION OF FUTURE WATER DISTRIBUTION SYSTEM

The future water system was analyzed using the updated and verified steady state hydraulic model that integrated facilities required to fix existing deficiencies and facilities required to serve projected demands in 2035. This steady state analysis identified areas of the COS MUD's future water system that could not maintain the performance and design criteria while supplying projected water demands in 2035. Additional model simulations were conducted to evaluate the need for other system improvements and/or enhancements (including new pipeline connections, parallel pipelines or replacement pipelines), in those areas not meeting the performance criteria.

Figures 8-1 and 8-2 illustrate the future water distribution system for North and South Stockton in 2035. Figure 8-1 also indicates potential locations for turnouts to serve DWSP WTP supply to CWSC. Some of the locations are existing interties that would require conversion (SCADA and meters) to a turnout. However, analysis of these turnouts is beyond the scope of this Water Master Plan Update. In addition, a 24-inch diameter Westside Transmission Main is recommended to connect the North and South Stockton service areas on the west side of the City. This transmission main is critical from both a water supply and capacity standpoint for the South Stockton Service Area.

The future water distribution system was evaluated under the following demand scenarios:

- Peak Hour Demand - A peak hour flow condition was simulated to evaluate the capability of the future distribution facilities to meet a peak hour demand condition. Peak hour demands are met by the combined flows from the water treatment plants, groundwater wells, and storage reservoirs.
- Maximum Day Demand plus Fire Flow - To evaluate the system under each maximum day plus fire flow condition, a two-step analysis was followed. The first step used the H_2ONET "Available Fire Flow Analysis" option to determine if the minimum pressure and required fire flow could be met with existing facilities. If the analysis indicated that the system failed to meet the minimum requirements for pressure and flow, a second analysis was performed. The second analysis involved running the model with pipeline improvements added to the distribution system to eliminate previously identified system constraints and/or deficiencies.

Subsequent sections describe the results of the steady state hydraulic modeling of the COS MUD's future water distribution system under peak hour demand and maximum day demand plus fire flow conditions.

Peak Hour Demand

The future system demand for peak hour was calculated as 238,683 gpm (343.7 mgd), representing 3.5 times the average day demand. It was assumed that approximately 20,200 gpm (29.1 mgd) and 13,680 gpm (19.7 mgd) would be available from the SEWD WTP and the DWSP WTP, respectively. It was also assumed that the available supply from the SEWD WTP would first be stored in a Terminal Reservoir, and then pumped into South Stockton to boost pressures. The peak hour demand results for North and South Stockton are further discussed below.

Results for the Future North Stockton Service Area

As shown in Figure 8-3, the majority of the North Stockton Service Area has pressures between 55 to 65 psi, while meeting peak hour demand. However, the pressures on the west and south side of the service area experience pressures between 50 to 55 psi.

Figure 8-3 also indicated that the velocities within the distribution system were generally below the 7 fps criterion; however, in the vicinity of the Southeast booster pump station, additional capacity was required. This is further described below:

- The 18-inch diameter pipeline west of the proposed Southeast booster pump station had a head loss of 23 ft/kft and a velocity of 11 fps.
- The 12-inch diameter pipelines west of the proposed Southeast booster pump station have a head loss of 19 ft/kft and a velocity of 8 fps.
- Various 8-inch and 6-inch diameter pipelines south of the proposed Southeast booster pump station have head losses that ranged between 25 to 180 ft/kft and velocities that ranged between 8 to 18 fps.
- The 24-inch diameter transmission pipelines near the FMS booster pump station had head losses between 4 to 8 ft/kft and velocities between 6 to 8 fps. However, no improvements are recommended for these pipelines exceeding the velocity and head loss criteria because the pressures are above 45 psi, and they are also existing pipelines.
- The 12-inch diameter pipeline along W. March Lane and east of I-5 had a head loss of 25 ft/kft and a velocity of 10 fps. However, no improvements are recommended for the pipeline exceeding the velocity and head loss criteria because the pressures are above 45 psi, and it is also an existing pipeline.
- The 12-inch diameter pipeline along Otto Drive and west of Mariners Drive had a head loss of 19 ft/kft and a velocity of 8 fps. However, no improvements are recommended for the pipeline exceeding the velocity and head loss criteria because the pressures are above 45 psi, and it is also an existing pipeline.
- The 12-inch diameter pipeline at the intersection of W. Swain Road and Plymouth Road had a head loss of 24 ft/kft and a velocity of 8 fps. However, no improvements are recommended for the pipeline exceeding the velocity and head loss criteria because the pressures are above 45 psi, and it is also an existing pipeline.

Pipeline improvement recommendations have been made for the pipelines listed above at the end of this chapter. In addition, there were other existing pipelines that exceeded the head loss criterion, but no mitigation is recommended, because the pipeline velocities were less than the 7 fps criterion in these cases.

Results for the Future South Stockton Service Area

During a maximum day demand condition, approximately 7,000 gpm was available from North Stockton (through the 24-inch diameter Westside Transmission Main) at a pressure of approximately 55 psi. However, during a peak hour demand analysis, only 5,500 gpm was available from North Stockton at a pressure of approximately 55 psi. This supply from North

Stockton will primarily help supply South Stockton during a maximum day demand condition when supply from the tanks may not be enough to meet consecutive maximum day demands.

Due to the extensive length of the Westside Transmission Main (approximately 9 miles), there is considerable head loss and pressure drop by the time the supply reaches the South Stockton Service Area. Therefore, it is proposed that the Westside Transmission Main will directly supply flow to the Weston Ranch tanks and allow the use the existing booster pumping capacity at the Weston Ranch station to boost pressures during a maximum day demand condition within the South Stockton Service Area. This configuration allows the Weston Ranch tanks to serve as a "Terminal Reservoir" for the Westside Transmission Main.

Figure 8-4 indicated that the system pressures during peak hour demands in 2035 did not meet the pressure criterion even with additional supply from North Stockton. Pressures were below the criterion mostly on the southwest side of the system. The pressures in the vicinity of the County Jail were as low as 34 psi. Installing a 12-inch diameter pipeline to parallel the 8-inch diameter pipeline on the west side of the County Jail increases the pressures to 36 psi, but this is still below the pressure criterion. Installing an additional 3 MG tank at the French Camp booster pump station would help boost pressures in the entire southwest side of the system. This additional tank will provide a proposed booster pump flow of 7,200 gpm to help the South Stockton Service Area meet the pressure criterion of 45 psi without any additional supply from North Stockton during a peak hour demand condition given the 12-inch diameter parallel pipeline improvement will also be implemented.

With the exception of the southwest side of the system, the system pressures in South Stockton generally ranged between 45 to 50 psi on the west side, and 60 to 75 psi on the east side. The east side of the South Stockton Service Area had higher pressures due to the east side's proximity to the SEWD WTP.

Figure 8-4 also indicated that the velocities within the distribution system were generally below the 7 fps criterion, except at the following locations:

- The 8-inch diameter pipeline connecting the Hospital to the County Jail had a head loss of 33 ft/kft and a velocity of 8 fps.
- The 18-inch diameter pipelines coming out of the WR booster pump station toward French Camp Road had head losses between 8 to 32 ft/kft and velocities between 7 to 13 fps. However, no improvements are recommended for these pipelines exceeding the velocity and head loss criteria, because the pressures are above 45 psi, and they are also existing pipelines.
- The 30-inch diameter pipeline coming out of the WR booster pump station had a head loss of 7 ft/kft and a velocity of 8 fps. However, no improvements are recommended for the pipeline exceeding the velocity and head loss criteria, because the pressures are above 45 psi in the vicinity of this area, and it is also an existing pipeline.

Pipeline improvement recommendations have been made for the pipelines listed above at the end of this chapter. In addition, there were other existing pipelines that exceeded the head loss criterion, but no mitigation is recommended, because the pipeline velocities were less than the 7 fps criterion in these cases.

Maximum Day plus Fire Flow Demand

Figures 8-5 and 8-6 present the locations of the fire flows modeled in North and South Stockton for 2035. The same fire flow locations were used for 2035, even though there were facility changes to observe whether the increased demand on the water system would cause the locations to fail the fire flow tests. These locations represented the different types of fire flows expected to occur in the COS MUD's future water distribution system. In all cases, the minimum residual pressure was above the criterion of 20 psi, indicating that the proposed future system configuration in 2035 could support the necessary fire flows. The results for North and South Stockton are discussed further below.

Results of the Fire Flow Analysis for the Future North Stockton Service Area

The following fire flow analysis assumed that 7,000 gpm is available for South Stockton (through the 24-inch diameter Westside Transmission Main) during a maximum day demand plus fire flow condition.

Fire flow tests were modeled at the following six (6) locations for North Stockton:

1. Northwest. A fire flow of 4,500 gpm was modeled at the intersection of A. G. Spanos Boulevard and Siskiyou Lane. All residual pressures remained above 20 psi and velocities were below 10 fps. However, a head loss of 12 ft/kft was experienced in an 8-inch diameter pipeline within close proximity to the fire flow. Currently, no improvements are recommended for the pipeline exceeding the head loss criterion, because the pressures are above 20 psi, and it is an existing pipeline.
2. Western side of Hammer Lane. A fire flow of 4,500 gpm was modeled at the intersection of Hammer Lane and Woodside Drive. All residual pressures remained above 20 psi. However, velocities reached 14 fps and head losses ranged from 11 to 80 ft/kft in the 4-inch, 6-inch and 8-inch diameter pipelines within close proximity to the fire flow. Currently, no improvements are recommended for the pipelines exceeding the velocity and head loss criteria, because the pressures are above 20 psi, and they are existing pipelines.
3. Southwest. A fire flow of 4,500 gpm was modeled at the intersection of Driftwood Place and Feather River Drive. All residual pressures remained above 20 psi and velocities were below 10 fps. However, pipeline head losses ranged from 11 to 26 ft/kft in the 8-inch and 12-inch diameter pipelines within close proximity to the fire flow. Currently, no improvements are recommended for the pipelines exceeding the head loss criterion, because the pressures are above 20 psi, and they are existing pipelines.
4. Central North Stockton. A fire flow of 3,000 gpm was modeled in the high density residential area close to the intersection of Iris Avenue and Strathaven Way. All residual pressures remained above 20 psi. However, velocities reached 11 fps and head losses ranged from 12 to 51 ft/kft in the 6-inch and 8-inch diameter pipelines within close proximity to the fire flow. Currently, no improvements are recommended for the pipelines exceeding the velocity and head loss criteria, because the pressures are above 20 psi, and they are existing pipelines.

5. Southeast. A fire flow of 2,000 gpm was modeled at the intersection of Mirasol Lane and Rayanna Drive. All residual pressures remained above 20 psi and velocities were below 10 fps. However, pipeline head losses ranged from 17 to 26 ft/kft in the 8-inch diameter pipelines within close proximity to the fire flow. Currently, no improvements are recommended for the pipelines exceeding the head loss criterion, because the pressures are above 20 psi, and they are existing pipelines.
6. Northeast. A fire flow of 4,500 gpm was modeled at the intersection of Bryant Drive and Wakeman Drive. All residual pressures remained above 20 psi, velocities below 10 fps, and head losses below 10 ft/kft, thus meeting the performance criteria.

The head loss criterion was not met for five out of the six fire flow tests. However, no improvements are recommended for these pipelines, because the pressure criterion has been met, and they are also existing pipelines. Generally, the modeling results indicate that fire flows can be supported in the North Stockton Service Area in 2035 given the recommended system improvements are implemented.

Results of the Fire Flow Analysis for the Future South Stockton Service Area

The following fire flow analysis assumed that 7,000 gpm would be available from North Stockton (through the 24-inch diameter Westside Transmission Main) during a maximum day demand plus fire flow condition.

Fire flow tests were modeled at the following five (5) locations in South Stockton:

1. East side. A fire flow of 4,500 gpm was modeled at the intersection of Arch Road and Fite Court. All residual pressures remained above 20 psi, velocities below 10 fps, and head losses below 10 ft/kft, thus meeting the performance criteria.
2. Airport. A fire flow of 4,500 gpm was modeled at the airport. All residual pressures remained above 20 psi. However, velocities reached 14 fps and head losses ranged from 11 to 96 ft/kft in the 6-inch and 8-inch diameter pipelines within close proximity to the fire flow. Currently, no improvements are recommended for the pipelines exceeding the velocity and head loss criteria, because the pressures are above 20 psi, and they are existing pipelines.
3. French Camp. A fire flow of 4,500 gpm was modeled on the 12-inch pipeline alongside I-5. The residual pressure was below 20 psi and the velocity reached 13 fps and the head loss was 41 ft/kft in the 12-inch diameter pipeline within close proximity to the fire flow. It is recommended that this pipeline be upsized to a 16-inch diameter pipeline to meet the minimum fire flow requirements.
4. County Jail. A fire flow of 4,500 gpm was modeled in the County Jail. All residual pressures remained above 20 psi. However, velocities reached 16 fps and head losses ranged from 14 to 118 ft/kft in the 8-inch diameter pipelines within close proximity to the fire flow. Currently, no improvements are recommended for the pipelines exceeding the velocity and head loss criteria, because the pressures are above 20 psi, and they are existing pipelines.

5. Weston Ranch. A fire flow of 2,000 gpm was modeled on an 8-inch pipeline near the east end of WR. All residual pressures remained above 20 psi and velocities were below 10 fps. However, pipeline head losses ranged from 15 to 37 ft/kft in the 8-inch diameter pipelines within close proximity to the fire flow. Currently, no improvements are recommended for the pipelines exceeding the head loss criterion, because the pressures are above 20 psi, and they are existing pipelines.

The head loss criterion was not met for four out of the five fire flow tests. However, no improvements are recommended for these pipelines, because the pressure criterion has been met, and they are also existing pipelines. Generally, the modeling results indicate that fire flows can be supported in the South Stockton Service Area in 2035 given the recommended system improvements are implemented.

Recommended Improvements for the Future Water System

The recommended improvements for pipelines, wells and storage, following the analysis of the future distribution system in North and South Stockton, are discussed below. Figures 8-7 and 8-8 illustrate the recommended improvements based on this analysis. These figures also illustrate the proposed pipelines in the 2035 water distribution system. The capital costs associated with these improvements are detailed in Chapter 9.

North Stockton Service Area

Pipelines. In order to meet the performance criteria during a peak hour demand condition, the following pipeline improvements are recommended for the 2035 water distribution system:

- Install pipelines of various diameters and lengths as shown in Figure 8-1.
- Install an 18-inch diameter parallel pipeline west of the proposed Southeast booster pump station.
- Install a 12-inch diameter parallel pipeline west of the proposed Southeast booster pump station.
- Install a 16-inch diameter parallel pipeline south of the proposed Southeast booster pump station.

Wells. Fifteen (15) new production wells are proposed for the 2035 water distribution system.

Storage. The following storage tanks are proposed for the 2035 water distribution system:

- North Central Tank (1) = 3.0 MG
- Southeast Tanks (2) = 6.0 MG
- DWSP Tank (1) = 10.0 MG

South Stockton Service Area

Pipelines. In order to meet the performance criteria during a peak hour demand condition, the following pipeline improvements are recommended for the 2035 water distribution system:

- Install pipelines of various diameters and lengths as shown in Figure 8-2.
- Install a 12-inch diameter parallel pipeline on Harty Lane inside the County Jail area.

The proposal of an additional tank at the French Camp booster pump station removes the velocity violation for the 8-inch diameter pipeline connecting the Hospital and the County Jail during a peak hour demand condition.

In order to meet the performance criteria during a maximum day plus fire flow condition, the following pipeline improvements are recommended for the 2035 water distribution system:

- Replace the existing 12-inch diameter pipeline along I-5 and north of E. Roth Road with a 16-inch diameter pipeline.

As recommended in Chapter 7, WYA suggests that the COS MUD should confirm the existing pipeline configuration in the Airport, County Jail and Hospital area for possible pipeline improvements to reduce velocities and head losses during peak hour demand and maximum day demand plus fire flow conditions.

Wells. Five (5) new production wells are proposed for the 2035 water distribution system.

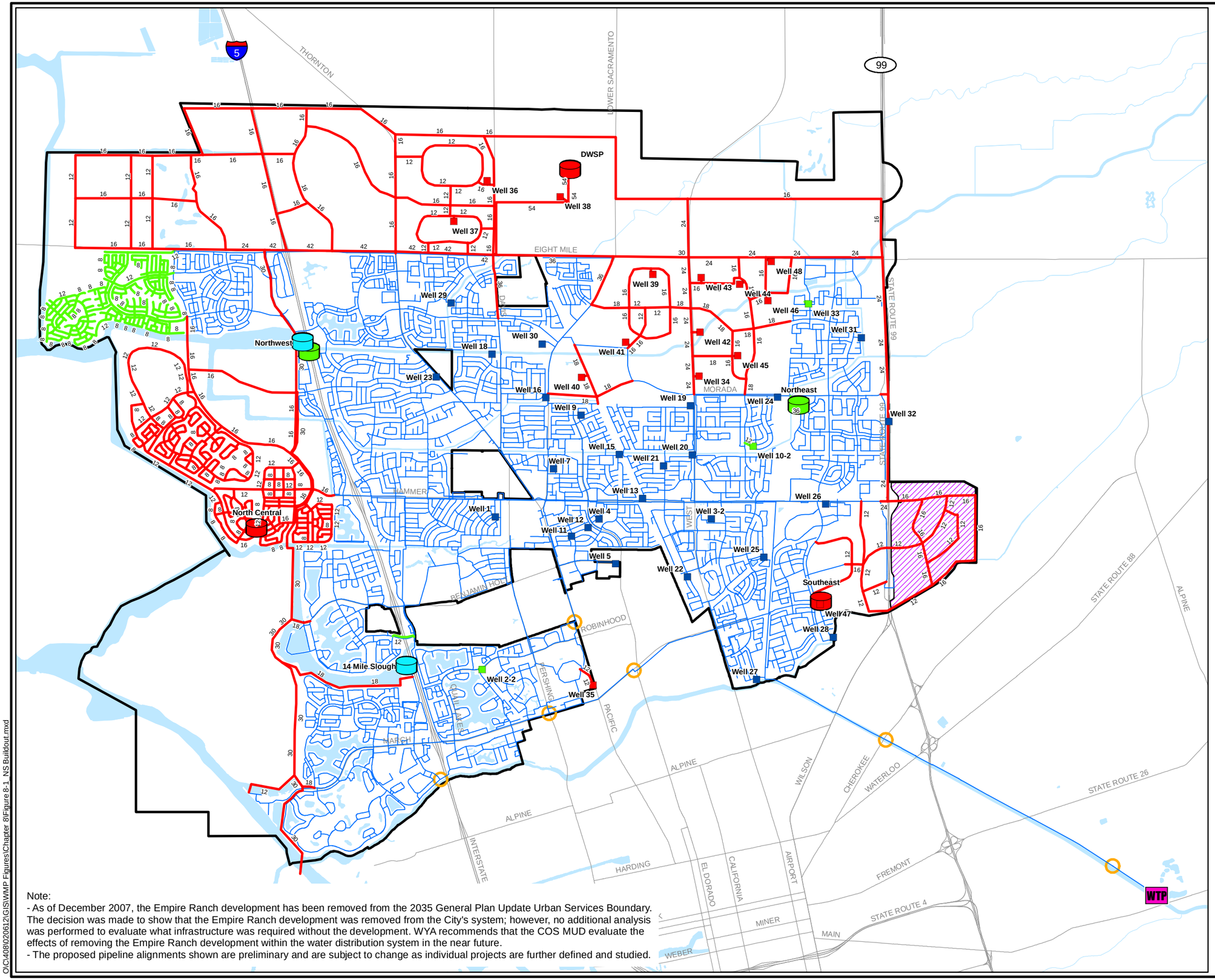
Storage. The following storage tanks are proposed for the 2035 water distribution system:

- Additional French Camp Tank (1) = 3.0 MG
- East Area Tanks (2) = 6.0 MG
- Terminal Reservoir (1) = 8.0 MG
- Far East Area Tanks (2) = 6.0 MG

FIGURE 8-1

City of Stockton
Municipal Utilities Department
Water Master Plan Update

NORTH STOCKTON 2035 DISTRIBUTION SYSTEM



0 0.375 0.75 1.5
Scale in Miles

LEGEND:

- Existing Well
- Near Term Well
- 2035 Well
- Existing Water Tank
- Near Term Water Tank
- 2035 Water Tank
- Existing Pipeline
- Near Term Pipeline
- 2035 Pipeline
- SEWD WTP
- Empire Ranch Development
- Potential Turnout to Serve CWSC
- Service Area
- Major Street
- Water Feature

Note:
- As of December 2007, the Empire Ranch development has been removed from the 2035 General Plan Update Urban Services Boundary. The decision was made to show that the Empire Ranch development was removed from the City's system; however, no additional analysis was performed to evaluate what infrastructure was required without the development. WYA recommends that the COS MUD evaluate the effects of removing the Empire Ranch development within the water distribution system in the near future.
- The proposed pipeline alignments shown are preliminary and are subject to change as individual projects are further defined and studied.

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Note:
- The proposed pipeline alignments shown are preliminary and are subject to change as individual projects are further defined and studied.

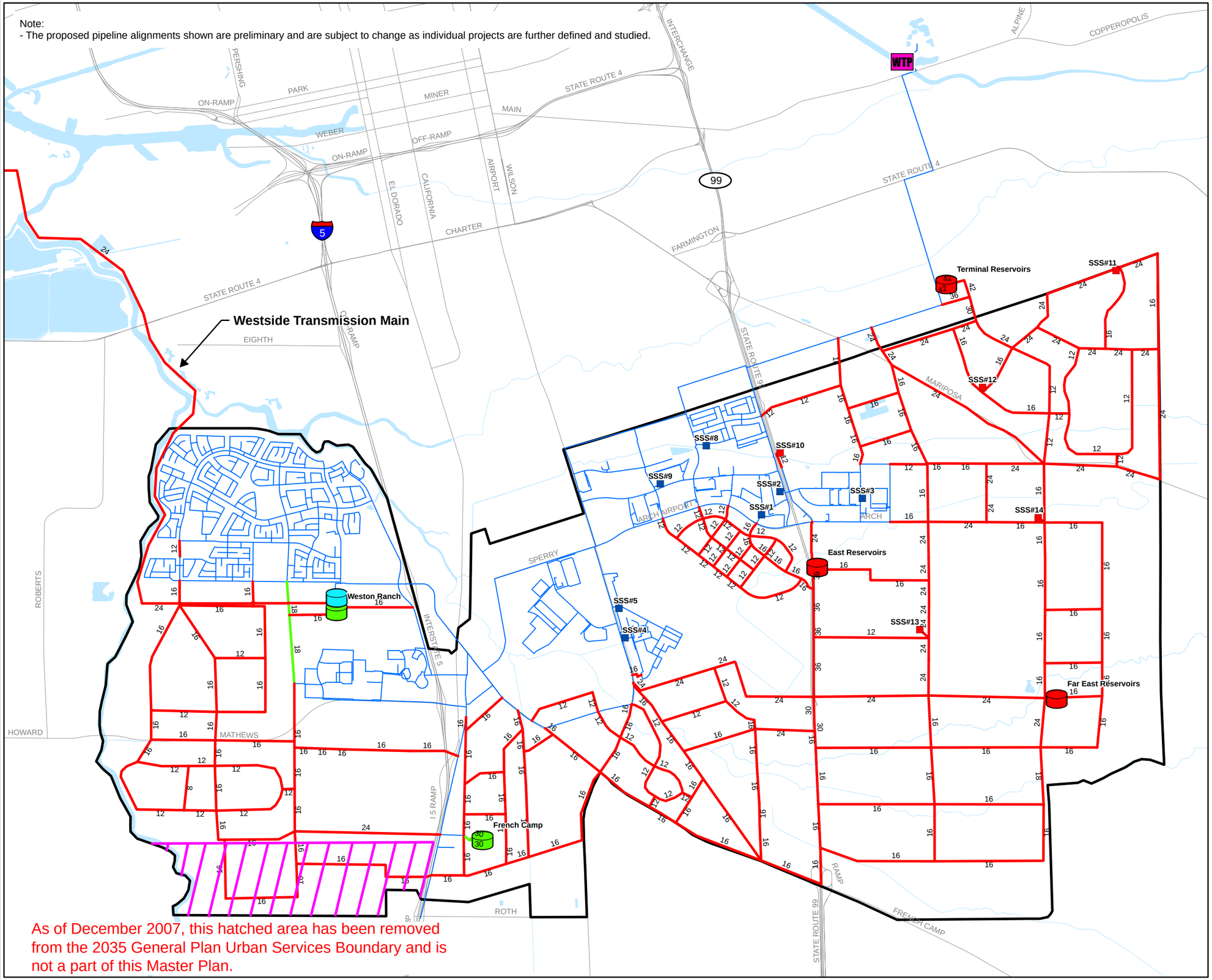

FIGURE 8-2

City of Stockton
Municipal Utilities Department
Water Master Plan Update

SOUTH STOCKTON
2035 DISTRIBUTION SYSTEM

N

0 0.3 0.6 1.2

Scale in Miles

LEGEND:

- Existing Well
- 2035 Well
- Existing Water Tank
- Near Term Water Tank
- 2035 Water Tank
- Existing Pipeline
- Near Term Pipeline
- 2035 Pipeline
- SEWD WTP
- Service Area
- Major Street
- Water Feature

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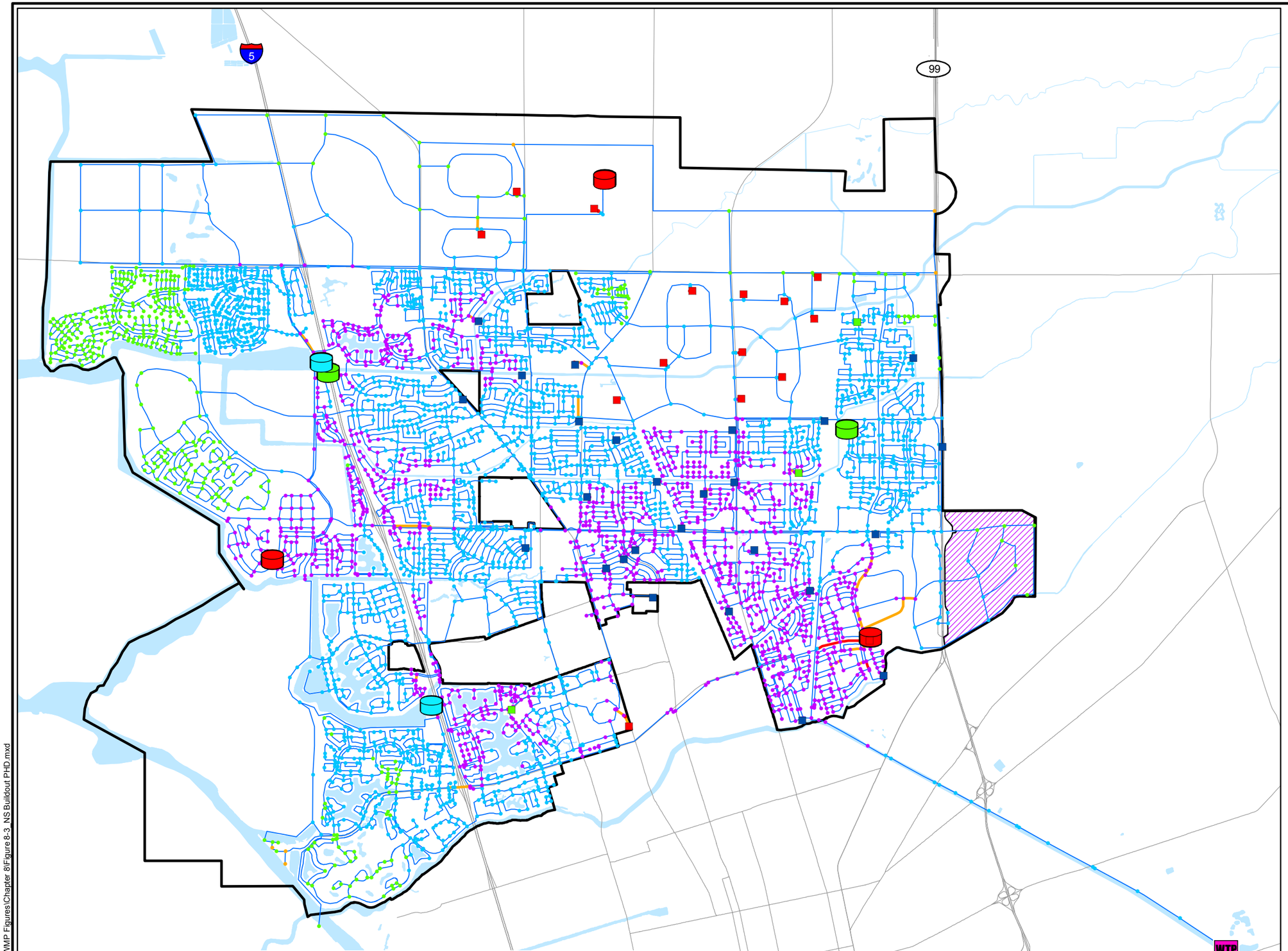
FIGURE 8-3

City of Stockton
Municipal Utilities Department
Water Master Plan Update

NORTH STOCKTON 2035 DISTRIBUTION SYSTEM PEAK HOUR ANALYSIS



N

0 0.375 0.75 1.5

Scale in Miles

LEGEND:

- Pressure ≤ 45 psi
- 45 < Pressure ≤ 50 psi
- 50 < Pressure ≤ 55 psi
- 55 < Pressure ≤ 60 psi
- Pressure > 60 psi
- Velocity ≤ 5 fps
- 5 fps < Velocity ≤ 7 fps
- Velocity > 7 fps
- Existing Well
- Near Term Well
- 2035 Well
- Existing Water Tank
- Near Term Water Tank
- 2035 Water Tank
- SEWD WTP
- Empire Ranch Development
- Service Area
- Major Street
- Water Feature

Note:
- As of December 2007, the Empire Ranch development has been removed from the 2035 General Plan Update Urban Services Boundary. The decision was made to show that the Empire Ranch development was removed from the City's system; however, no additional analysis was performed to evaluate what infrastructure was required without the development. WYA recommends that the COS MUD evaluate the effects of removing the Empire Ranch development within the water distribution system in the near future.

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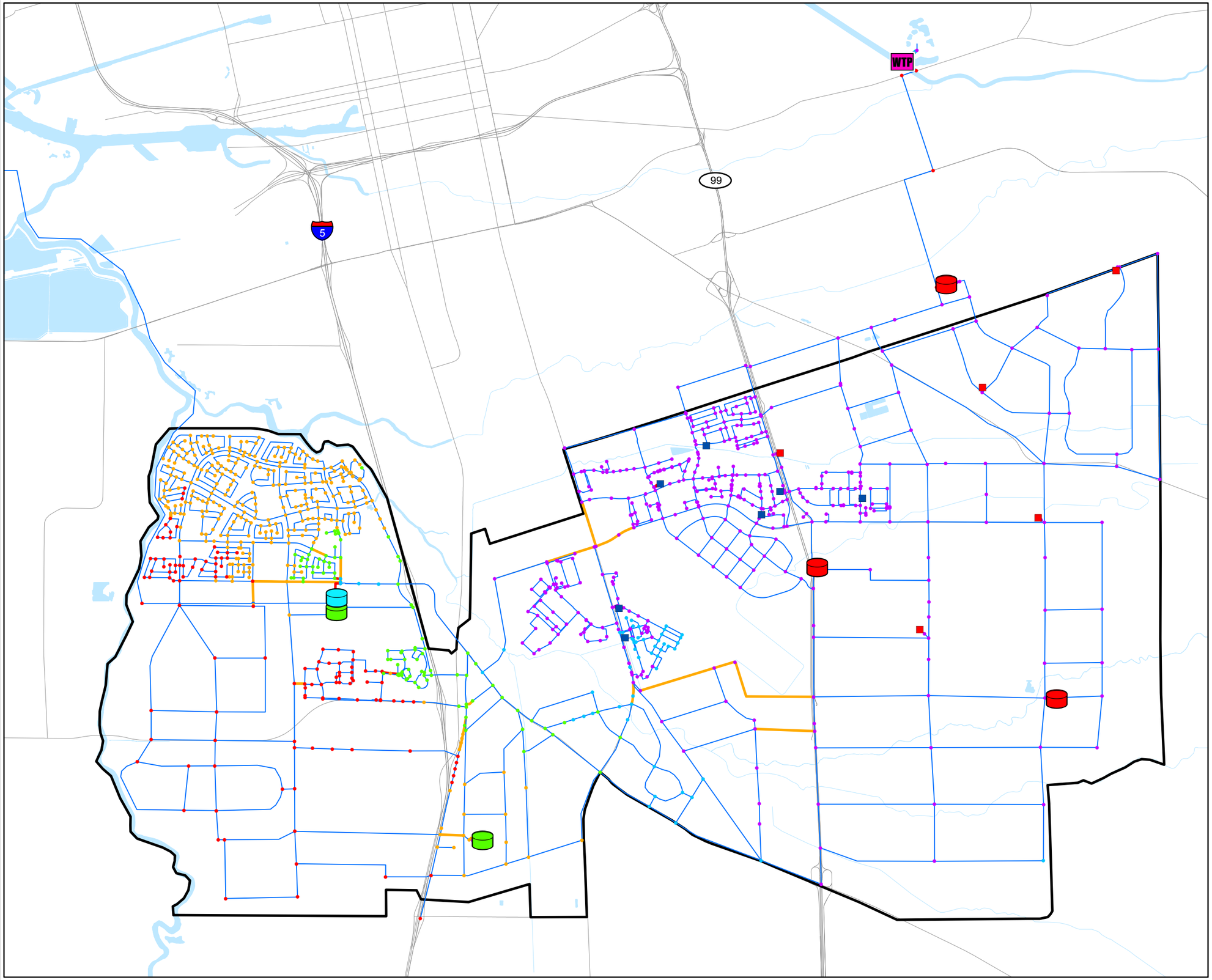

FIGURE 8-4

City of Stockton
Municipal Utilities Department
Water Master Plan Update

SOUTH STOCKTON 2035 DISTRIBUTION SYSTEM PEAK HOUR ANALYSIS

N

0 0.3 0.6 1.2

Scale in Miles

LEGEND:

- Pressure ≤ 45 psi
- 45 < Pressure ≤ 50 psi
- 50 < Pressure ≤ 55 psi
- 55 < Pressure ≤ 60 psi
- Pressure > 60 psi
- Velocity ≤ 5 fps
- 5 fps < Velocity ≤ 7 fps
- Velocity > 7 fps
- Existing Well
- 2035 Well
- Existing Water Tank
- Near Term Water Tank
- 2035 Water Tank
- SEWD WTP
- Service Area
- Major Street
- Water Feature

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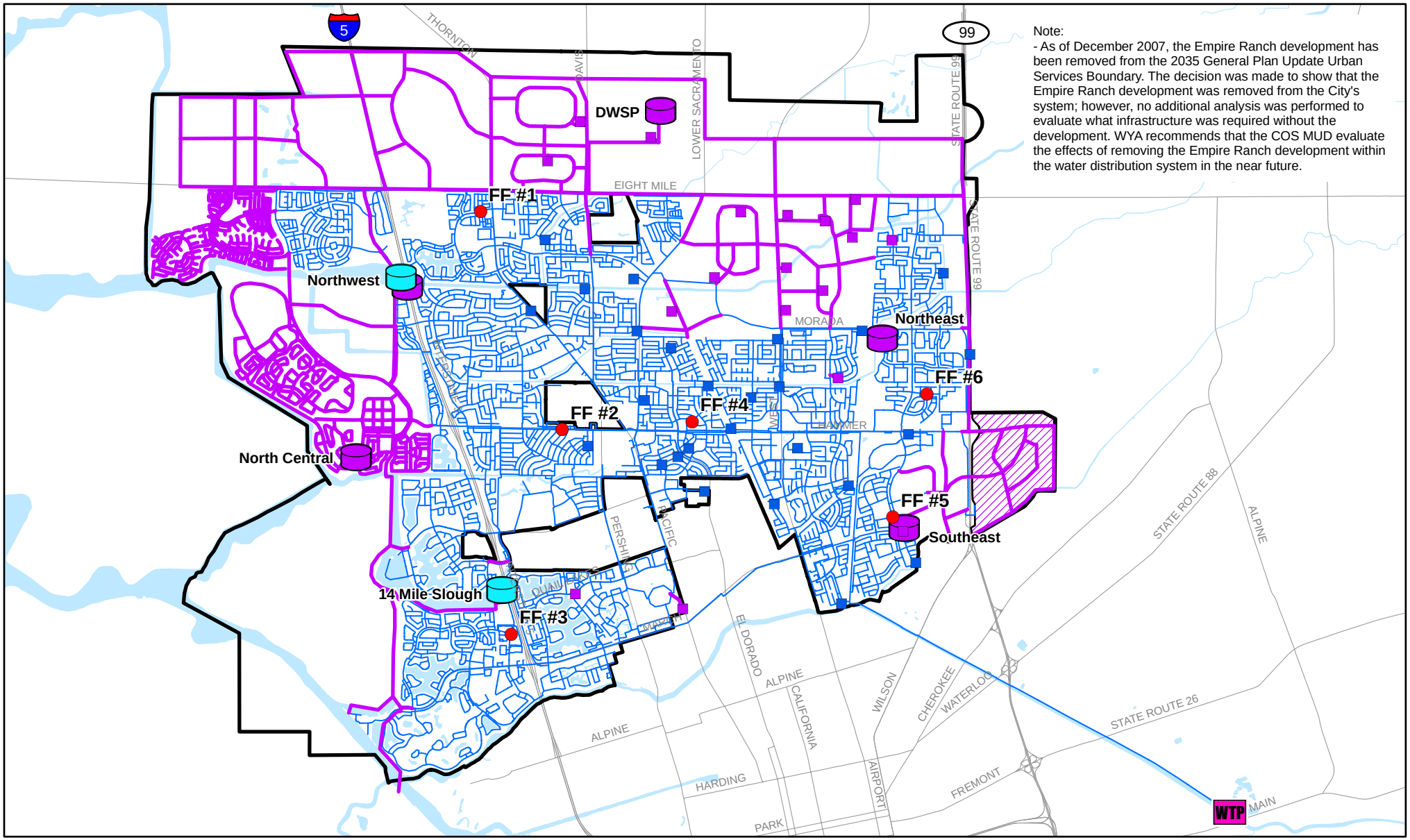

Note:
- As of December 2007, the Empire Ranch development has been removed from the 2035 General Plan Update Urban Services Boundary. The decision was made to show that the Empire Ranch development was removed from the City's system; however, no additional analysis was performed to evaluate what infrastructure was required without the development. WYA recommends that the COS MUD evaluate the effects of removing the Empire Ranch development within the water distribution system in the near future.

LEGEND:

- Existing Well
- Proposed Well
- Existing Water Tank
- Proposed Water Tank
- Fire Flow Location
- Existing Pipeline
- Proposed Pipeline
- SEWD WTP
- Empire Ranch Development
- Service Area
- Major Street
- Water Feature

N

0 0.5 1 2
Scale in Miles

FIGURE 8-5

City of Stockton
Municipal Utilities Department
Water Master Plan Update

NORTH STOCKTON FIRE FLOW LOCATIONS

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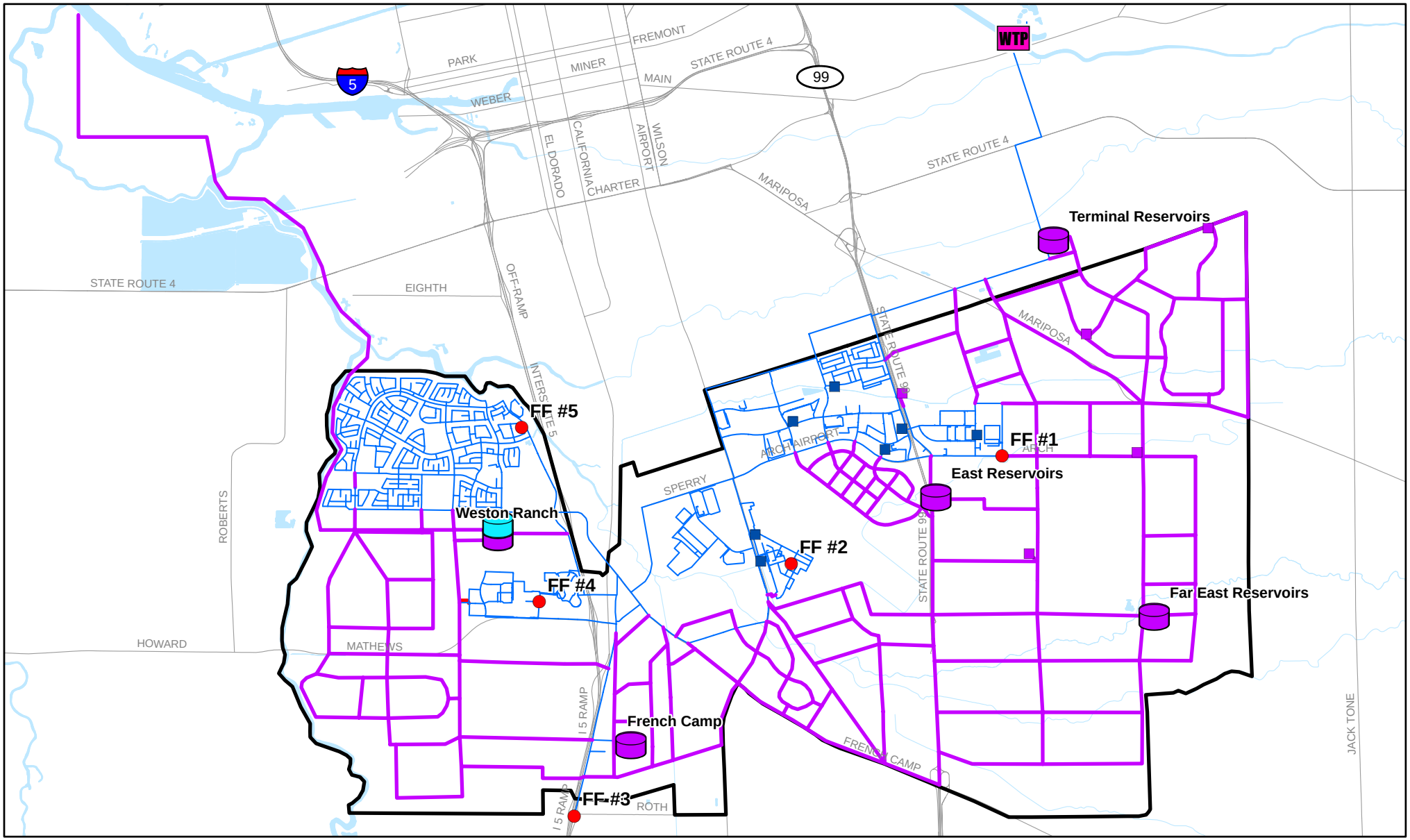

LEGEND:

- Existing Well
- Proposed Well
- Existing Water Tank
- Proposed Water Tank
- Fire Flow Location
- Existing Pipeline
- Proposed Pipeline
- WTP SEWD WTP
- Service Area
- Major Street
- Water Feature

N

0 0.5 1 2

Scale in Miles

FIGURE 8-6

City of Stockton
Municipal Utilities Department
Water Master Plan Update

SOUTH STOCKTON FIRE FLOW LOCATIONS

WEST YOST ASSOCIATES Consulting Engineers

Note:
- As of December 2007, the Empire Ranch development has been removed from the 2035 General Plan Update Urban Services Boundary. The decision was made to show that the Empire Ranch development was removed from the City's system; however, no additional analysis was performed to evaluate what infrastructure was required without the development. WYA recommends that the COS MUD evaluate the effects of removing the Empire Ranch development within the water distribution system in the near future.
- The proposed pipeline alignments shown are preliminary and are subject to change as individual projects are further defined and studied.

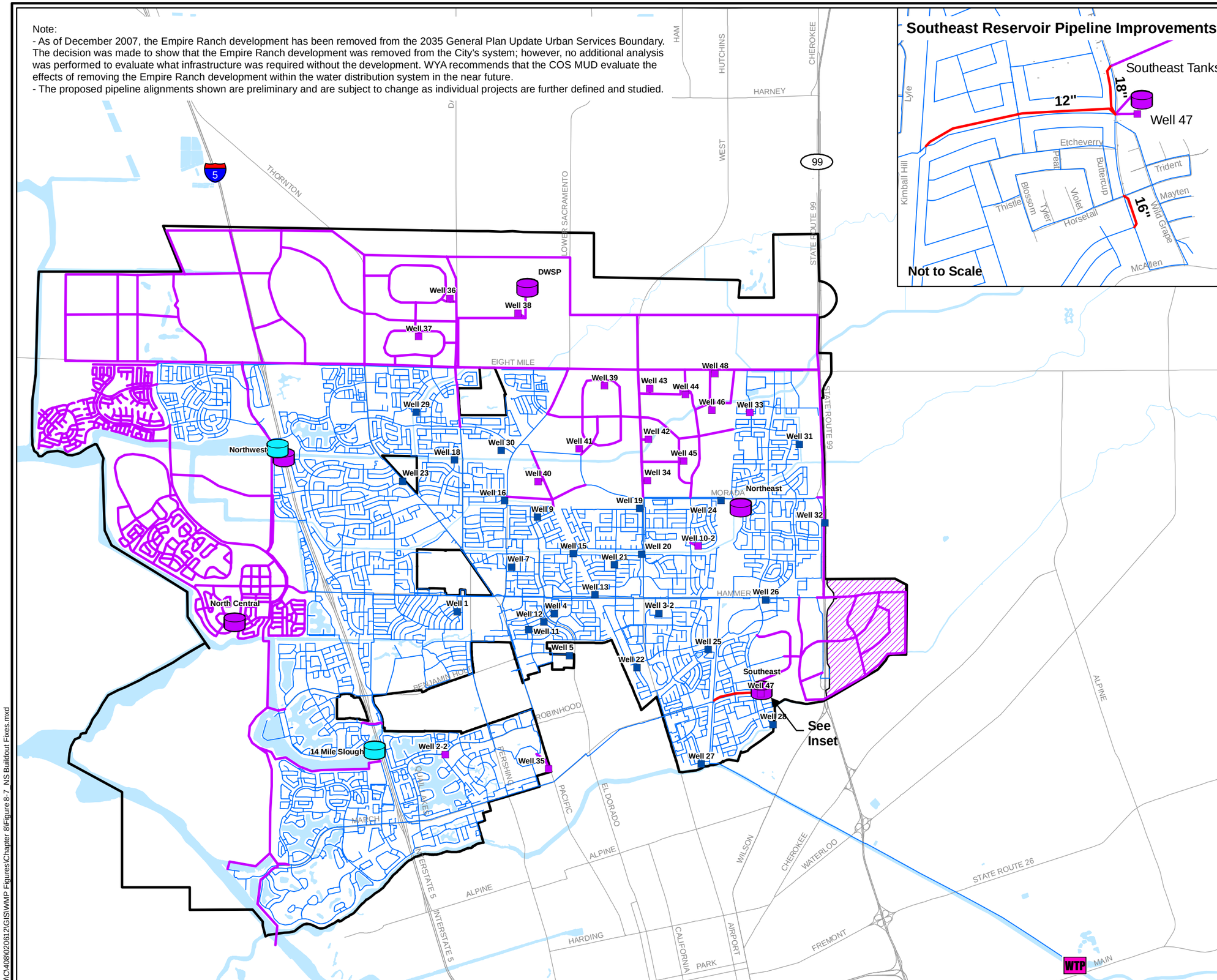

FIGURE 8-7

City of Stockton
Municipal Utilities Department
Water Master Plan Update

NORTH STOCKTON
2035 IMPROVEMENTS

N

0 0.4 0.8 1.6

Scale in Miles

LEGEND:

- Existing Well
- Proposed Well
- Existing Water Tank
- Proposed Water Tank
- Pipeline Improvement
- Existing Pipeline
- Proposed Pipeline
- SEWD WTP
- Empire Ranch Development
- Service Area
- Major Street
- Water Feature

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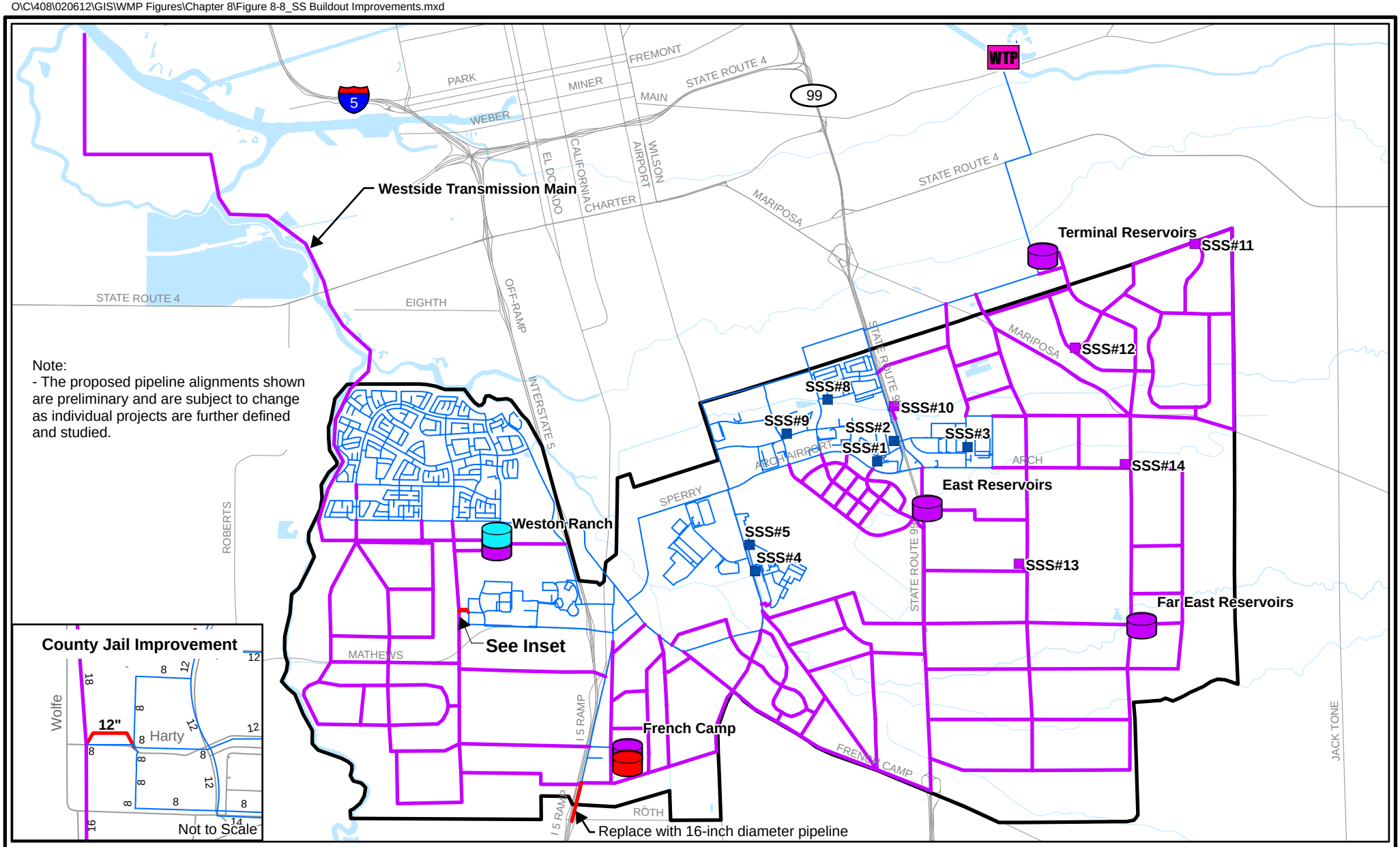


FIGURE 8-8

City of Stockton
Municipal Utilities Department
Water Master Plan Update

SOUTH STOCKTON 2035 IMPROVEMENTS

WEST YOST ASSOCIATES Consulting Engineers

CHAPTER 9. RECOMMENDED WATER SYSTEM CAPITAL IMPROVEMENT PROGRAM

The purpose of this chapter is to present the recommended improvements and estimates of probable construction costs for the COS MUD's water system in North and South Stockton service areas that will enable the COS MUD to provide adequate service to both existing and future customers.

Evaluations previously described in Chapters 7 and 8 of this Water Master Plan Update identified the need for additional water facilities throughout the COS MUD's North and South Stockton service areas. Subsequent sections of this chapter present estimates of probable construction costs for the water system improvements in the COS MUD's North and South Stockton service areas over two planning horizons: near term (approximately the next 5 years) and 2035 (buildout). Table 9-1 presents a summary of all probable construction costs for the COS MUD water system and Figures 9-1 and 9-2 illustrate the recommended improvements for North and South Stockton.

Costs are presented in July 2008 dollars based on the Engineering News Record Construction Cost Index (ENR CCI) of 8293 (20 Cities Average). Total CIP costs include the following contingencies and project cost allowances:

- Construction Contingency: 35 percent
- Project Cost Allowances: 35 percent
  - Design: 10 percent
  - Construction Management: 15 percent
  - Administration: 10 percent

A complete description of the assumptions used in developing the estimates of probable construction costs is provided in Appendix C.

COSTS OF RECOMMENDED NEAR TERM IMPROVEMENTS FOR THE NORTH AND SOUTH STOCKTON SERVICE AREAS

Figures 9-1 and 9-2 illustrates the recommended near term improvements for the COS MUD's North and South Stockton service areas. These improvements are required to correct deficiencies within the existing water system. Near term improvements can begin immediately, but are generally required in the next 5 to 10 years. Table 9-2 and 9-3 lists the recommended near term facilities for the North and South Stockton service areas and their associated costs.

COSTS OF RECOMMENDED 2035 IMPROVEMENTS FOR THE NORTH AND SOUTH STOCKTON SERVICE AREAS

Figures 9-1 and 9-2 illustrate the facility improvements recommended for 2035 in the North and South Stockton service areas. It is envisioned that these improvements would be completed by 2035. Tables 9-4 and 9-5 lists the recommended 2035 facilities for the North and South Stockton service areas and their associated costs. Figures 9-3 and 9-4 illustrates the estimated timing of future facility improvements in North and South Stockton service areas.

Table 9-1. Summary of CIP Costs for North and South Stockton[a,b,c]

Area	Near Term, dollars	2035, dollars	Total, dollars
North Stockton	380,194,000	272,645,000	652,839,000
South Stockton	47,470,000	302,586,000	350,056,000
Total	427,664,000	575,231,000	1,002,895,000

(a) Includes 35 percent contingency and 35 percent other project costs.
(b) Based on the July 2008 ENR index of 8293.
(c) Rounded to the nearest $1,000.

Table 9-2. Near Term Capital Improvement Program Costs for North Stockton

Item Description	Unit of Measure	Estimated Quantity	Unit Cost, dollars/unit[a]	Estimated Cost, dollars
DWSP[b]				
Intake	each	1	19,300,000	19,300,000
Pipelines	each	1	89,600,000	89,600,000
WTP	each	1	80,100,000	80,100,000
Storage				
5.00 MG DWSP Tanks	each	2	6,100,000	12,200,000
3.00 MG Northeast Tanks	each	2	3,600,000	7,200,000
3.00 MG Northwest Tank[c]	each	1	--	--
Wells				
2.9 MG, 250 hp Well #33	each	1	1,000,000	1,000,000
2.9 MG, 250 hp Well #2-2	each	1	1,000,000	1,000,000
2.9 MG, 250 hp Well #10-2	each	1	1,000,000	1,000,000
Pump Stations				
19.7 mgd DWSP Booster Pump Station	each	1	3,703,000	3,703,000
20.74 mgd Northeast Booster Pump Station	each	1	3,843,000	3,843,000
10.37 mgd Northwest Booster Pump Station[c]	each	1	--	--
Pipelines[d]				
Improvement				
12-inch diameter Swain Road Parallel Pipeline (Between Morgan Place and Highway 5)	lf	1,225	190	232,750
Westlake Development				
12-inch diameter Distribution Mains	lf	22,190	190	4,216,100
16-inch diameter Distribution Mains	lf	1,035	240	248,400
Subtotal				223,643,250
Contingency (35%)				78,275,138
Other Project Costs (35%)				78,275,138
Total[e]				380,194,000

[a] Based on the July 2008 ENR index of 8293.

[b] Based on the total capital cost for DWSP as presented in the June 2007 DWSP Cost Study. Costs were based on the three categories as provided by the COS MUD staff in February 2008 and scaled to represent July 2008 ENR index of 8293.

[c] Per COS MUD staff, this tank and booster pump station has been constructed as of May 2008. Therefore, their costs will not be included in this CIP.

[d] Proposed pipelines less than 12-inches in diameter are not included. Proposed pipelines associated with new tanks, booster pump stations, and wells are also not included.

[e] Rounded to the nearest $1,000.

Table 9-3. Near Term Capital Improvement Program Costs for South Stockton

Item Description	Unit of Measure	Estimated Quantity	Unit Cost, dollars/unit[a]	Estimated Cost, dollars
WTP				
SEWD WTP Expansion[b]	each	1	--	--
Storage				
4.00 MG Terminal Reservoir Tanks	each	2	4,800,000	9,600,000
3.00 MG French Camp Tank	each	1	3,600,000	3,600,000
3.00 MG Weston Ranch Tank	each	1	3,600,000	3,600,000
Pump Stations				
29.1 mgd Terminal Reservoir Booster Pump Station	each	1	4,967,000	4,967,000
10.37 mgd French Camp Booster Pump Station	each	1	2,475,000	2,475,000
10.37 mgd Weston Ranch Booster Pump Station	each	1	2,475,000	2,475,000
Pipelines[c]				
Improvement				
18-inch diameter pipeline from French Camp Road towards Matthews Road	lf	4,640	260	1,206,400
Subtotal				27,923,400
Contingency (35%)				9,773,190
Other Project Costs (35%)				9,773,190
Total[d]				47,470,000

[a] Based on the July 2008 ENR index of 8293.

[b] Based on subtotal cost listed in Table 6-1 in the July 2007 Evaluation of the Dr. Joe Waidhofer WTP Expansion Draft TM. Cost is included in the COS MUD's current CIP.

[c] Proposed pipelines less than 12-inches in diameter are not included. Proposed pipelines associated with new tanks, booster pump stations, and wells are also not included.

[d] Rounded to the nearest $1,000.

Table 9-4. 2035 Capital Improvement Program Costs for North Stockton

Item Description	Unit of Measure	Estimated Quantity	Unit Cost, dollars/unit[a]	Estimated Cost, dollars
Storage				
3.00 MG North Central Tank	each	1	3,600,000	3,600,000
3.00 MG Southeast Tanks	each	2	3,600,000	7,200,000
Wells				
2.9 MG, 250 hp Well #34 through Well #48	each	15	1,000,000	15,000,000
Pump Stations				
10.37 mgd North Central Booster Pump Station	each	1	2,475,000	2,475,000
20.74 mgd Southeast Booster Pump Station	each	1	3,843,000	3,843,000
Pipelines[b]				
Improvement				
12-inch diameter parallel pipeline (west of Southeast Booster Pump Station)	lf	2,555	190	485,450
16-inch diameter parallel pipeline (west of Southeast Booster Pump Station)	lf	455	240	109,200
18-inch diameter parallel pipeline (west of Southeast Booster Pump Station)	lf	640	260	166,400
Westside Transmission Main				
12-inch diameter parallel pipeline (tie-in)	lf	3,105	190	589,950
18-inch diameter parallel pipeline (tie-in)	lf	9,750	260	2,535,000
30-inch diameter Westside Transmission Main	lf	38,150	410	15,641,500
DWSP Transmission Mains				
36-inch diameter Transmission Mains	lf	3,490	470	1,640,300
42-inch diameter Transmission Mains	lf	12,460	540	6,728,400
54-inch diameter Transmission Mains	lf	8,480	670	5,681,600
Bear Creek Developments				
12-inch diameter Distribution Mains	lf	3,810	190	723,900
16-inch diameter Distribution Mains	lf	31,310	240	7,514,400
18-inch diameter Transmission Mains	lf	20,005	260	5,201,300
Empire Ranch Development [c]				
12-inch diameter Distribution Mains	lf	13,040	190	--
16-inch diameter Distribution Mains	lf	16,180	240	--
Gateway Development				
16-inch diameter Distribution Mains	lf	38,425	240	9,222,000
Lauchland Development				
12-inch diameter Distribution Mains	lf	23,370	190	4,440,300
16-inch diameter Distribution Mains	lf	6,375	240	1,530,000
Origone Ranch Development				
12-inch diameter Distribution Mains	lf	12,805	190	2,432,950
16-inch diameter Distribution Mains	lf	3,475	240	834,000
The Preserve Development (Atlas Tract)				
16-inch diameter Distribution Mains	lf	6,125	240	1,470,000
Sanctuary Development				
12-inch diameter Distribution Mains	lf	57,840	190	10,989,600
16-inch diameter Distribution Mains	lf	23,395	240	5,614,800
24-inch diameter Transmission Mains	lf	215	340	73,100
Thompson Development				
12-inch diameter Distribution Mains	lf	5,065	190	962,350
16-inch diameter Distribution Mains	lf	4,195	240	1,006,800
Distribution/Transmission Mains				
12-inch diameter Distribution Mains	lf	10,095	190	1,918,050
16-inch diameter Distribution Mains	lf	75,855	240	18,205,200
24-inch diameter Transmission Mains	lf	37,540	340	12,763,600
30-inch diameter Transmission Mains	lf	4,115	410	1,687,150
36-inch diameter Transmission Mains	lf	9,460	470	4,446,200
Jack and Boring (Freeway or Water)				
30-inch diameter Westside Transmission Main	lf	1,690	1,270	2,146,300
12-inch diameter Distribution Mains	lf	300	440	132,000
16-inch diameter Distribution Mains	lf	1,810	510	923,100
18-inch diameter Transmission Mains	lf	720	620	446,400
Subtotal				160,379,300
Contingency (35%)				56,132,755
Other Project Costs (35%)				56,132,755
Total[d]				272,645,000

[a] Based on the July 2008 ENR index of 8293.

[b] Proposed pipelines less than 12-inches in diameter are not included. Proposed pipelines associated with new tanks, booster pump stations, and wells are also not included.

[c] As of December 2007, the Empire Ranch Development has been removed from the 2035 General Plan Update Urban Services Boundary. Therefore, costs for this development have been removed from the CIP.

[d] Rounded to the nearest $1,000.

Table 9-5. 2035 Capital Improvement Program Costs for South Stockton

Item Description	Unit of Measure	Estimated Quantity	Unit Cost, dollars/unit[a]	Estimated Cost, dollars
Storage				
3.00 MG French Camp Tank	each	1	3,600,000	3,600,000
3.00 MG East Tanks	each	2	3,600,000	7,200,000
3.00 MG Far East Tanks	each	2	3,600,000	7,200,000
Wells				
2.9 MG, 250 hp Well SS#10 through Well SS#14	each	5	1,000,000	5,000,000
Pump Stations				
10.37 mgd French Camp Booster Pump Station	each	1	2,475,000	2,475,000
20.74 mgd East Pump Booster Station	each	1	3,843,000	3,843,000
20.74 mgd Far East Booster Pump Station	each	1	3,843,000	3,843,000
Pipelines[b]				
Improvement				
12-inch diameter parallel pipeline on Harty Lane	lf	630	190	119,700
16-inch diameter replacement pipeline along I-5 and north of E. Roth Road	lf	2,025	240	486,000
Westside Transmission Main				
24-inch diameter Westside Transmission Main	lf	46,530	340	15,820,200
French Camp Development				
16-inch diameter Distribution Mains	lf	9,230	240	2,215,200
Mariposa Lakes Development				
12-inch diameter Distribution Mains	lf	20,170	190	3,832,300
16-inch diameter Distribution Mains	lf	17,430	240	4,183,200
24-inch diameter Transmission Mains	lf	32,160	340	10,934,400
30-inch diameter Transmission Mains	lf	1,130	410	463,300
River Run Development				
12-inch diameter Distribution Mains	lf	23,070	190	4,383,300
16-inch diameter Distribution Mains	lf	42,000	240	10,080,000
Tidewater Development				
12-inch diameter Distribution Mains	lf	23,385	190	4,443,150
16-inch diameter Distribution Mains	lf	4,360	240	1,046,400
Distribution/Transmission Mains				
12-inch diameter Distribution Mains	lf	39,955	190	7,591,450
16-inch diameter Distribution Mains	lf	218,245	240	52,378,800
18-inch diameter Transmission Mains	lf	2,600	260	676,000
24-inch diameter Transmission Mains	lf	60,145	340	20,449,300
30-inch diameter Transmission Mains	lf	1,555	410	637,550
36-inch diameter Transmission Mains	lf	7,090	470	3,332,300
42-inch diameter Transmission Mains	lf	220	540	118,800
Jack and Boring (Freeway or Water)				
24-inch diameter Westside Transmission Main	lf	560	620	347,200
12-inch diameter Distribution Mains	lf	210	440	92,400
16-inch diameter Distribution Mains	lf	1,380	510	703,800
24-inch diameter Transmission Mains	lf	800	620	496,000
Subtotal				177,991,750
Contingency (35%)				62,297,113
Other Project Costs (35%)				62,297,113
Total[c]				302,586,000

[a] Based on the July 2008 ENR index of 8293.

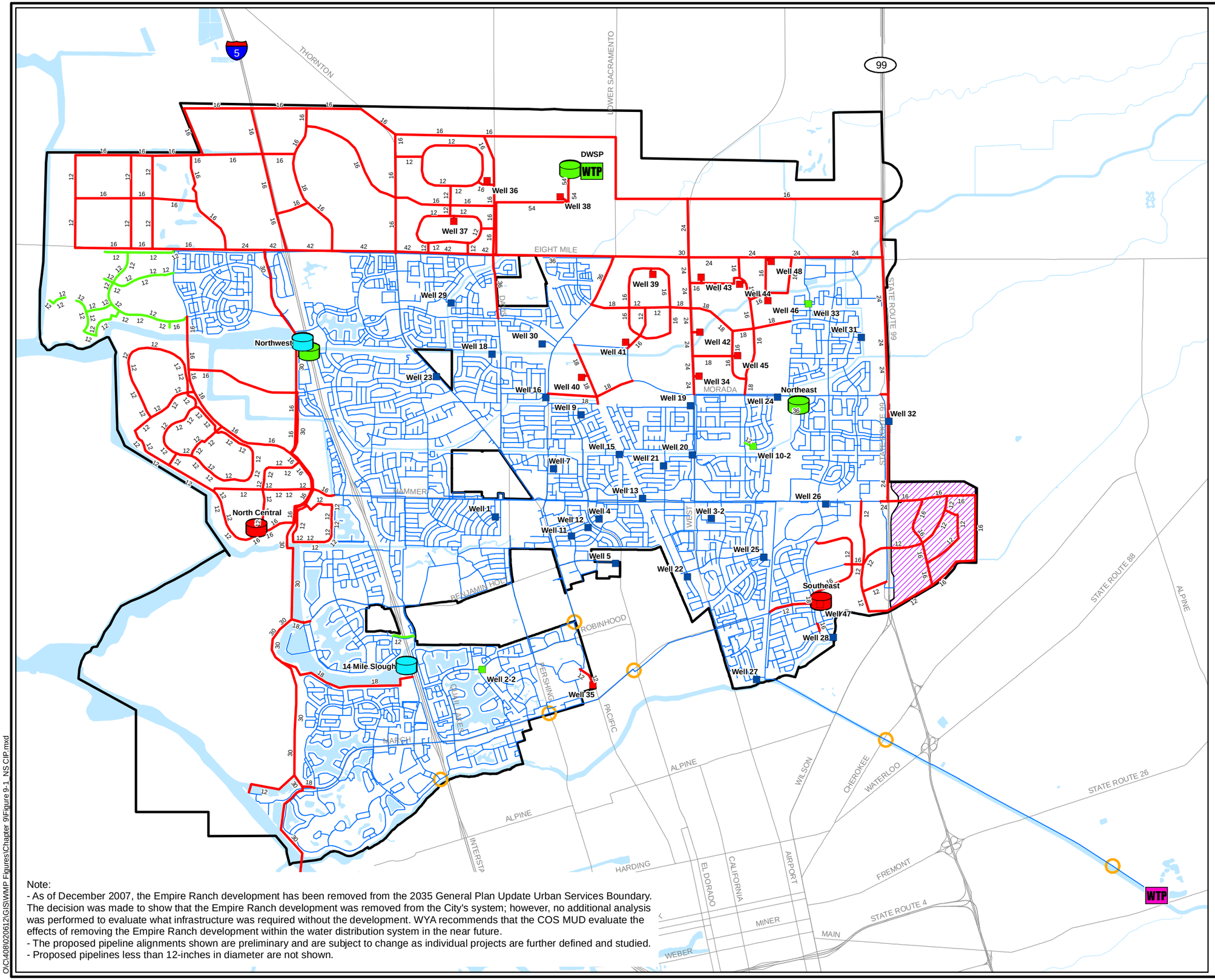
[b] Proposed pipelines less than 12-inches in diameter are not included. Proposed pipelines associated with new tanks, booster pump stations, and wells are also not included.

[c] Rounded to the nearest $1,000.

FIGURE 9-1

City of Stockton
Municipal Utilities Department
Water Master Plan Update

NORTH STOCKTON EXISTING AND BUILDOUT CIP RECOMMENDATIONS



Note:
- As of December 2007, the Empire Ranch development has been removed from the 2035 General Plan Update Urban Services Boundary. The decision was made to show that the Empire Ranch development was removed from the City's system; however, no additional analysis was performed to evaluate what infrastructure was required without the development. WYA recommends that the COS MUD evaluate the effects of removing the Empire Ranch development within the water distribution system in the near future.
- The proposed pipeline alignments shown are preliminary and are subject to change as individual projects are further defined and studied.
- Proposed pipelines less than 12-inches in diameter are not shown.

N

0 0.375 0.75 1.5
Scale in Miles

LEGEND:

- Existing Well
- Near Term Well
- 2035 Well
- Existing Water Tank
- Near Term Water Tank
- 2035 Water Tank
- Existing Pipeline
- Near Term Pipeline
- 2035 Pipeline
- DWSP WTP (Near Term)
- SEWD WTP (Near Term Expansion)
- Empire Ranch Development
- Potential Turnout to Serve CWSC
- Service Area
- Major Street
- Water Feature

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Note:
- The proposed pipeline alignments shown are preliminary and are subject to change as individual projects are further defined and studied.
- Proposed pipelines less than 12-inches in diameter are not shown.

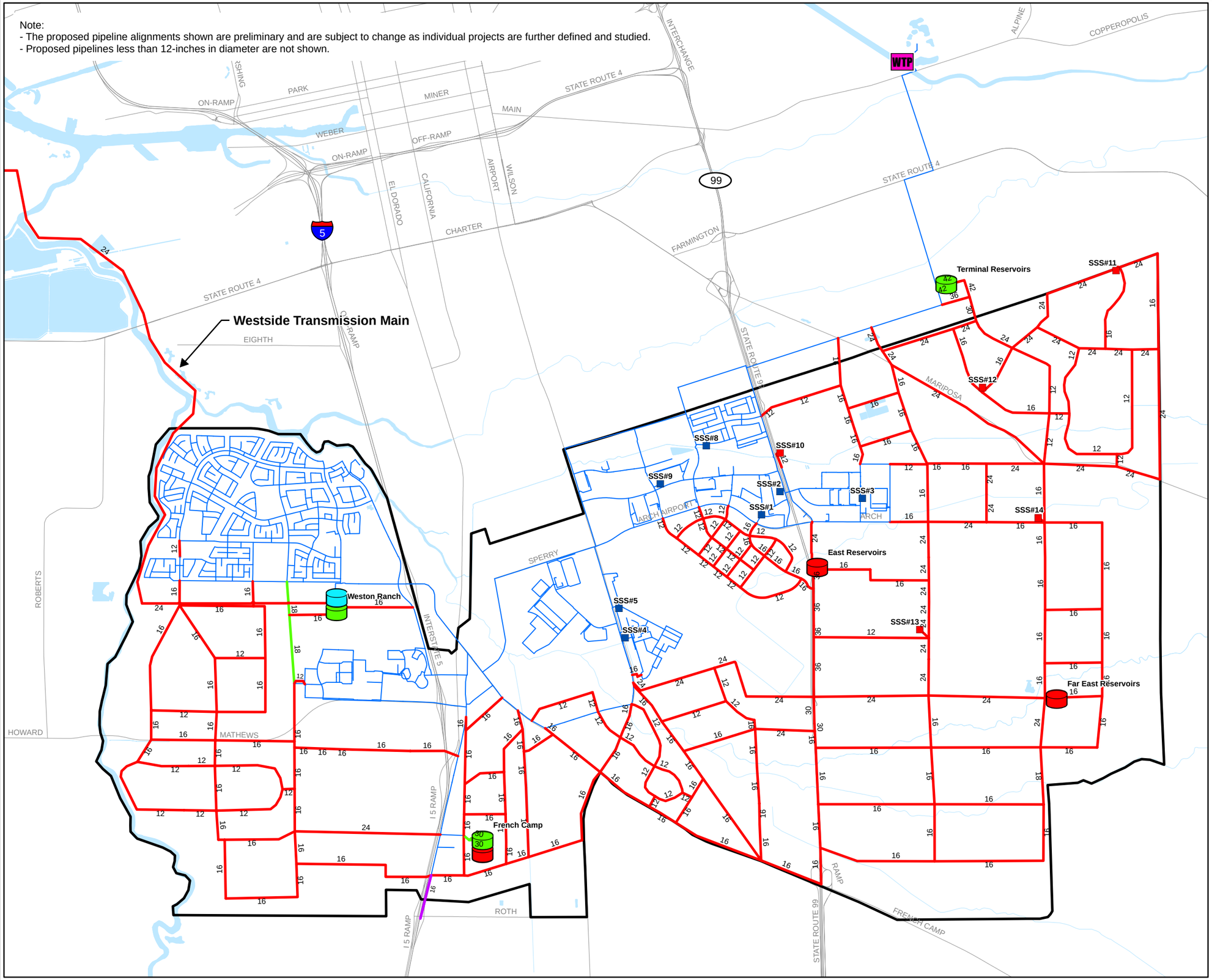

FIGURE 9-2

City of Stockton
Municipal Utilities Department
Water Master Plan Update

SOUTH STOCKTON EXISTING AND BUILDOUT CIP RECOMMENDATIONS

N

0 0.3 0.6 1.2
Scale in Miles

LEGEND:

- Existing Well
- 2035 Well
- Existing Water Tank
- Near Term Water Tank
- 2035 Water Tank
- Existing Pipeline
- Near Term Pipeline
- 2035 Pipeline
- 2035 Pipeline Replacement
- SEWD WTP (Near Term Expansion)
- Service Area
- Major Street
- Water Feature

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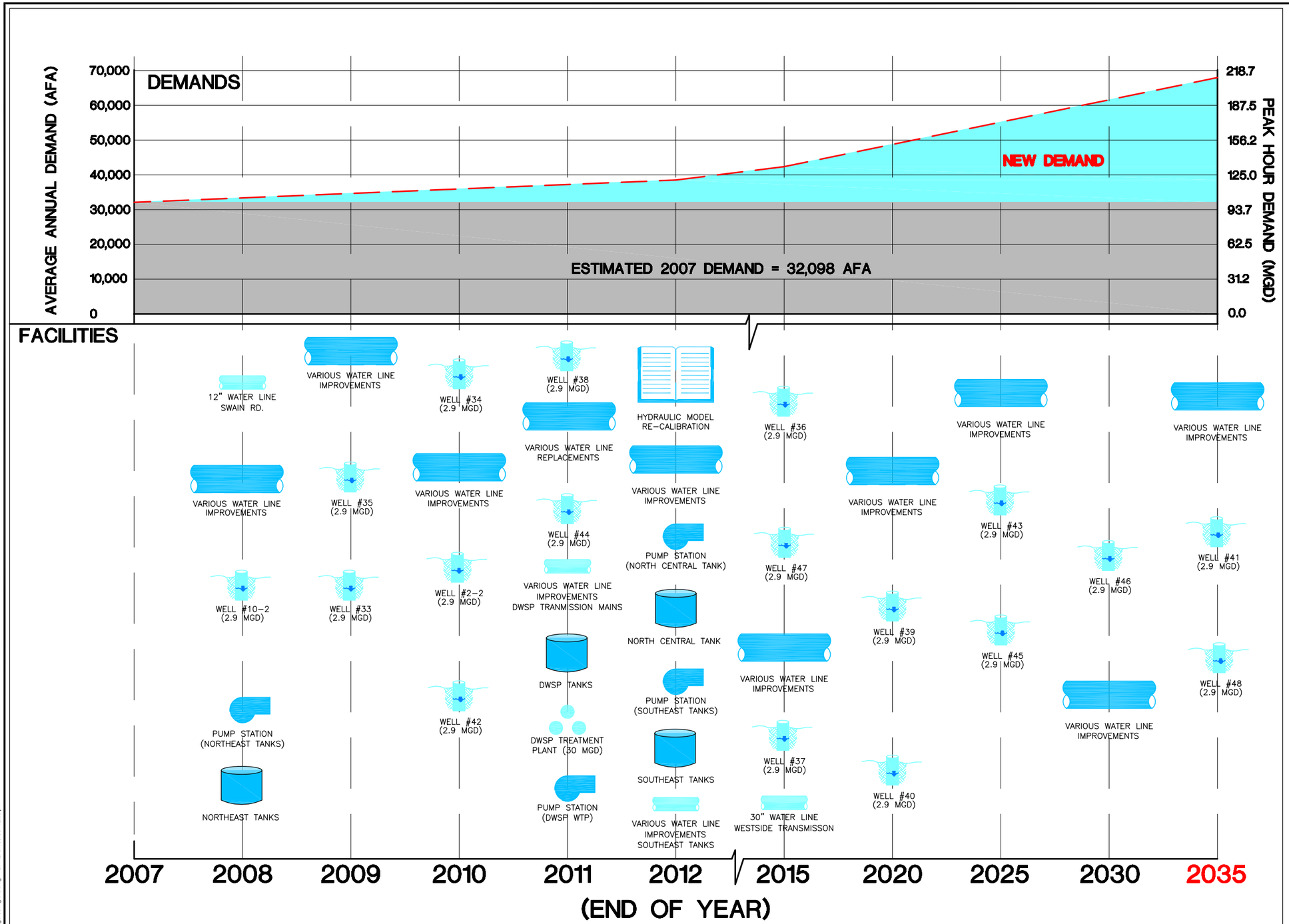

FIGURE 9-3

City of Stockton
Municipal Utilities Department
Water Master Plan Update

TIMING OF MAJOR WATER SUPPLY AND DISTRIBUTION FACILITIES IN NORTH STOCKTON

N

0 NO SCALE

NOTES:

LEGEND:

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CAD FILE: Cp/C408/02-06-12/CAD/Figures/Fig 9-3.dwg DATE: 07-03-08 12:00 pm

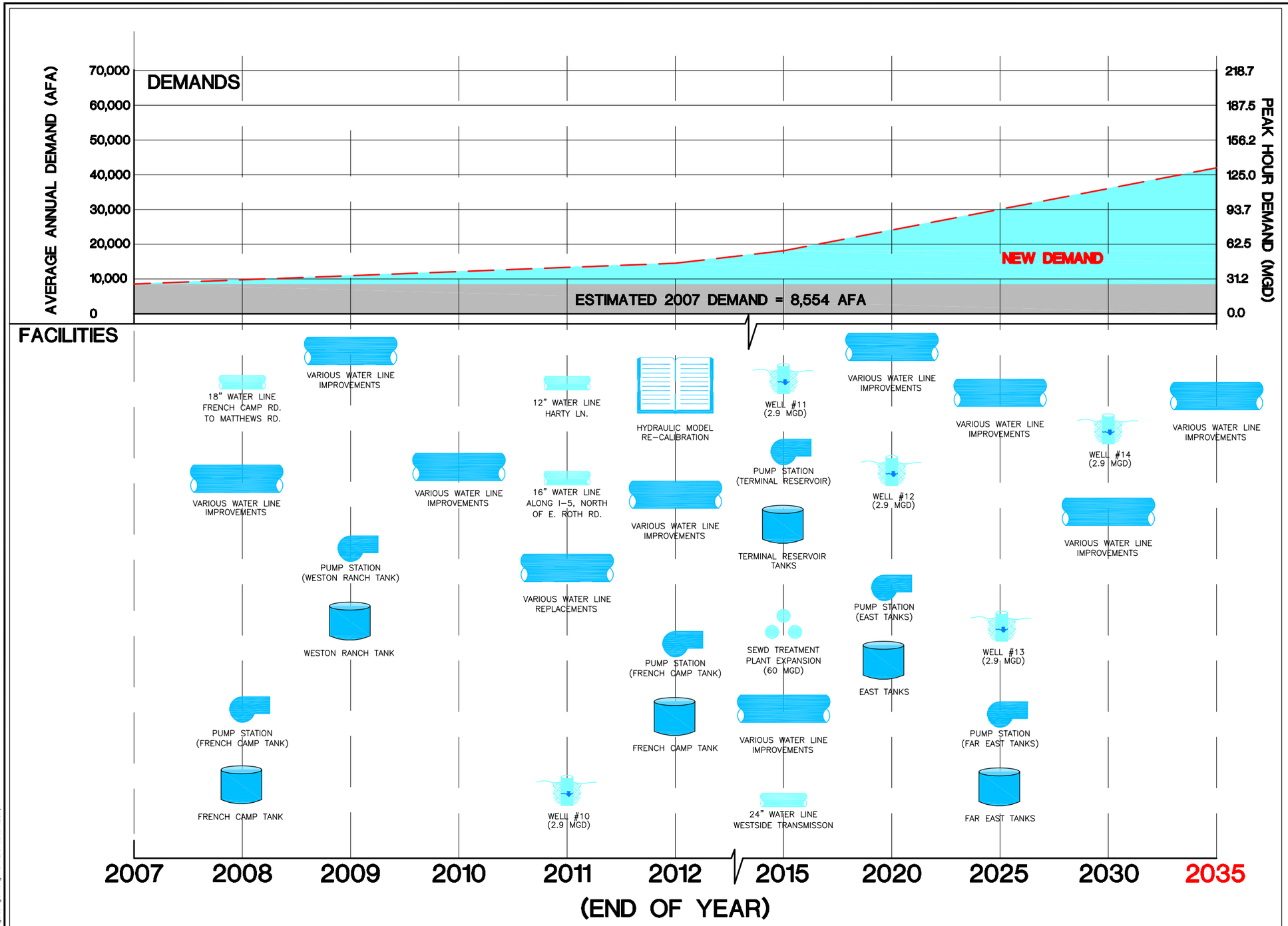

FIGURE 9-4

City of Stockton
Municipal Utilities Department
Water Master Plan Update

TIMING OF MAJOR WATER SUPPLY AND DISTRIBUTION FACILITIES IN SOUTH STOCKTON

N

0 – –
NO SCALE

NOTES:

LEGEND:

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APPENDIX A

March 2005 UAFW Analysis

W E S T
Y O S T
& ASSOCIATES
Consulting Engineers

TECHNICAL MEMORANDUM

DATE: March 21, 2005 Project No.: 408-02-05-07

TO: Bob Granberg, City of Stockton
Mark Madison, City of Stockton

FROM: Dave Peterson, Project Engineer
Brad Ledesma, Project Engineer
Carman Ng, Staff Engineer

SUBJECT: Unaccounted-for Water within the City of Stockton Water Utility Service Area

The purpose of this Technical Memorandum (TM) is to document West Yost & Associates' (WYA) evaluation of unaccounted-for water in the City of Stockton Municipal Utilities Department's (COSMUD) potable water system. Identifying unaccounted-for water losses requires adequately defining the extents of the COSMUD service area, elements that make-up the COSMUD unaccounted-for water, and available data.

The following sections of this TM describe WYA's unaccounted-for water evaluation:

- Summary of Results
- Description of the COSMUD Service Area
- Definition of Unaccounted-For Water
- Data Available for the Evaluation
- Results of the Evaluation

SUMMARY OF RESULTS

The COSMUD's unaccounted-for water is the difference between the recorded production and metered consumption (includes metered wholesaled and wheeled quantities). Based on available data at the time this TM was completed, the COSMUD's unaccounted-for water has averaged approximately 4.8 percent over the last six calendar years, ranging from a low of 2.1 percent in 2000 to a high of 7.7 percent in 1999.

Additionally, calendar years 1999, 2002, and 2004 had higher unaccounted-for water quantities than other years. The following factors contributed to the higher observed unaccounted-for water for those years:

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- The "other" water quantity recorded in 1999 only included construction water. Normally, this would also include hydrant flushing and street sweeping.
- The "other" water quantity recorded for 2002 and 2004 is much smaller than the quantities reported for 2000, 2001, and 2003. The quantity reported likely includes only construction water, contributing to a higher unaccounted-for water quantity.

Unaccounted-for water percentages among other comparable water systems can vary greatly and range from 3 to 25 percent based on WYA's other clients. Consequently, COSMUD's average unaccounted-for water (4.8 percent) is considered very good, indicating a tight water system. The COSMUD can reduce the unaccounted-for water percentage by keeping better track of water use in the "other" category (e.g., water used for construction, hydrant flushing, and street sweeping).

DESCRIPTION OF THE COSMUD SERVICE AREA

Identifying the boundaries of the City's water utility service area and the various agreements that govern water distribution within its boundaries is vital to understanding the data available, and its applicability to determine the City's unaccounted-for water.

The City of Stockton Metropolitan Area (COSMA) corresponds to the general plan boundary adopted on January 22, 1990, and is divided into three water service areas. These service areas, and the corresponding water purveyor serving them, are illustrated on Figure 1. As shown on Figure 1, COSMUD and the San Joaquin County Maintenance Districts (SJCMD) serve North Stockton, South Stockton, and Walnut Plant Area (WPA); California Water Services Company (CWSC) serves Central Stockton.

Both the CWSC and the COSMUD water systems use surface water provided by the Stockton East Water District (SEWD) and groundwater pumped from their respective municipal supply wells. The SJCMD water systems use "county owned" municipal supply wells, but the COSMUD also wheels surface water the County purchases from SEWD and wholesales COSMUD groundwater to two SJCMDs (Lincoln Village Maintenance District (LVMD) and Colonial Heights Maintenance Districts (CHMD)). The COSMUD also receives a mixture of surface water and groundwater from the CWSC to supplement its groundwater supply in the WPA; this water is considered surface water purchased from SEWD and wheeled by the CWSC.

This TM only addressed the unaccounted-for water in the COSMUD service area and did not evaluate losses within the CWSC or the SJCMD water systems; consequently, the definition of, and data used to determine the City's unaccounted-for water must account for water wheeled to LVMD and CHMD, and water wheeled from the CWSC to serve the WPA.

DEFINITION OF UNACCOUNTED-FOR WATER

For this evaluation, unaccounted-for water is the amount of water purchased or pumped and conveyed by the COSMUD, minus all metered water consumption. Metered water consumption includes sales to the public (i.e., residential, commercial, industrial, and institutional customers), sales to the LVMD and CHMD, and if available, water used for other purposes (e.g., construction

or hydrant flushing). Figure 2 is a diagram illustrating the unaccounted-for water as defined in this evaluation; a detailed description of the data used to account for each component illustrated on Figure 2 follows.

Per the direction of COSMUD staff, this evaluation only determined the average unaccounted-for water for calendar years 1999 through 2004. Unaccounted-for water use was not evaluated on a monthly basis.

DATA AVAILABLE FOR THE EVALUATION

The COSMUD's accounted-for water consists of two major components: recorded production and metered consumption. Recorded production consists of surface water metered from the SEWD, groundwater pumped from its municipal supply wells, and water wheeled from the CWSC to serve the WPA. Metered consumption consists of metered retail water use, water wheeled to the LVMD and CHMD, and other recorded water use. The difference between the recorded production and metered consumption is the COSMUD's unaccounted-for water. A detailed description of each component follows. Tables 1 and 2 summarize the total production and metered consumption for the COSMUD system for calendar years 1999 through 2004.

Production: Surface Water for North Stockton

Treated surface water flows from the SEWD Water Treatment Plant (SEWD WTP) to COSMUD's water system in the North Stockton area and recorded using a master meter. The location of the master meter and the SEWD WTP are illustrated on Figure 3. The SEWD provides the recorded flows to the COSMUD, who then summarizes the data on annual production reports completed for the months of April through March of each year. OMI/Thames (OMI), a City of Stockton contractor, also summarizes the same information in monthly reports for each calendar year for submittal to the Department of Water Resources (DWR). An example of the meter data read by the SEWD (see Exhibit A), the summary production report produced by the COSMUD (see Exhibit B), and the DWR table produced by OMI (see Exhibit C) are included as Attachment 1.

Consequently, three data sources are available to obtain the total quantity of surface water purchased from the SEWD WTP by the COSMUD for use in North Stockton: the actual meter data read by the SEWD, the summary table produced by the COSMUD, and the DWR table produced by OMI. A comparison of the total surface water purchased for January 2003 recorded by the three sources indicate that significant differences exist among them.

For example, the meter reading reported by SEWD in January 2003 indicates that 383.336 million gallons (MG) of surface water was delivered to the COSMUD North Stockton System, but the COSMUD summary report and OMI's DWR report indicate that 369.36 MG and 396.31 MG, respectively, were delivered. Additionally, the surface water reported on the COSMUD summary report for the LVMD and CHMD wholesale connections is actually included in the surface water purchased by the COSMUD.

After discussing these discrepancies with City and OMI staff, WYA decided that the actual meter data provided by the SEWD (see Exhibit A of Attachment 1) represented the best source of data for the total surface water delivered for the COSMUD's North Stockton System. Using the monthly meter data reports provided by the SEWD, WYA determined the total surface water delivered to the COSMUD's North Stockton System for calendar years 1999 through 2004. Table 1 summarizes the total surface water delivered to the COSMUD for use in its North Stockton system; this quantity of water includes surface water wheeled to the LVMD and CHMD.

Production: Groundwater Pumped from Municipal Supply Wells

The COSMUD supplements its surface water supply with groundwater pumped from municipal supply wells. Figure 3 illustrates the location of the COSMUD municipal supply wells. The COSMUD records flows from its municipal supply wells using meters located at each well, then summarizes the data in its production summary reports. An example of the meter data recorded at each well is provided as Exhibit D of Attachment 1; an example of the production summary report is also provided in as Exhibit B of Attachment 1.

Consequently, two sources are available to obtain the total quantity of groundwater pumped by the COSMUD: actual meter data and the annual summary reports. WYA decided to use the actual meter data from each well (see Exhibit D of Attachment 1) for consistency with the data used for the surface water purchased for North Stockton.

WYA determined the total groundwater pumped for calendar years 1999 through 2004 using monthly meter data for each well. Groundwater for the LVMD and CHMD was not included because the wells used to pump groundwater in these areas are not within the COSMUD water system and are not reflected in the consumption report. Table 1 summarizes the total groundwater pumped by the COSMUD for use in its North Stockton, South Stockton, and Walnut Plant systems; this quantity of water includes groundwater from the COSMUD system sold to the LVMD and CHMD.

Production: Water Wheeled by the CWSC

The COSMUD obtains water from the CWSC to supplement groundwater supply in the WPA. SEWD and OMI staff record flows from the CWSC into the WPA using a master meter located at the Filbert Interconnection (see Figure 3). The SEWD reports its reading of the Filbert meter on the same report used to record surface water flows to the COSMUD North Stockton system (see Exhibit A of Attachment 1), and OMI reports its reading on monthly production reports for the Walnut Plant (see Exhibit D, page A-6 of Attachment 1).

Consequently, two sources are available to obtain the quantity of water delivered to the WPA from the CWSC system: meter readings from the SEWD and meter readings from OMI. A comparison of the meter data for January 2003 indicates that significant differences exist between the two sets of data; the SEWD indicates that 11.648 MG were purchased, while OMI indicates that 11.988 MG were purchased (see Exhibit D, page A-6 of Attachment 1).

WYA decided to use the meter data produced by the SEWD for consistency with the data used for the surface water quantities delivered to the North Stockton system. Using SEWD meter data,

WYA determined the total amount of water delivered by the CWSC system to serve the WPA for calendar years 1999 through 2004 (see Table 1).

Metered Consumption: Retail Customers

The COSMUD has water meters on all its retail customers, and summarizes the flows for each customer on monthly cycle billing reports; each cycle represents a group of meters. An example of a cycle report used in this evaluation is included as Exhibit E of Attachment 1. OMI also summarizes the same information on the DWR table previously presented as Exhibit C of Attachment 1.

Consequently, two sources are available to obtain the quantity of water sold to COSMUD retail customers: the cycle billing reports produced by the COSMUD and the DWR table produced by OMI. A comparison of the meter data for January 2003 indicates that differences exist between the two sets of data; the cycle billing report indicates that 461.00 MG (616,275 ccf) were purchased, while the DWR table indicates that 464.62 MG were purchased.

After discussing this discrepancy with COSMUD staff, it was determined that the cycle billing reports are produced using a computer program that manipulates recorded meter data directly, while the DWR tables are entered in by hand. Therefore, WYA decided to use the cycle billing reports to determine the quantity of water sold to COSMUD retail customers for calendar years 1999 through 2004. Table 2 summarizes the total water sold to retail customers.

Metered Consumption: Wholesale and Wheeled Water to LVMD and CHMD

The LVMD and CHMD purchase water from the COSMUD to supplement groundwater pumped from their wells. The water provided by the COSMUD consists of a mixture of surface water purchased from the SEWD, which is wheeled through the COSMUD North System, and groundwater pumped from COSMUD owned municipal supply wells. Flows from the COSMUD system into the LVMD and CHMD systems are recorded using three master meters for the LVMD (Pershing Meter, Plymouth Meter, Greeley Meter) and two master meters for the CHMD (Portola Meter and Thornton Meter). Figure 3 illustrates the location of all five meters.

The COSMUD records flows through each meter and summarizes them on monthly statement of charges reports (statement reports). An example of a statement report used in this evaluation is included as Exhibit F of Attachment 1. WYA determined the total amount of water sold to the LVMD and CHMD for calendar years 1999 through 2004 using monthly statement reports from January 1999 through December 2004. Table 2 summarizes the total water sold to these wholesale customers.

During compilation of the data, WYA discovered that the Plymouth Meter recorded no flows into the LVMD in December 2001 and January 2002, contributing to the COSMUD's total unaccounted-for water.

Metered Consumption: Other

As indicated on the DWR table presented as Exhibit C of Attachment 1, OMI also records water consumption quantities under a category labeled as "other." Discussion with OMI staff indicated that the "other" category contains construction water, street sweeping water, and hydrant flushing water. This information is not included in the cycle billing reports or the wholesale meters. Consequently, the "other" category reported on the DWR tables represents another portion of the total accounted-for water use within the COSMUD water system. WYA used the "other" information reported on the DWR tables to account for additional authorized water use (e.g., construction water, hydrant flushing, or street sweeping). Table 2 summarizes the total water measured and categorized as "other" uses.

During compilation of the data, WYA noticed that the "other" quantities reported for 1999, 2002 and 2004 were much lower than quantities reported for other years. The quantity reported for 1999 indicates that it only includes construction water and therefore, does not contain hydrant flushing and street sweeping. As there were no qualifiers for the quantity reported for 2002 and 2004, but we suspect that, as in 1999, only construction water made up the "other" amount.

RESULTS OF THE EVALUATION

As discussed previously, the COSMUD's unaccounted-for water is the difference between the recorded production and metered consumption plus wholesale and wheeled water to the County. Table 3 summarizes the COSMUD's unaccounted-for water between 1999 and 2004. As shown in Table 3, the COSMUD's unaccounted-for water has averaged approximately 4.8 percent over the last five calendar years, ranging from a low of 2.1 percent in 2000 to a high of 7.7 percent in 1999.

Additionally, calendars years 1999, 2002, and 2004 had higher unaccounted-for water quantities than other years. The following factors contributed to the higher observed unaccounted-for water for those years:

- The "other" water quantity recorded in 1999 only included construction water. Normally, this would also include hydrant flushing and street sweeping.
- The "other" water quantity recorded for 2002 and 2004 is much smaller than the quantities reported for 2000, 2001, and 2003. The quantity reported likely includes only construction water, contributing to a higher unaccounted-for water quantity.

Unaccounted-for water percentages among different water systems can vary greatly and has ranged from 3 to 25 percent within WYA's other clients. Consequently, COSMUD's average unaccounted-for water (4.8 percent) is considered very good, indicating an extremely tight water system. The COSMUD can reduce the unaccounted-for water percentage by keeping better track of water use in the "other" category (e.g., water used for construction, hydrant flushing, and street sweeping).

Table 1. Historical Production from 1999-2004[a]

Year	SEWD, MG	Wells, MG[b]	WPA Intertie, MG	Total, MG[c]
1999	5,658	3,363	146	9,167
2000	5,668	3,353	150	9,171
2001	5,659	4,139	164	9,962
2002	6,114	4,227	147	10,488
2003	6,144	4,415	141	10,701
2004	6,927	4,794	177	11,899

[a] Production data obtained from City Annual Water Production Records in City's files.

[b] Does not include well production of Lincoln Village and Colonial Heights Wells.

[c] Total Production = COS MUD Wells + COS MUD SEWD + Walnut Plant Intertie

Table 2. Accounted For Consumption from 1999-2004

Year	Retail, MG[a]	Wholesale, MG[b]	Other, MG[c]	Total, MG
1999[d]	7,845	612	8	8,465
2000	8,261	613	109	8,982
2001	8,948	635[e]	102	9,685
2002	9,181	640[e]	75	9,896
2003	9,490	623	156	10,269
2004	10,400	641	75	11,116

[a] Based on retail cycle billing information provided by the City.

[b] Based on metered information for Lincoln Village and Colonial Heights (Pershing, Plymouth, Greeley, Portola and Thornton connections).

[c] Based on DWR tables provided by the City.

[d] DWR Tables indicate that "other" category only includes construction water.

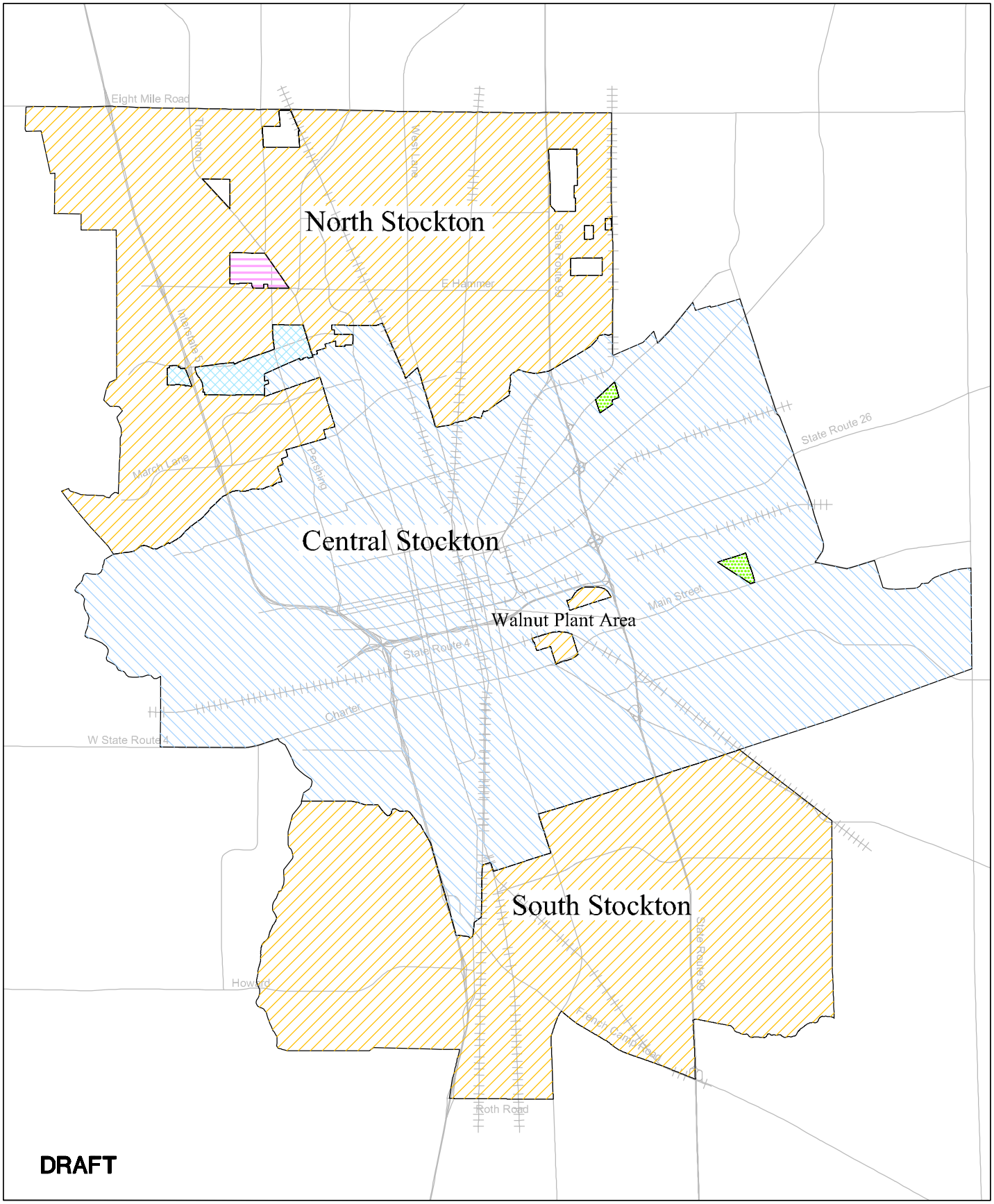
[e] Plymouth meter did not register for December 2001 and January 2002.

Table 3. Unaccounted For Water 1999-2004[a]

Year	Production, MG	Consumption, MG	Unaccounted-For, MG	Unaccounted[b], %	Comments
1999	9,167	8,465	702	7.7	"other" category only includes construction water
2000	9,171	8,982	188	2.1	
2001	9,962	9,685	277	2.8	Plymouth meter did not register for 12/01
2002	10,488	9,896	592	5.6	Plymouth meter did not register for 1/02
2003	10,701	10,269	432	4.0	
2004	11,899	11,116	783	6.6	
AVERAGE				4.8	

[a] Calculated using information provided by City (see Tables 1 and 2).

[b] Unaccounted % = Unaccounted/Production



LEGEND

- City of Stockton Water Utility
- Lincoln Heights Maintenance District
- Colonial Heights Maintenance District
- California Water Service Company
- Stockton East Water District
- Other County Areas

N

0 1.0 2.0
SCALE IN MILES

FIGURE 1

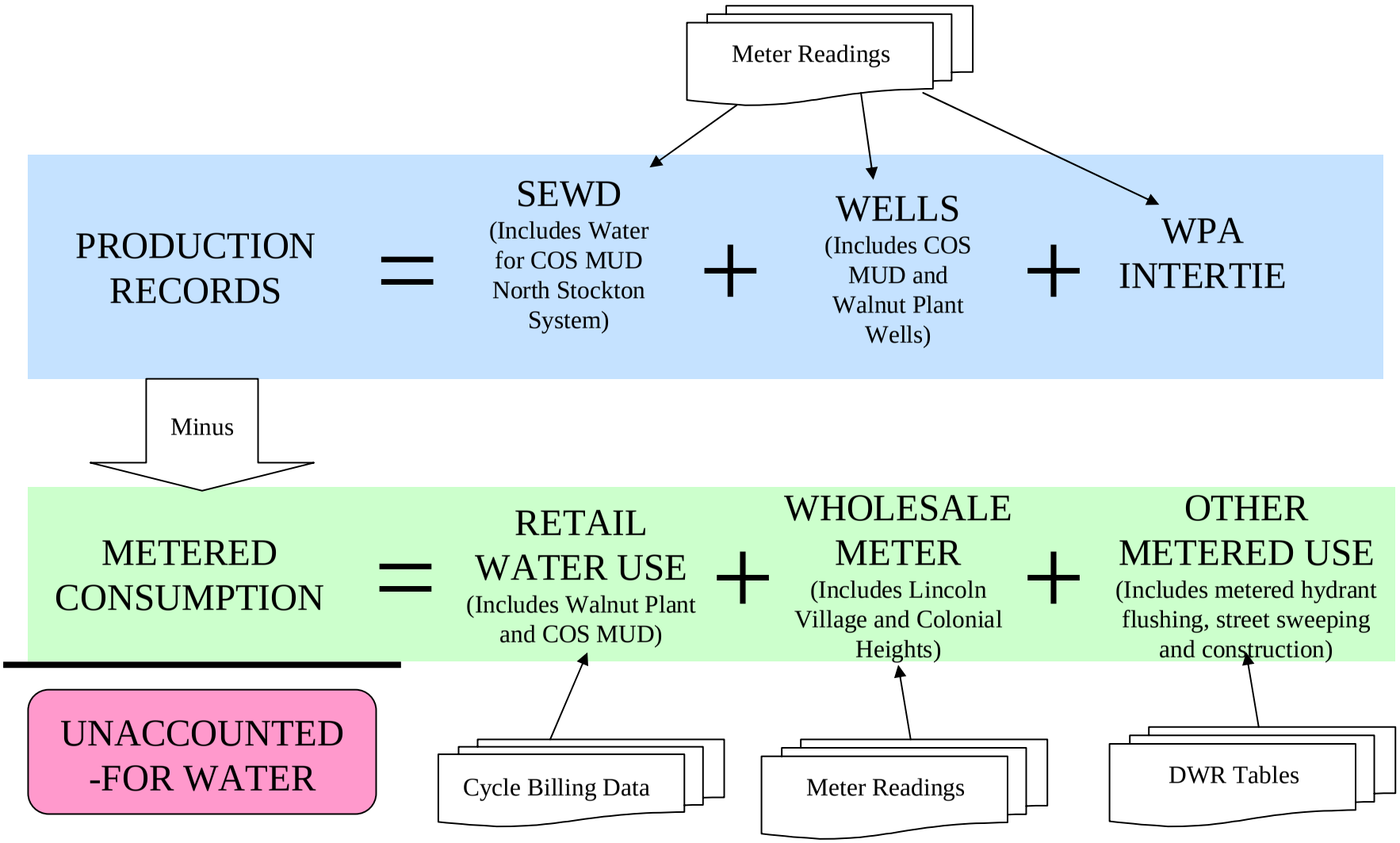
City of Stockton
Unaccounted-For Analysis
EXISTING SERVICE AREAS

WEST YOST & ASSOCIATES

Revised: 03/18/05

Location: i:\408\0507\FIG01.dwg

FIGURE 2: UNACCOUNTED FOR WATER FLOW CHART



Last Revised: 02/16/05
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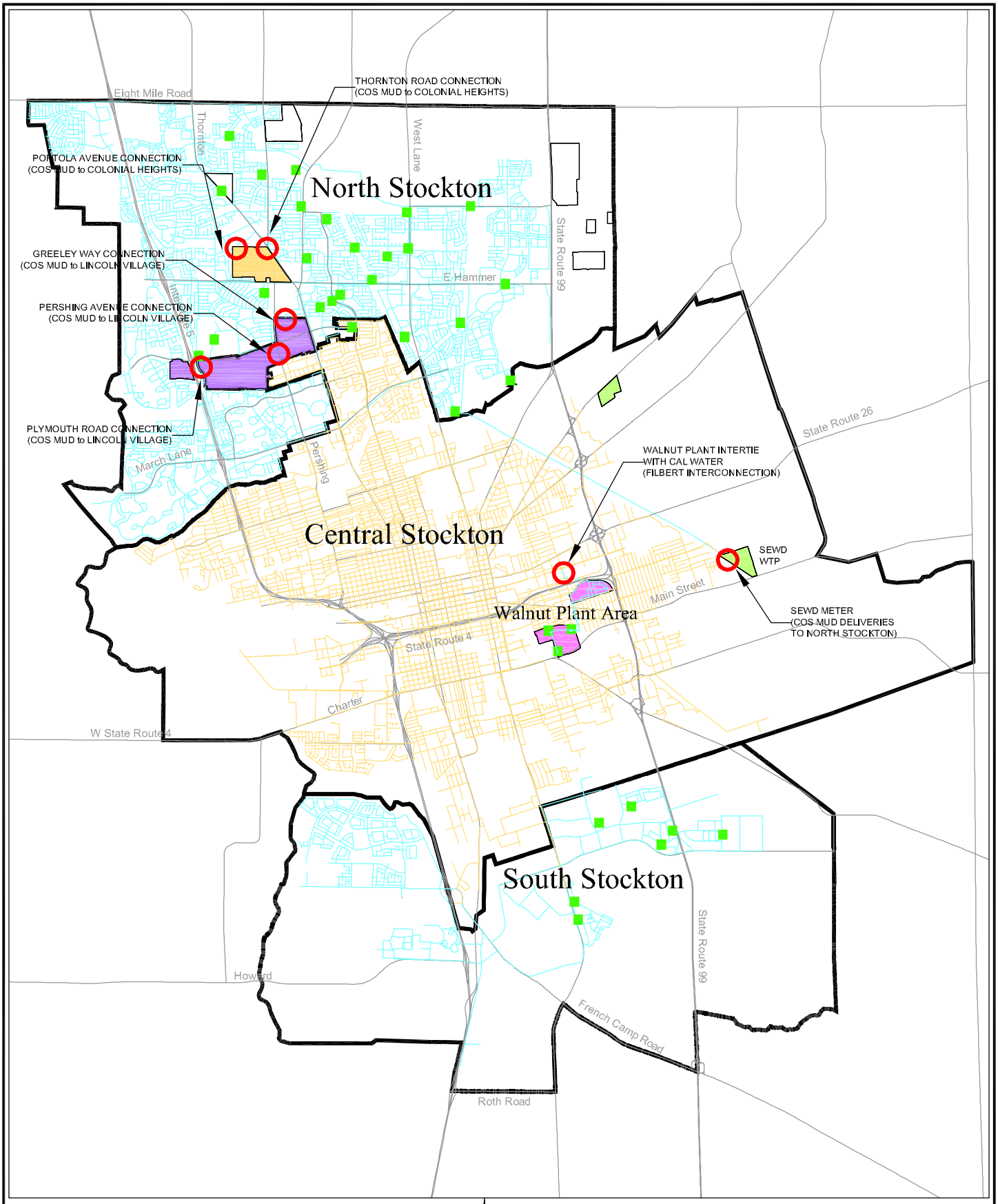
West Yost & Associates



LEGEND

- COS MUD WELLS
- COS MUD PIPELINES
- CAL WATER PIPELINES
- KEY DATA LOCATION
- ROADS
- SEWD WTP
- WALNUT PLANT
- LINCOLN VILLAGE
- COLONIAL HEIGHTS

N

0 4950 9900
SCALE IN FEET

FIGURE 3

City of Stockton
Unaccounted-For Analysis
LOCATION OF METERS

WEST YOST & ASSOCIATES

CAD FILE: I:/408/05-07/FIG03.dwg DATE: 02-16-05

ATTACHMENT 1

Exhibit A: Example of SEWD Meter Records A-1

Exhibit B: Example of COSMUD Summary of Production Report A-2

Exhibit C: Example of DWR Report A-3

Exhibit D: Example of Well Meter Data A-4

Exhibit E: Example Cycle Billing Report A-7

Exhibit F: Example Statement Reports A-8

Date: January, 2003

STOCKTON METROPOLITAN AREA WATER PRODUCTION

Stockton East Water District Deliveries*

City of Stockton	383.336	MG	A
California Water Service	440.235	MG	B
California Water Wells	196.349	MG	H
Diamond Walnut	11.648	MG	C*

* This information comes from John Yoshimura, SEWD (209) 948-0537

San Joaquin County Wells**

Colonial Heights		MG

** This information comes from Ron Rall, San Joaquin County (209) 468-3090

Month	SEWD	CAL WATER			COS WATER			LINCOLN MAINT. DIST. COS			C H WATER			TOTAL METROPOLITAN AREA			% OF YTD
		WELLS	SEWD	TOTAL	WELLS	SEWD	TOTAL	WELLS	SEWD	TOTAL	WELLS	SEWD	TOTAL	WELLS	SEWD	TOTAL	
Apr-02	983.18	347.29	495.92	843.21	319.80	446.80	766.60	11.13	28.42	39.55	0.16	12.04	12.20	667.25	983.18	1,650.43	7.45
May-02	1,224.15	469.37	619.26	1,088.62	428.08	566.47	994.55	27.12	23.24	50.36	2.17	15.18	17.35	899.62	1,224.15	2,123.77	9.59
Jun-02	1,224.22	620.26	655.36	1,275.62	611.04	523.01	1,134.05	34.56	33.92	68.48	11.66	11.93	23.59	1,242.97	1,224.22	2,467.19	11.14
Jul-02	1,257.24	761.47	659.85	1,421.33	745.77	554.49	1,300.26	39.72	34.82	74.53	18.48	8.08	26.56	1,525.72	1,257.24	2,782.96	12.57
Aug-02	1,274.79	708.55	645.65	1,354.20	637.58	584.01	1,221.59	27.02	36.70	63.72	13.72	8.43	22.15	1,359.85	1,274.79	2,634.64	11.90
Sep-02	1,258.98	603.90	636.23	1,240.13	548.69	573.85	1,122.54	26.90	37.00	63.90	9.71	11.90	21.61	1,162.30	1,258.98	2,421.28	10.93
Oct-02	1,314.29	362.56	673.82	1,036.38	353.33	588.86	942.19	10.85	37.35	48.20	0.61	14.26	14.87	716.50	1,314.29	2,030.79	9.17
Nov-02	1,087.11	142.34	587.71	730.05	137.62	461.73	599.35		27.84	27.84	0.03	9.84	9.87	279.99	1,087.11	1,367.10	6.17
Dec-02	915.85	271.10	494.34	765.44	103.60	397.38	500.98		20.72	20.72	0.18	3.41	3.59	374.88	915.85	1,290.73	5.83
Jan-03	823.57	196.35	428.59	624.94	*37.20	369.36	406.56		20.29	20.29	0.01	5.33	5.34	196.36	823.57	1,019.93	4.61
Feb-03	785.83	182.95	389.33	572.27	67.81	372.53	440.33		19.78	19.78	0.03	4.19	4.22	250.78	785.83	1,036.61	4.68
Mar-03	974.11	203.70	477.12	680.82	139.36	459.39	598.75	0.30	29.01	29.31	0.02	8.58	8.60	343.07	974.11	1,317.18	5.95
MILL. GALS	13,123.12	4,869.84	6,763.18	11,633.02	4,129.88	5,897.89	10,027.75	177.60	349.09	526.69	56.78	113.19	169.97	9,019.28	13,123.33	22,142.60	
AFA	40,272.86	14,944.79	20,755.17	35,699.97	12,673.97	18,099.73	30,773.64	545.02	1,071.32	1,616.34	174.25	347.36	521.61	27,678.79	40,273.49	67,952.29	
% OF YTD	100.00%	41.86	58.14	100.00	41.18	58.82	100.00	33.72	66.28	100.00	33.41	66.59	100.00	40.73	59.27	100.00	100

* Includes adjustment for October, November and December, 2002

June and September 2002 figures corrected per John Yoshimura SEWD

SUMMARY INFORMATION
TOTAL USAGE: WATER YEAR 2002-2003

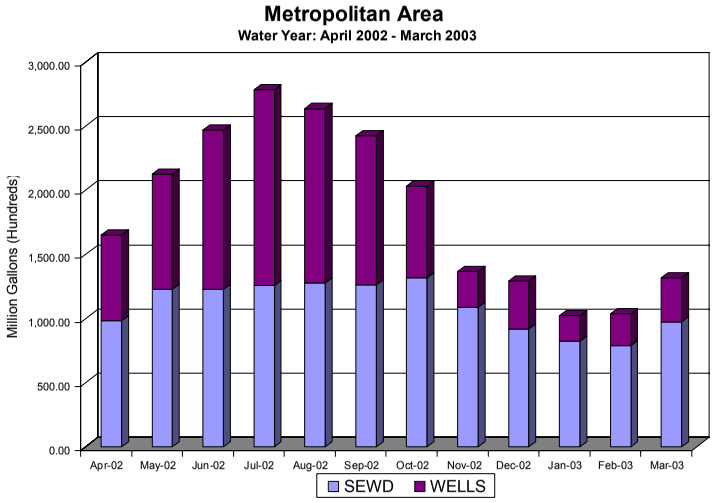
	MG/YTD	AF/YTD	%/YTD
Cal Water	11,633.02	35,699.97	52.45
City Water	9,850.15	30,228.62	44.41
LV Maint.	526.69	1,616.34	2.37
CH Maint.	169.97	521.61	0.77
	22,179.83	68,066.53	100.00

RECORDED DISTRIBUTION OF SEWD WATER TO CONTRACTORS

	Alloc.	Delvd.	Diff.	AFA
Cal Water	52.960%	51.536%	-1.424%	20755.17
City Water	42.950%	44.942%	1.992%	18099.73
LV Maint	2.480%	2.660%	0.180%	1071.32
CH Maint	1.610%	0.862%	-0.748%	347.36
	100.000%	100.000%	0.000%	40273.57

CITY PRODUCTION FOR WATER CONSERVATION

Month	M.G.
Apr-02	755.47
May-02	967.43
Jun-02	1,099.49
Jul-02	1,260.54
Aug-02	1,194.57
Sep-02	1,095.64
Oct-02	931.34
Nov-02	599.35
Dec-02	500.98
Jan-03	406.56
Feb-03	440.33
Mar-03	598.45
TOTAL	9,850.14



Note: SEWD Allocation is proration of revised base monthly payment for fiscal year 4/1-3/31

Exhibit B

State of California | Department of Water Resources | The Resources Agency

PUBLIC WATER SYSTEM STATISTICS

Calendar Year 2003

Mailing Label

1. General Information

Please follow the guidelines on the back of this form.

Contact : Dennis C.W. DeCoite
Title: Director of Operations
Phone: (209 937-8757
Fax: (209) 937-8720
E-mail: ddecoite@omiinc.com
Website:
Communities served:
City of Stockton
County: San Joaquin
Population served 119,600

2. Active Service Connections

Customer Class	Recycled Water	Potable Water		Complete this portion if the system serves all or part of an incorporated city: Inside City Limits		Outside City Limits	
		Metered	Unmetered	Metered	Unmetered	Metered	Unmetered
Single Family Residential		32,961		32,912		49	
Multi-family Residential		4,984		4,944		40	
Commercial/Institutional		1,226		1,183		43	
Industrial							
Landscape Irrigation		693		693			
Other		70		65		5	
Agricultural Irrigation							
TOTAL		39934		39797		137	

3. Total Water Into the System - Units of production:

☐ acre-feet ☑ million gallons ☐ hundred cubic feet

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Potable	*Wells*	78.08	67.81	139.36	143.21	364.75	688.55	856.91	763.08	625.4	451.54	148.92	87.48	4415.09
	Surface													
	Purchased 1/	396.31	395.06	497	518.31	578.39	594.41	579.9	592.38	597.28	619.86	493.2	433.24	6295.34
	Total Potable	474.39	462.87	636.36	661.52	943.14	1282.96	1436.81	1355.46	1222.68	1071.4	642.12	520.72	10710.43
Recycled 2/														

1/ Potable wholesale supplier(s): Stockton East Water District

2/ Recycled wholesale supplier(s): City of Stockton

Level of treatment: Tertiary

4. Metered Water Deliveries - Units of delivery:

☐ acre-feet ☑ million gallons ☐ hundred cubic feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
A. Single Family Residential	262.2	237.84	254.99	331.09	391.23	618.51	748.68	769.97	663.37	559.14	500.68	278.28	5615.98
B. Multi-family Residential	98.74	83.66	82.32	96.53	101.33	123.33	136.86	149.63	130.76	111.74	113.99	88.28	1317.17
C. Commercial/Institutional	81.14	75.15	80.7	104.31	120.94	184.1	214.81	214.49	213.1	156.93	140.65	78.78	1665.1
D. Industrial													
E. Landscape Irrigation	18.9	9.14	16.95	40.56	50.97	105.84	116.04	163.67	147.35	104.46	78.78	27.23	879.89
F. Other	3.64	3.44	4.92	6.38	21.08	30.68	36.76	10.99	13.55	15.73	6.97	1.79	155.93
Total Urban Retail(A thru F)	464.62	409.23	439.88	578.87	685.55	1062.46	1253.15	1308.75	1168.13	948	841.07	474.36	9634.07
Agricultural Irrigation													
Wholesale(*to other agencies*)	25.62	23.97	37.89	37.18	71.07	67	88.22	74.45	65.51	63.06	35.28	26.09	615.34

Exhibit C

NORTH SYSTEM
MONTHLY WELL PRODUCTION
Jan-03

DAYS 31 FROM 1/1/03 TO 2/1/03

STA. NO.	LOCATION	*******METER READING****** HOURS	FLOW	ELECT or GAS	HOURS OPERATED	PROD. (MG)	KWH (FT^3) USED	GPM	KWH/MG FT^3/MG	STATUS
1	PARKWOODS	18356.8	535024	2847	0.00	0.00	320	0	0	abu
4	VILLA DORADO	8542	553349	19364	0.00	0.00	720	0	0	abu
5	ANDERSON PARK	6159.1	246300	38293	0.00	0.00	91	0	0	abu
7	GALLOWAY	17948.3	216923	78269	0.00	0.00	0	440	0	out
9	DON CARLOS	14198.1	383781	55183	295.50	7.69	11534	434	1499	abu
10	BENJAMIN HOLT	17914.5	8635	1741	0.00	0.00	2320	0	0	off
11	INGLEWOOD	800.1	292330	5005	0.60	0.00	200	0	0	out
12	LESLIE	11544.8	477366	12177	8.70	0.32	520	621	1605	abu
13	TIFFANY	6627.7	544143	29188	0.00	0.00	1	0	0	off
15	GLASGOW	294.2	20678	8574	0.00	0.00	0	0	0	off
16	ROYAL OAKS	2272	0	56898	0.00	0.00	0	1550	0	abu
18	HICKOCK	15342.2	709876	12061	0.00	0.00	76	0	0	off
19	MORADA/WEST LANE	2541.8	239538	16696	0.00	0.00	0	0	0	abu
20	WEST LANE/MOSHER	1300.5	89920	64727	0.00	0.00	0	0	0	abu
21	CORTEZ PARK	664.7	70295	14440	1.40	0.15	360	1726	2483	abu
22	SWAIN/TAM O'SHANTER	6.6	6	2174	0.00	0.00	0	0	0	off
23	OTTO	21984.8	782857	83345	0.00	0.00	0	0	0	abu
24	SAFFRON	2456.6	405097	3542	0.00	0.00	0	900	0	****off
25	PANELLA PARK	2278.7	311398	26725	0.00	0.00	0	0	0	abu
26	AUTO CENTER	8508	942530	58988	20.00	2.17	232	1808	107	abu
27	HORSE PARK	764.7	94033	945	0.00	0.00	160	0	0	abu
28	BLOSSOM RANCH	870.5	80136	error	0.00	0.0(		0	0	abu***
29	PIXLEY	9687.9	1039670	10736	0.00	0.00	0	2672	0	abu
28	BLOSSOM WAY (rt. meter)			921			0			
				TOTAL WELL PRODUCTION		10.33 I		0.33	City MGD	
		D	4710826	STOCKTON EAST		383.34		12.37	S.E. MGD	
				TOTAL NORTH SYSTEM		393.67		12.70	Total MGD	

Well Soundings
#10..... 24'
#17..... stuck
#24..... 61'
#27..... 54'
#28..... 69'
#29.....
#WP1..... n/a
#S3..... 73'

****flow meter not working
***elect mtr shows "error"/ no reading

SOUTH SYSTEM
MONTHLY WELL PRODUCTION

Jan-03

*

DAYS
31 FROM 1/1/03 TO 2/1/03

STA. NO.	LOCATION	*******METER READING****** HOURS	FLOW	ELECT or GAS	HOURS OPERATED	PROD. (MG)	KWH (FT^3) USED	GPM	KWH/MG FT^3/MG	REMARKS
SS1	QUANTAS	23861.3	511789	77320	692.8	58.951	8130	1418	138	run
SS2	N. ARCH FRONTAGE	4438.1	346549	47250	1.9	0.135	203	1184	1504	abu
SS3	FRONTIER	540.6	63617	10902	27.5	1.971	4760	1195	2415	run
SS4	AIRPORT SOUTH	11105.4	510457	37586	84.3	4.499	6320	889	1405	run
SS5	AIRPORT NORTH	11267.9	522657	42955	23.5	1.071	2320	760	2166	run
SS8	POCK PARK	5894.9	820918	8898	8.2	1.123	2480	2283	2208	abu

TOTAL SOUTH SYSTEM 67.75 K
MG/DAY 2.185

WALNUT PLANT
MONTHLY WELL PRODUCTION

Jan-03

*
DAYS
31

FROM 1/1/03 TO 2/1/03

STA. NO.	LOCATION	*******METER READING****** HOURS	FLOW	ELECT or GAS	HOURS OPERATED	PROD. (MG)	KWH (FT^3) USED	GPM	KWH/MG FT^3/MG	REMARKS
WP1	WORTH & EMERALD	710.3	40314	1365	0	0	0	0	0	*out*
WP2	WORTH & DIAMOND	NA	31	96773	NA	0	0	N/A	0	*off*
WP3	DIAMOND&MORMON SLOUGH	4586.7	10894	9	0.1	0.004	0	667	0	*abu*

TOTAL WELL PRODUCTION	0.004	
133328 FILBERT INTERCONNECT	11.988	WP1 motor burnt
TOTAL WALNUT PLANT SYSTEM	11.992	
MG/DAY	0.3868	

US426L WATER SERVICE REPORT CYCLES 11 - 33 16:14:48 3/03/03 PAGE 1
1/09/03 - 2/07/03

CYCLE	USER TYPE		NO. ACCTS	USE/FEET	USE/AVER	REV/METER	REV/OTHER	REV/TOTAL	REV/AVER
11-13	AP	APARTMENT	116	19,816	171	3,918.10	12,830.99	16,749.09	144.39
	C	COMMERCIAL	436	21,993	50	10,537.74	14,236.34	24,774.08	56.82
	CO	CONDOMINIUM	476	4,529	10	7,243.16	3,373.00	10,616.16	22.30
	DU	DUPLEX	525	6,969	13	7,679.05	5,175.81	12,854.86	24.49
	IR	IRREGATION	382	9,207	24	10,059.86	5,909.02	15,968.88	41.80
	IN	INSTITUTIONAL	14	1,351	97	678.26	898.44	1,576.70	112.62
	SF	SINGLE FAMILY	8,054	91,971	11	129,317.92	64,220.97	193,538.89	24.03
	TR	TRIPLEX	236	2,954	13	3,383.24	2,384.92	5,768.16	24.44
		SUBTOTAL	10,239	158,790	16	172,817.33	109,029.49	281,846.82	27.53
14-16	AP	APARTMENT	118	7,890	67	2,918.59	5,191.91	8,110.50	68.73
	C	COMMERCIAL	46	1,135	25	1,382.33	754.88	2,137.21	46.46
	CO	CONDOMINIUM	762	7,378	10	10,051.46	5,156.78	15,208.24	19.96
	DU	DUPLEX	939	15,345	16	13,446.01	11,406.70	24,852.71	26.47
	IR	IRREGATION	85	1,324	16	2,535.23	863.30	3,398.53	39.98
	IN	INSTITUTIONAL	12	1,144	95	719.63	736.13	1,455.76	121.31
	SF	SINGLE FAMILY	8,164	93,663	11	123,931.64	66,561.97	190,493.61	23.33
	TR	TRIPLEX	289	6,132	21	4,319.16	4,736.05	9,055.21	31.33
		SUBTOTAL	10,415	134,011	13	159,304.05	95,407.72	254,711.77	24.46
17-19	AP	APARTMENT	92	15,291	166	2,271.43	9,826.65	12,098.08	131.50
	C	COMMERCIAL	31	2,736	88	1,067.51	1,802.76	2,870.27	92.59
	CO	CONDOMINIUM	16	1,131	71	544.00	751.57	1,295.57	80.97
	DU	DUPLEX	703	11,074	16	9,956.74	8,326.11	18,282.85	26.01
	IR	IRREGATION	28	1,822	65	980.25	1,183.73	2,163.98	77.29
	IN	INSTITUTIONAL	12	599	50	634.03	398.35	1,032.38	86.03
	SF	SINGLE FAMILY	6,677	78,664	12	95,016.02	56,321.21	151,337.23	22.67
	TR	TRIPLEX	436	13,666	31	6,986.36	9,208.92	16,195.28	37.15
		SUBTOTAL	7,995	124,983	16	117,456.34	87,819.30	205,275.64	25.68
20-33	AP	APARTMENT	77	16,245	211	3,126.87	10,376.42	13,503.29	175.37
	C	COMMERCIAL	583	62,474	107	17,189.85	38,837.01	56,026.86	96.10
	CO	CONDOMINIUM	2	238	119	47.79	158.27	206.06	103.03
	DU	DUPLEX	164	2,709	17	2,354.07	2,041.89	4,395.96	26.80
	IR	IRREGATION	161	12,917	80	5,176.91	7,565.33	12,742.24	79.14
	IN	INSTITUTIONAL	77	17,040	221	5,070.66	12,737.94	17,808.60	231.28
	SF	SINGLE FAMILY	7,542	86,234	11	118,543.74	66,544.17	185,087.91	24.54
	TR	TRIPLEX	39	634	16	564.93	481.69	1,046.62	26.84
		SUBTOTAL	8,645	198,491	23	152,074.82	138,742.72	290,817.54	33.64
11-33	AP	APARTMENT	403	59,242	147	12,234.99	38,225.97	50,460.96	125.21
	C	COMMERCIAL	1,096	88,338	81	30,177.43	55,630.99	85,808.42	78.29
	CO	CONDOMINIUM	1,256	13,276	11	17,886.41	9,439.62	27,326.03	21.76
	DU	DUPLEX	2,331	36,097	15	33,435.87	26,950.51	60,386.38	25.91
	IR	IRREGATION	656	25,270	39	18,752.25	15,521.38	34,273.63	52.25
	IN	INSTITUTIONAL	115	20,134	175	7,102.58	14,770.86	21,873.44	190.20
	SF	SINGLE FAMILY	30,437	350,532	12	466,809.32	253,648.32	720,457.64	23.67
	TR	TRIPLEX	1,000	23,386	23	15,253.69	16,811.58	32,065.27	32.07
		TOTAL	37,294	616,275	17	601,652.54	430,999.23	1,032,651.77	27.69

January

461.0 MG

Exhibit E

(Water Year April 2002 - March 2003)
LINCOLN VILLAGE MONTHLY WATER BILLING DATA

Prepared: 2/24/03
Billing Period: Jan-2003 Total SEWD Delivered: 823.6 M.G. 2,527.5 A.F.

CITY ENTITLEMENT:	43.0%	1,086.8	AC FT
Less to DWG System:	1.4%	35.7	AC FT
Delivery to North System:	41.6%	1,051.1	AC FT
LINCOLN VILLAGE ENTITLEMENT	2.7%	68.5	AC FT
Colonial Heights	0.8%	20.5	AC FT
N STOCKTON, LVW & CH ENTITLEMENT	45.1%	1,140.0	AC FT
DEBIT OR (CREDIT):		-36.4	AC FT

STOCKTON EAST WATER DELIVERIES INTO NORTH STOCKTON AQUEDUCT

Meter Readings: ENDING: 4,710,826 BEGINNING: 4,327,490 383.3 M.G.

Total Delivery in Acre Feet:			1,176.4 A.F.
North Stockton Entitlement:	92.2%	1,084.6	A.F.
Lincoln Village Entitlement:	6.0%	70.7	A.F.
Colonial Heights Entitlement:	1.8%	21.1	A.F.

MONTHLY BILL FOR CITY WATER SERVICE AND WHEELING CHARGES

SEWD Production for Period of: January-03 823.6 M.G.

Lincoln's SEWD Entitlement:	2.7%	68.49	AC FT
Lincoln's Pipeline Entitlement	6.0%	70.68	AC FT

Meter Readings:

Pershing Avenue Meter:				
Ending:	1/31/03	257,449		
Beginning:	1/1/03	246,058		
Metered Delivery:		11,391	CCF	26.2 AC FT.
				41.988%
Plymouth Road Meter:				
Ending:	1/31/03	203,335		
Beginning:	1/1/03	197,828		
Metered Delivery:		5,507	CCF	12.6 AC FT.
				20.299%
Greeley Way Meter:				
Ending:	1/31/03	96,427		
Beginning:	1/1/03	86,196		
Metered Delivery:		10,231	CCF	23.5 AC FT.
				37.712%
		27,129	CCF	62.3 AC FT.

Net City Delivery to Lincoln Village:

Billing Units (100 Cubic Feet)	0 CCF	62.3 AC FT.
	0.000 M.G.	20.3 M.G.

Billing for Month:

Ready to Serve Charge (Three 8" Meters):	$622.65
Quantity Charge (Note 2):	$0.00
Equity Factor (per Service Agreement):	$49.81
TOTAL BILLING FOR PERIOD:	$672.46

Wheeling Charges ($15/ac ft) 70.68 Acre Feet $1,060.21

TOTAL CITY CHARGE: $1,732.67

Notes:

1999-2000 SEWD Allocations are used.
City Equity factor became effective July 1, 1992 (7.8%).

CC: Stockton East Water District, Attention: John Yoshimura
San Joaquin County, Attention: Ron Rall

STATEMENT OF CHARGES

COLONIAL HEIGHTS

Billing Period: January 2003

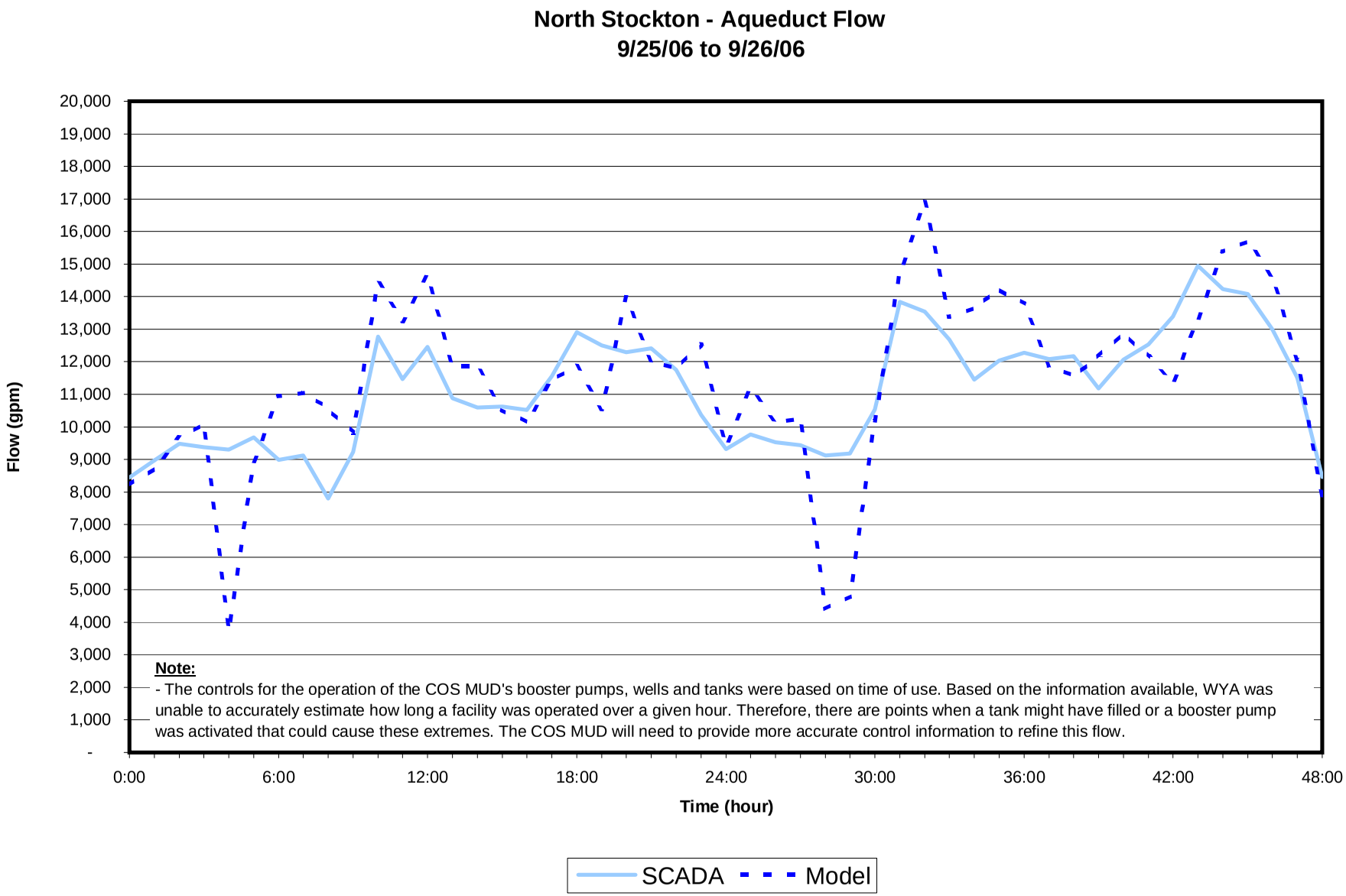
	Meter Readings			
	Ending	Beginning	CCF	A.F.
Portola Avenue	22,100	18,854	3,246	7.452
Thornton Road	243,541	239,660	3,881	8.910
		TOTAL:	7,127	16.361

Wheeling Charges @ $15/AF: $245.42

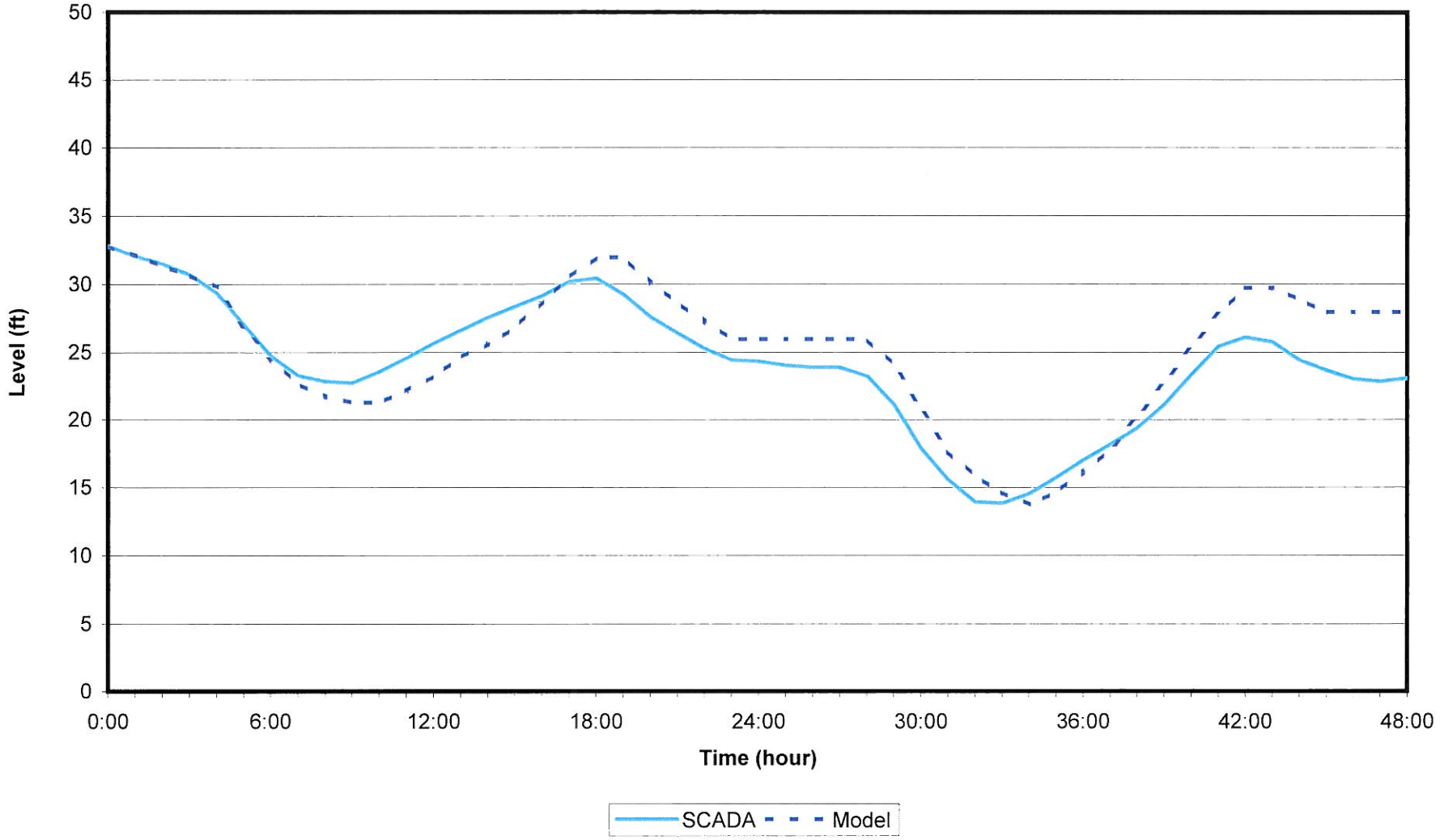
Note: Send Statement to Ron Rall
San Joaquin County Maintenance Districts, 1702 E. Scotts, Stkn. CA 95205

APPENDIX B

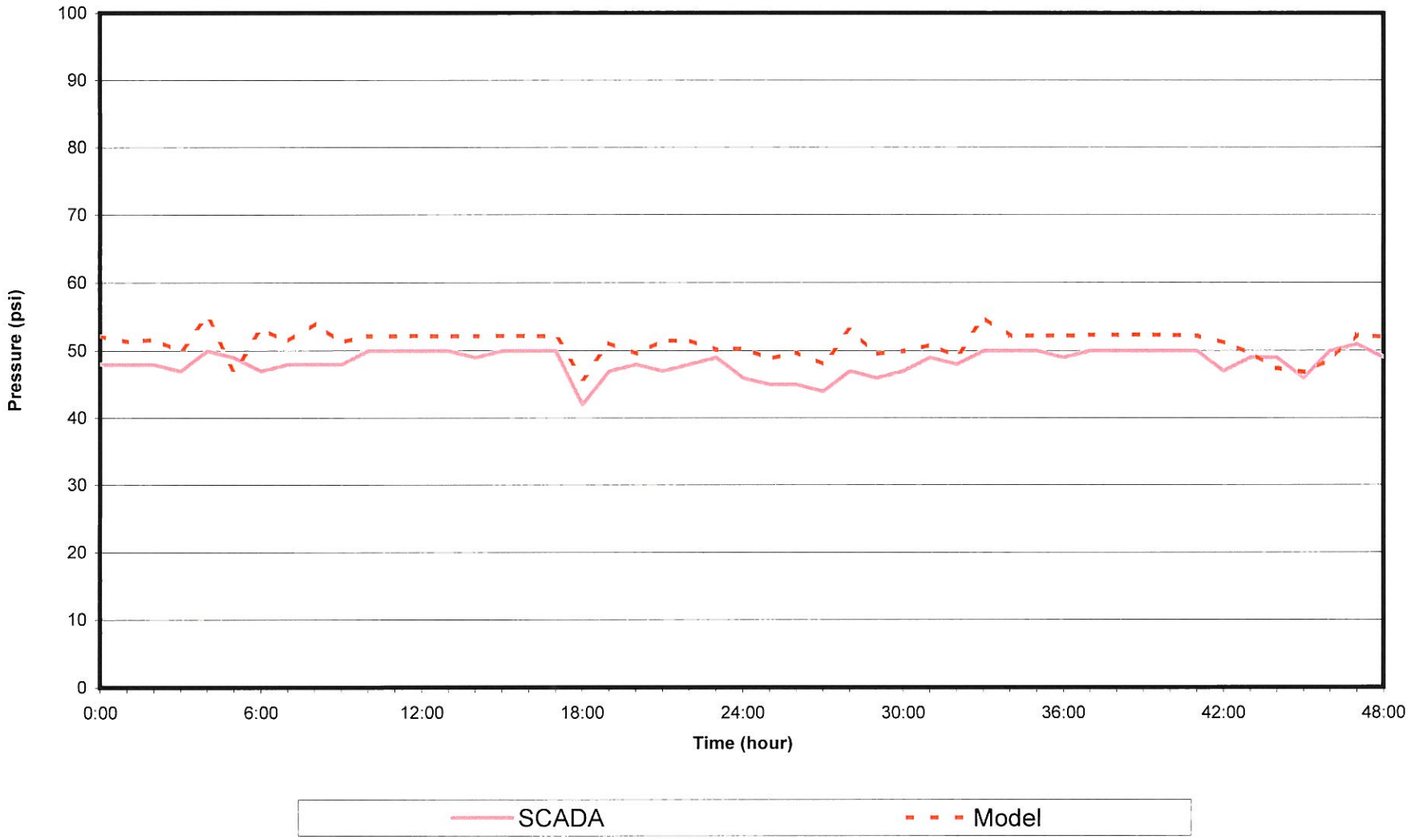
Verification Results


North Stockton - Aqueduct Flow
9/25/06 to 9/26/06
Flow (gpm)
20,000
19,000
18,000
17,000
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
-
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
Note:
- The controls for the operation of the COS MUD's booster pumps, wells and tanks were based on time of use. Based on the information available, WYA was unable to accurately estimate how long a facility was operated over a given hour. Therefore, there are points when a tank might have filled or a booster pump was activated that could cause these extremes. The COS MUD will need to provide more accurate control information to refine this flow.
SCADA
Model

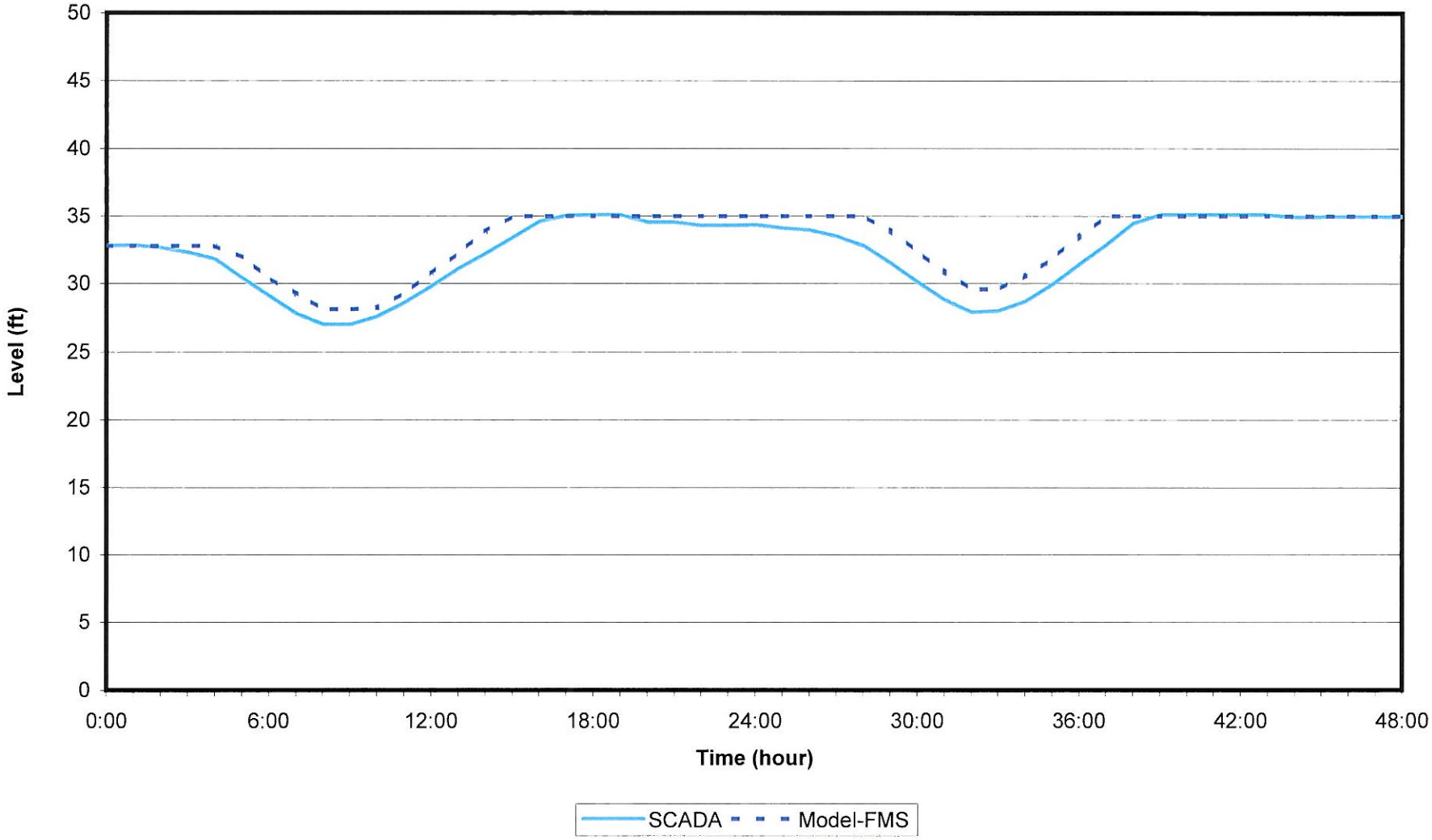
North Stockton - Northwest Reservoir Combined Tank Level
9/25/06 to 9/26/06



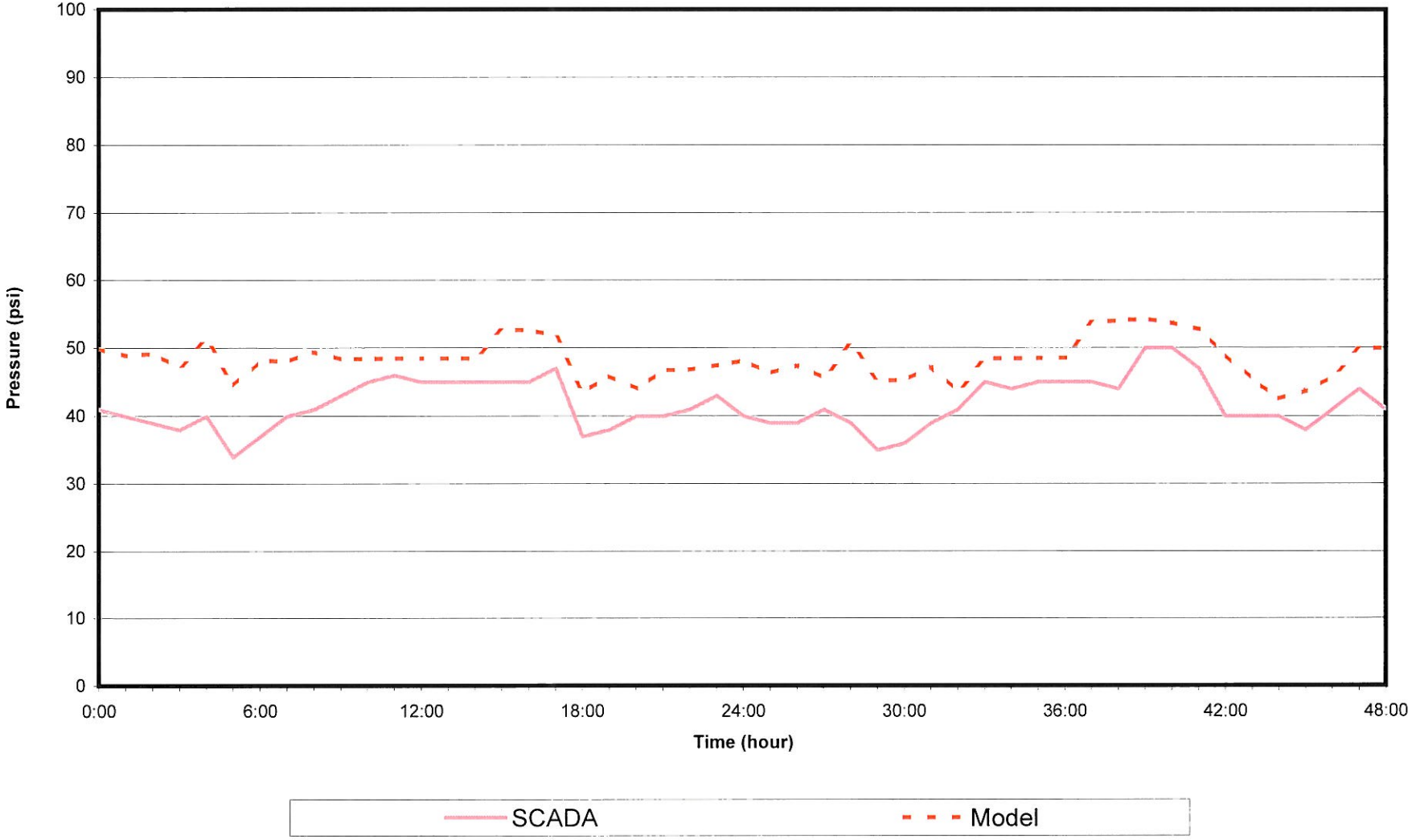
North Stockton - Northwest Reservoir Discharge Pressure
9/25/06 to 9/26/06

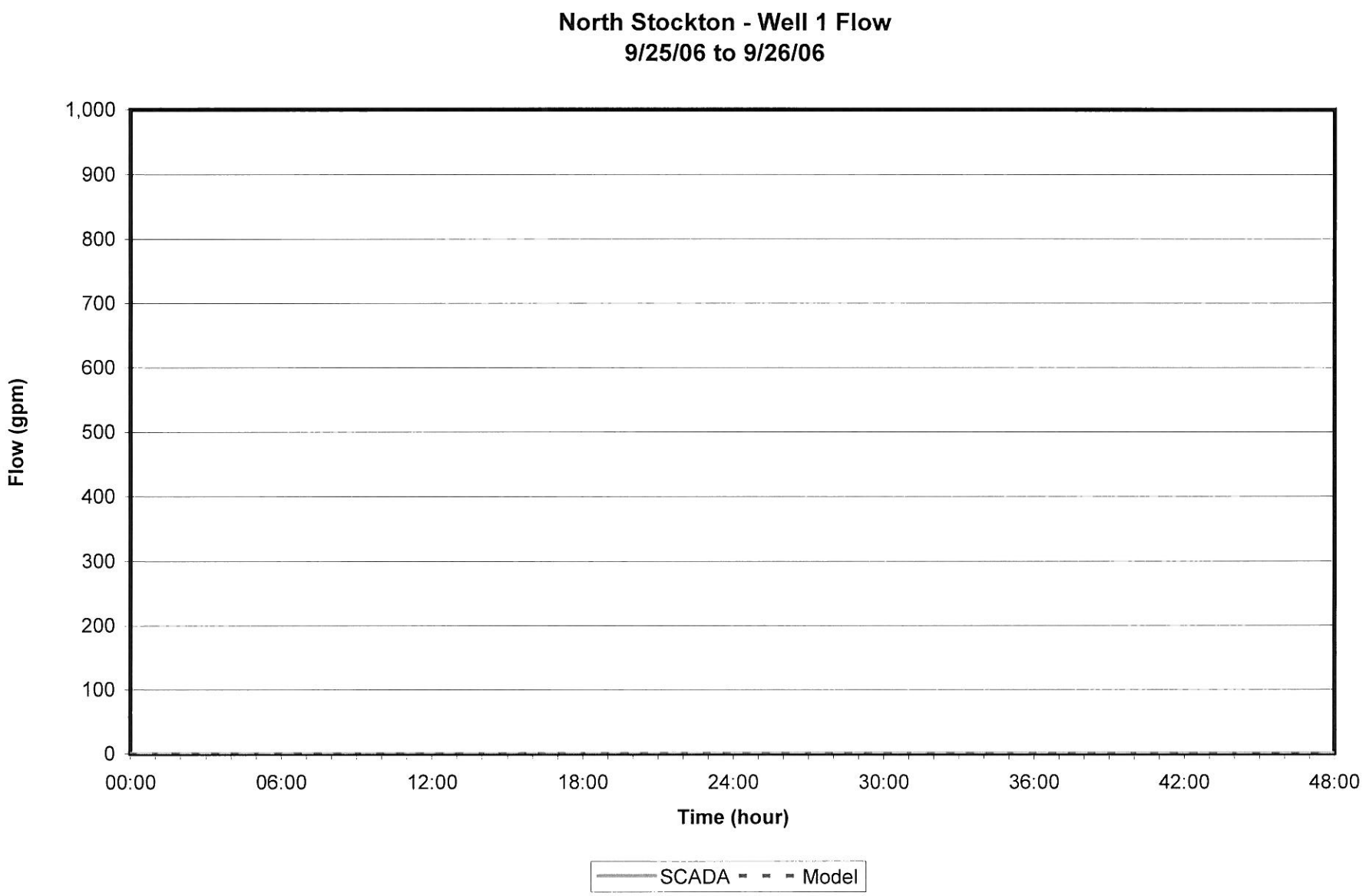


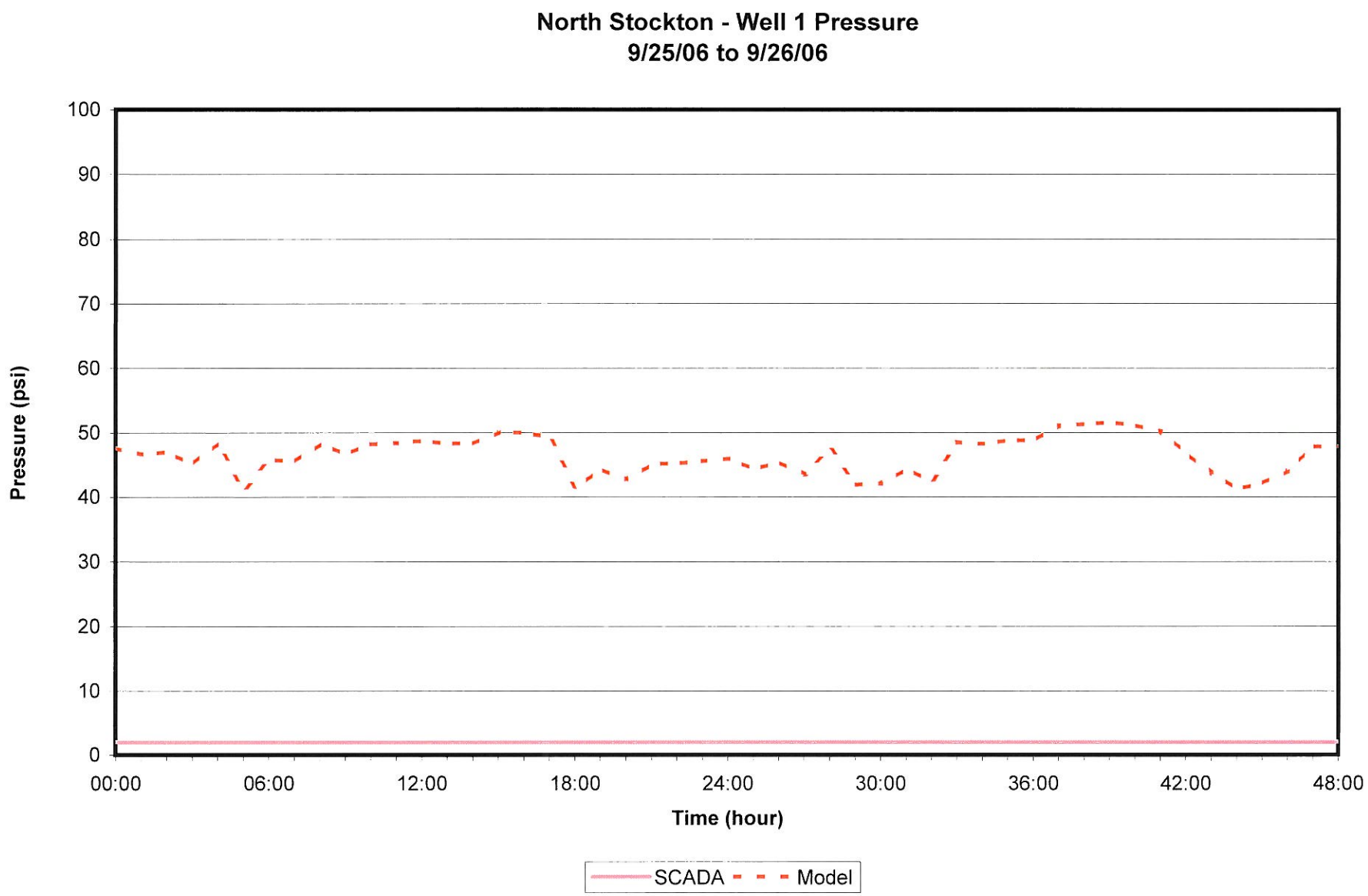
North Stockton - 14 Mile Slough Combined Tank Level
9/25/06 to 9/26/06

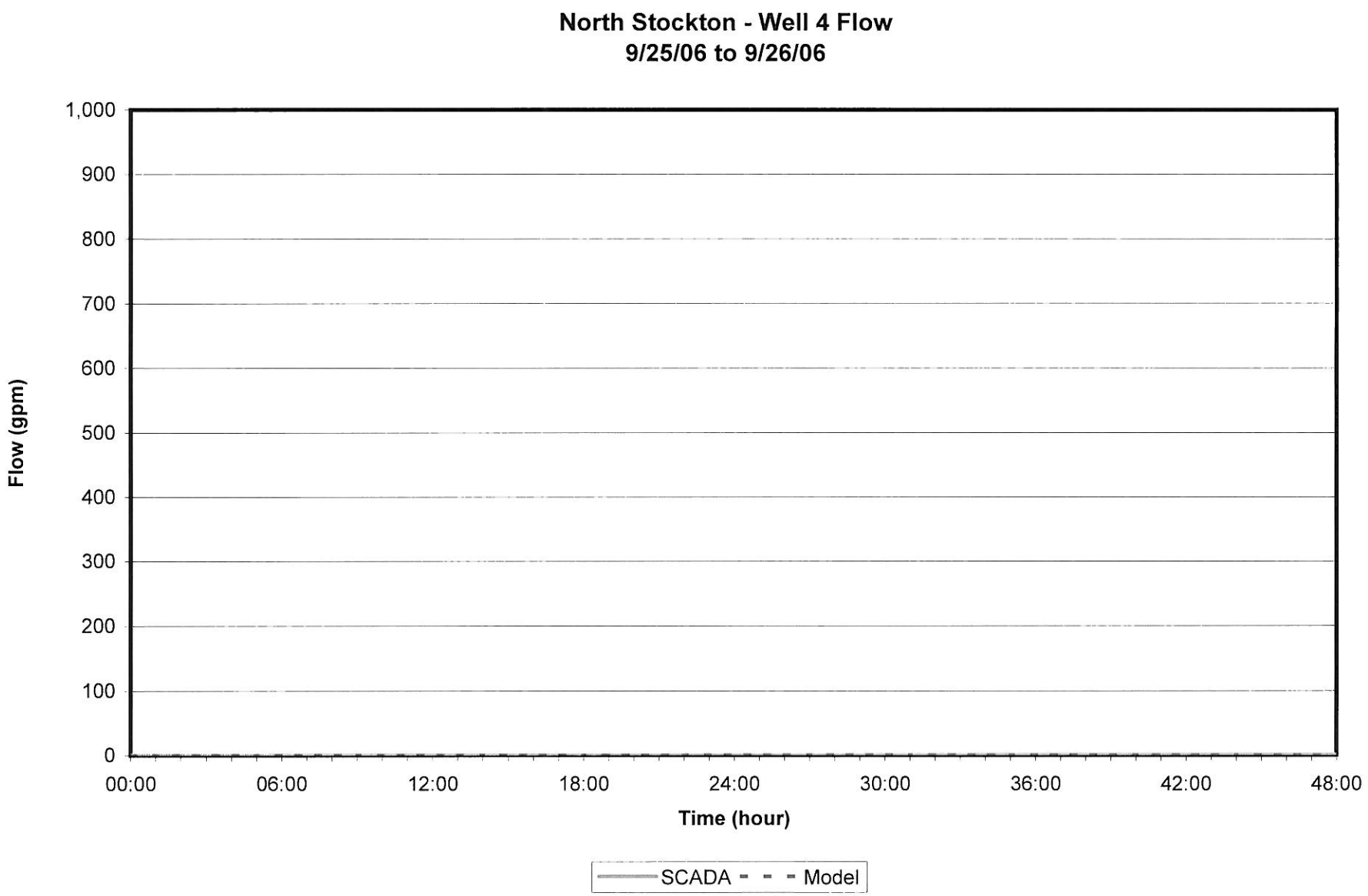


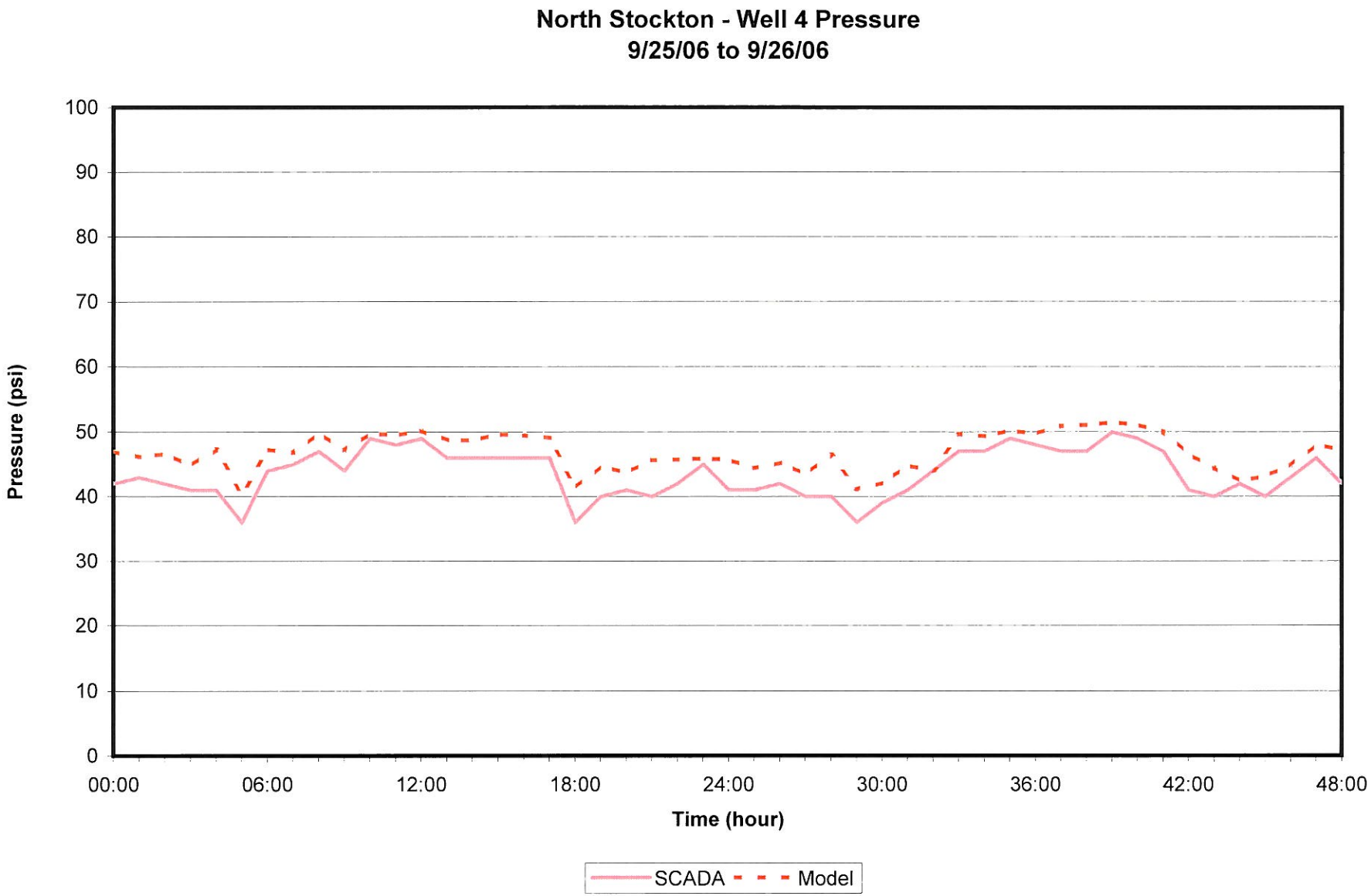
North Stockton - 14 Mile Slough Discharge Pressure
9/25/06 to 9/26/06

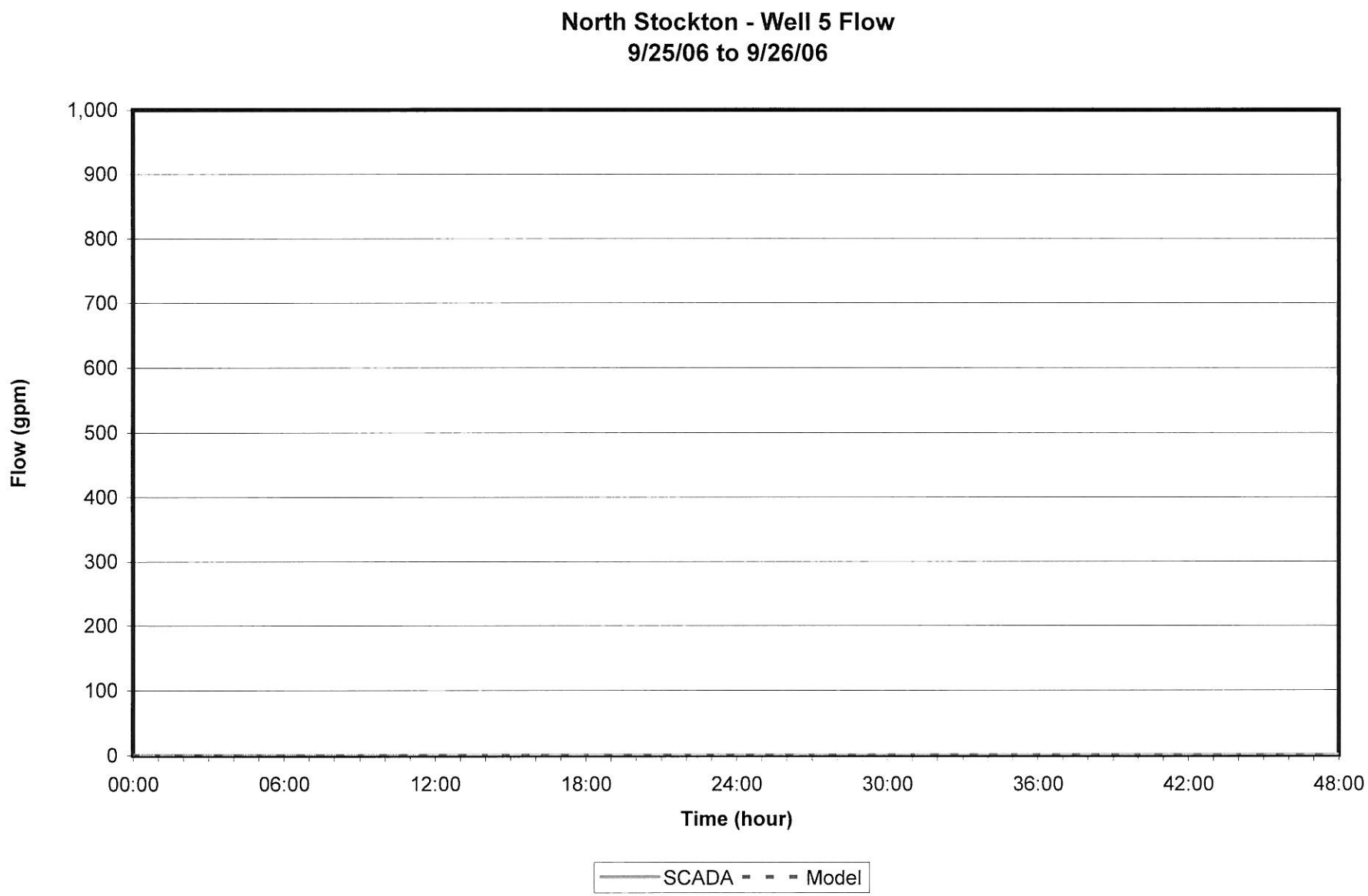


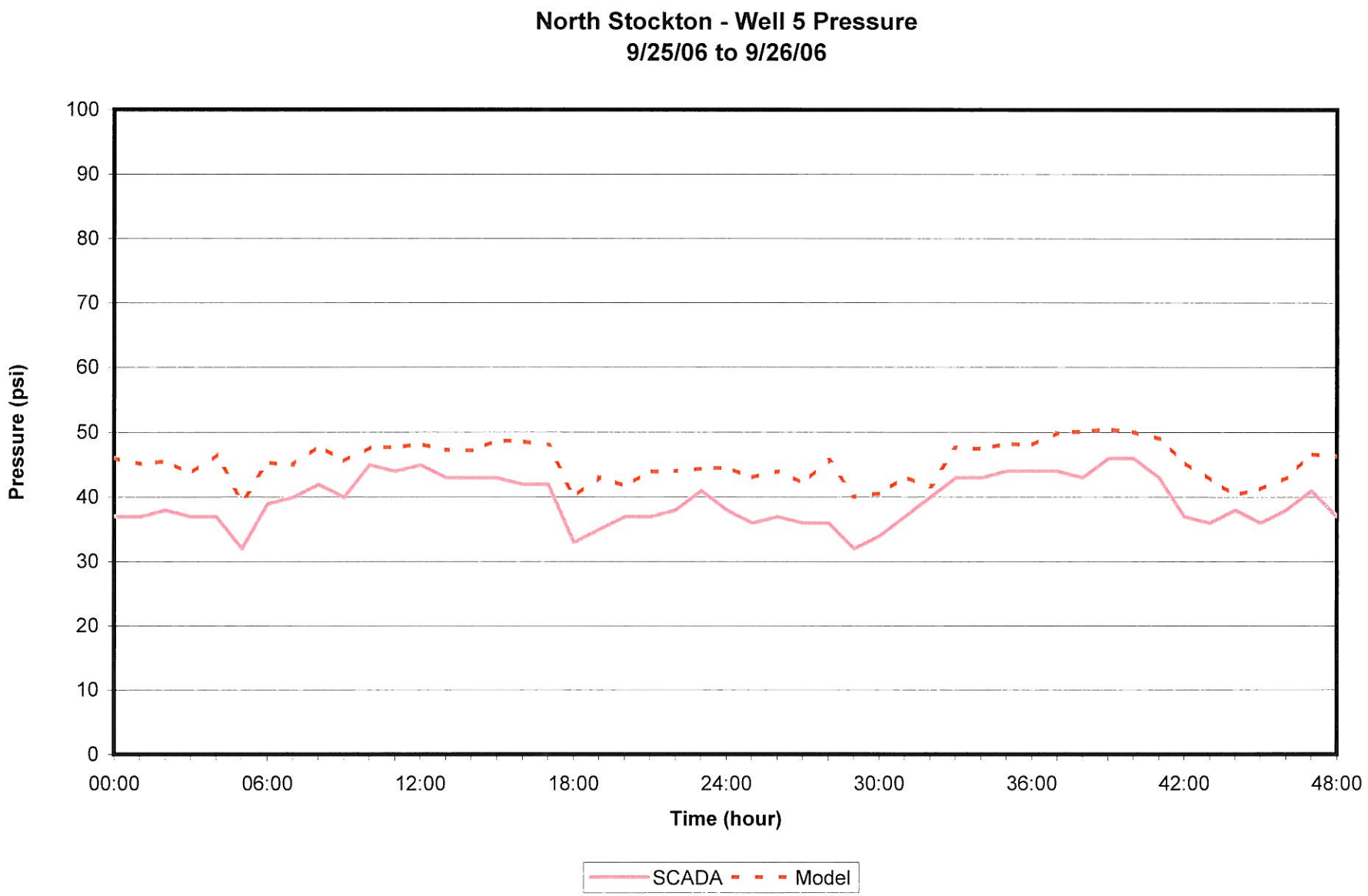

North Stockton - Well 1 Flow
9/25/06 to 9/26/06
Flow (gpm)
1,000
900
800
700
600
500
400
300
200
100
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

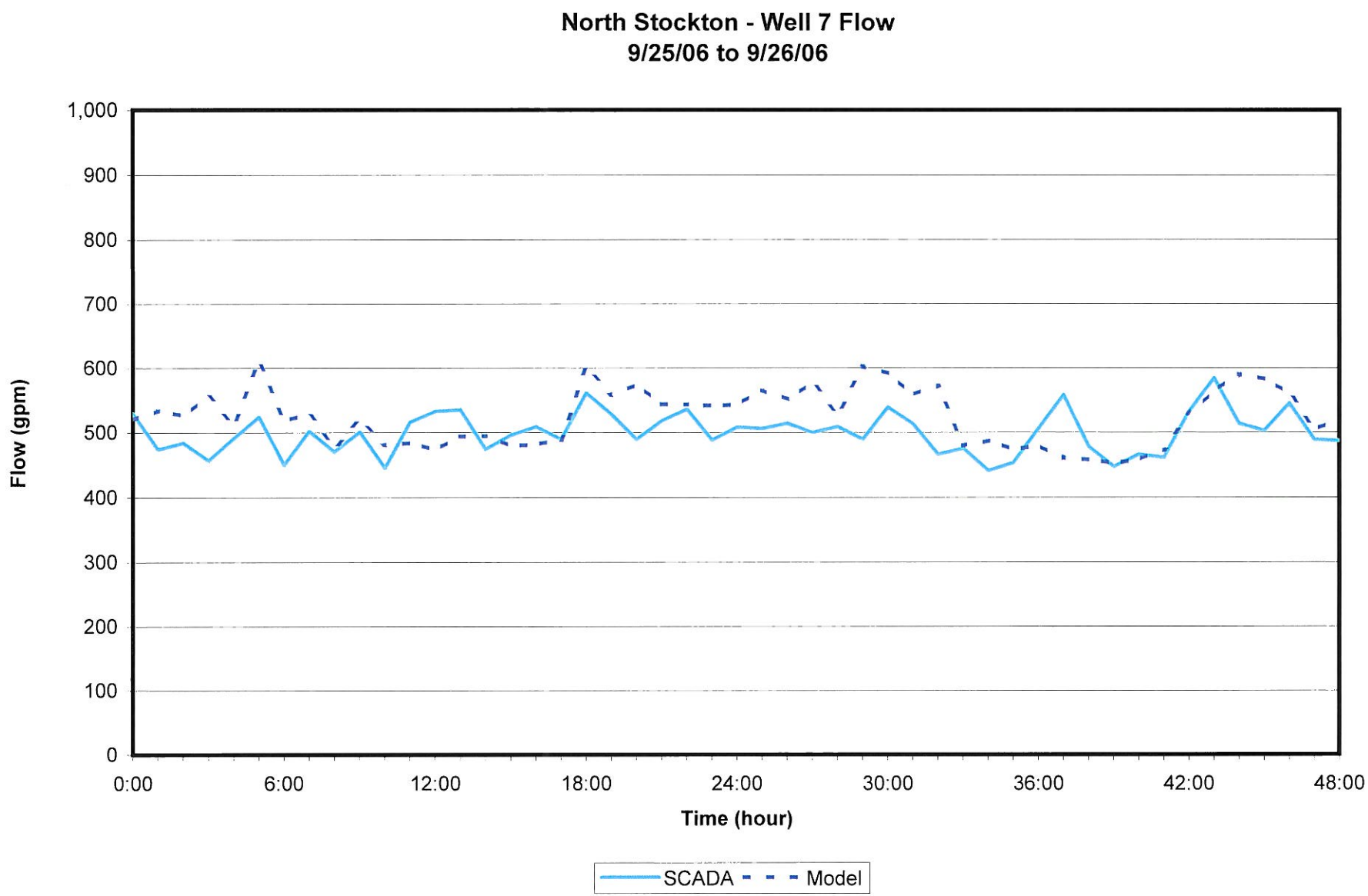

North Stockton - Well 1 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

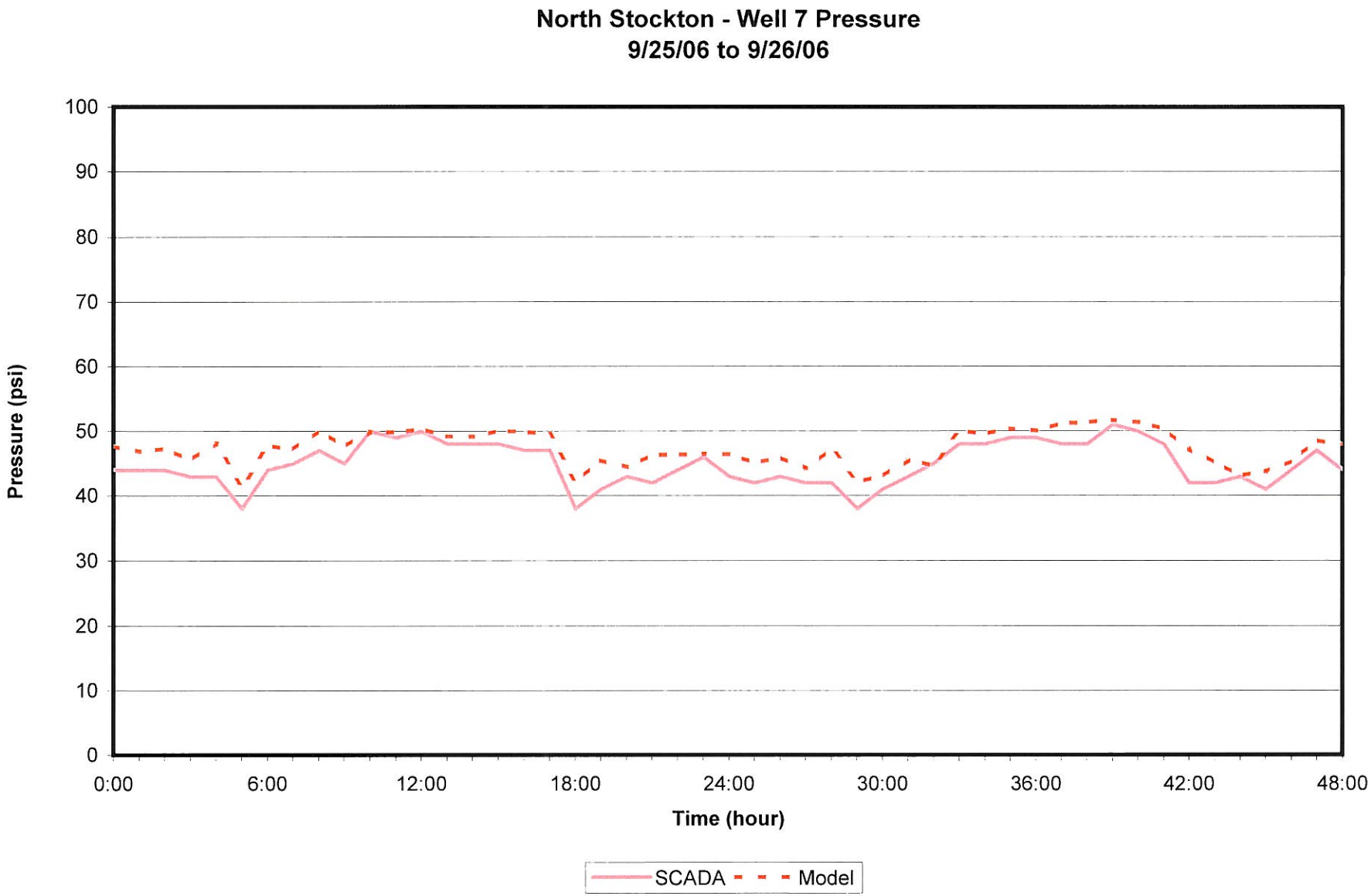

North Stockton - Well 4 Flow
9/25/06 to 9/26/06
Flow (gpm)
1,000
900
800
700
600
500
400
300
200
100
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

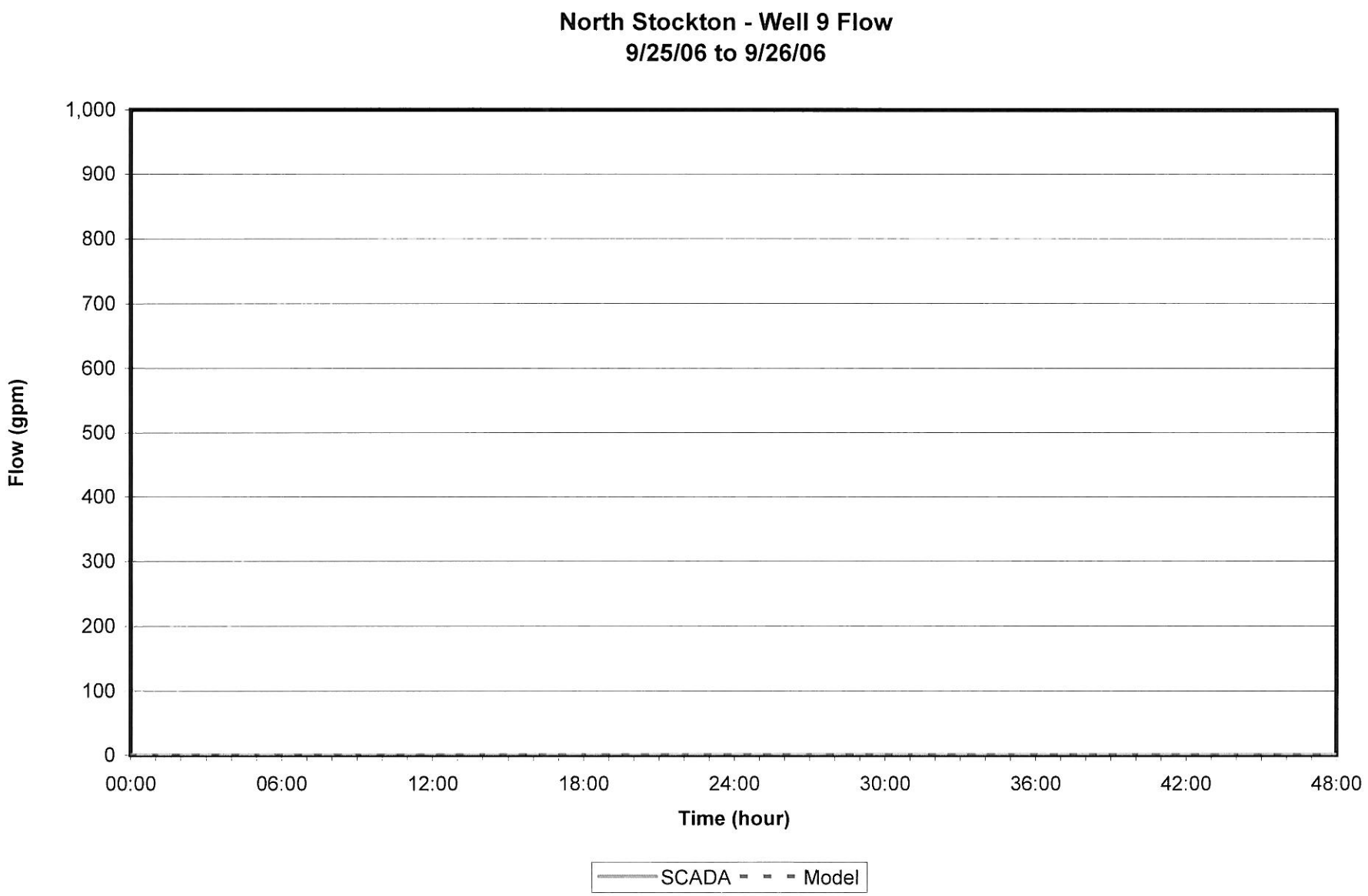

North Stockton - Well 4 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

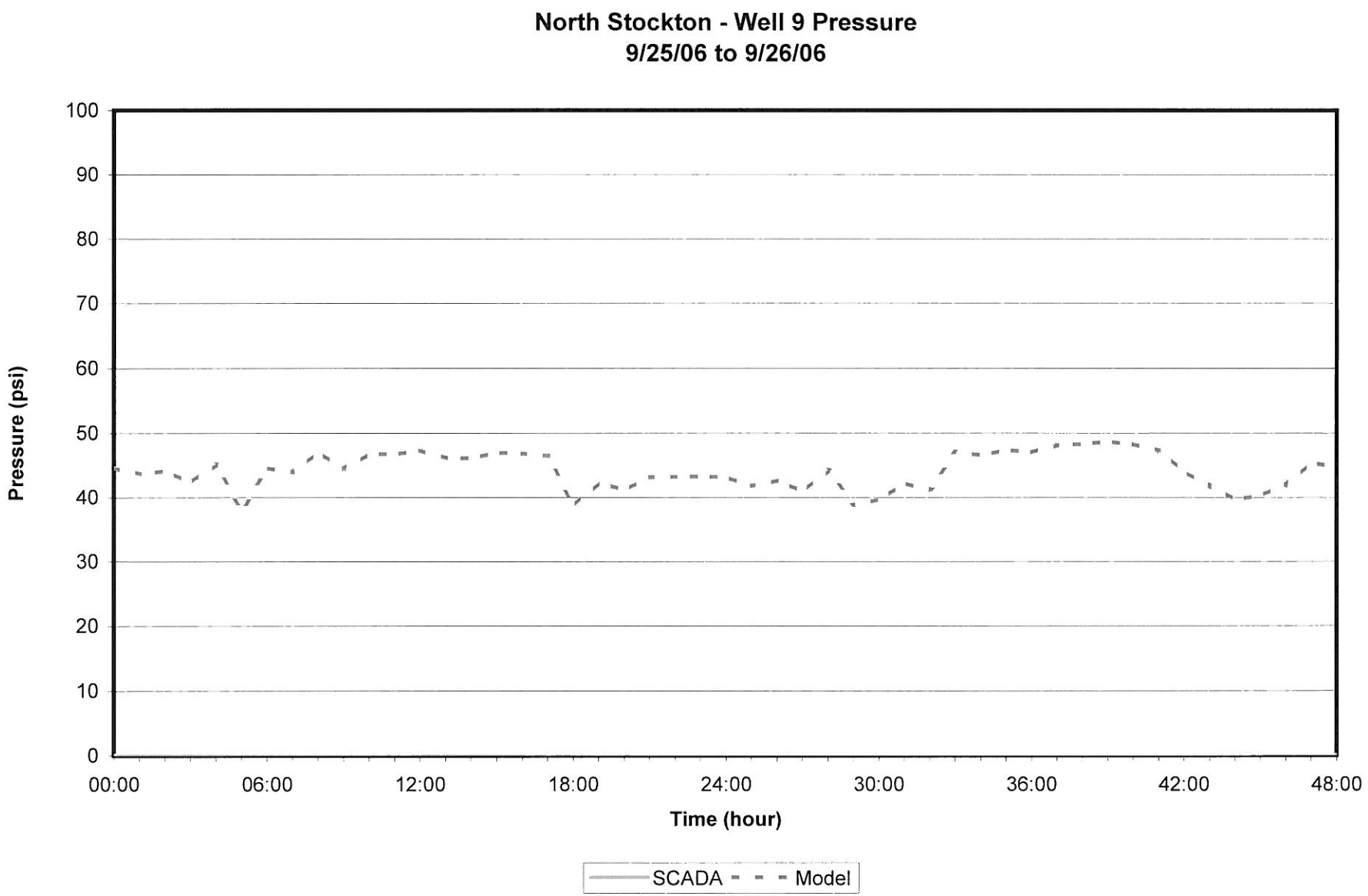

North Stockton - Well 5 Flow
9/25/06 to 9/26/06
1,000
900
800
700
600
500
400
300
200
100
0
Flow (gpm)
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

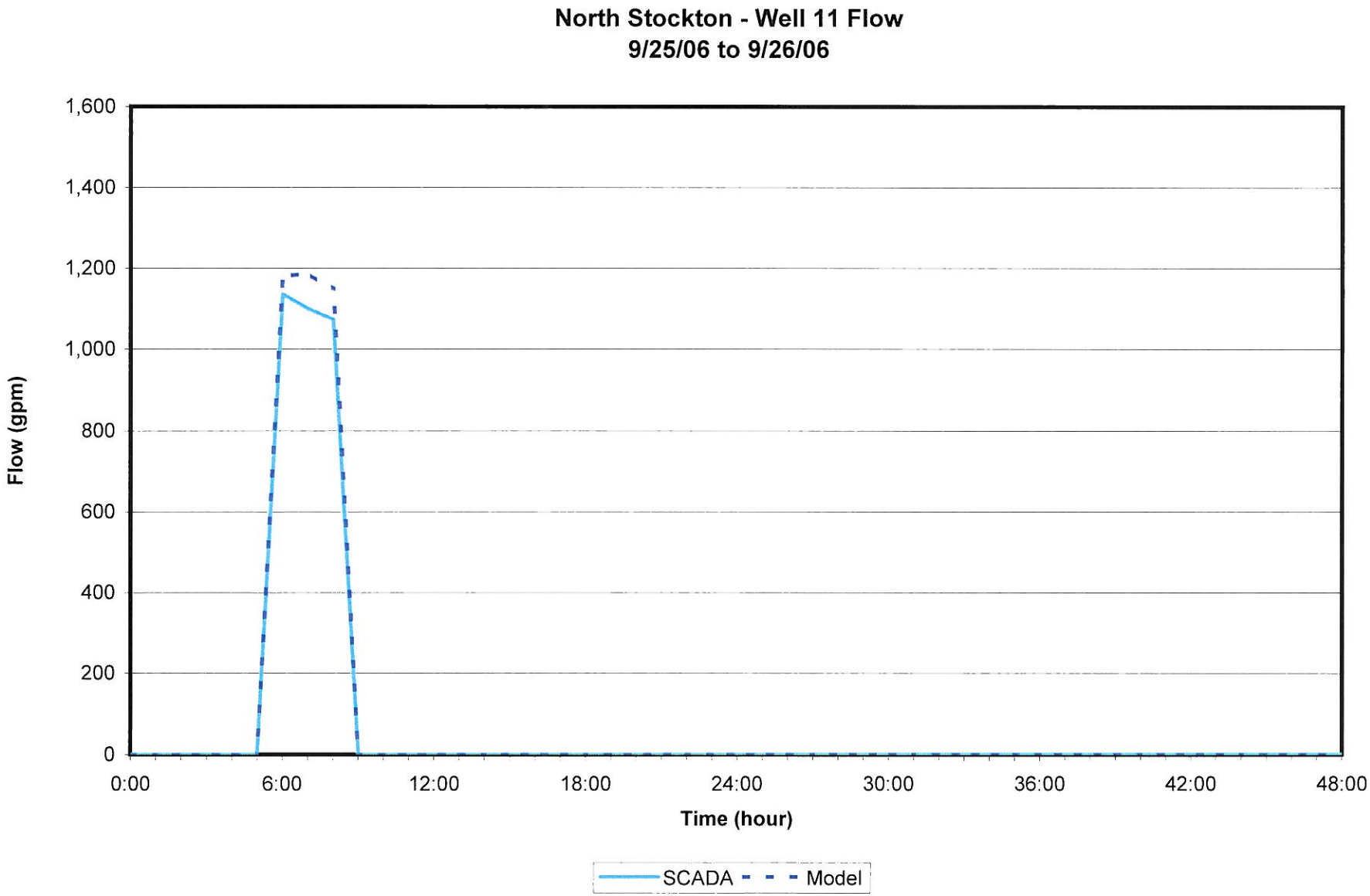

North Stockton - Well 5 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

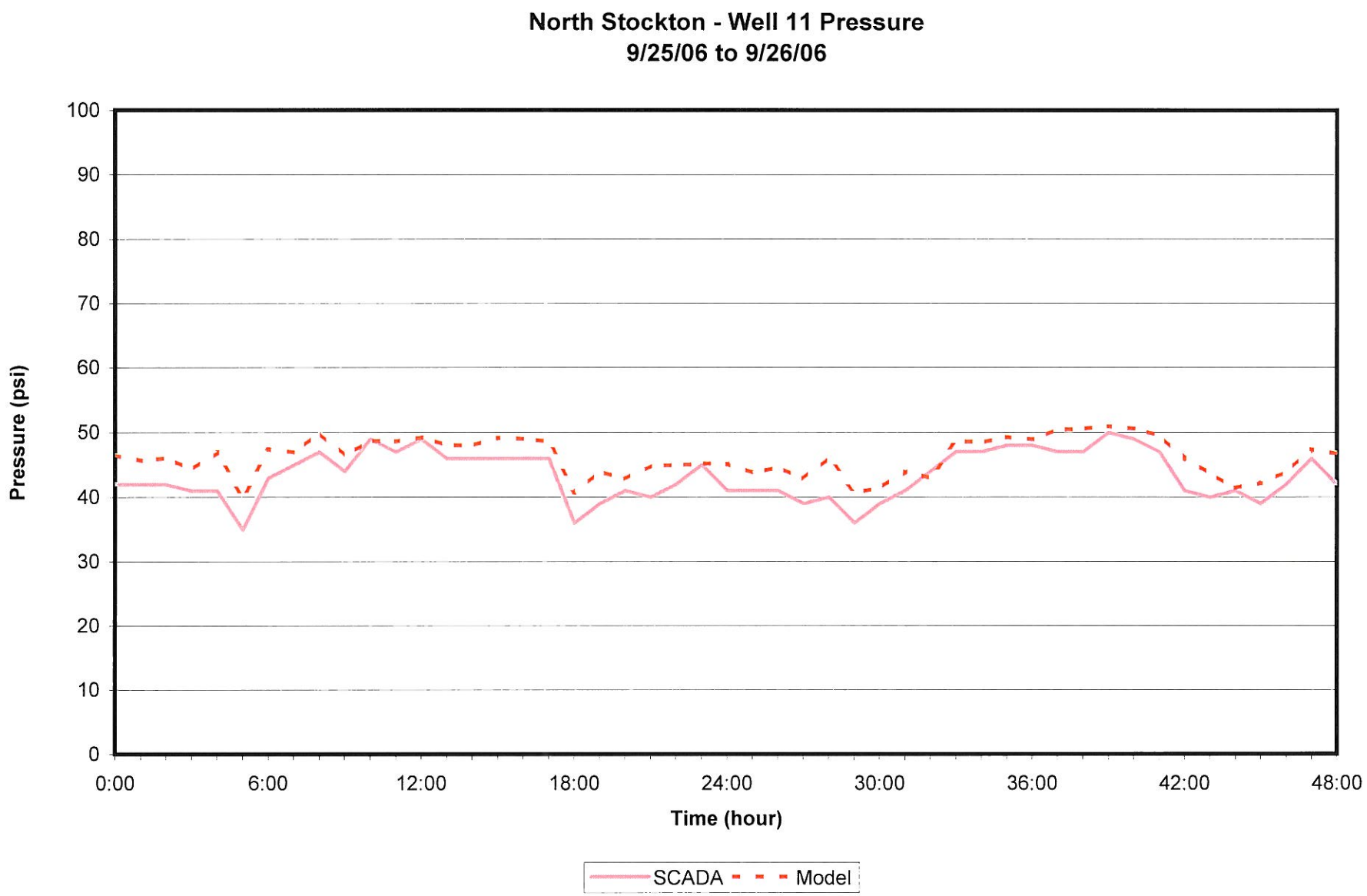

North Stockton - Well 7 Flow
9/25/06 to 9/26/06
Flow (gpm)
1,000
900
800
700
600
500
400
300
200
100
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

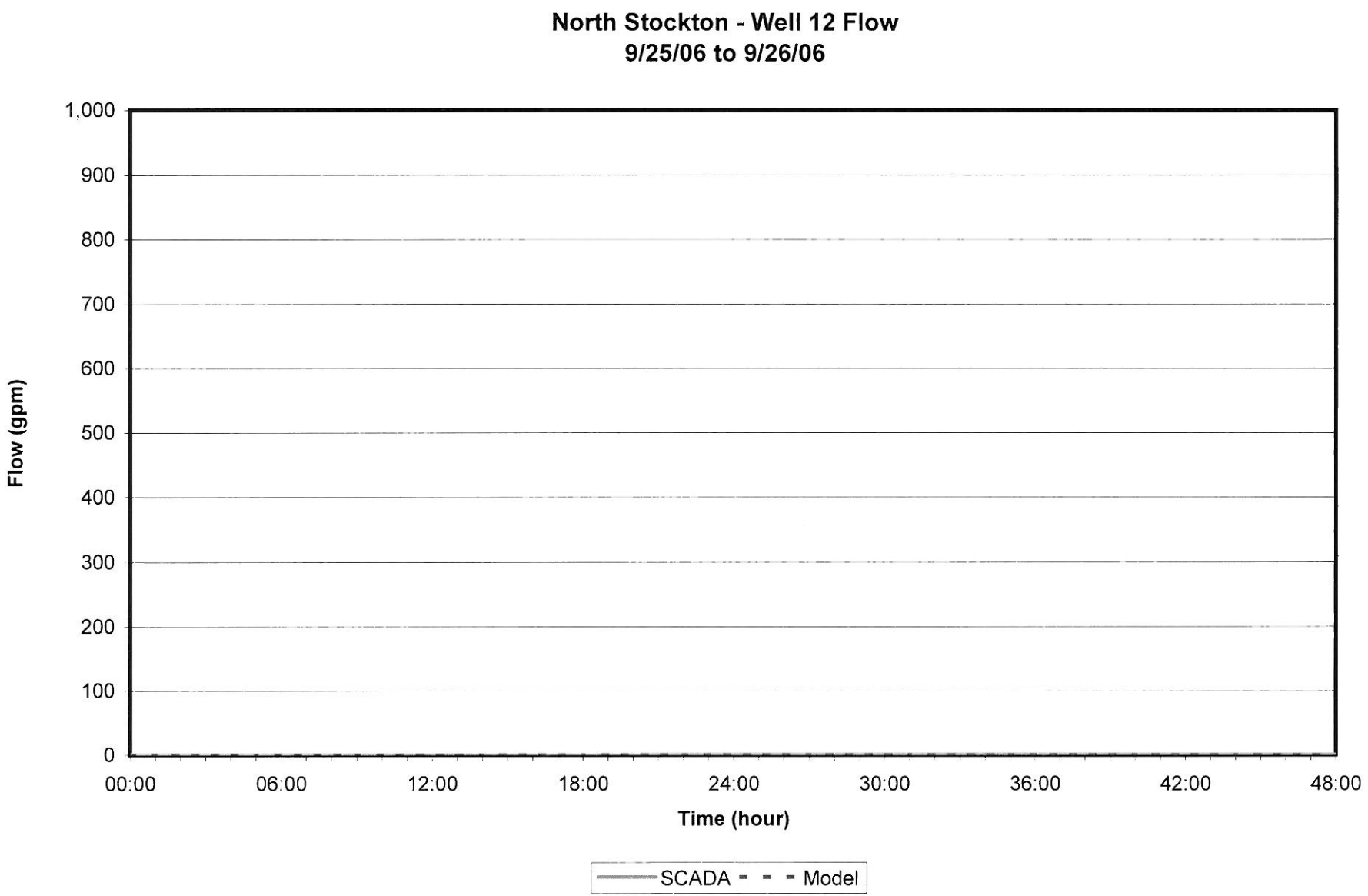

North Stockton - Well 7 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

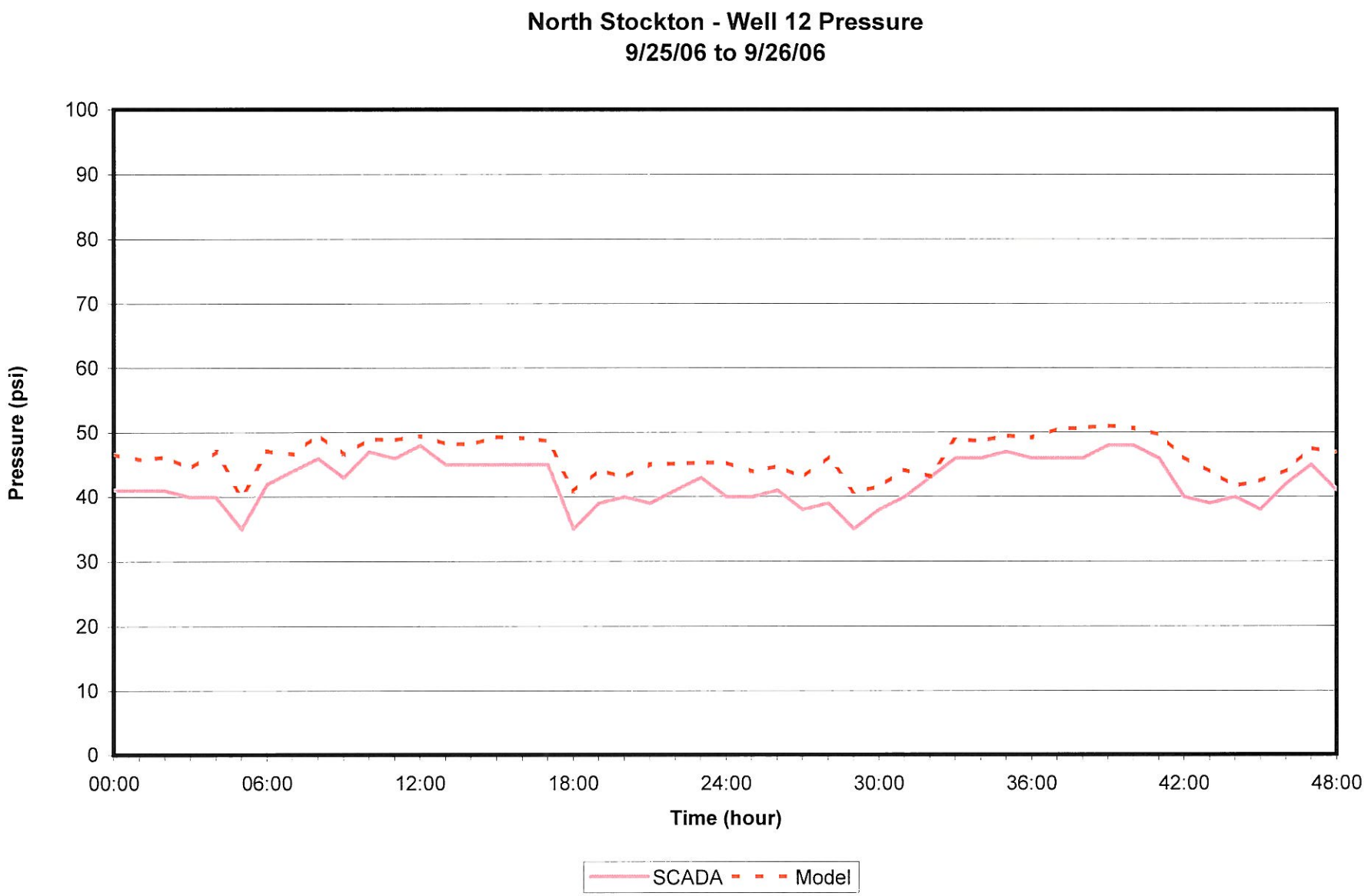

North Stockton - Well 9 Flow
9/25/06 to 9/26/06
Flow (gpm)
1,000
900
800
700
600
500
400
300
200
100
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

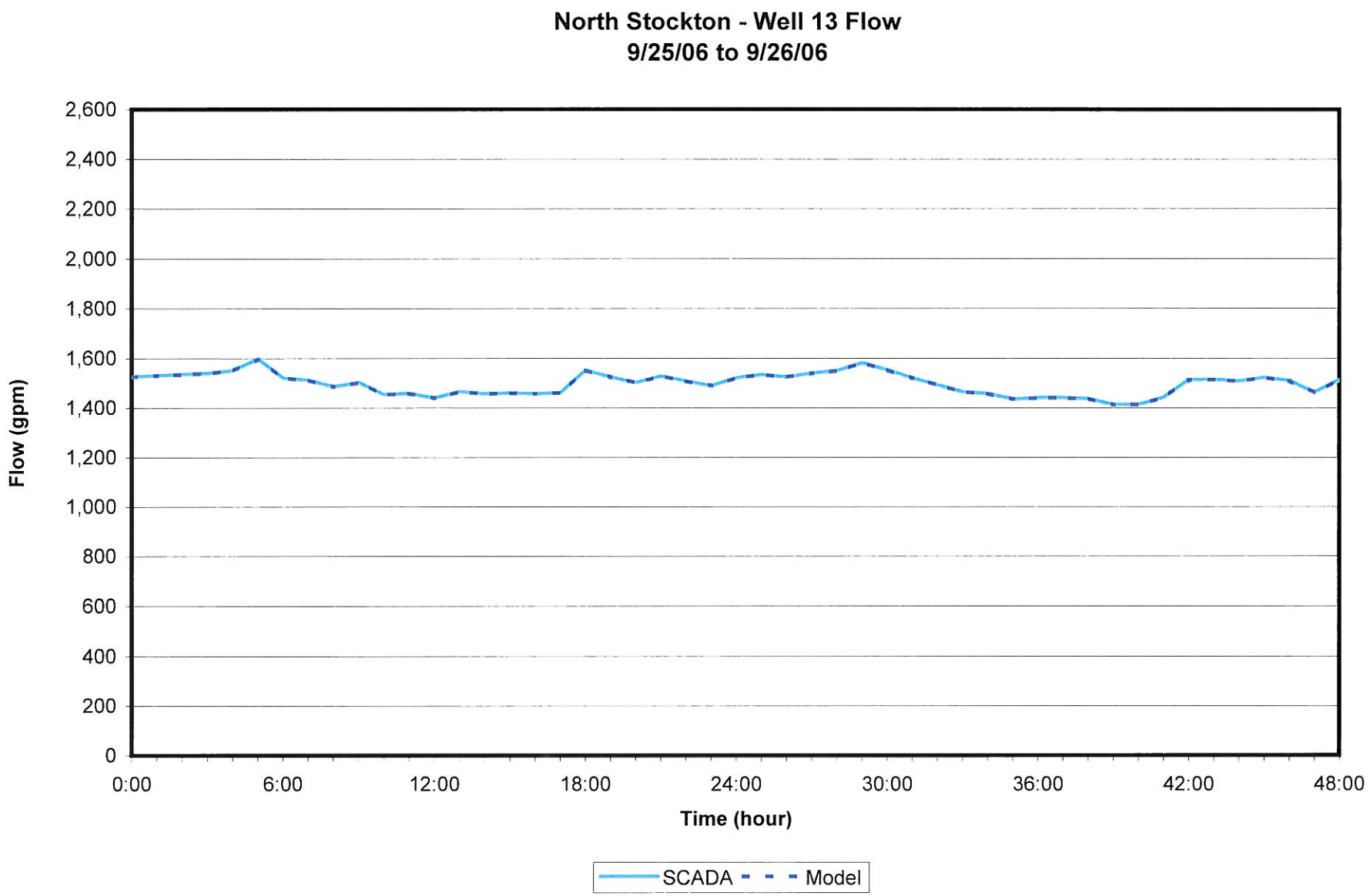

North Stockton - Well 9 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

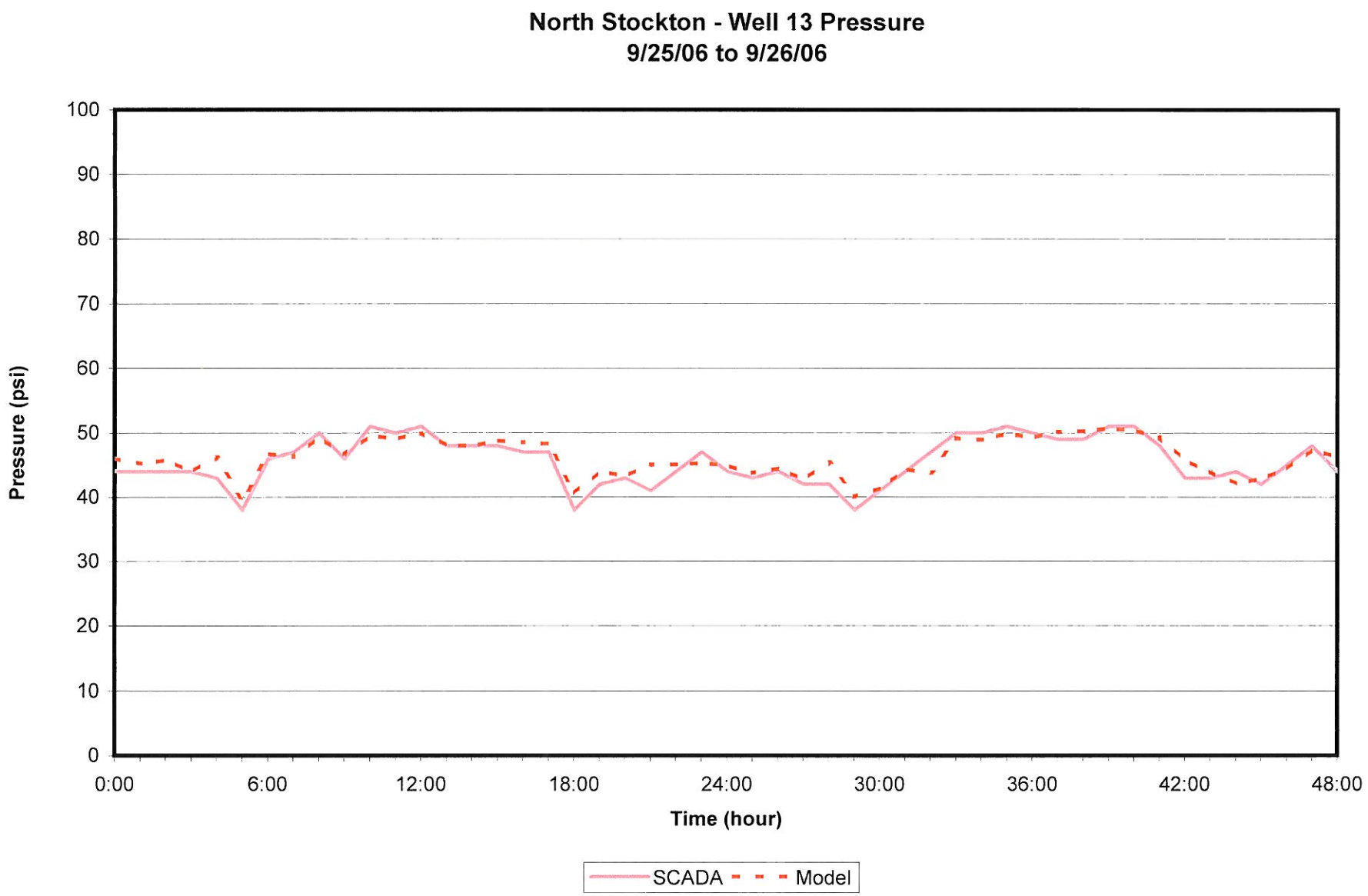

North Stockton - Well 11 Flow
9/25/06 to 9/26/06
Flow (gpm)
1,600
1,400
1,200
1,000
800
600
400
200
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

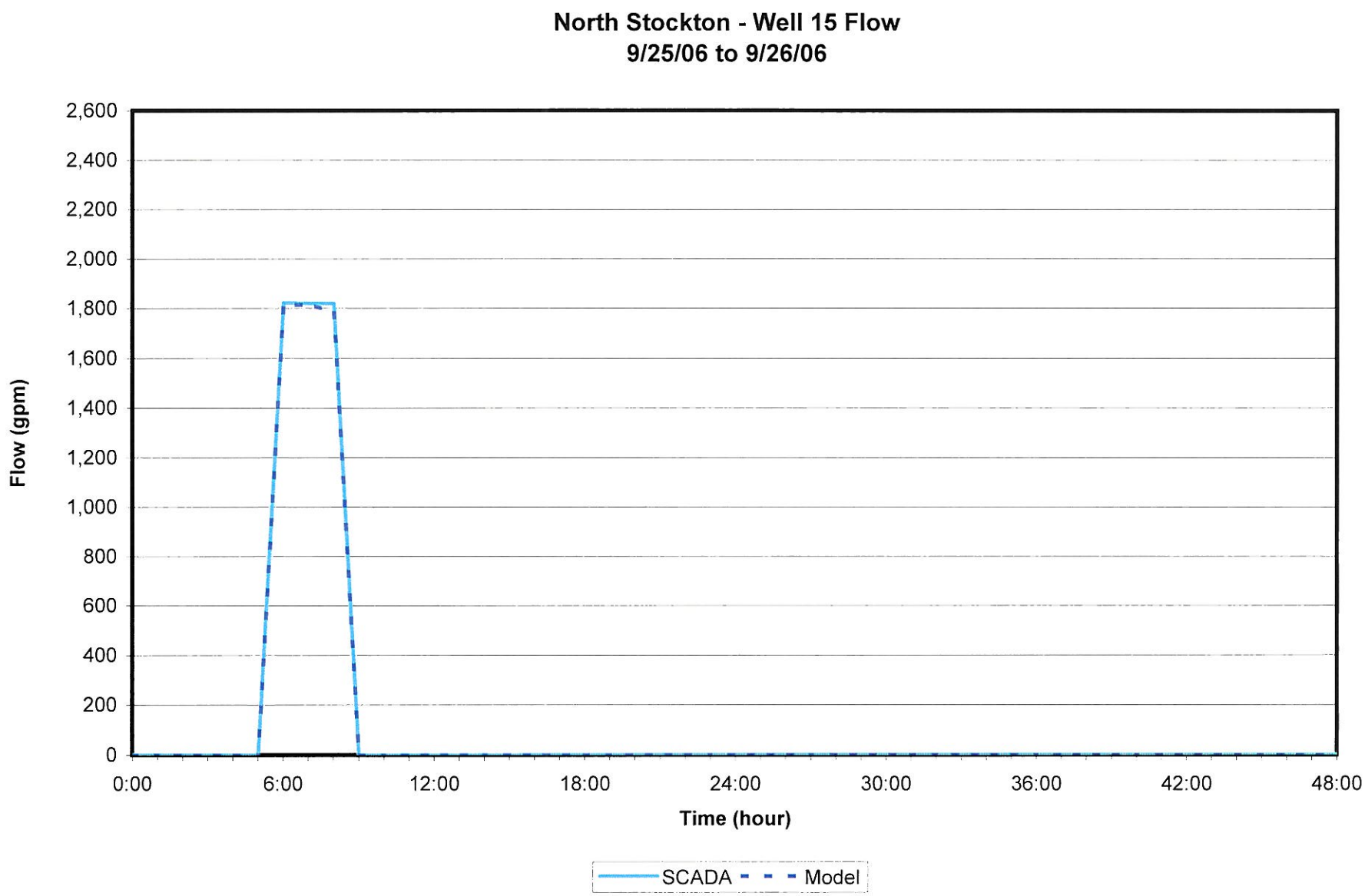

North Stockton - Well 11 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

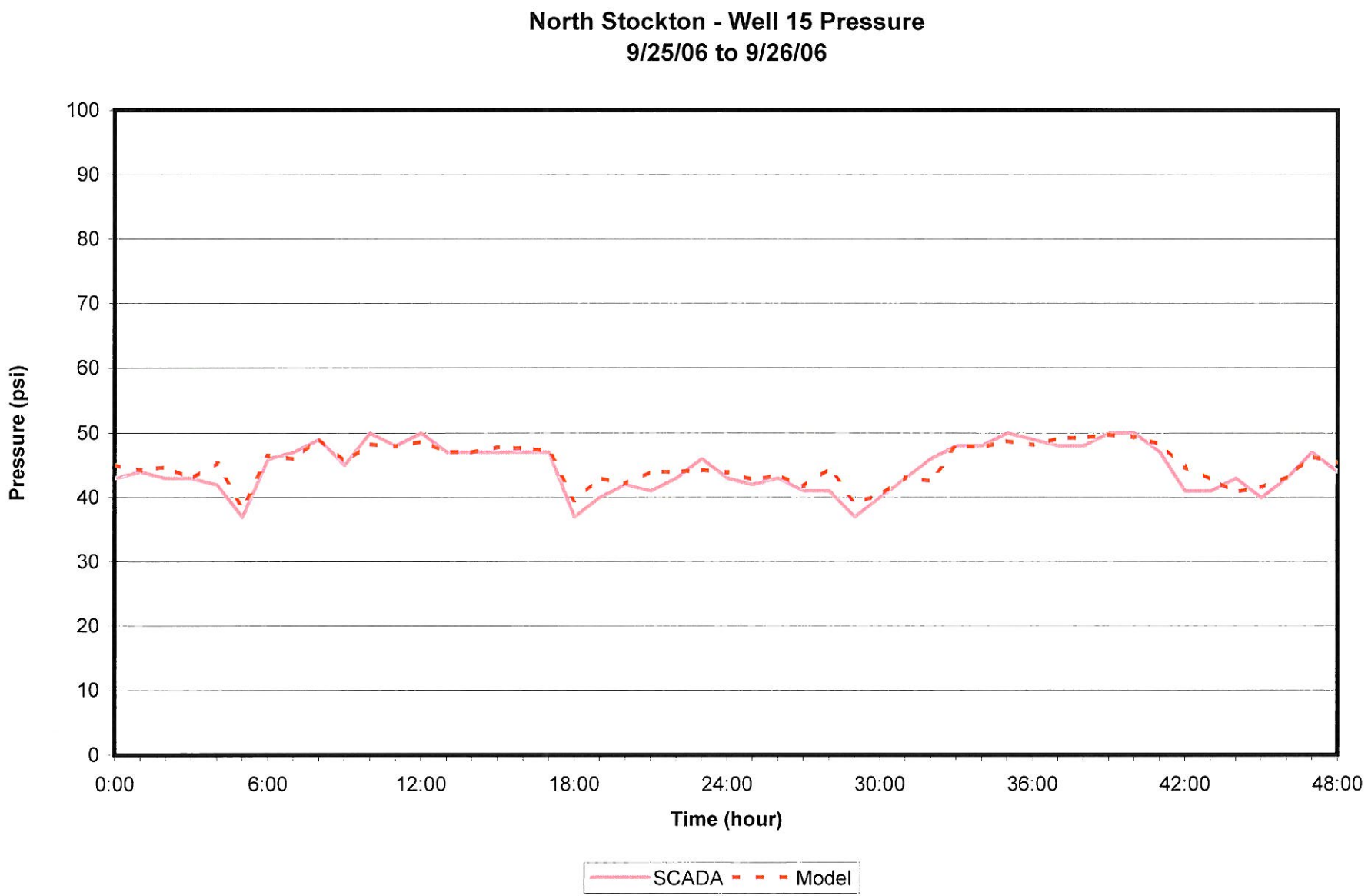

North Stockton - Well 12 Flow
9/25/06 to 9/26/06
Flow (gpm)
1,000
900
800
700
600
500
400
300
200
100
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

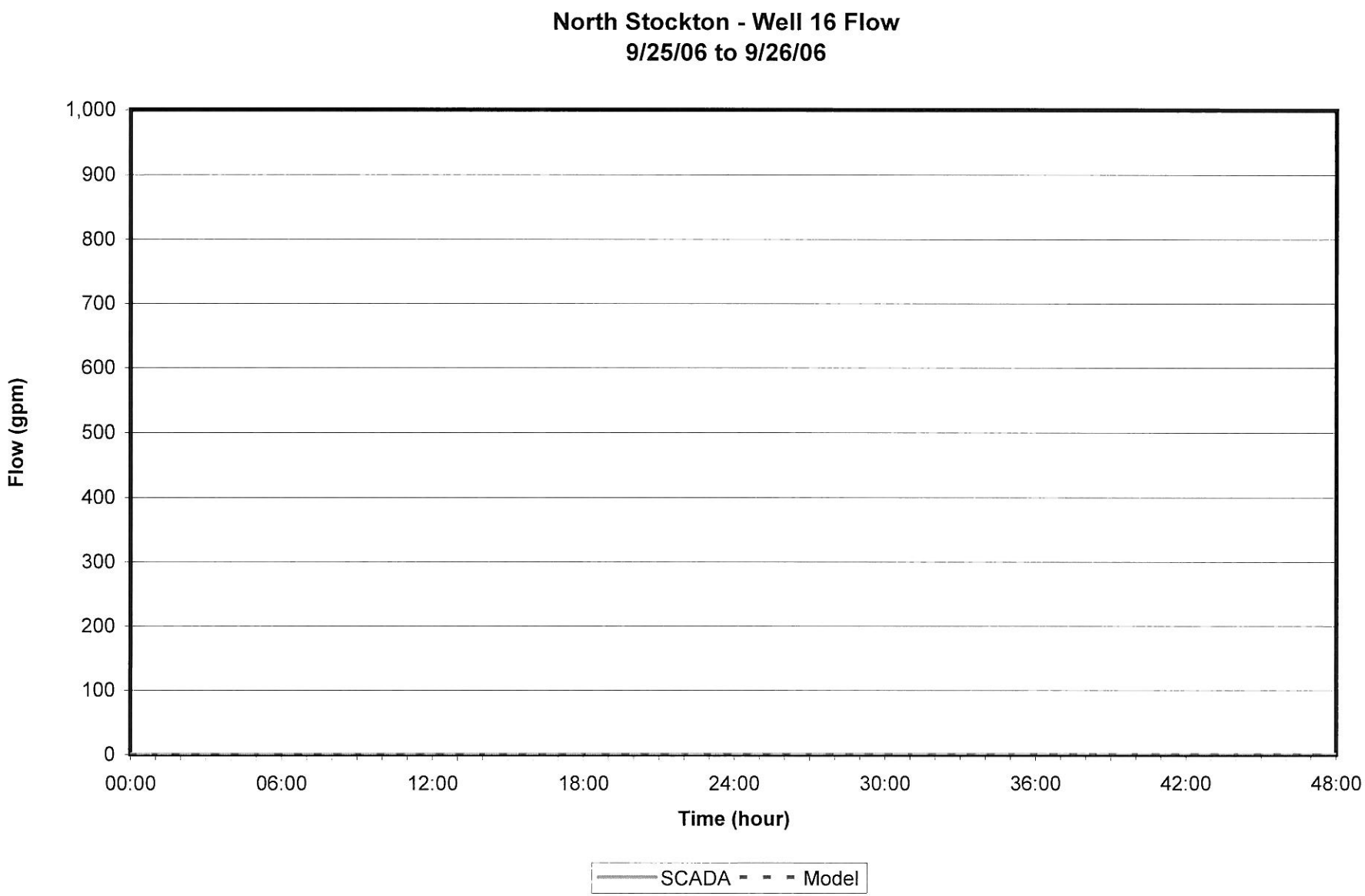

North Stockton - Well 12 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

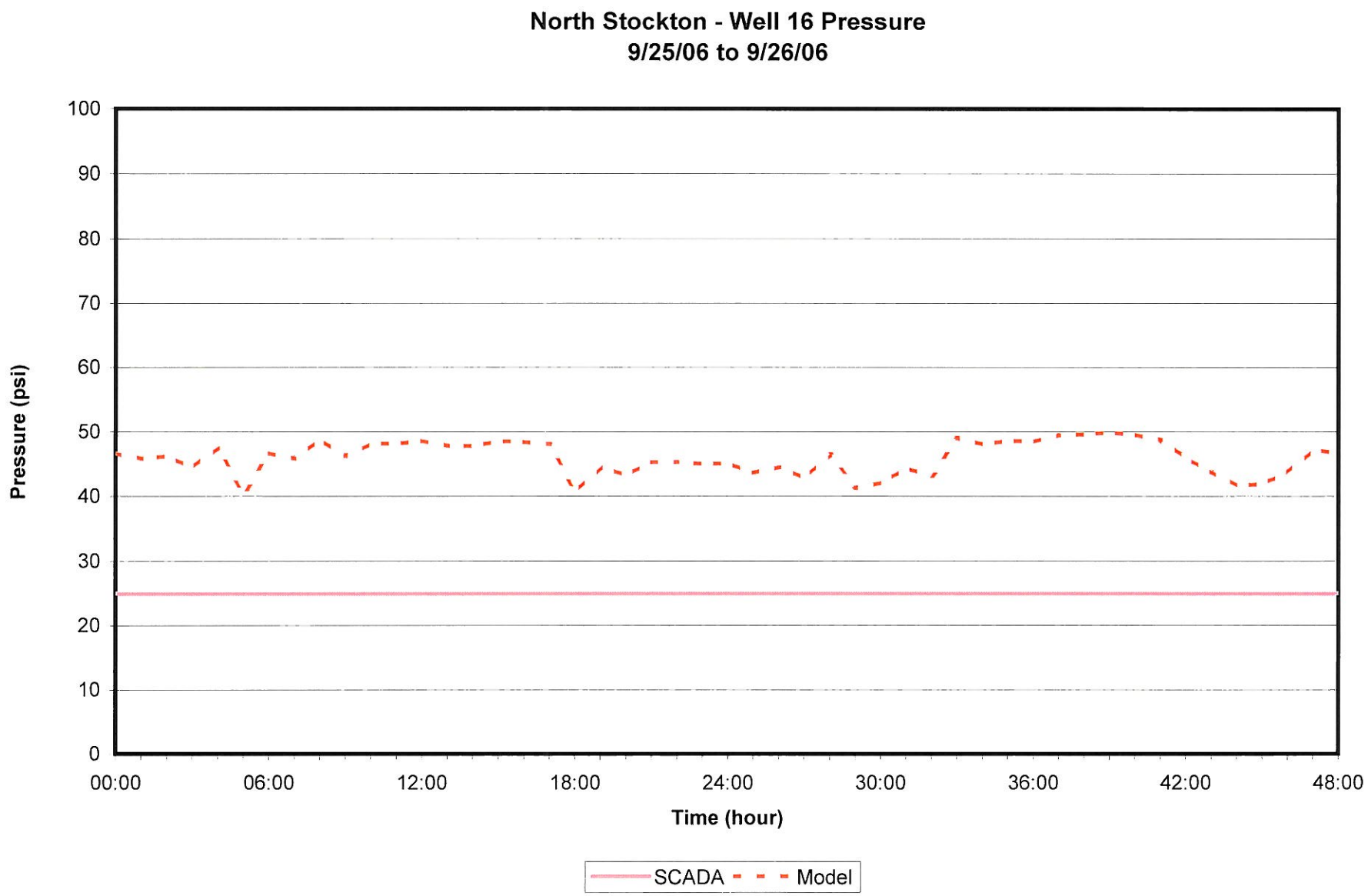

North Stockton - Well 13 Flow
9/25/06 to 9/26/06
Flow (gpm)
2,600
2,400
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

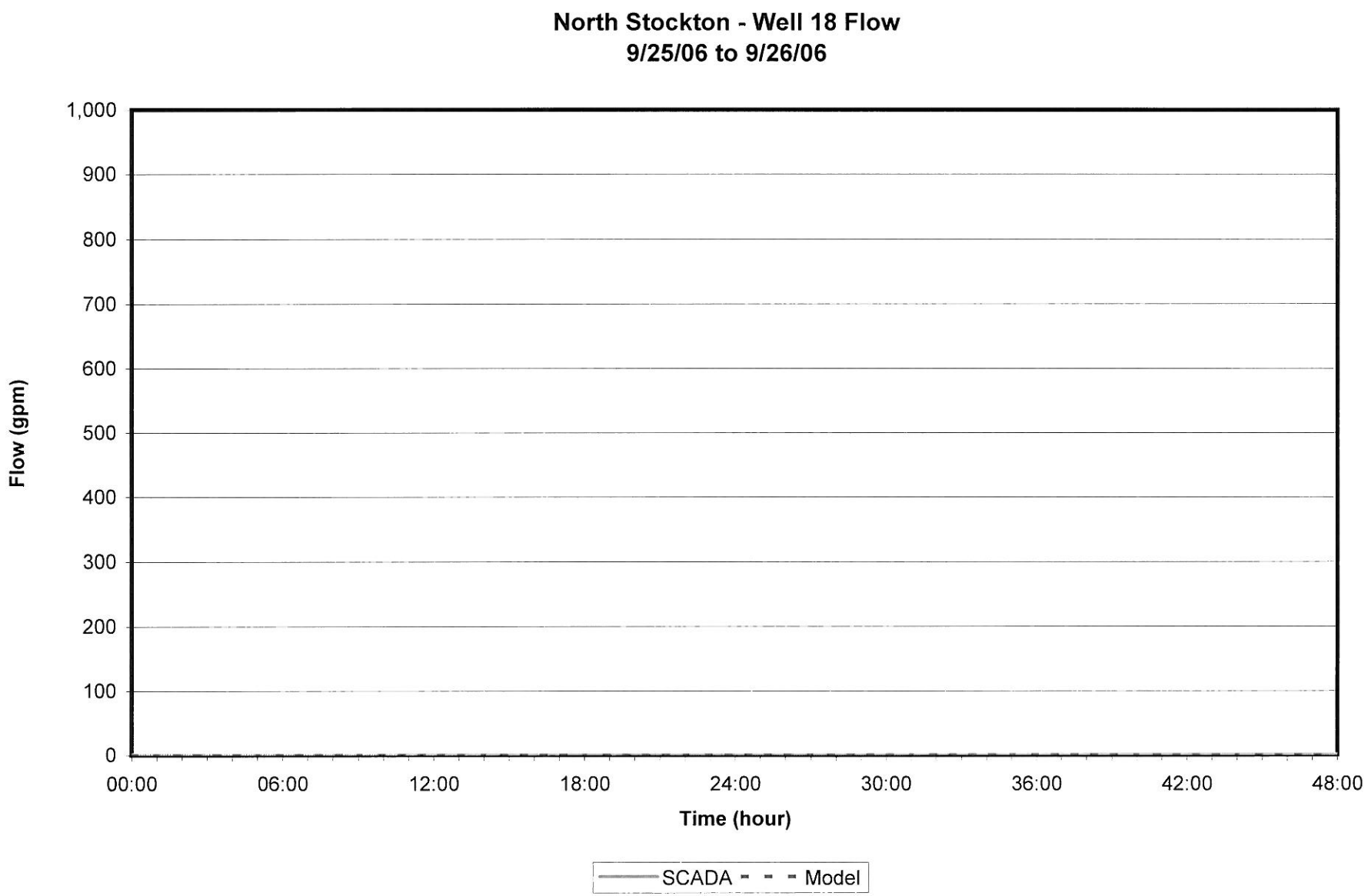

North Stockton - Well 13 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

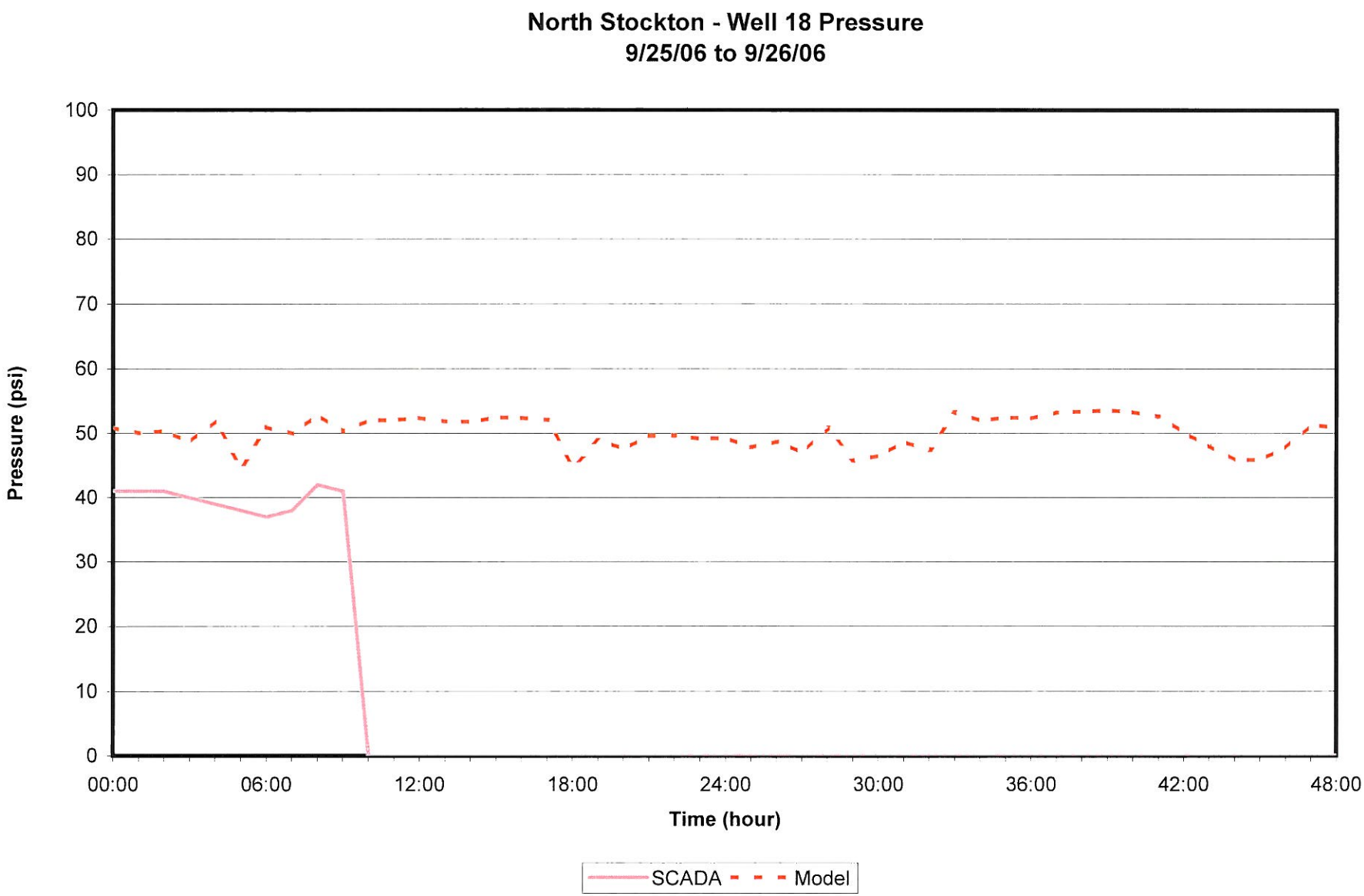

North Stockton - Well 15 Flow
9/25/06 to 9/26/06
Flow (gpm)
2,600
2,400
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

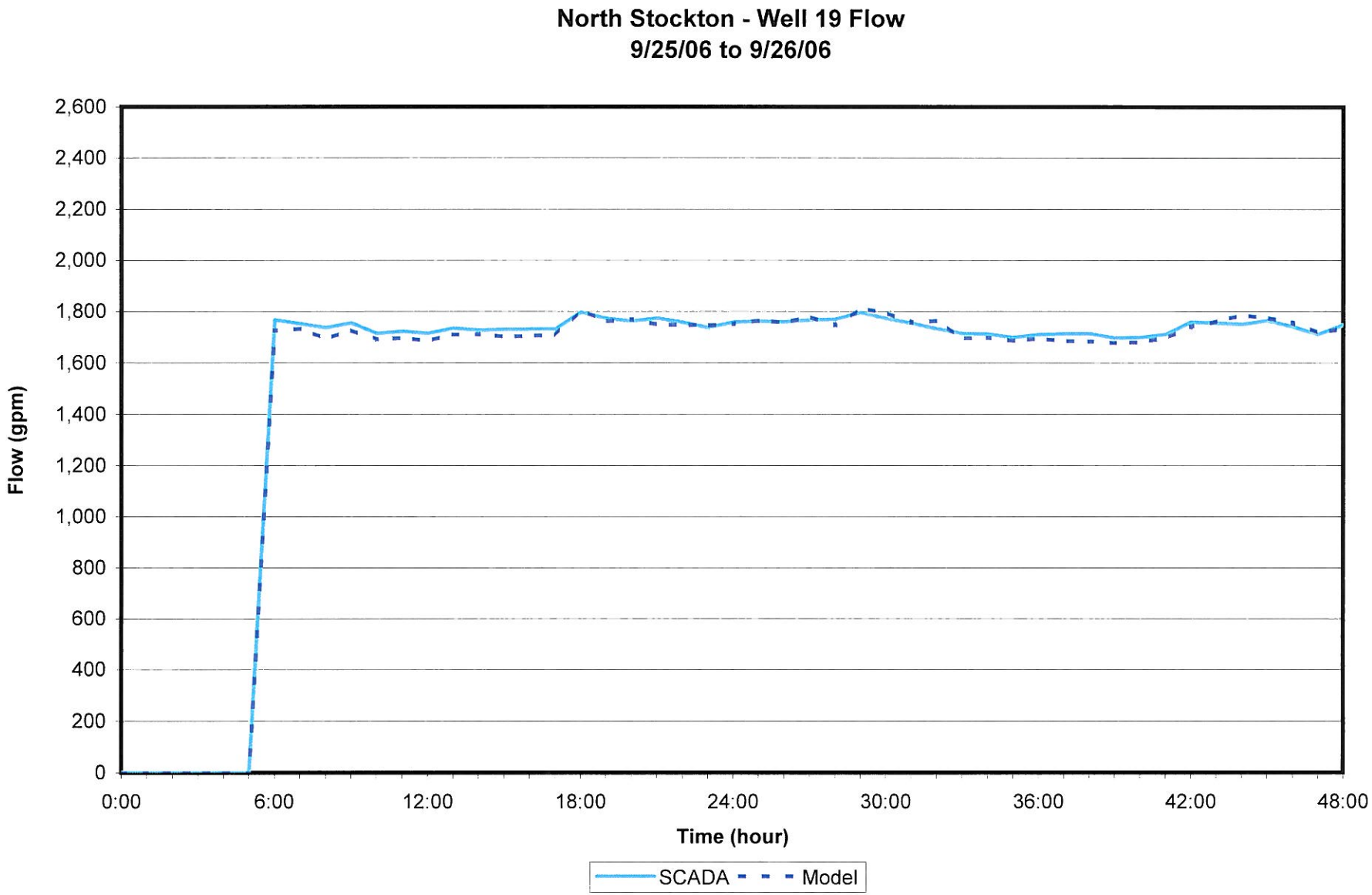

North Stockton - Well 15 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

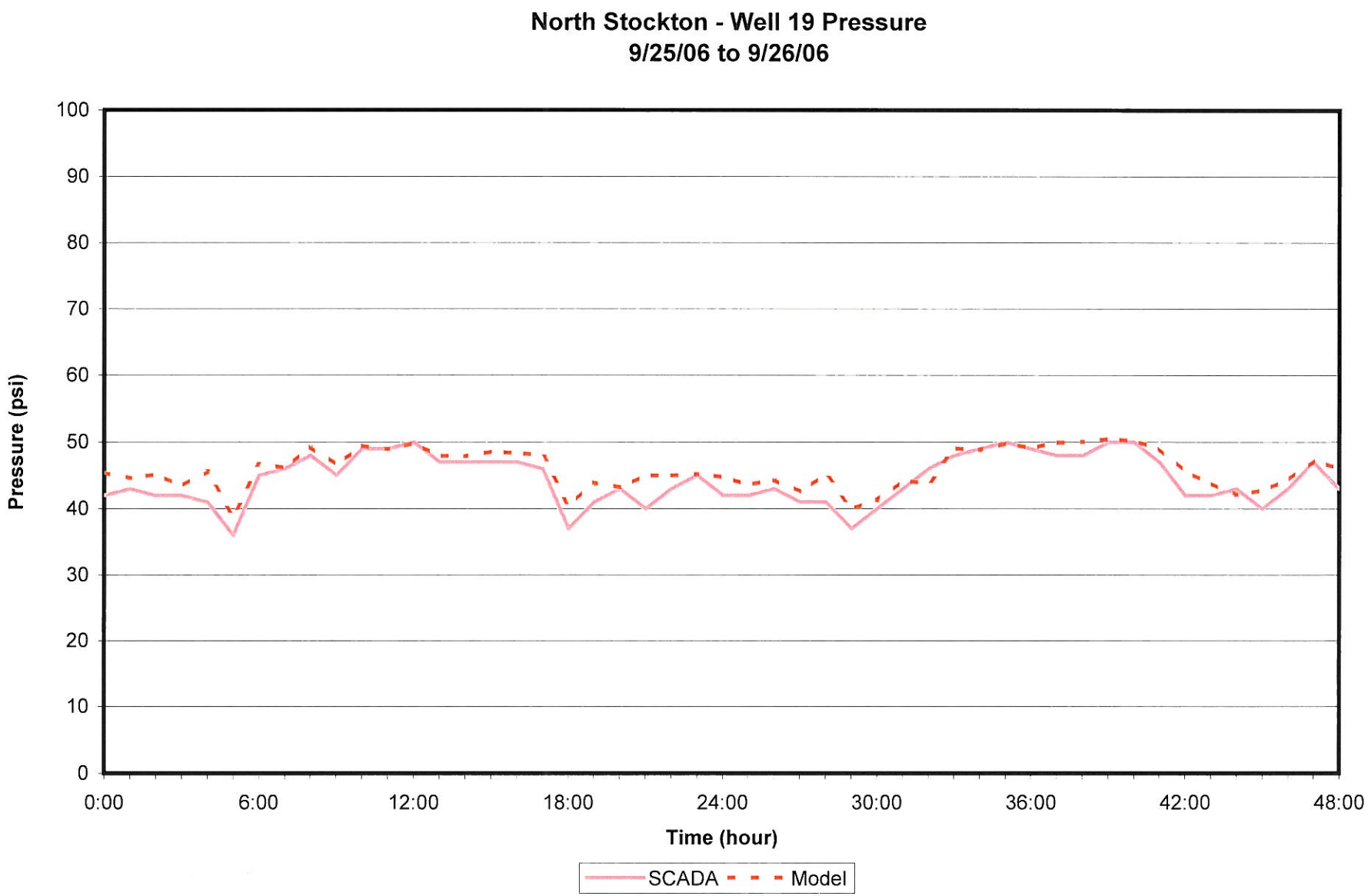

North Stockton - Well 16 Flow
9/25/06 to 9/26/06
Flow (gpm)
1,000
900
800
700
600
500
400
300
200
100
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

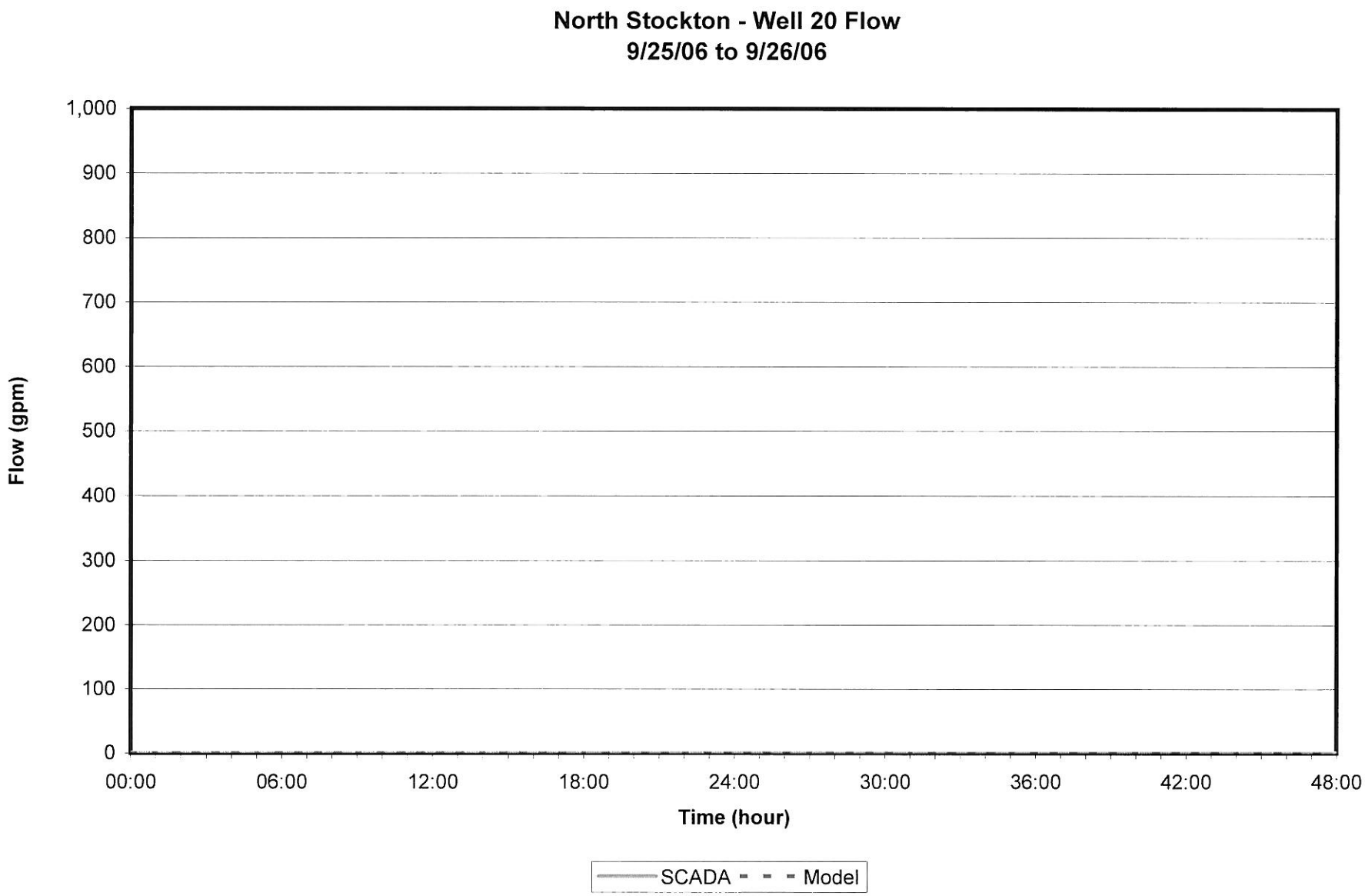

North Stockton - Well 16 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

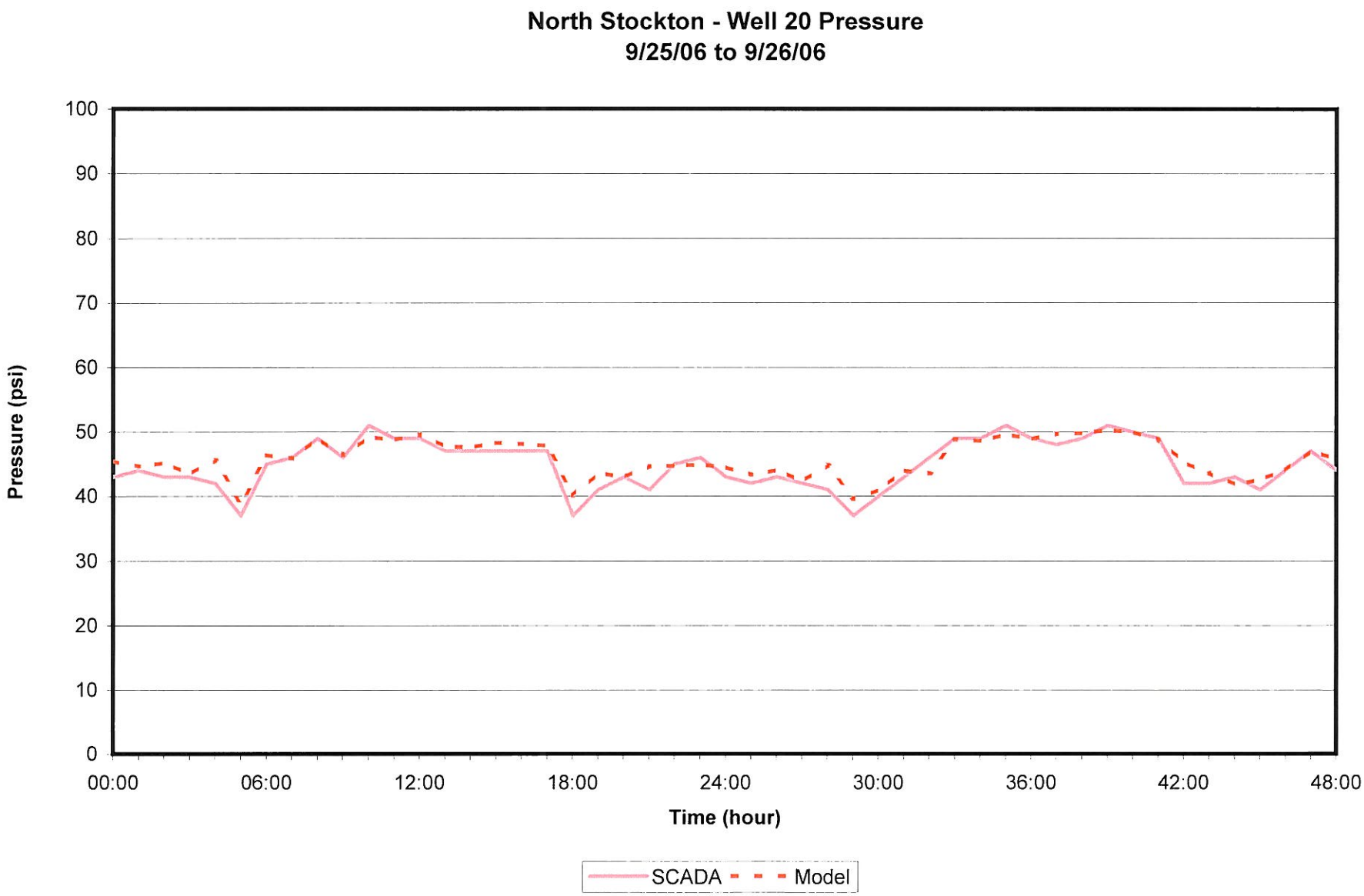

North Stockton - Well 18 Flow
9/25/06 to 9/26/06
Flow (gpm)
1,000
900
800
700
600
500
400
300
200
100
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

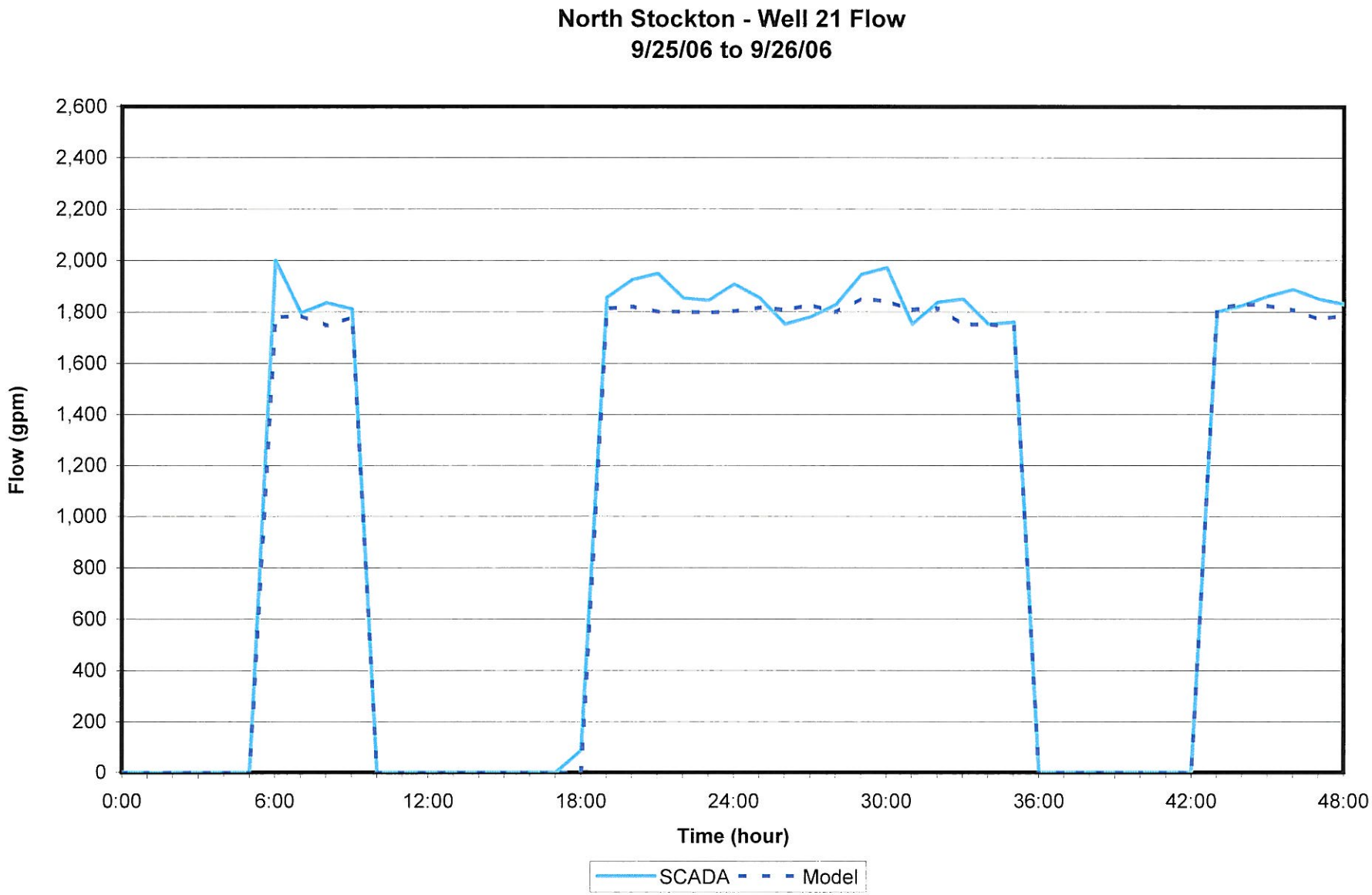

North Stockton - Well 18 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

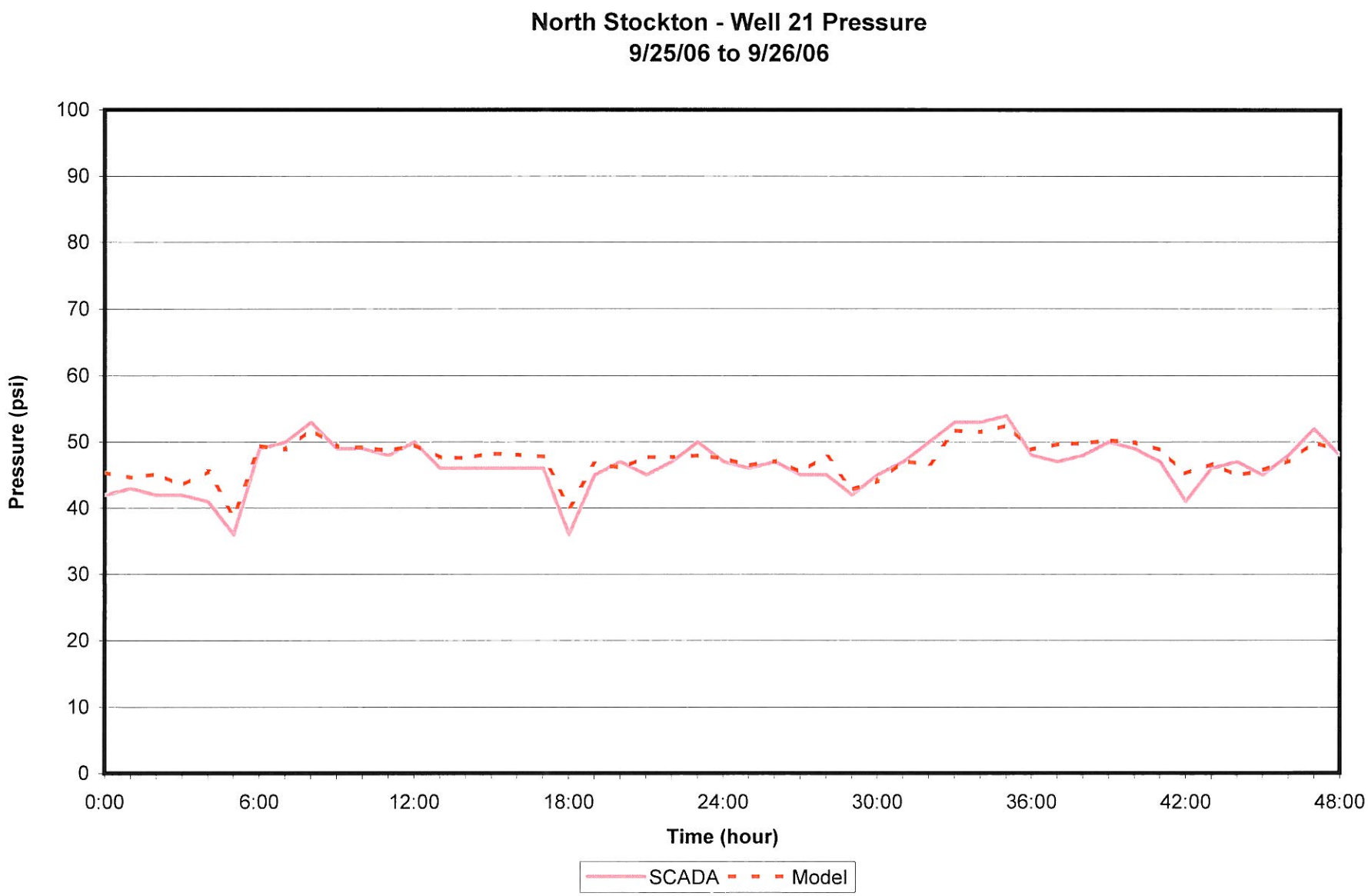

North Stockton - Well 19 Flow
9/25/06 to 9/26/06
Flow (gpm)
2,600
2,400
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

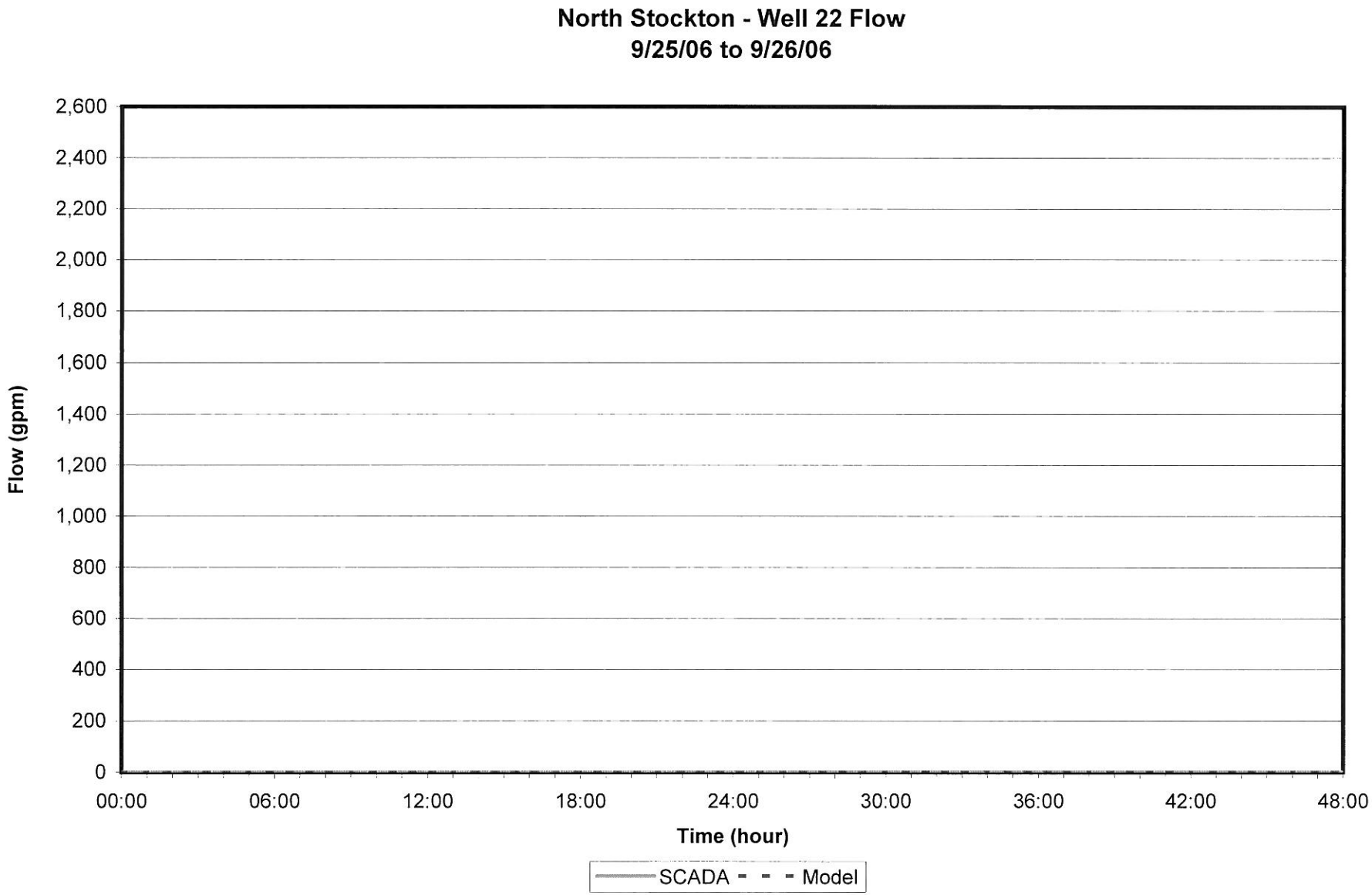

North Stockton - Well 19 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

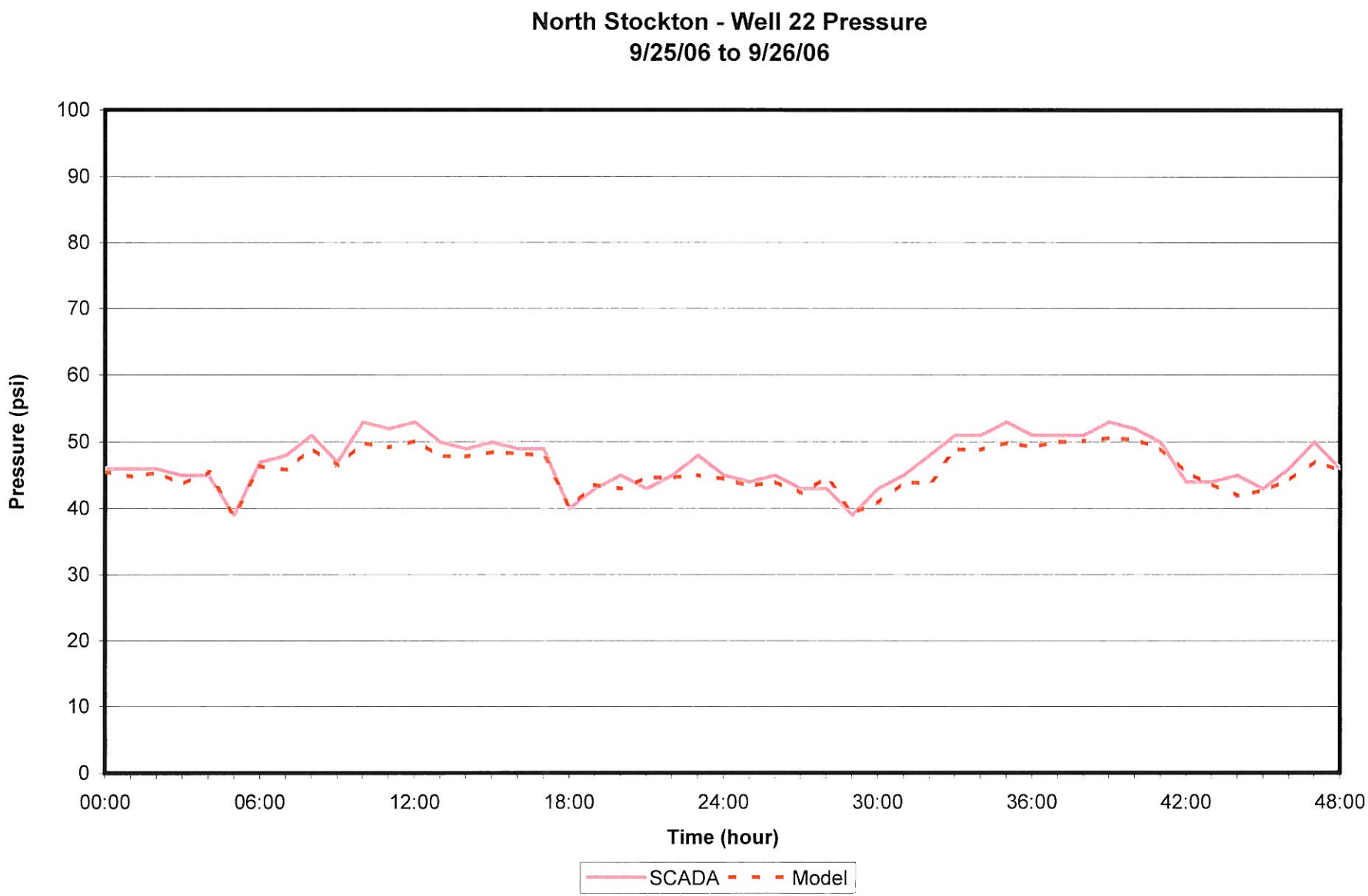

North Stockton - Well 20 Flow
9/25/06 to 9/26/06
Flow (gpm)
1,000
900
800
700
600
500
400
300
200
100
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model


North Stockton - Well 20 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model


North Stockton - Well 21 Flow
9/25/06 to 9/26/06
Flow (gpm)
2,600
2,400
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model


North Stockton - Well 21 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model


North Stockton - Well 22 Flow
9/25/06 to 9/26/06
Flow (gpm)
2,600
2,400
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model



WYA Last Revised: June 2007
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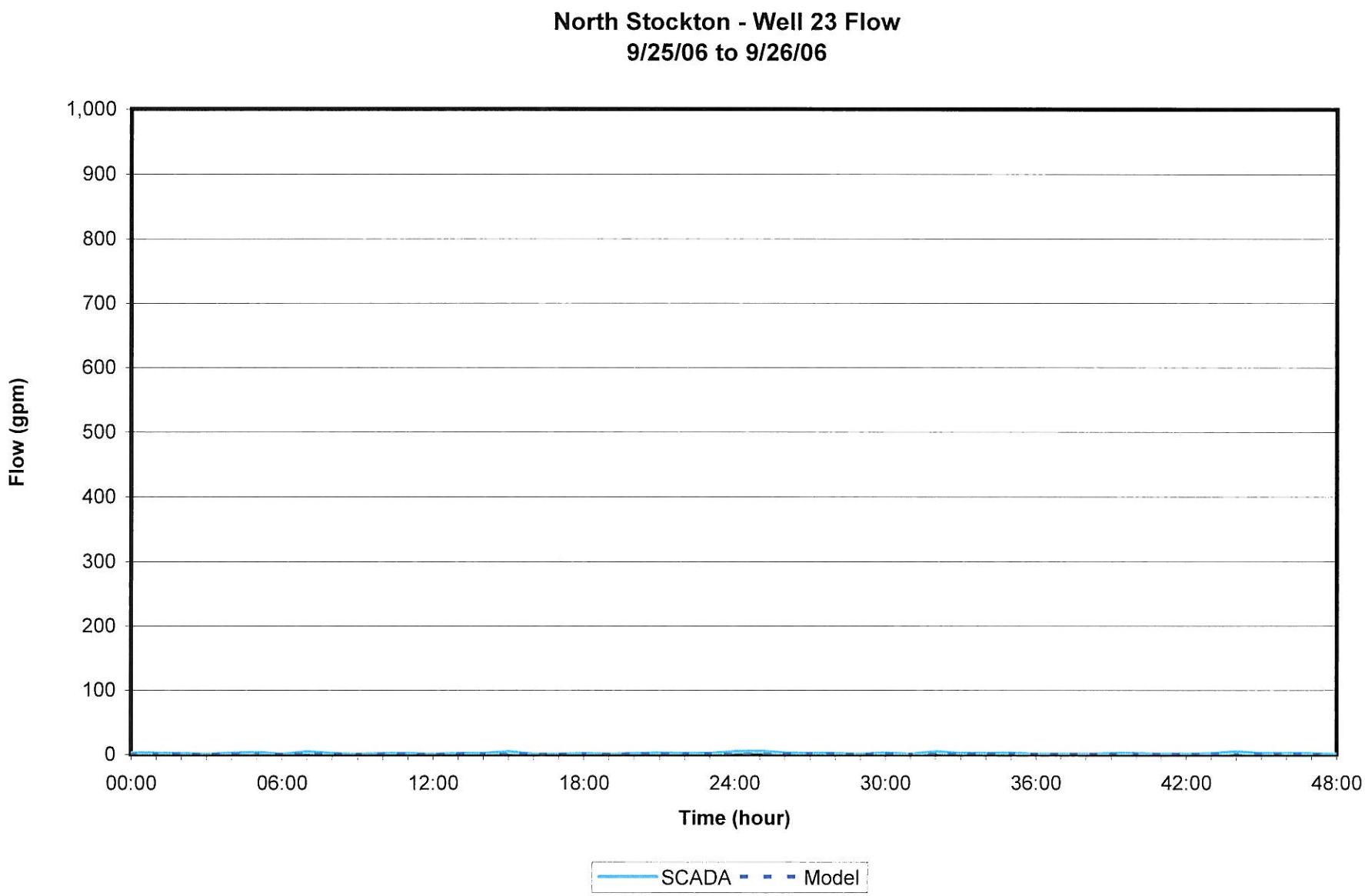
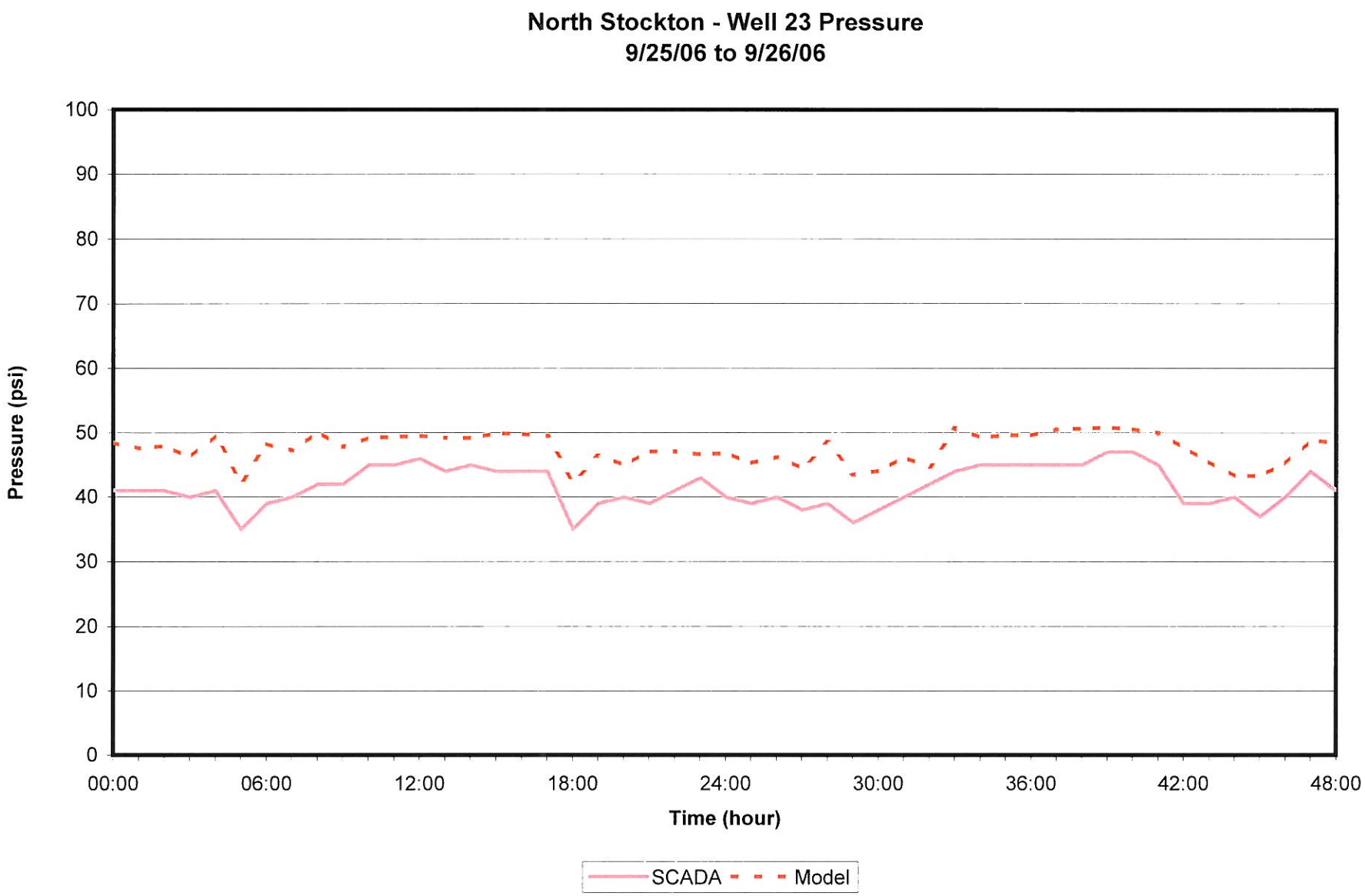
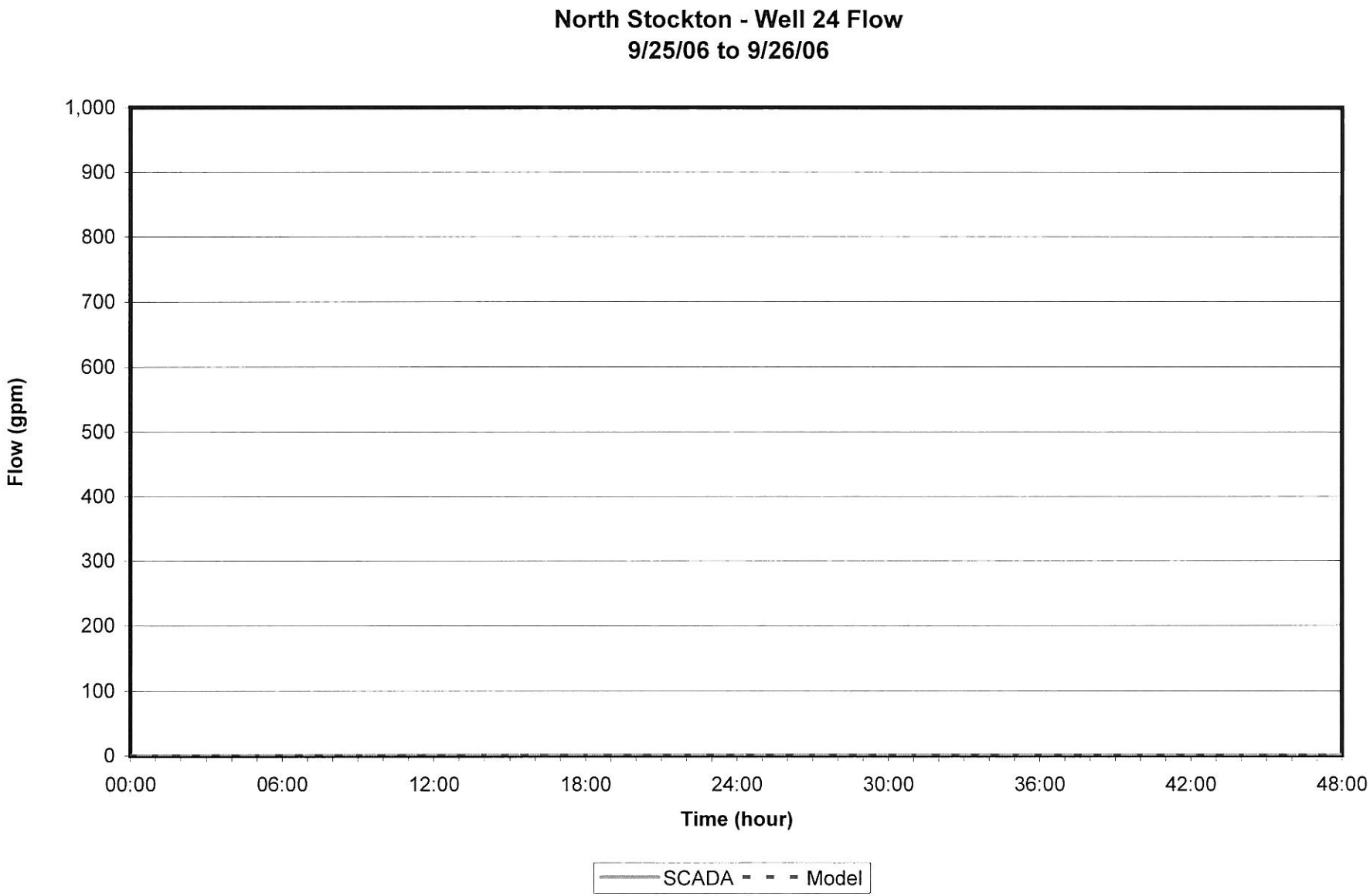
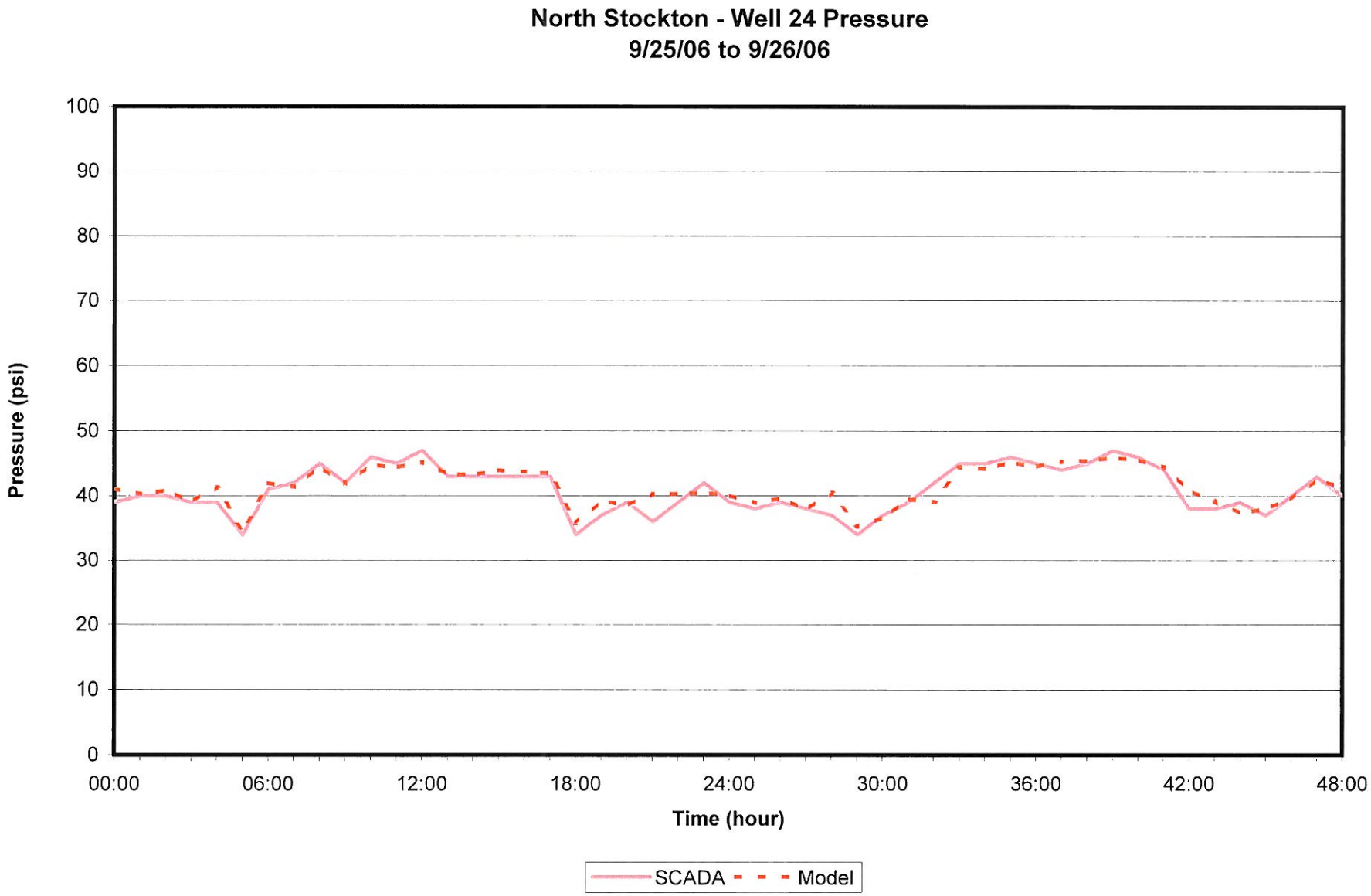
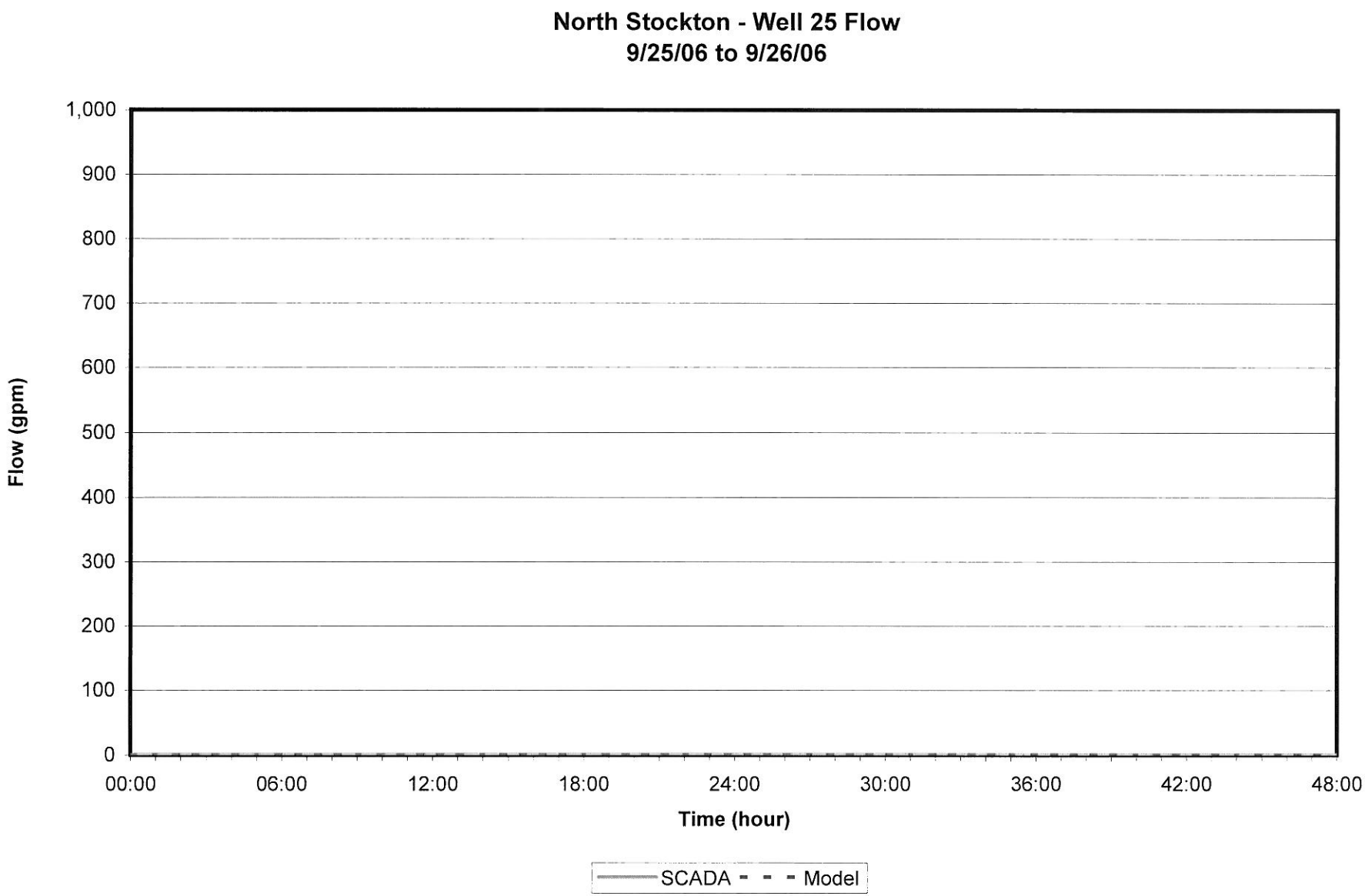
City of Stockton
Water Master Plan Update

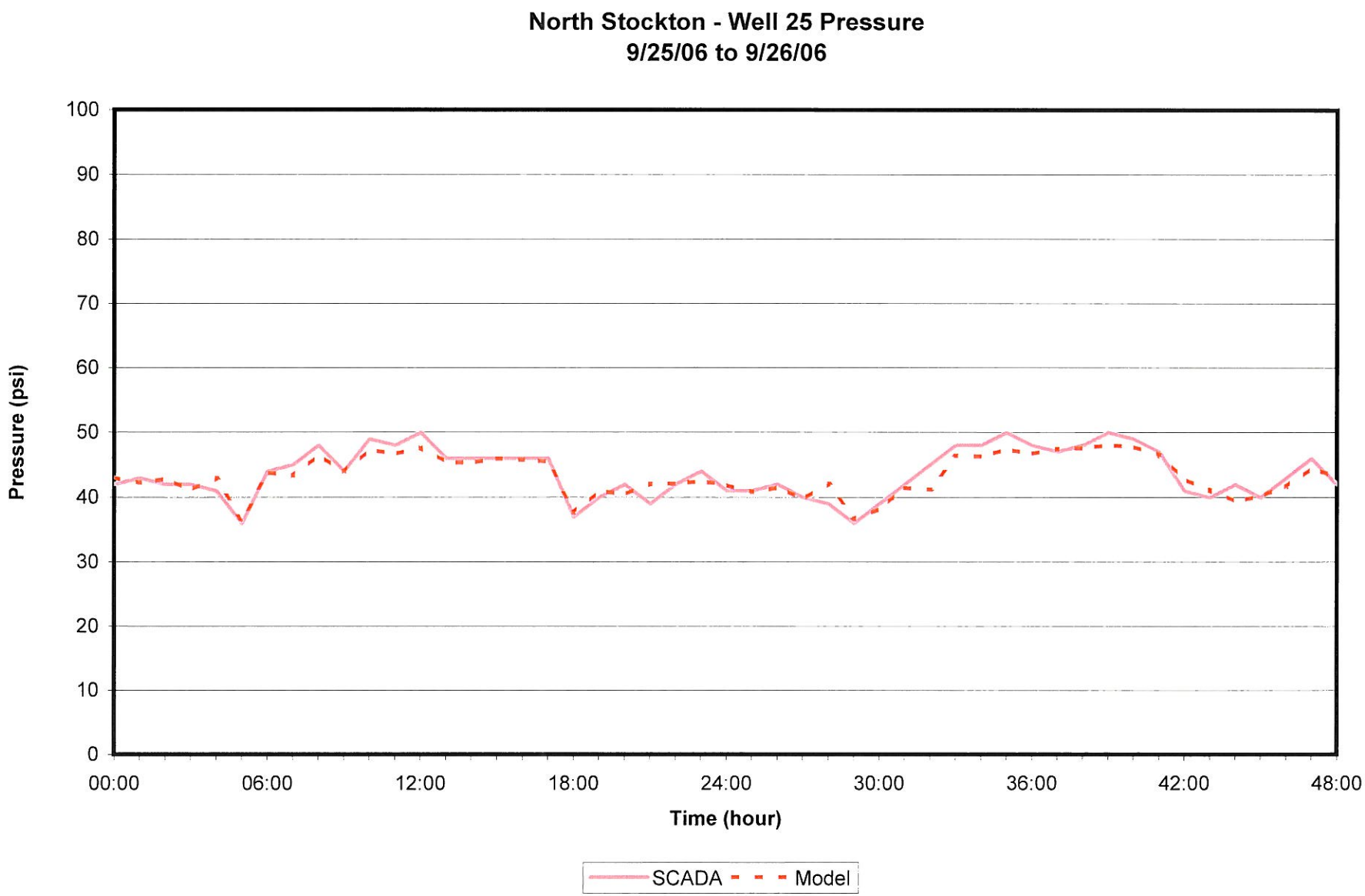

North Stockton - Well 23 Flow
9/25/06 to 9/26/06
Flow (gpm)
1,000
900
800
700
600
500
400
300
200
100
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

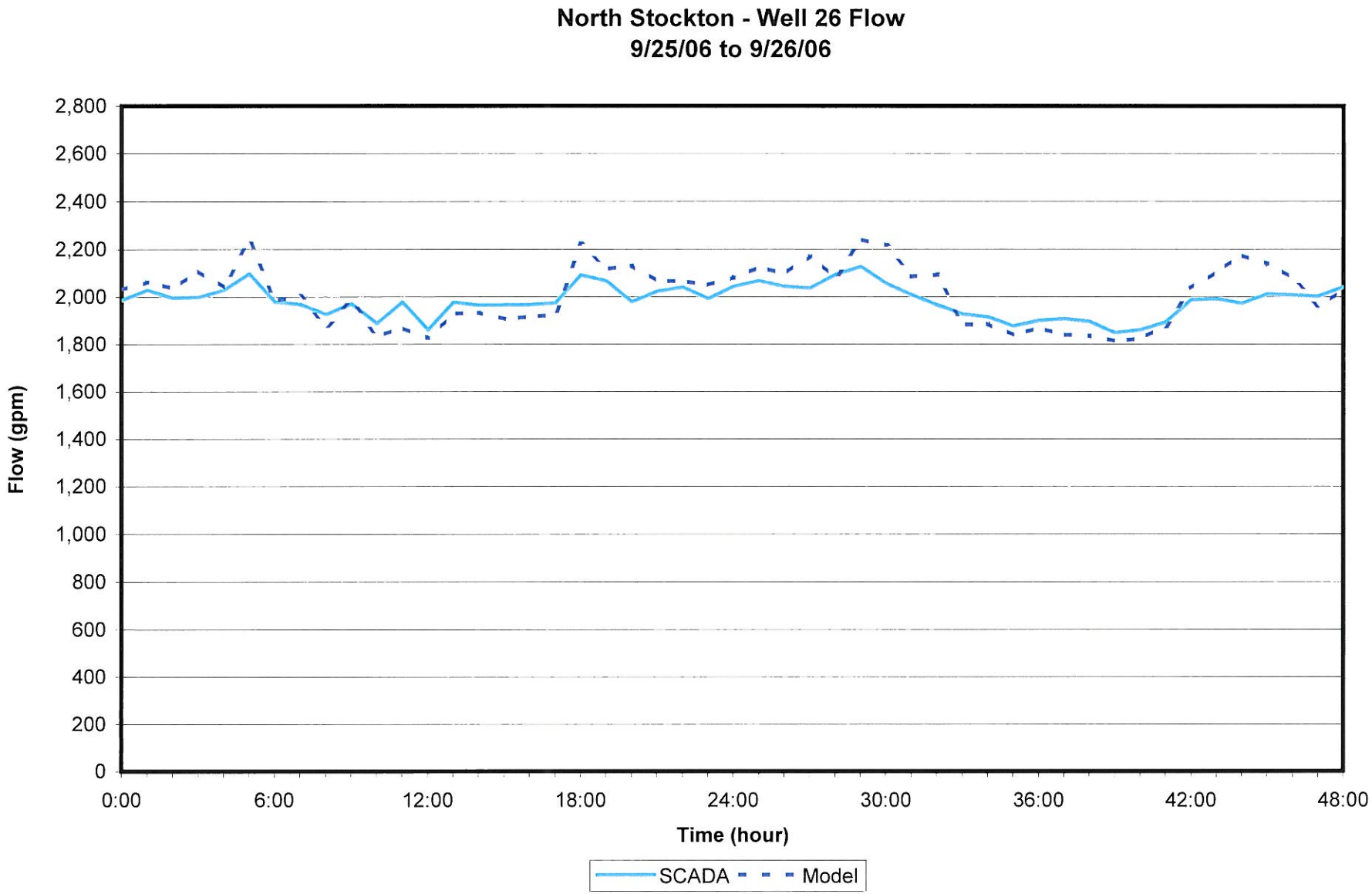

North Stockton - Well 23 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

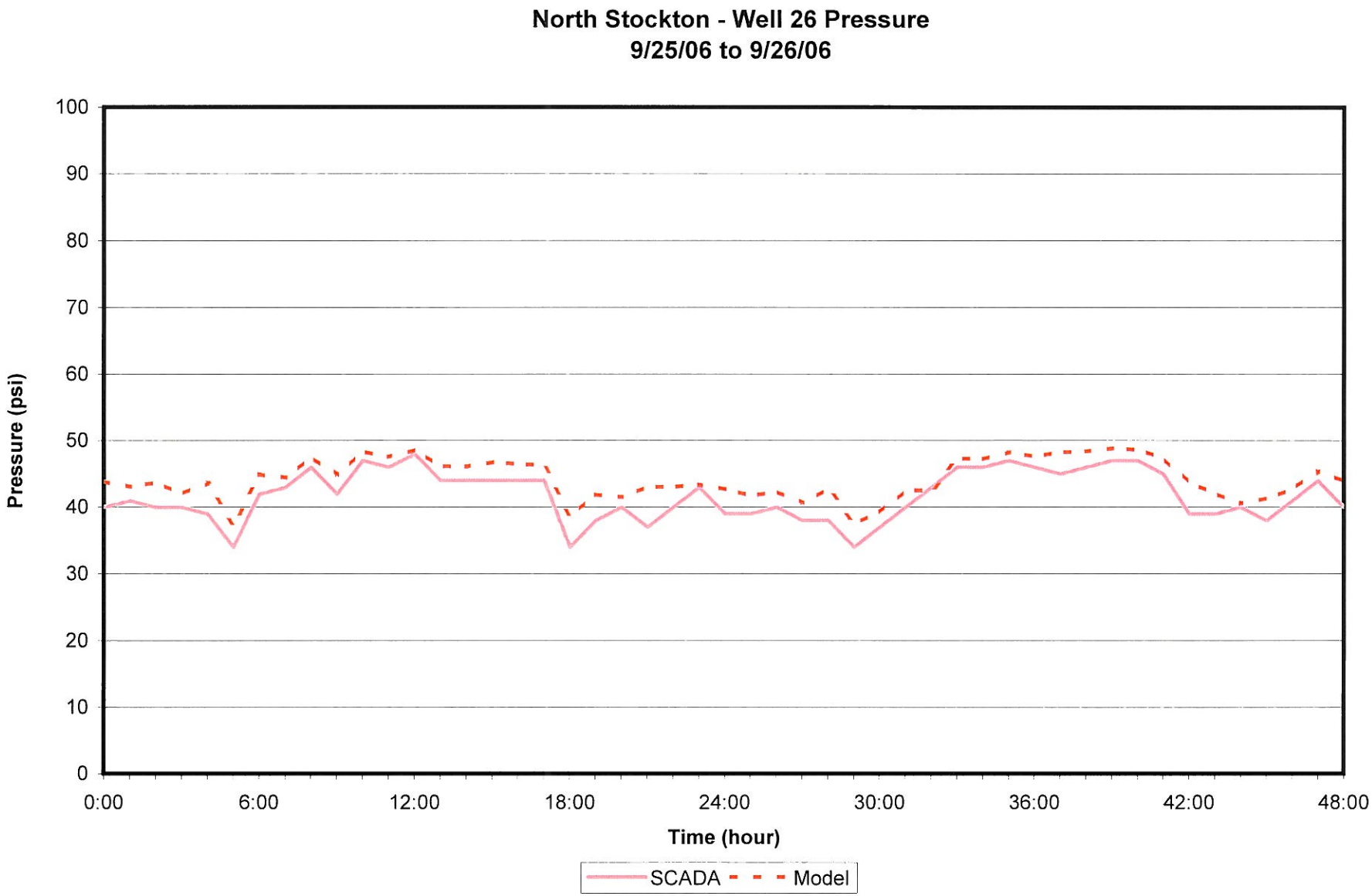

North Stockton - Well 24 Flow
9/25/06 to 9/26/06
Flow (gpm)
1,000
900
800
700
600
500
400
300
200
100
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

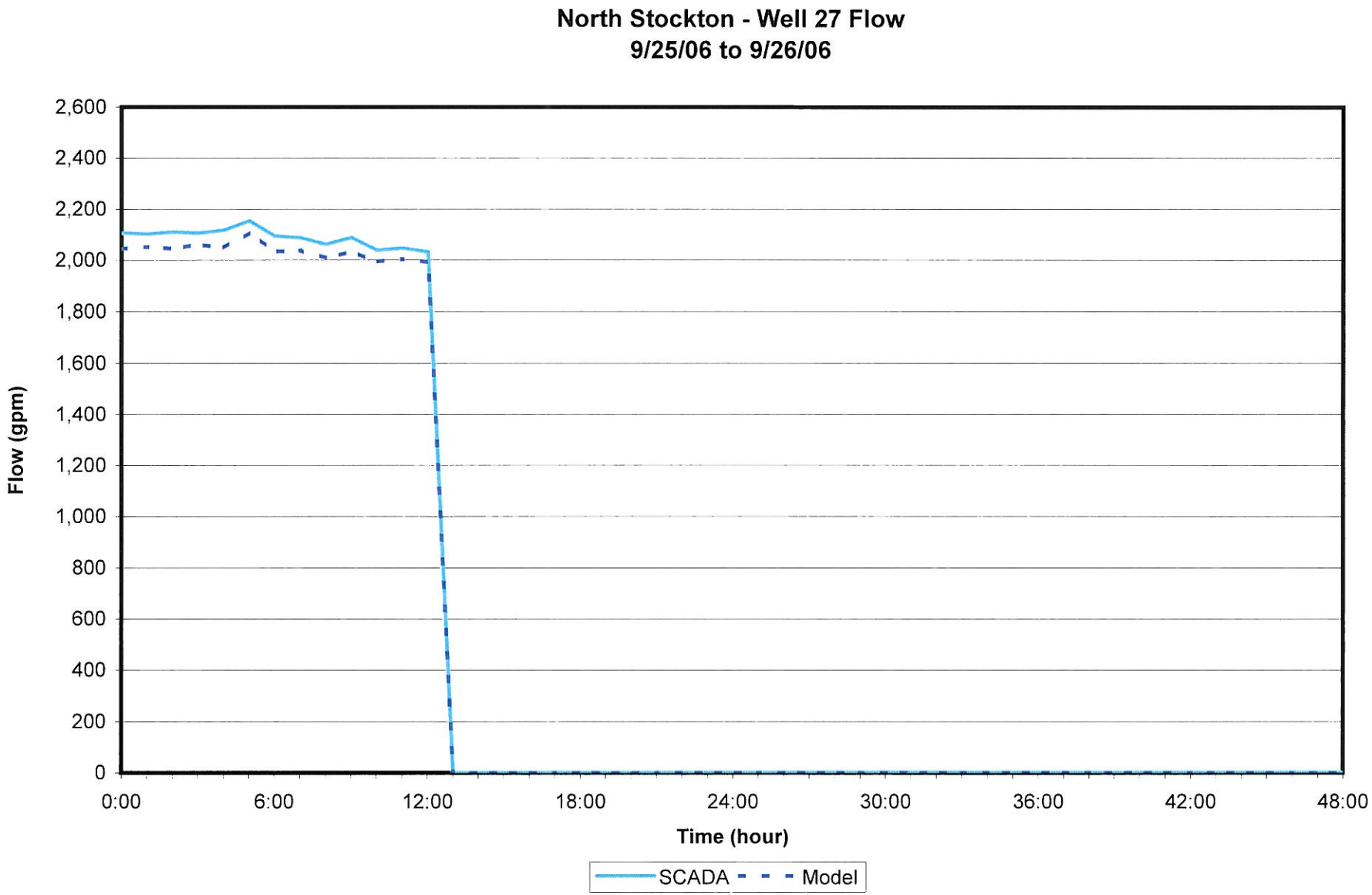

North Stockton - Well 24 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

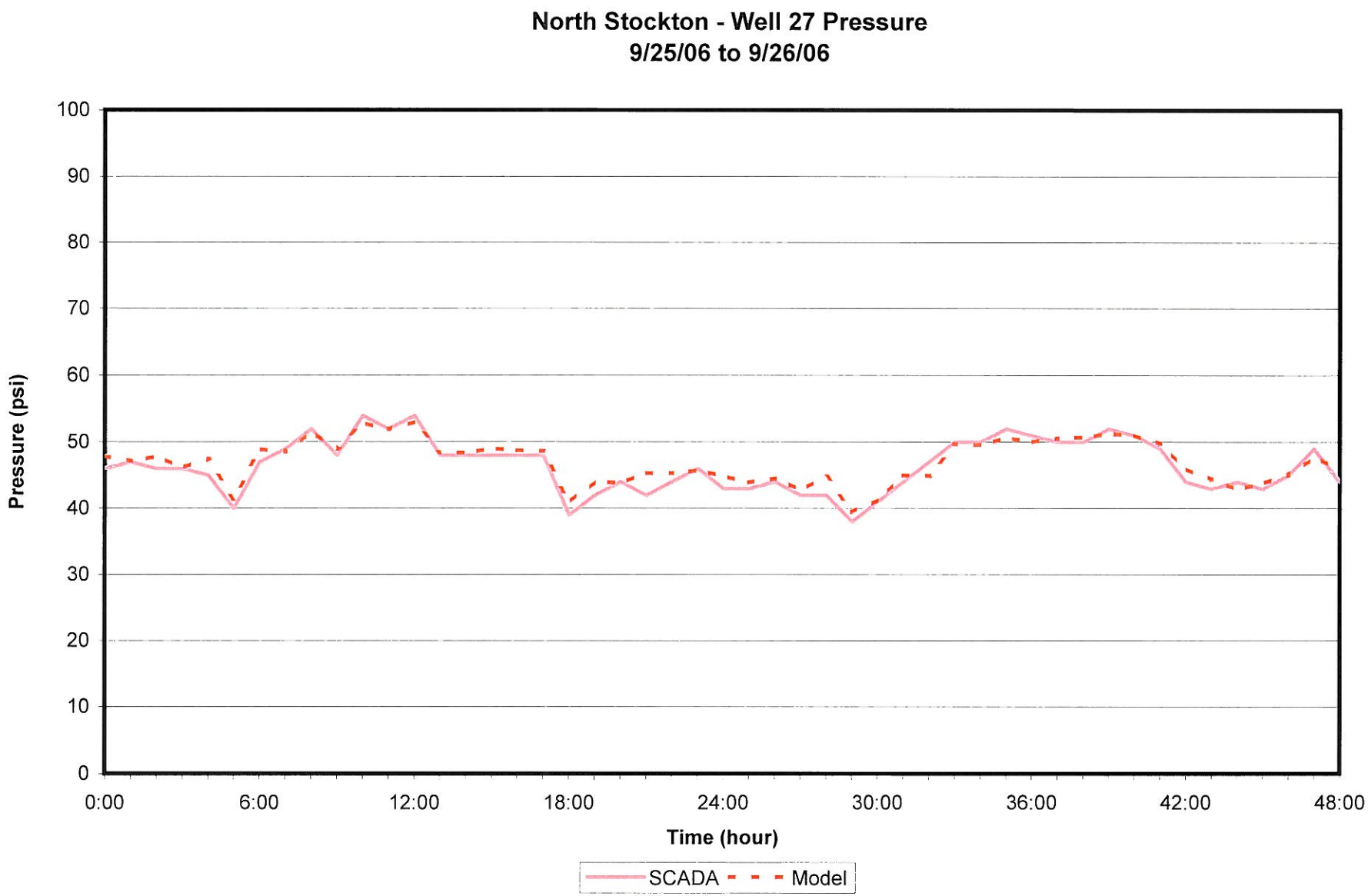

North Stockton - Well 25 Flow
9/25/06 to 9/26/06
Flow (gpm)
1,000
900
800
700
600
500
400
300
200
100
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

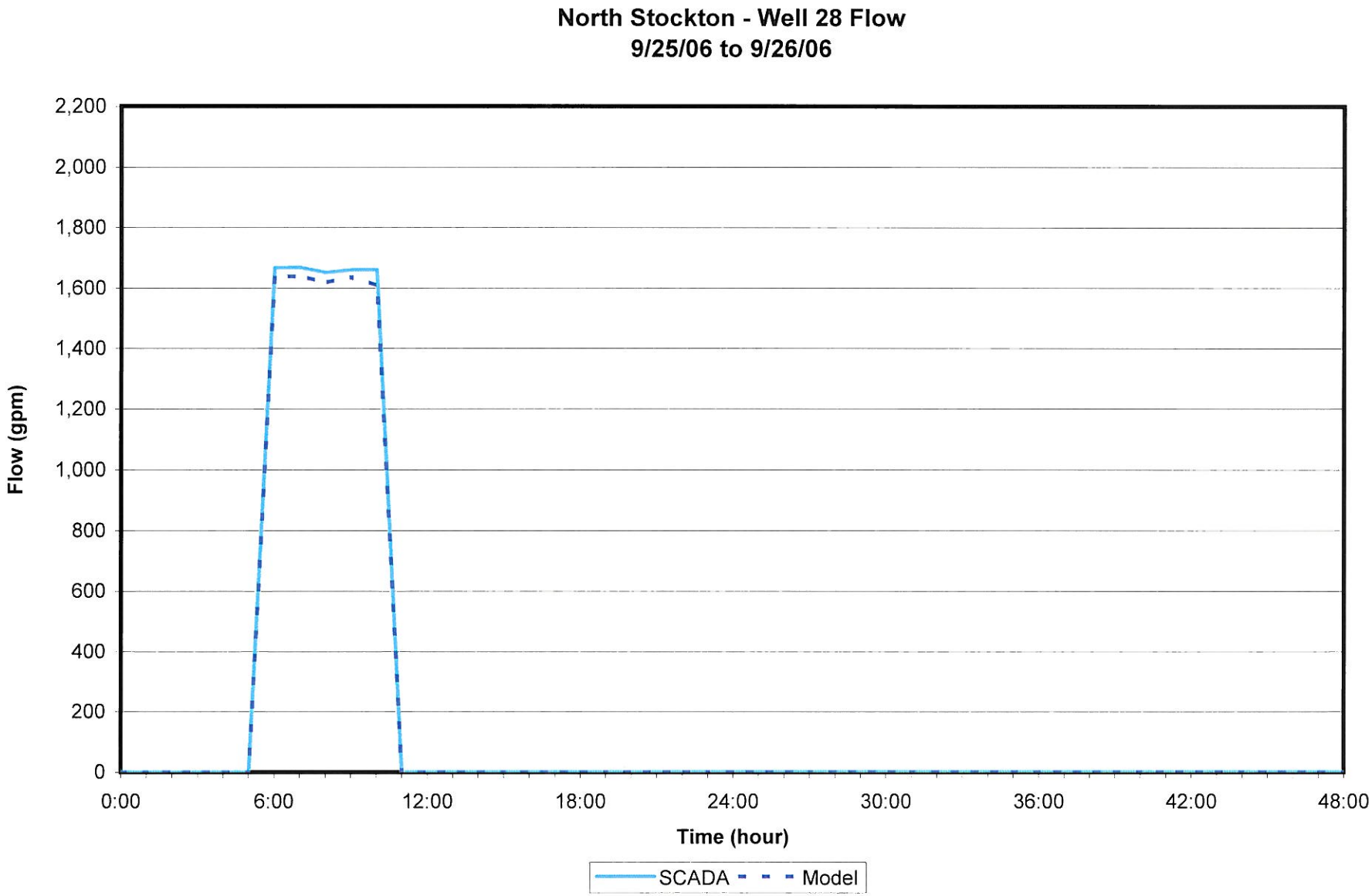

North Stockton - Well 25 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

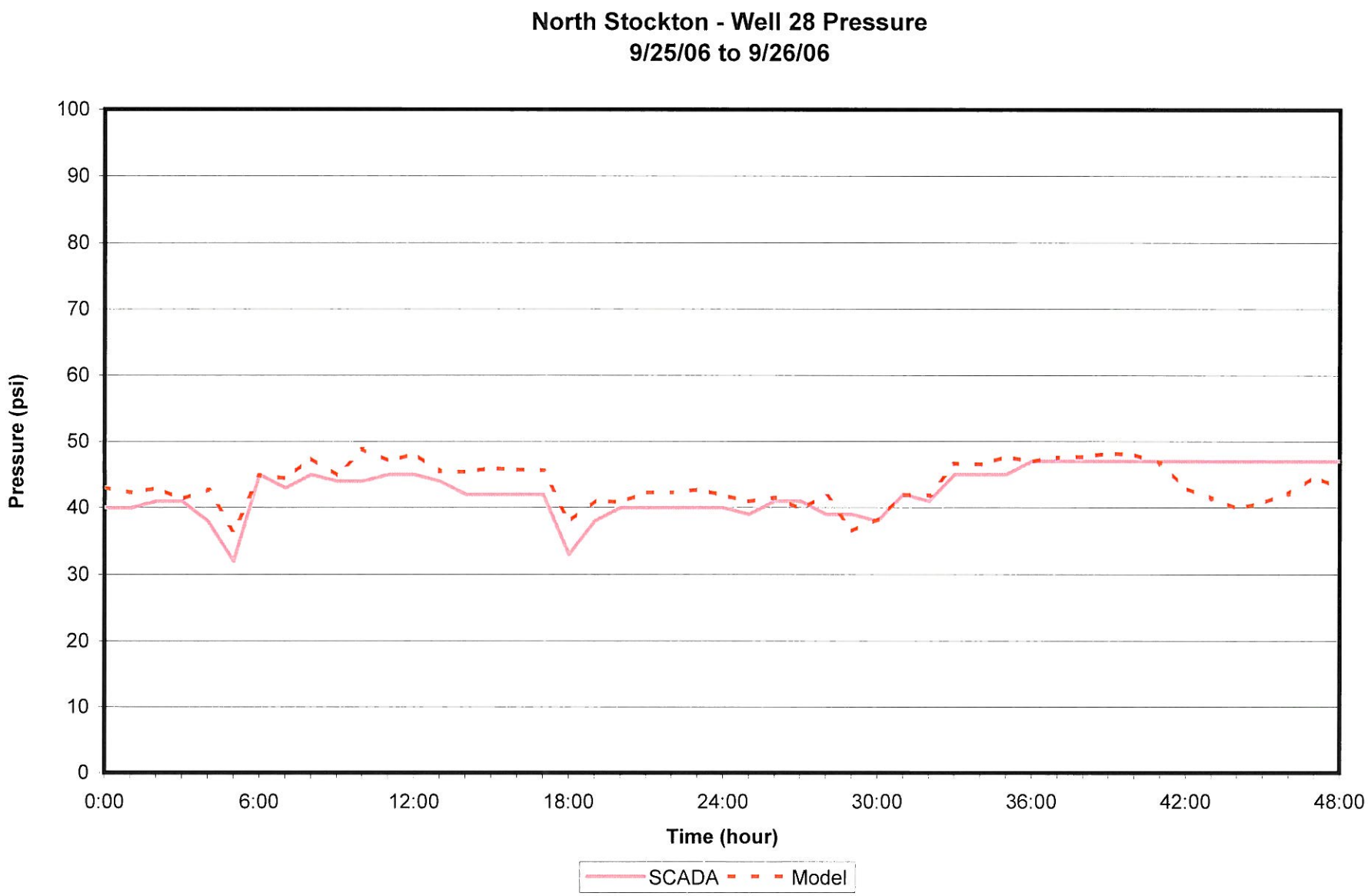

North Stockton - Well 26 Flow
9/25/06 to 9/26/06
Flow (gpm)
2,800
2,600
2,400
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

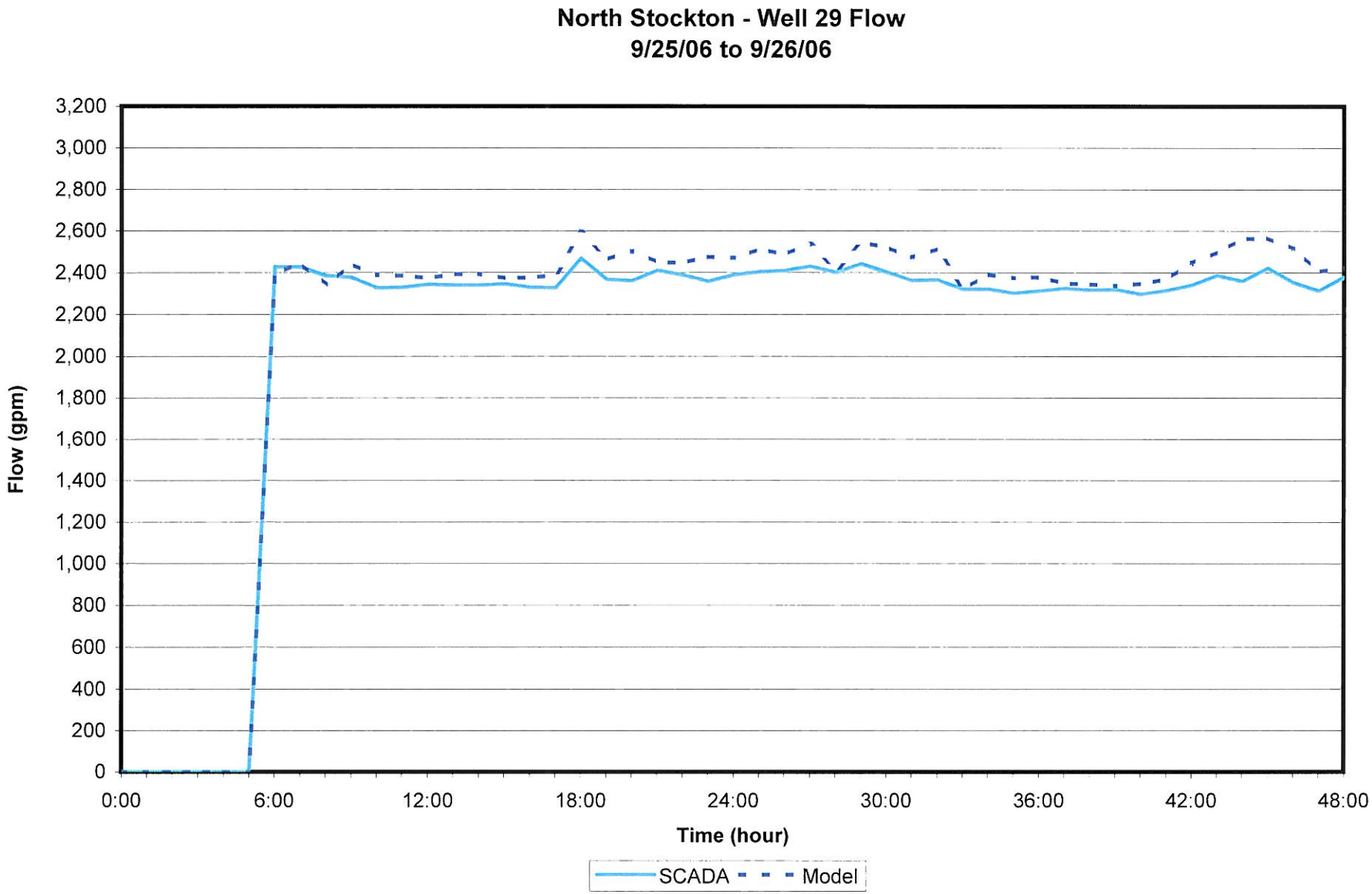

North Stockton - Well 26 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

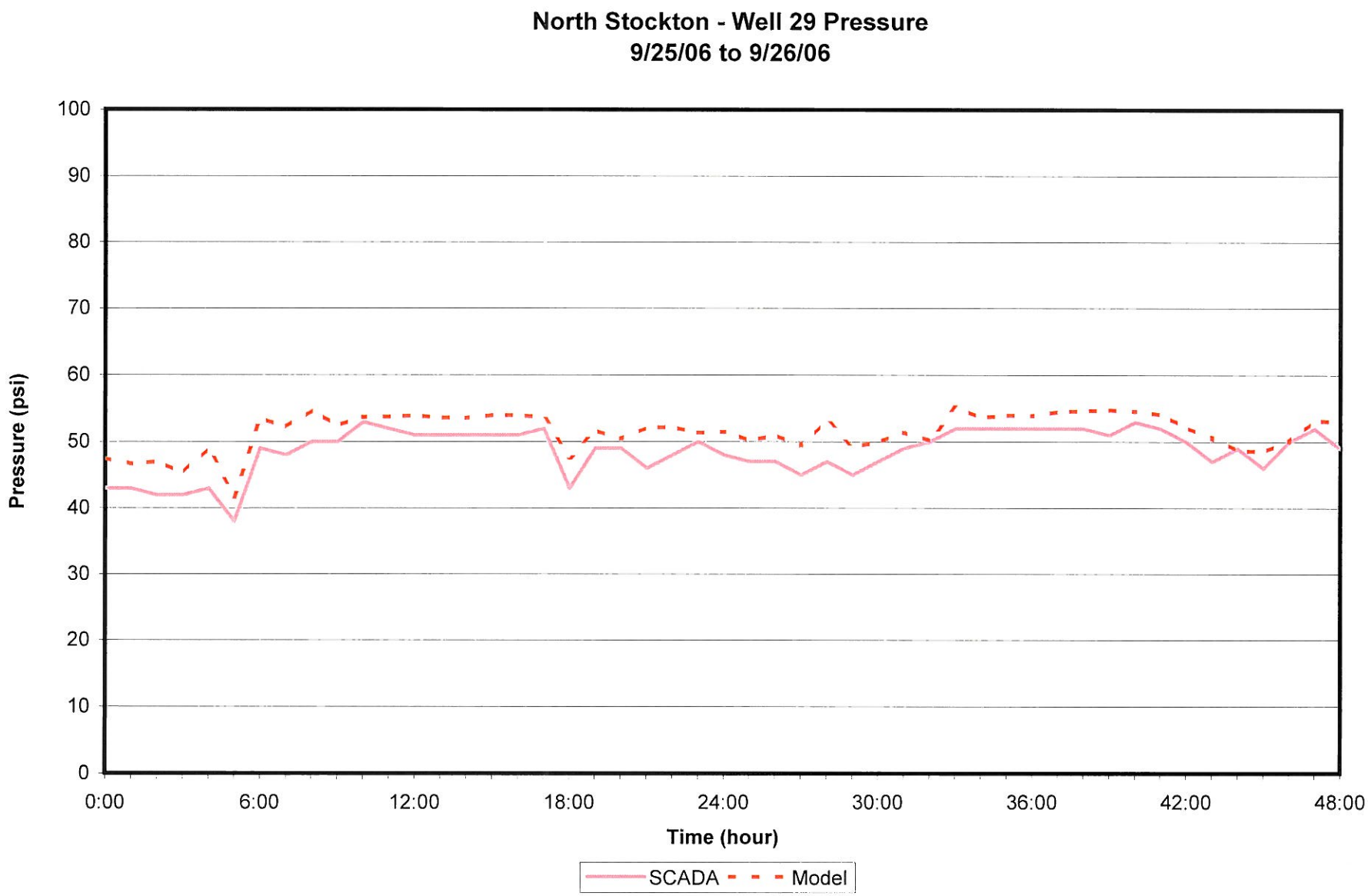

North Stockton - Well 27 Flow
9/25/06 to 9/26/06
Flow (gpm)
2,600
2,400
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

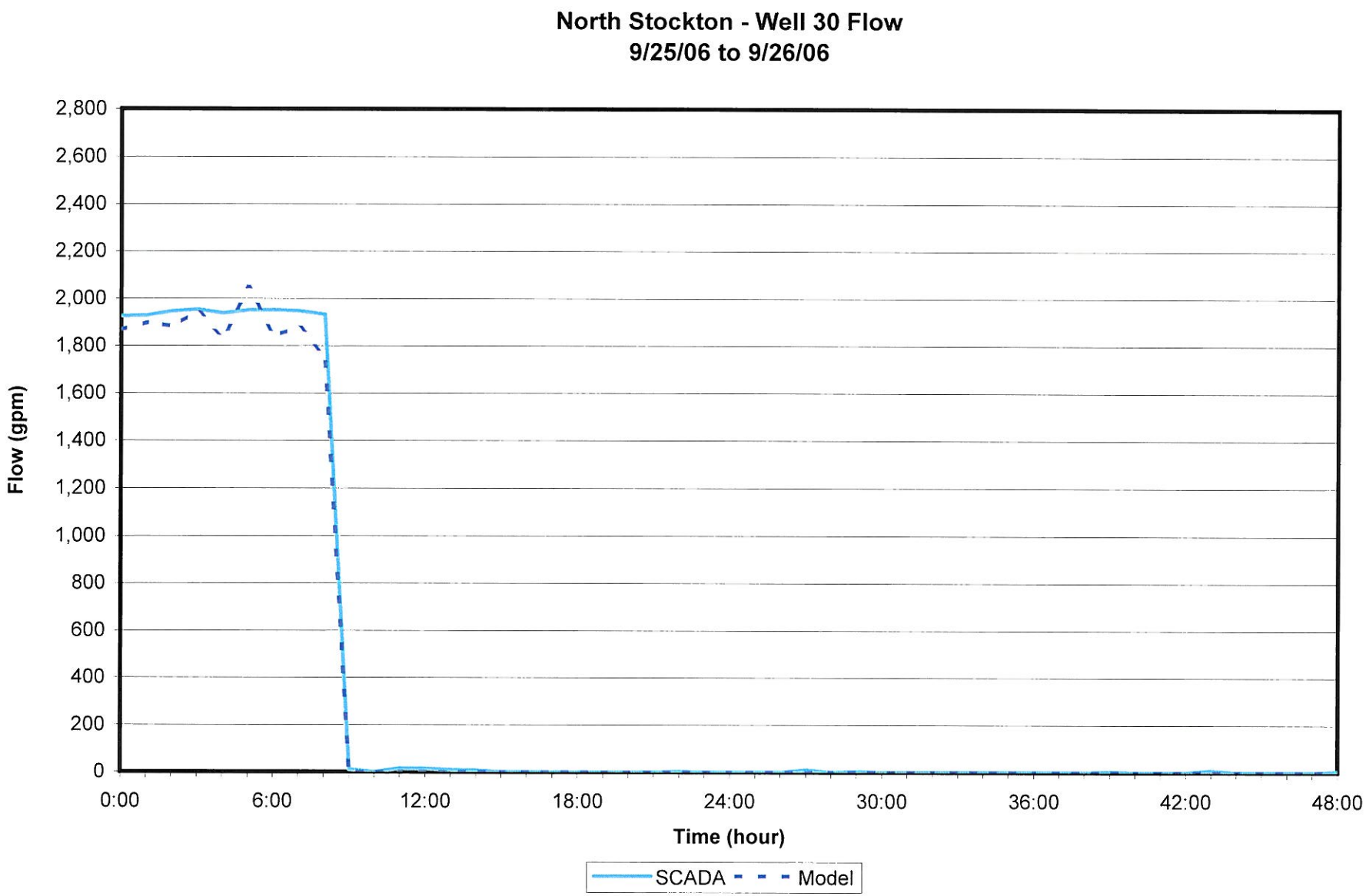

North Stockton - Well 27 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

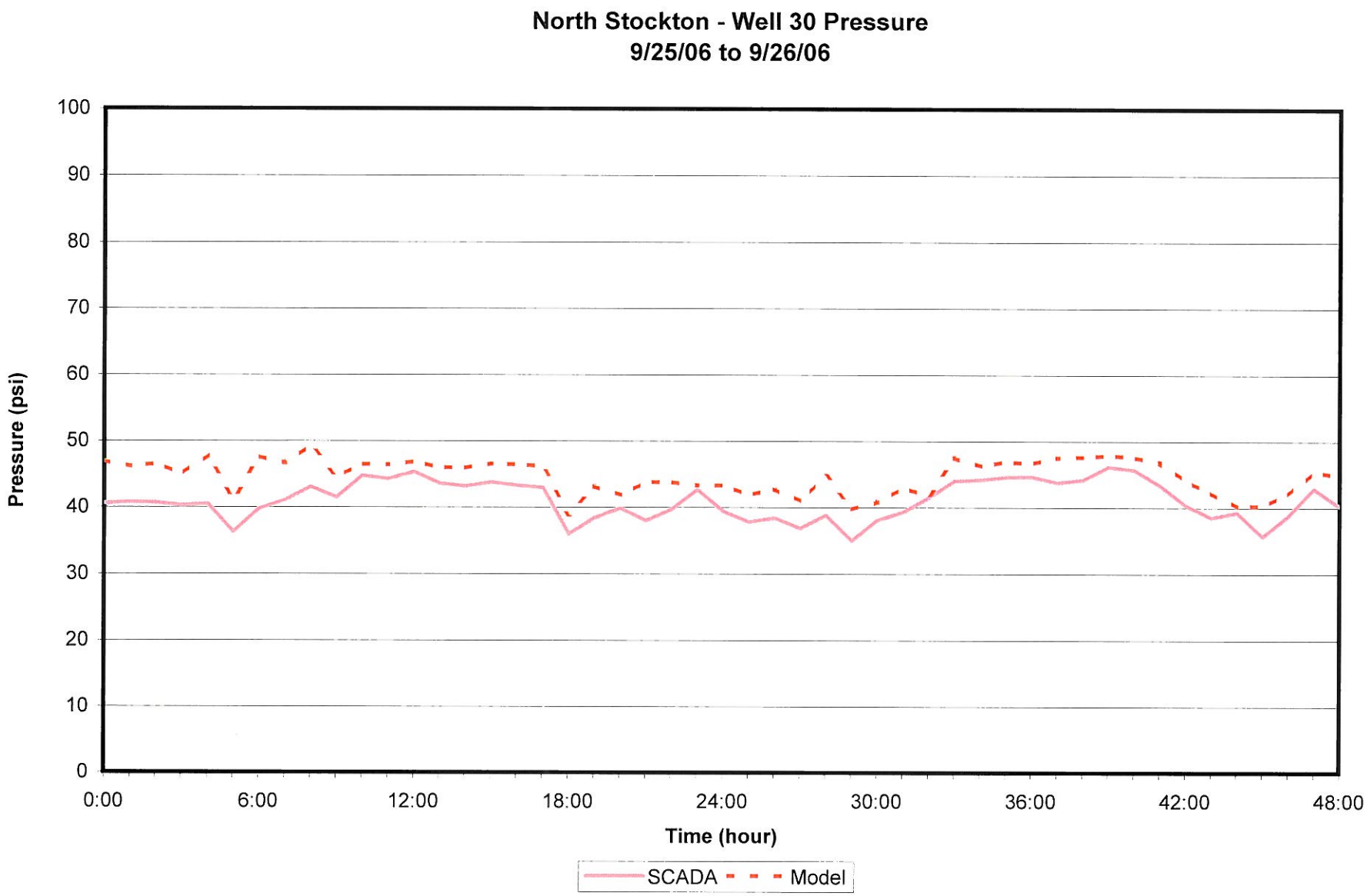

North Stockton - Well 28 Flow
9/25/06 to 9/26/06
Flow (gpm)
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

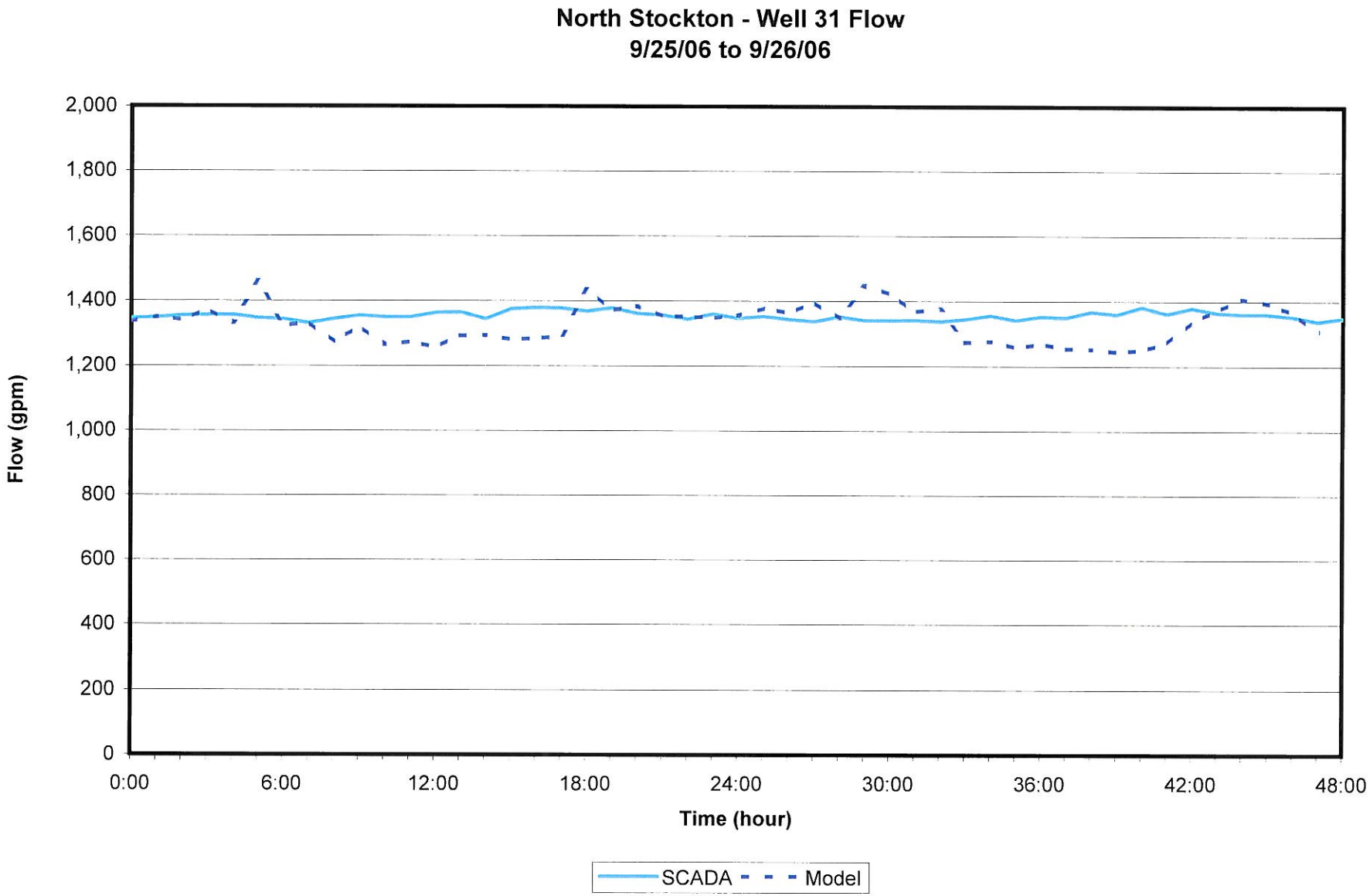

North Stockton - Well 28 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

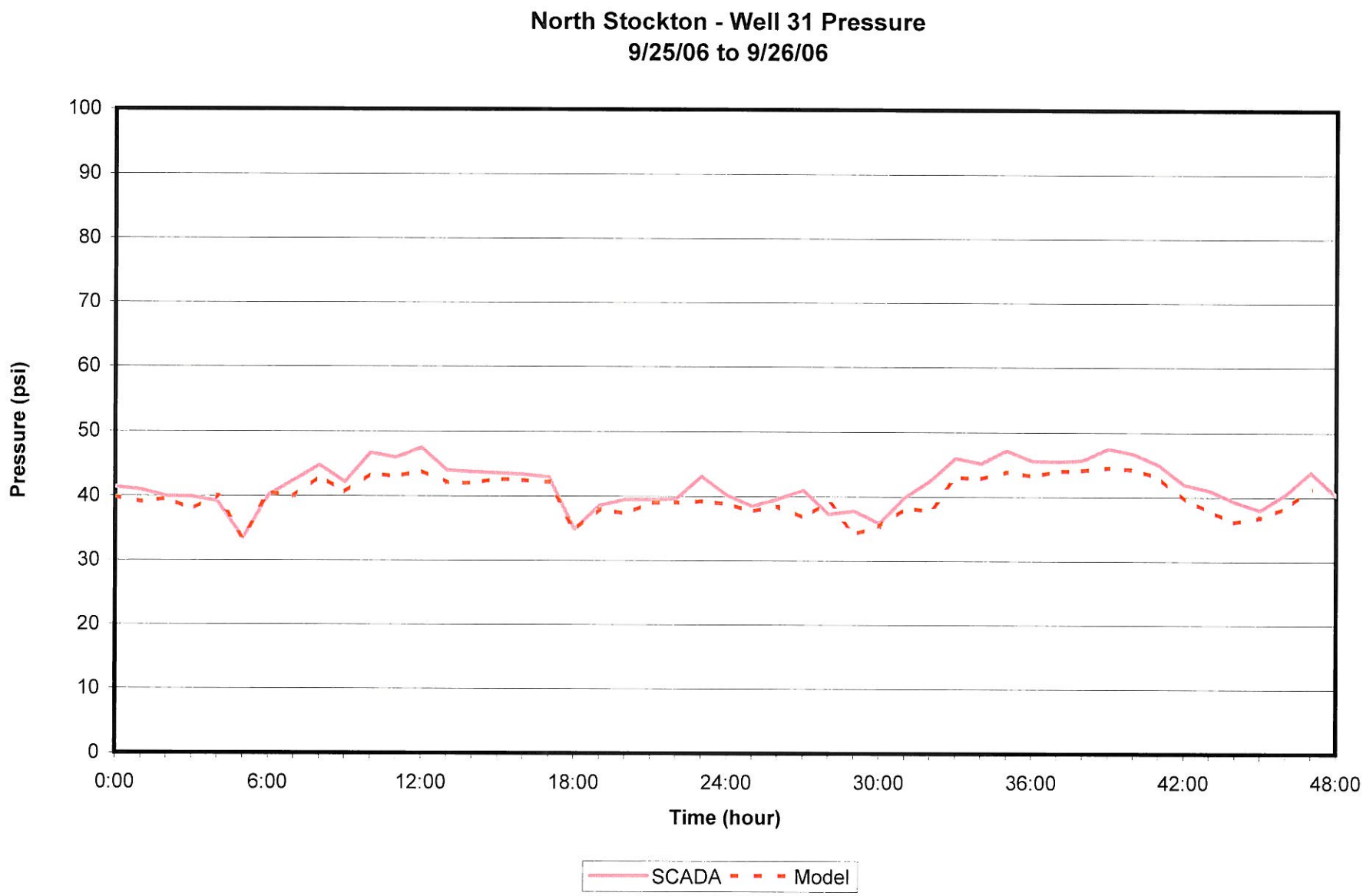

North Stockton - Well 29 Flow
9/25/06 to 9/26/06
Flow (gpm)
3,200
3,000
2,800
2,600
2,400
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

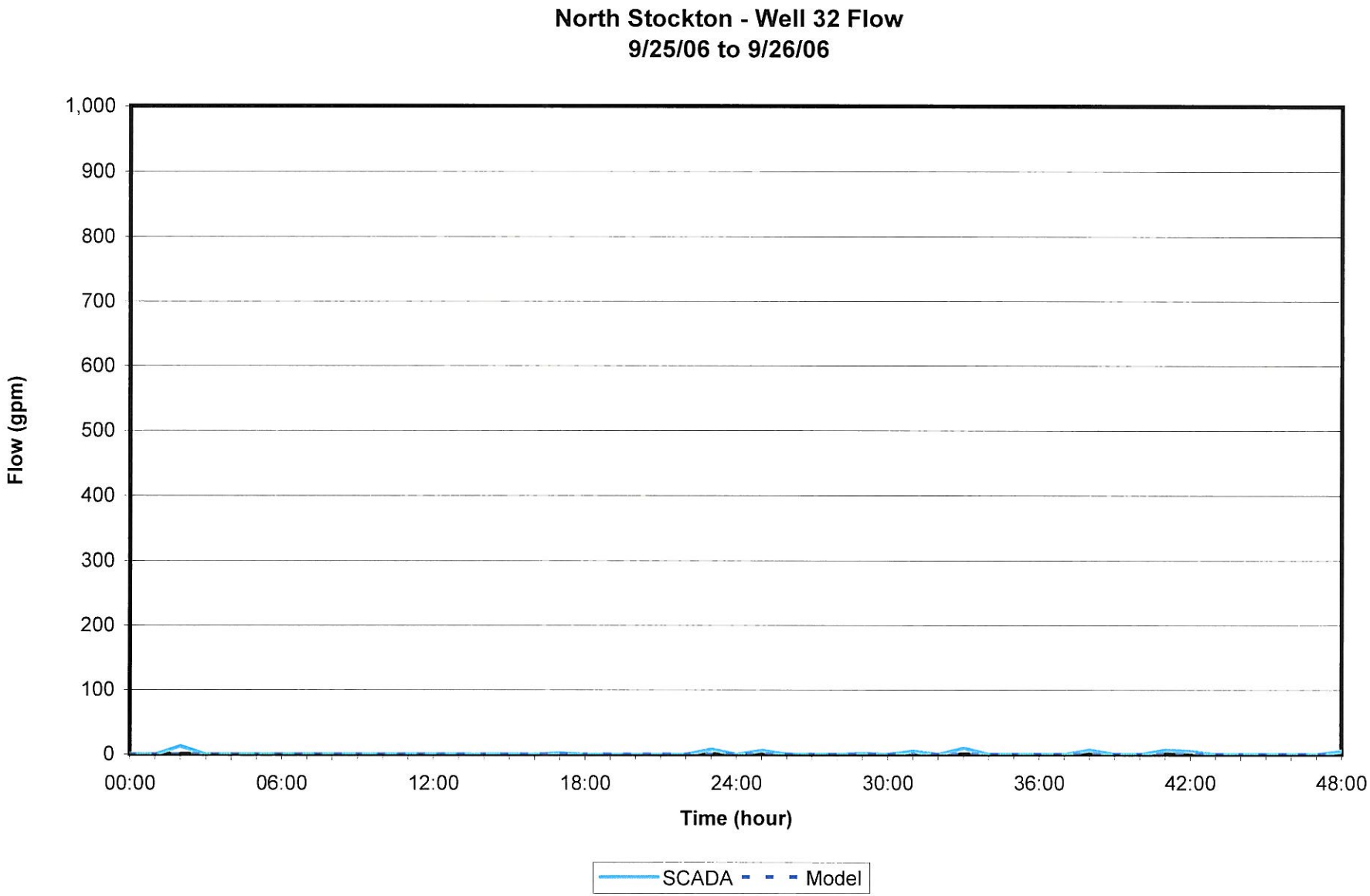

North Stockton - Well 29 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

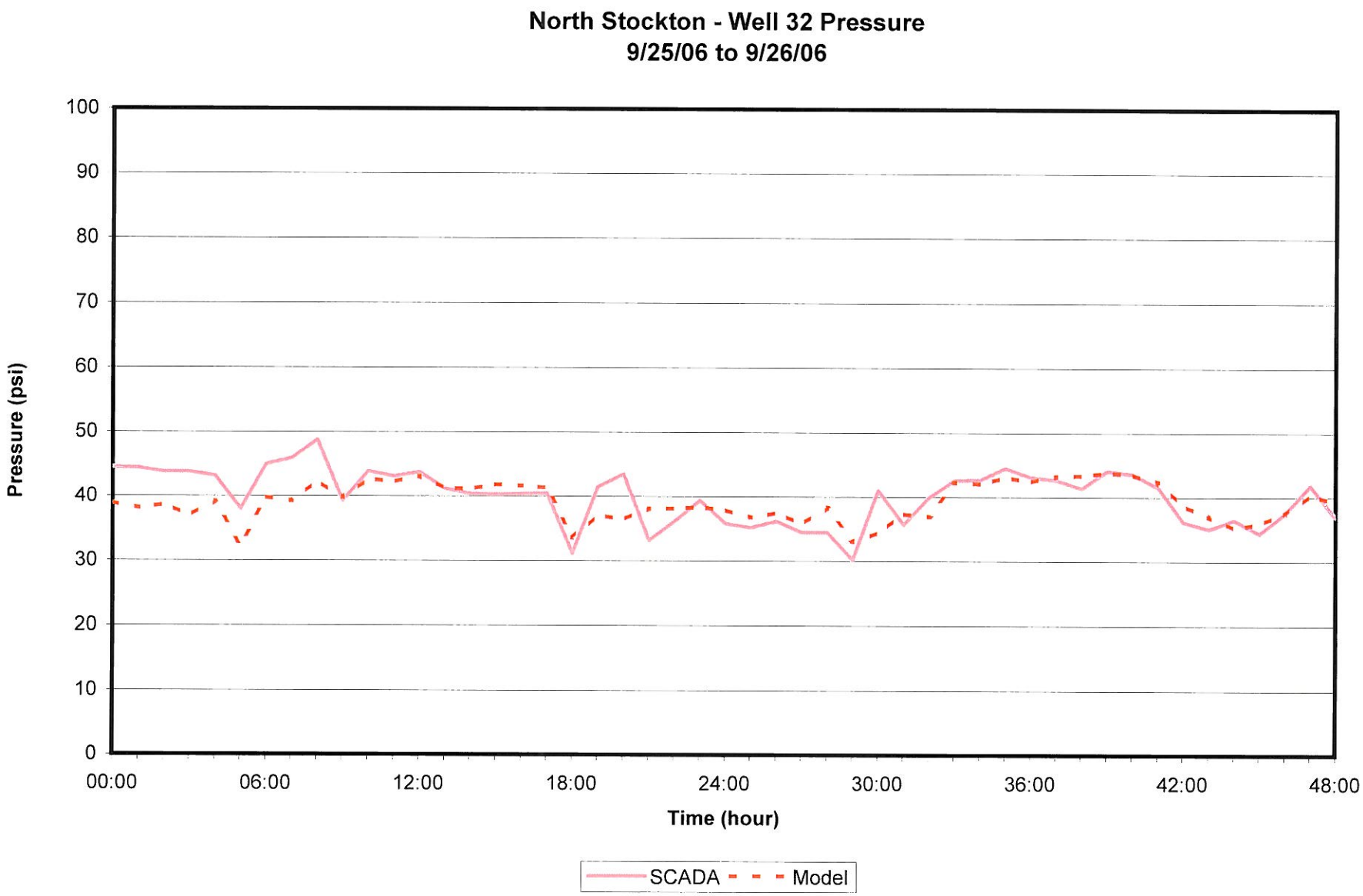

North Stockton - Well 30 Flow
9/25/06 to 9/26/06
Flow (gpm)
2,800
2,600
2,400
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

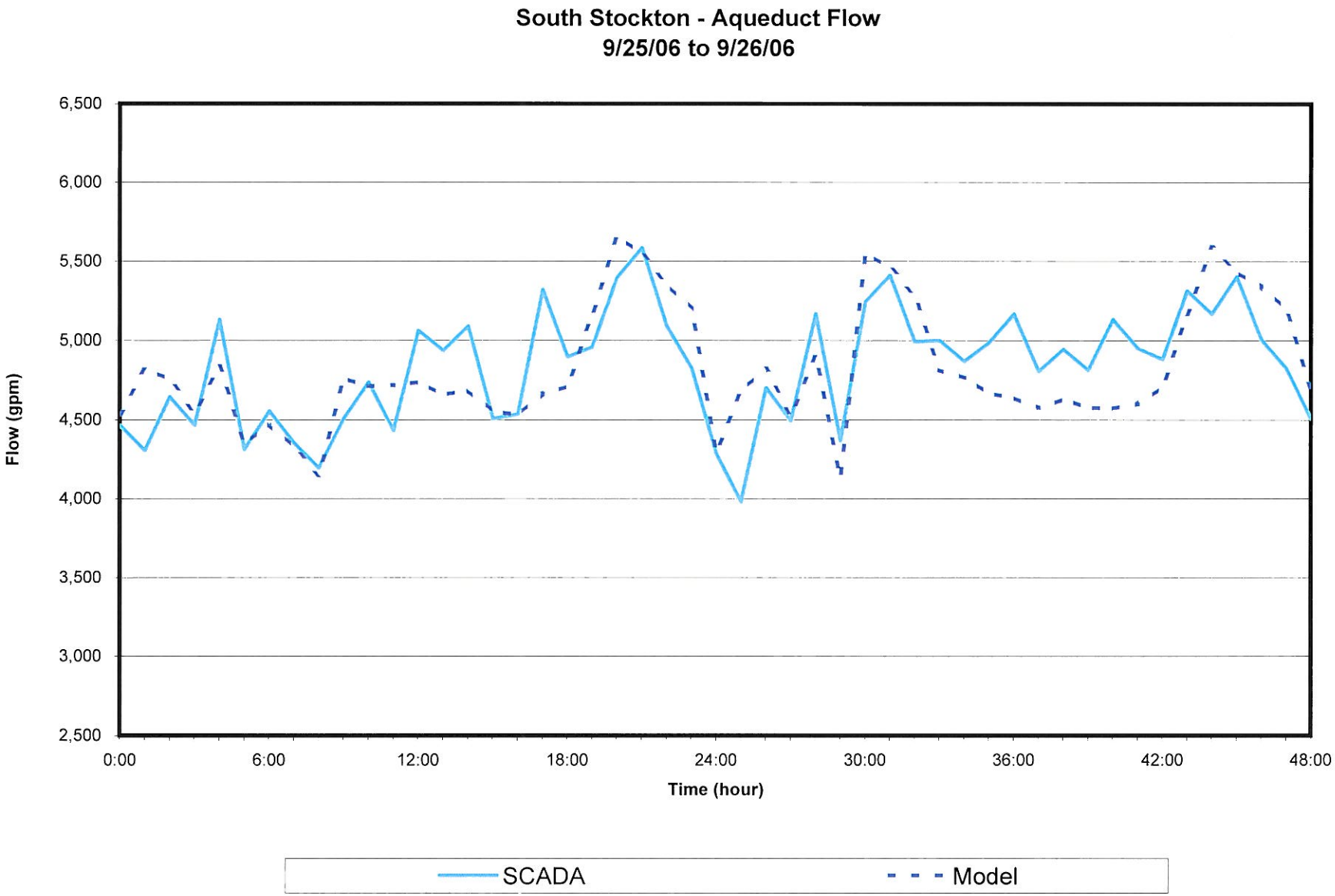

North Stockton - Well 30 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model


North Stockton - Well 31 Flow
9/25/06 to 9/26/06
Flow (gpm)
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

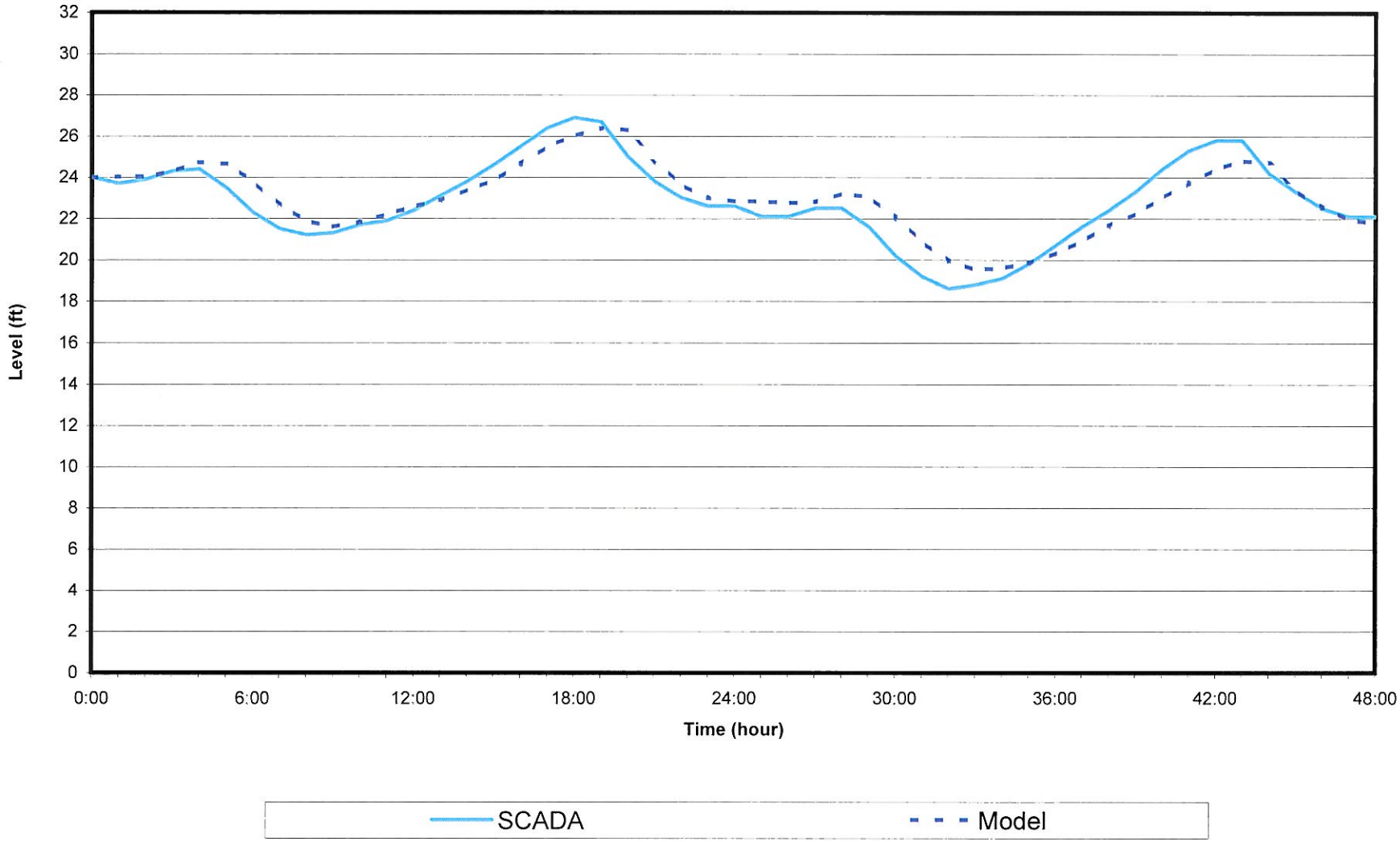

North Stockton - Well 31 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model


North Stockton - Well 32 Flow
9/25/06 to 9/26/06
Flow (gpm)
1,000
900
800
700
600
500
400
300
200
100
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

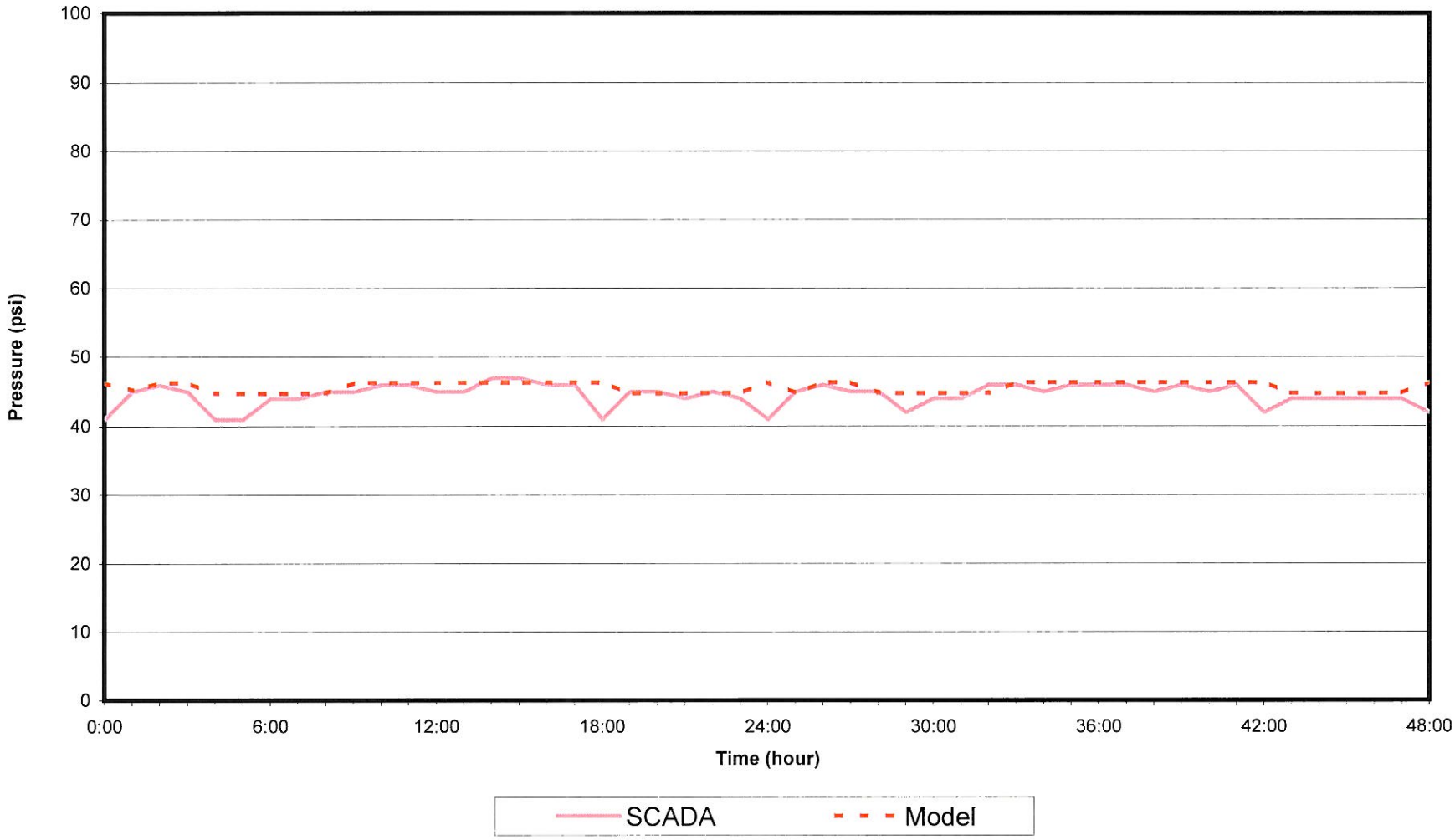

North Stockton - Well 32 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

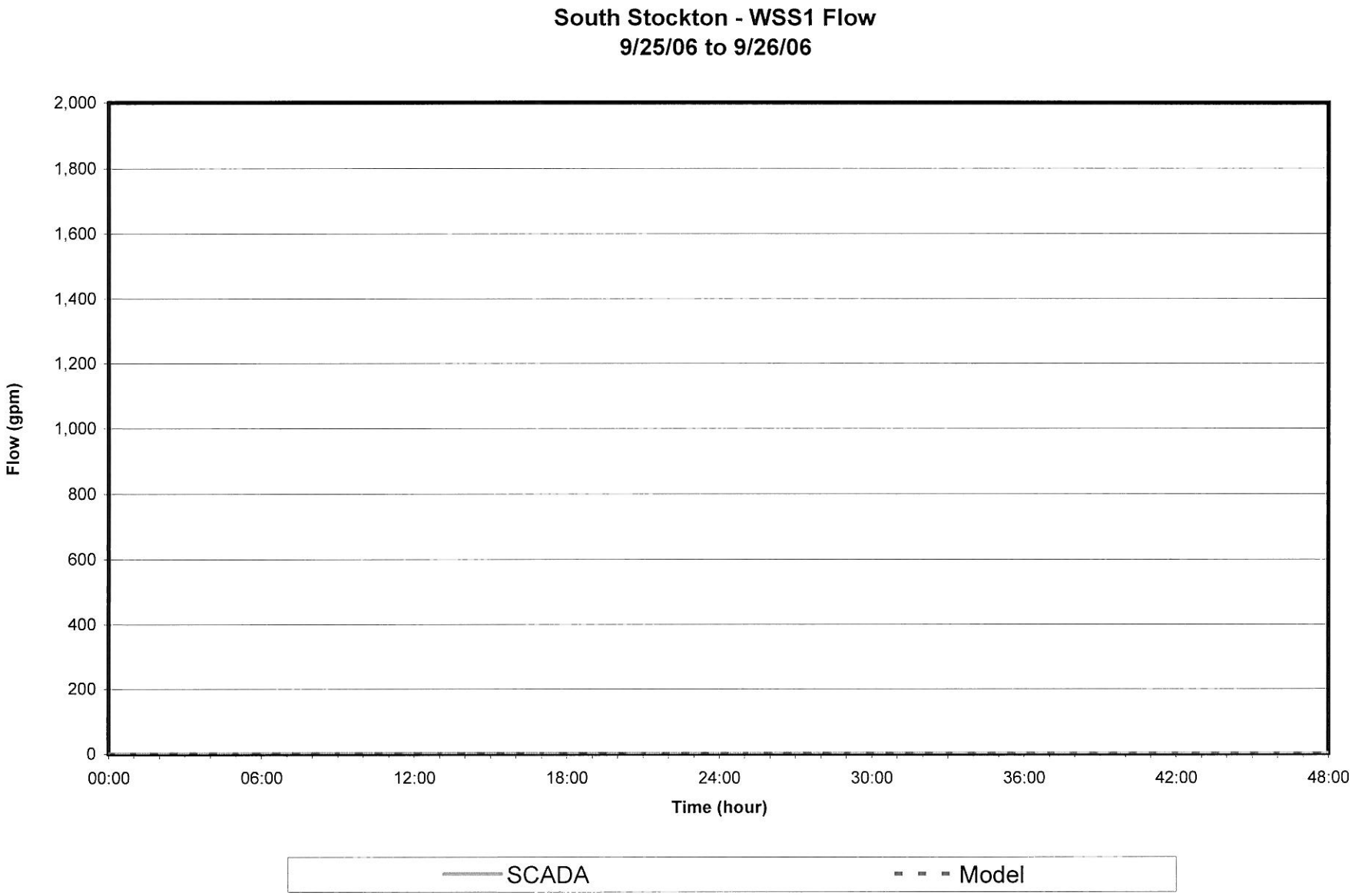

South Stockton - Aqueduct Flow
9/25/06 to 9/26/06
Flow (gpm)
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

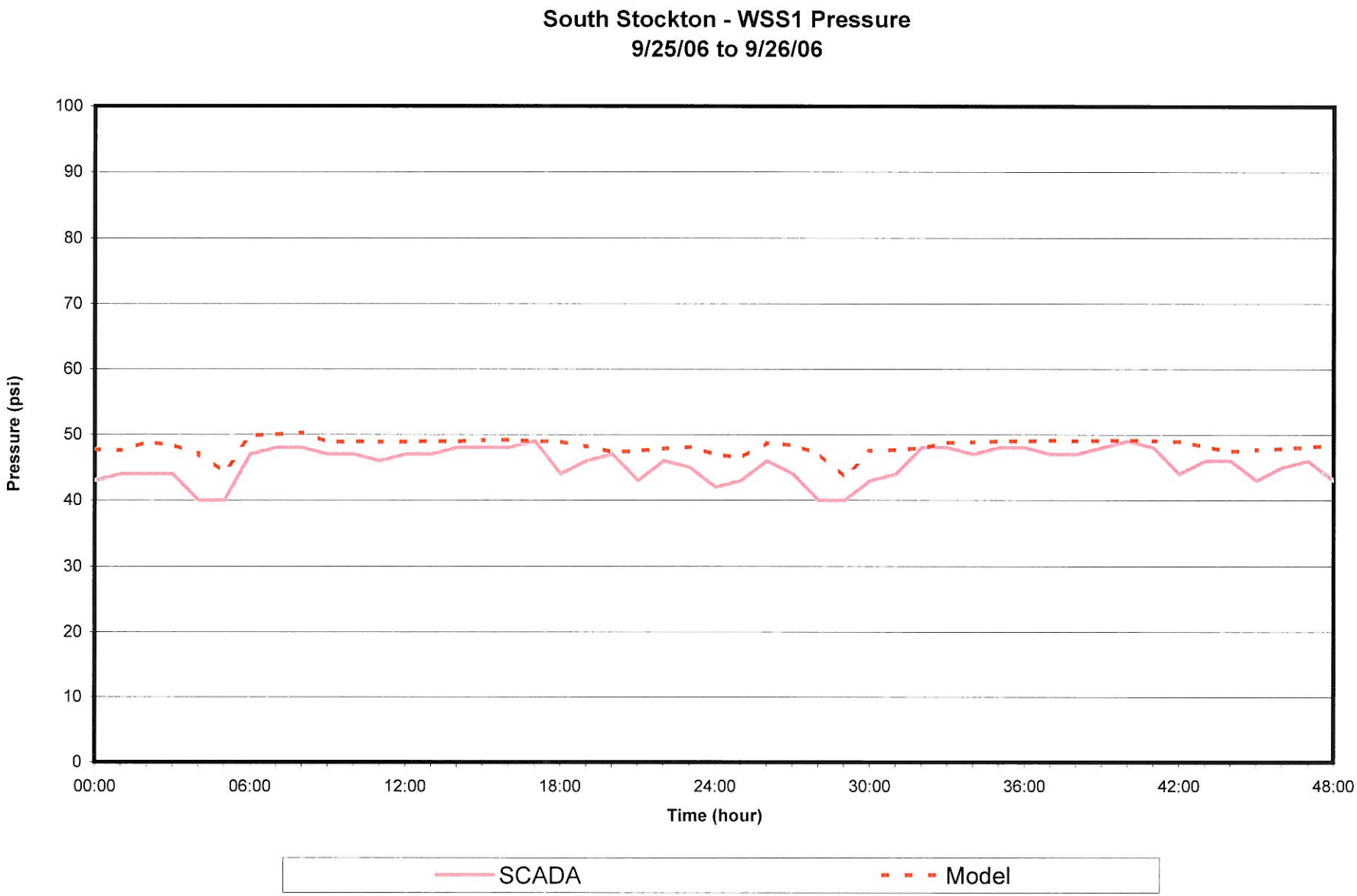
South Stockton - Weston Ranch Reservoir Level
9/25/06 to 9/26/06

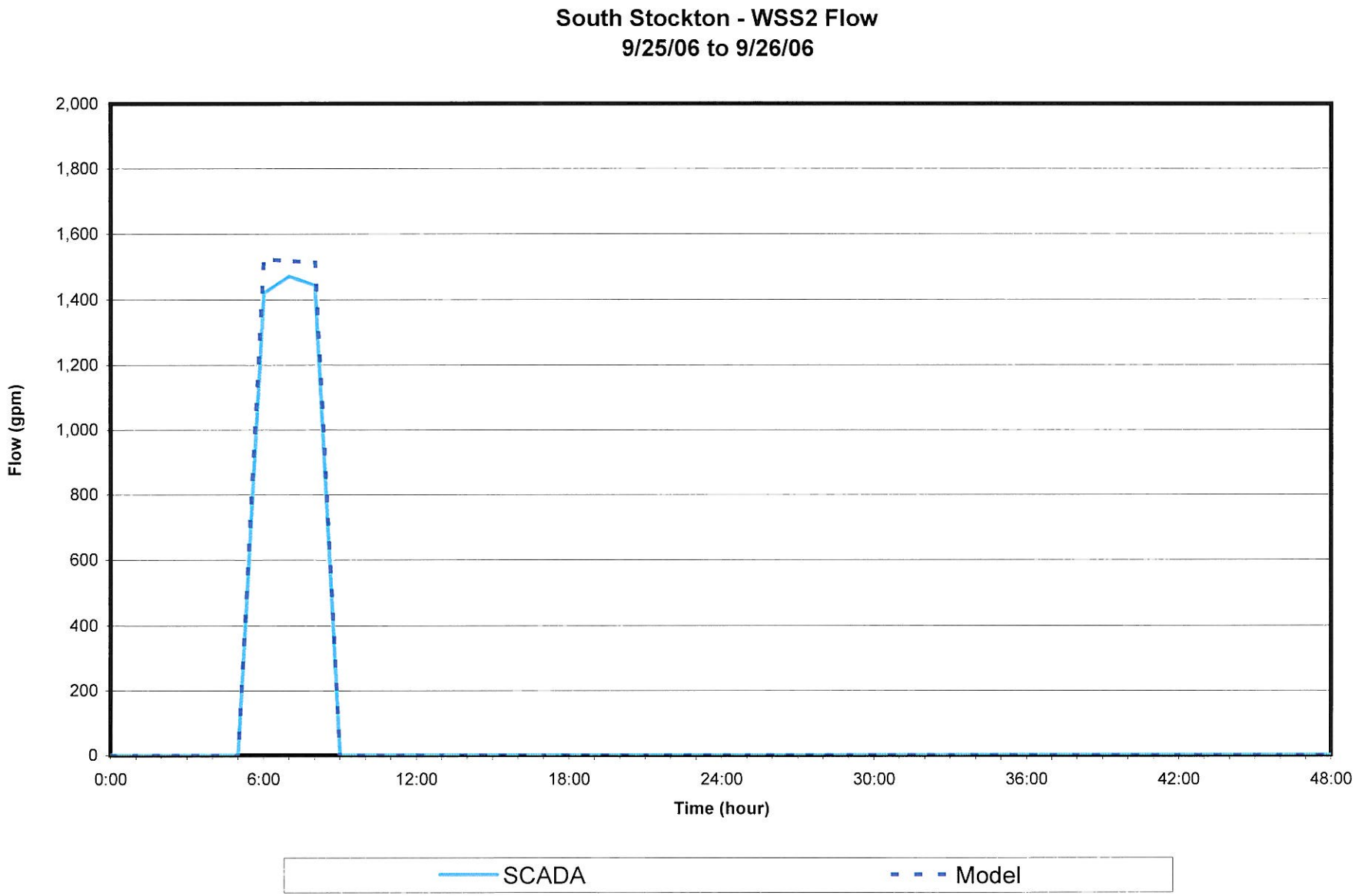


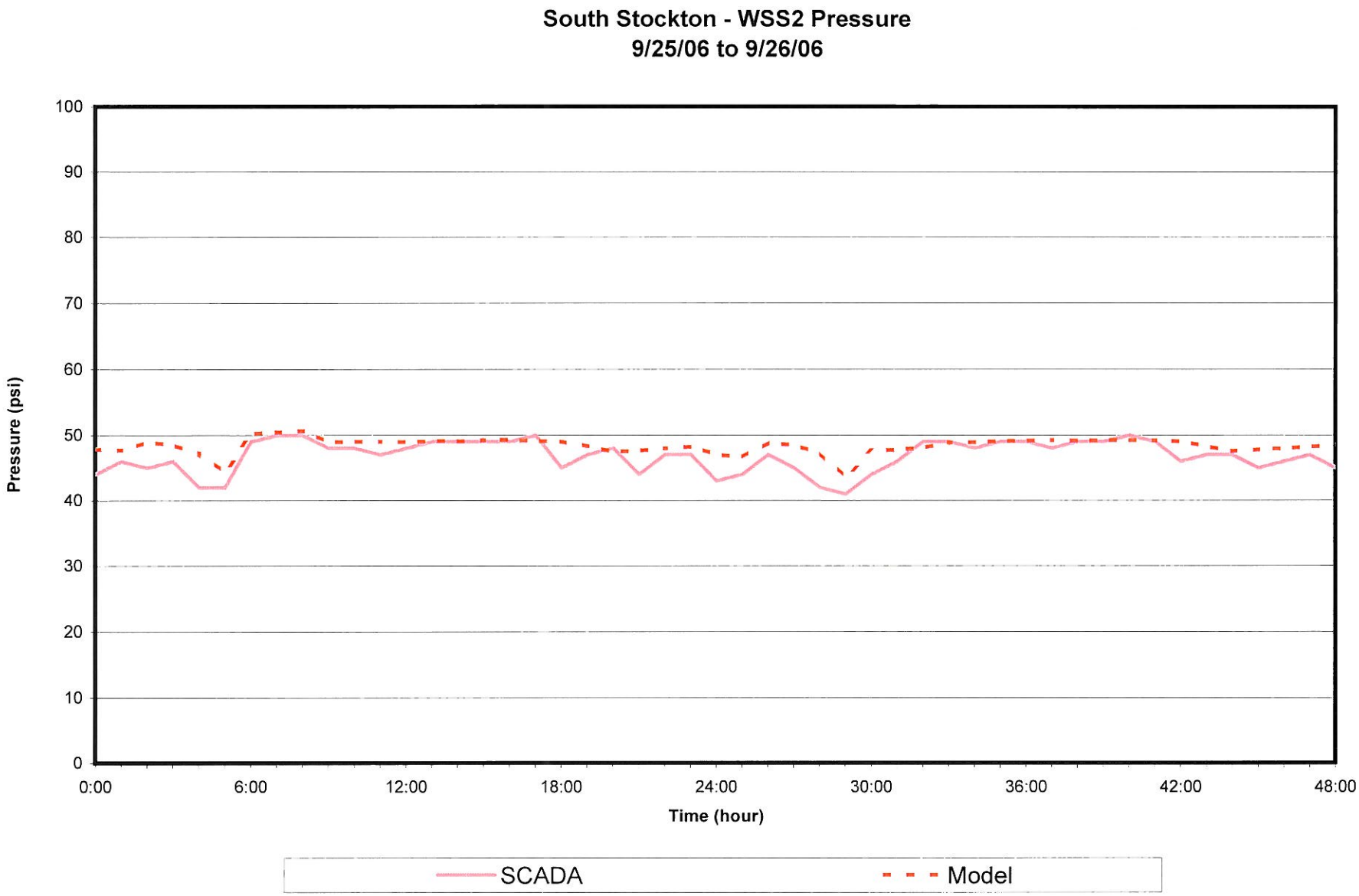
South Stockton - Weston Ranch Reservoir Discharge Pressure
9/25/06 to 9/26/06

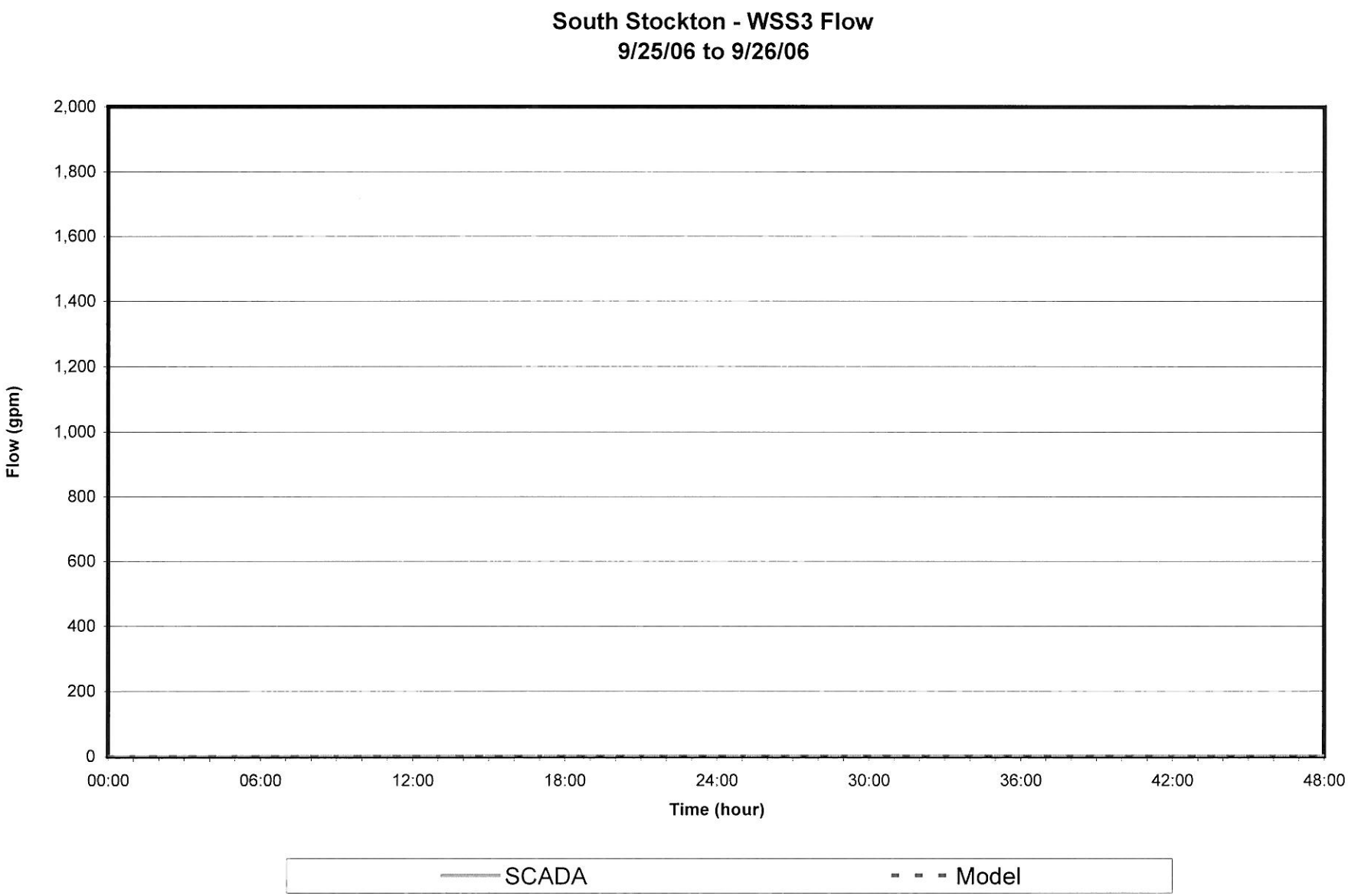


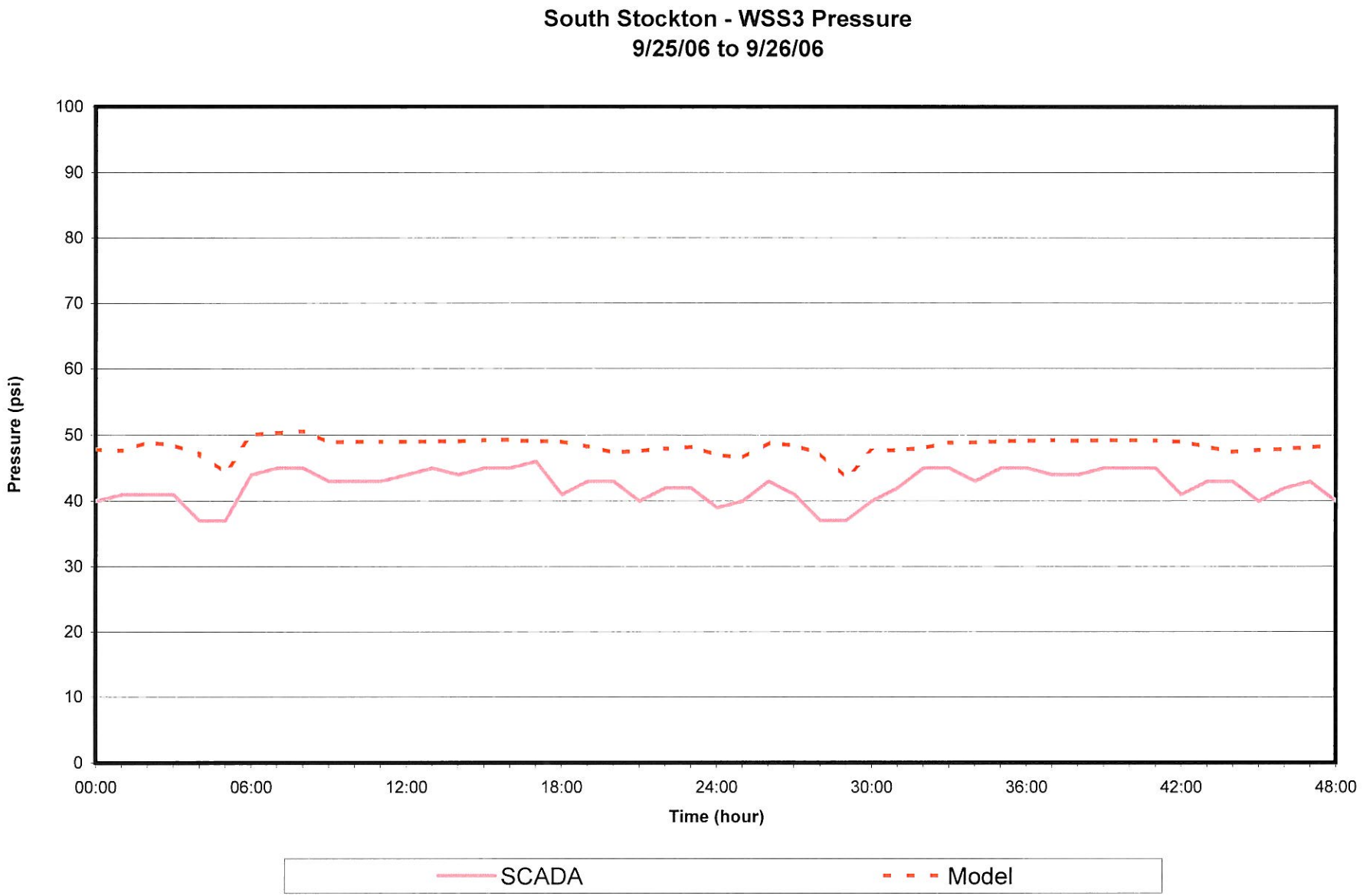

South Stockton - WSS1 Flow
9/25/06 to 9/26/06
Flow (gpm)
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

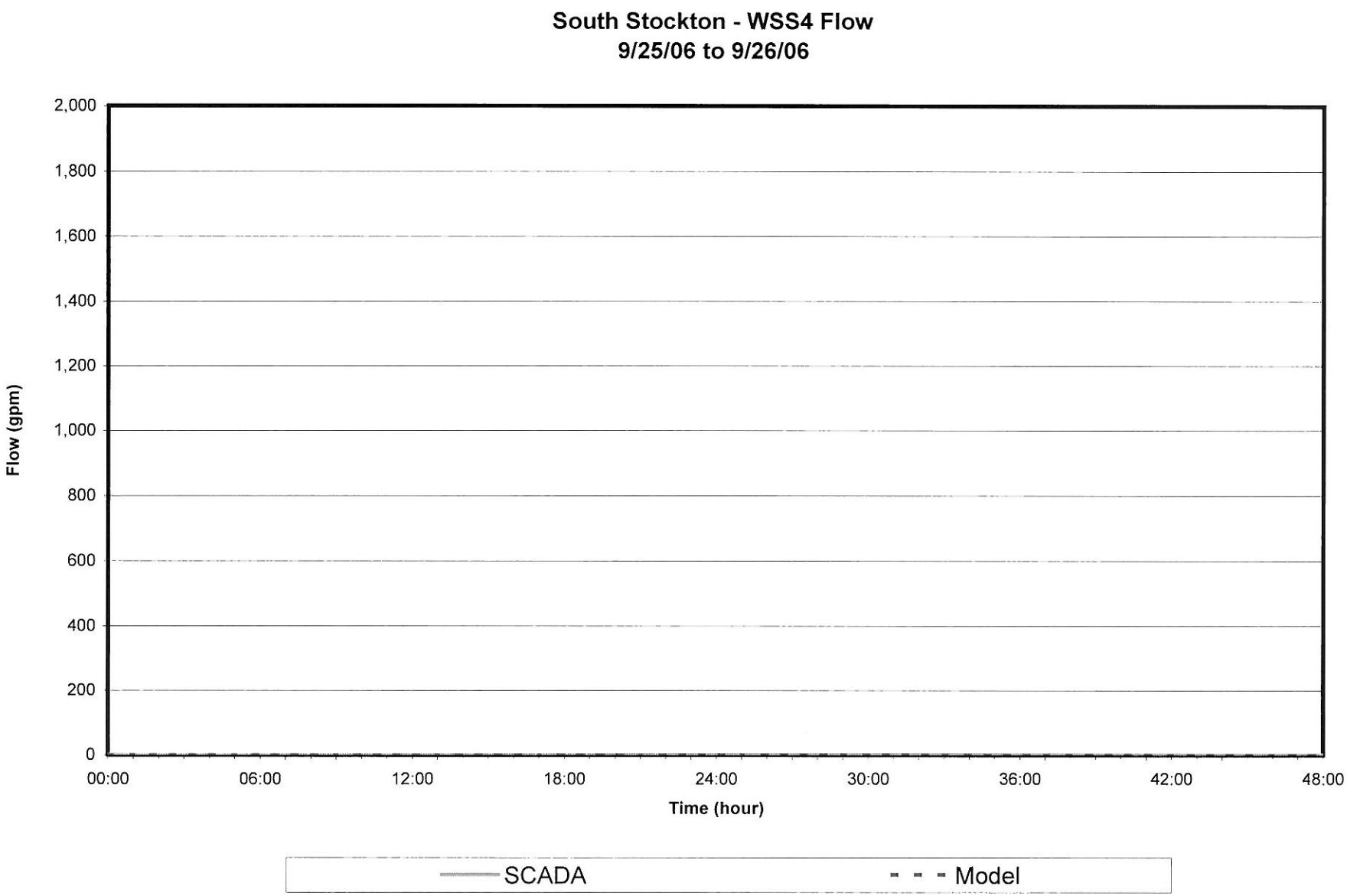

South Stockton - WSS1 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

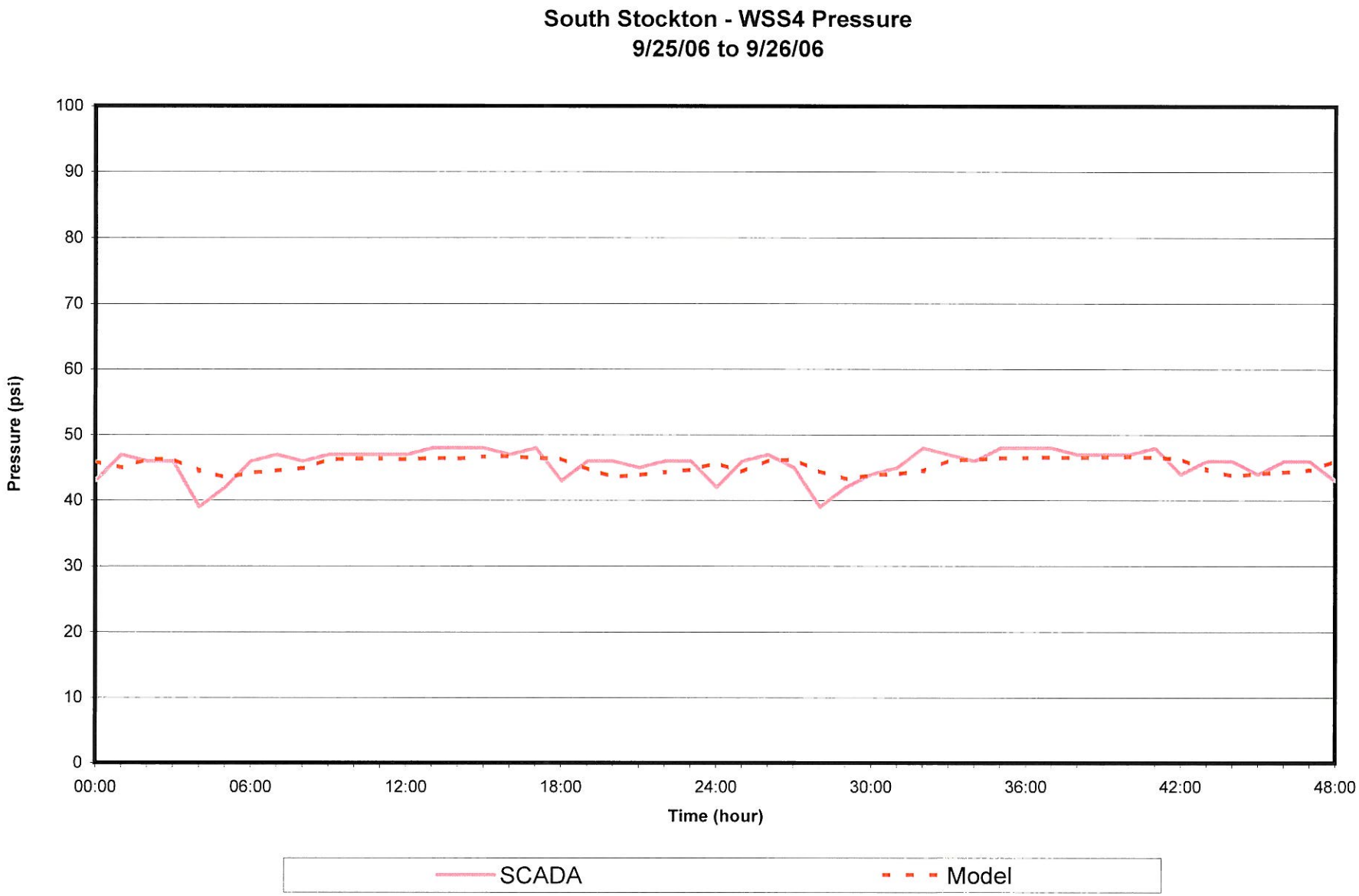

South Stockton - WSS2 Flow
9/25/06 to 9/26/06
Flow (gpm)
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

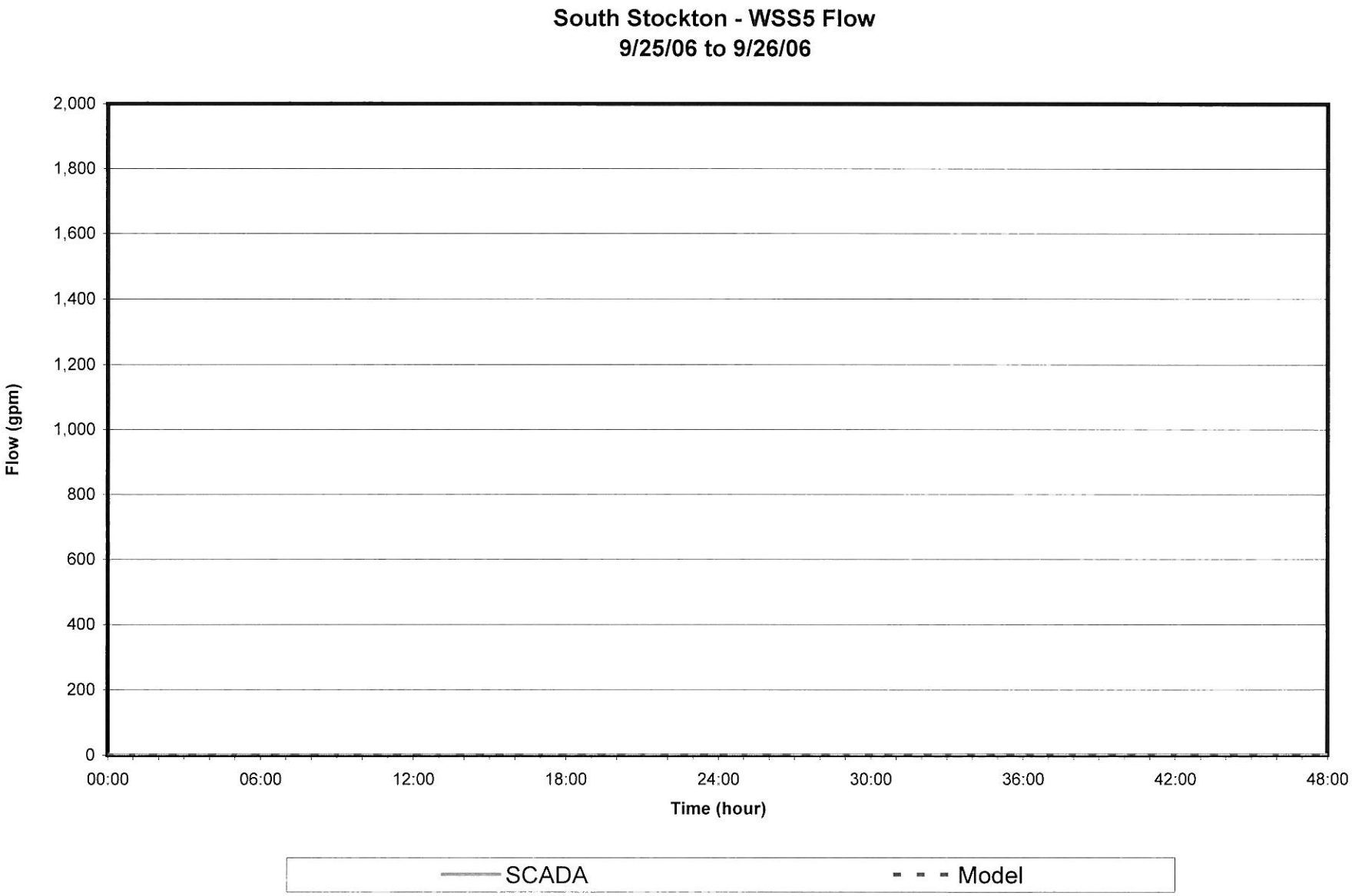

South Stockton - WSS2 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
0:00
6:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

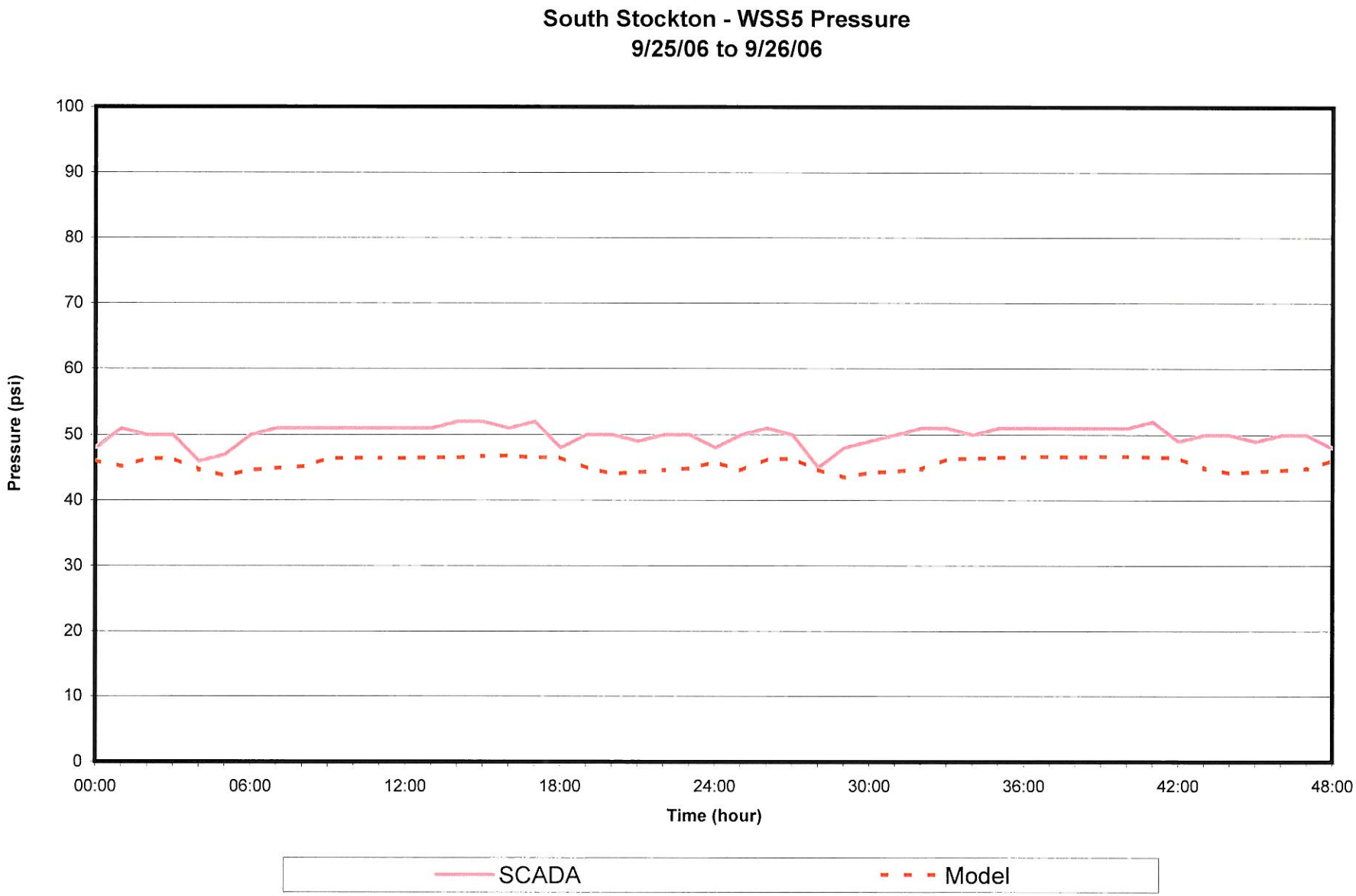

South Stockton - WSS3 Flow
9/25/06 to 9/26/06
Flow (gpm)
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

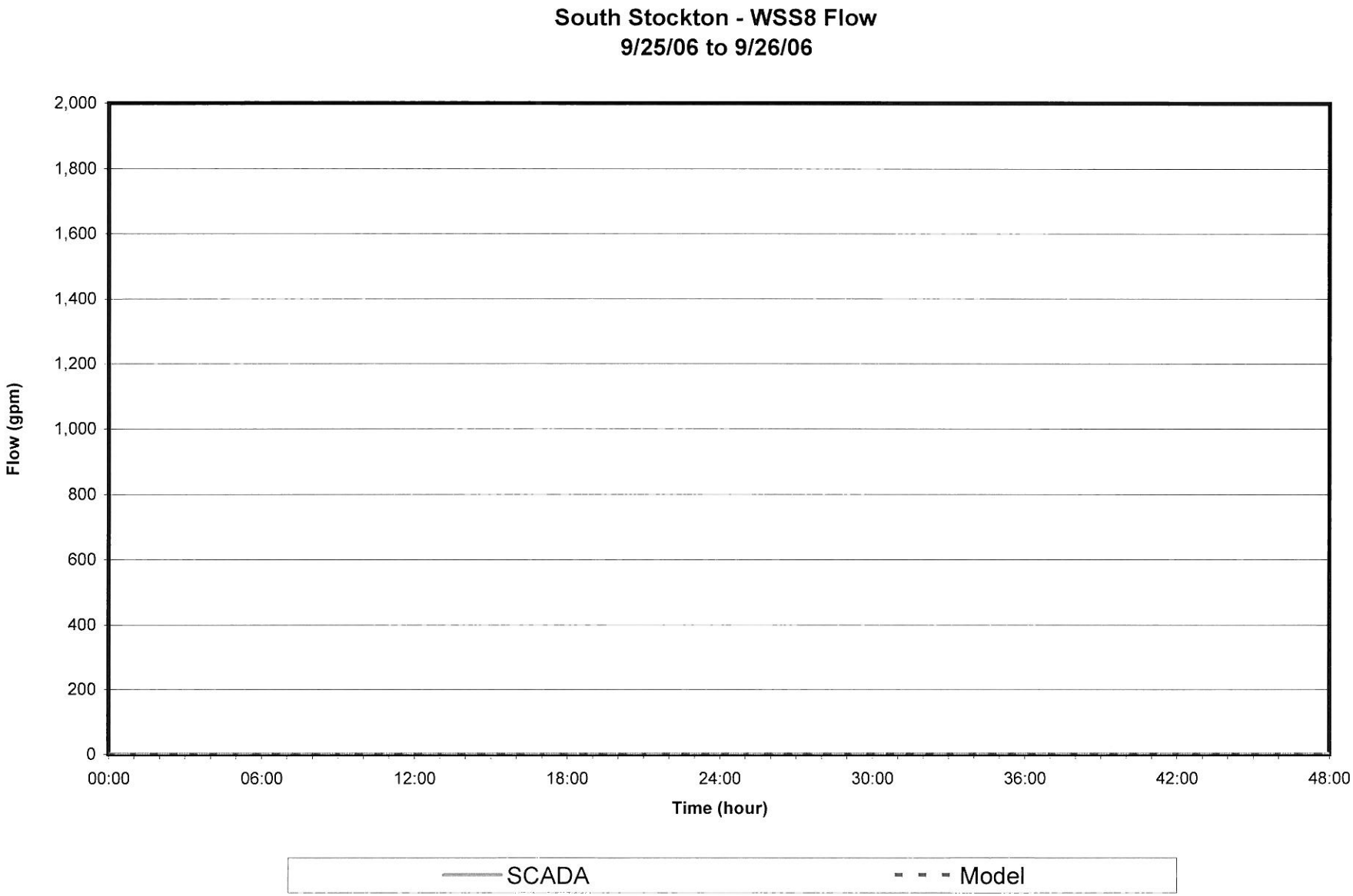

South Stockton - WSS3 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

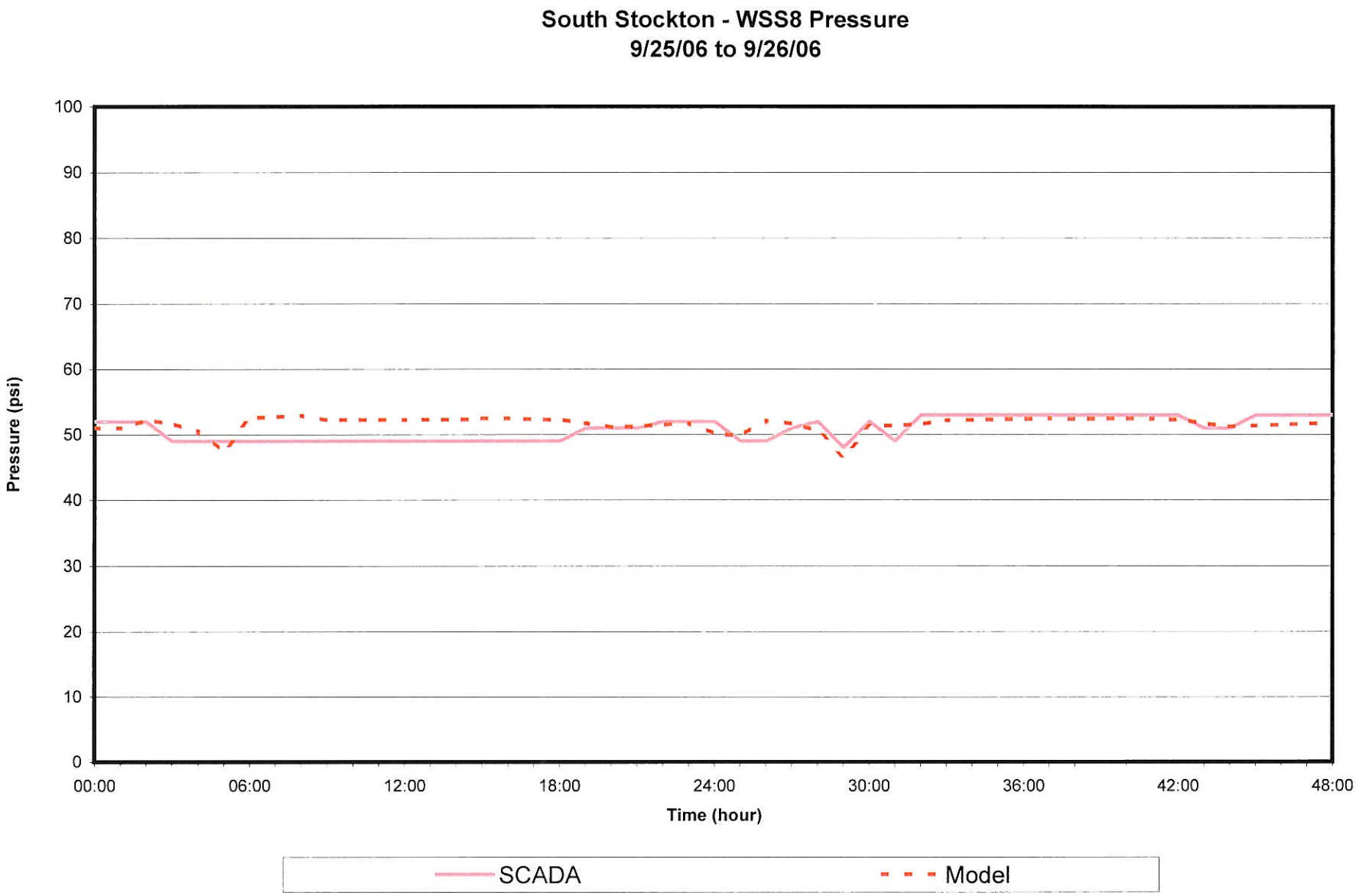

South Stockton - WSS4 Flow
9/25/06 to 9/26/06
Flow (gpm)
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

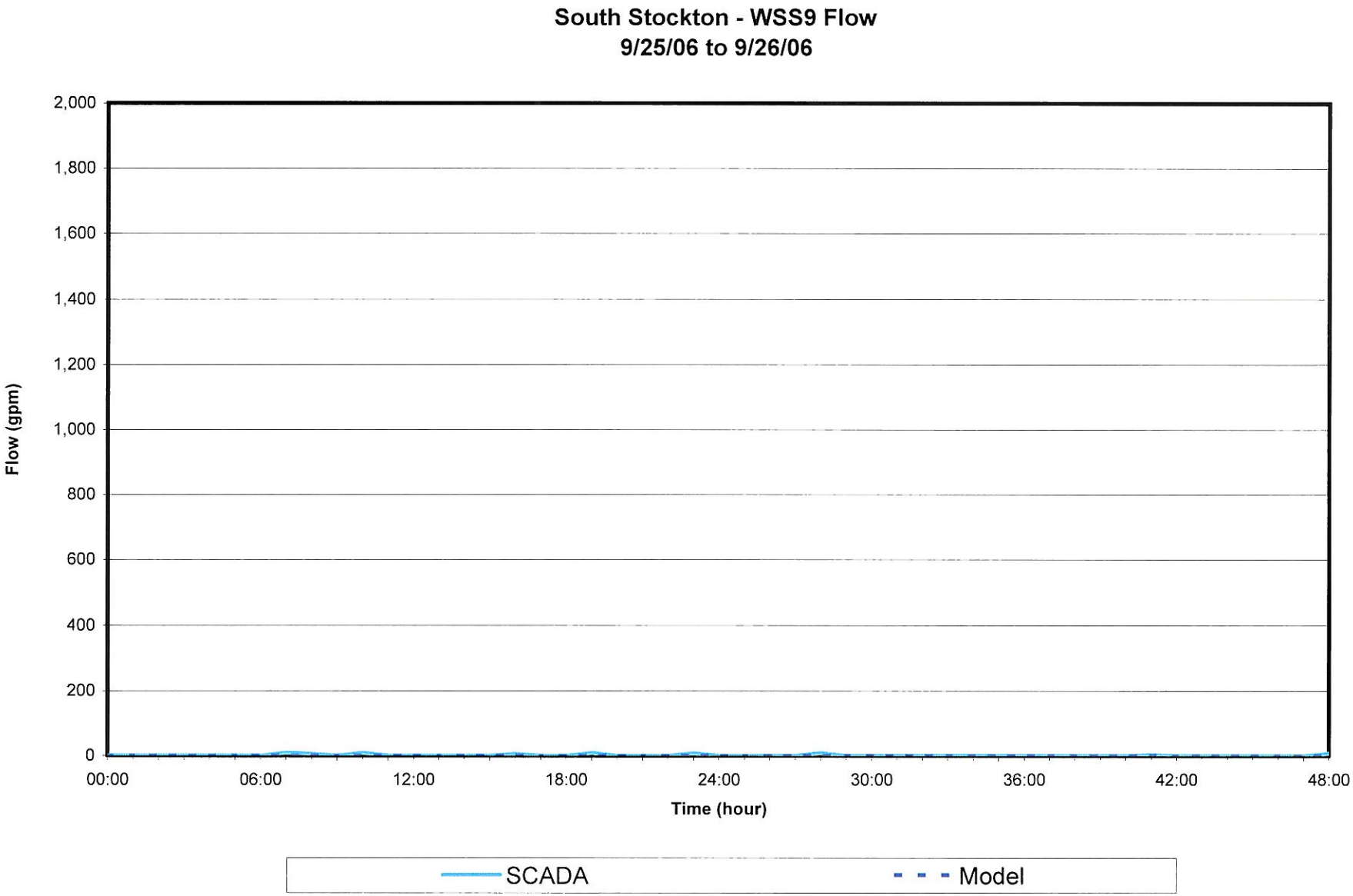

South Stockton - WSS4 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

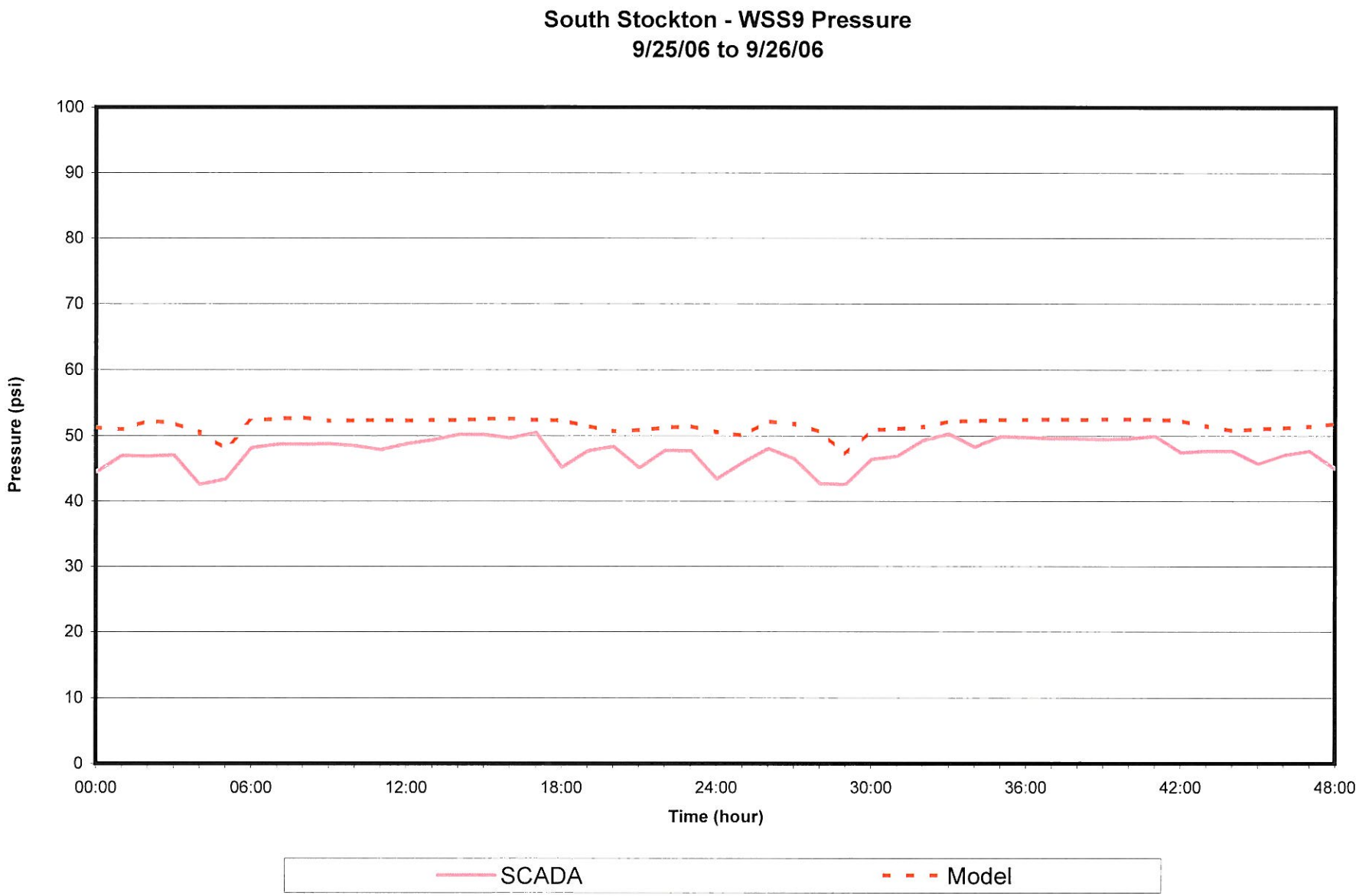

South Stockton - WSS5 Flow
9/25/06 to 9/26/06
Flow (gpm)
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model


South Stockton - WSS5 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

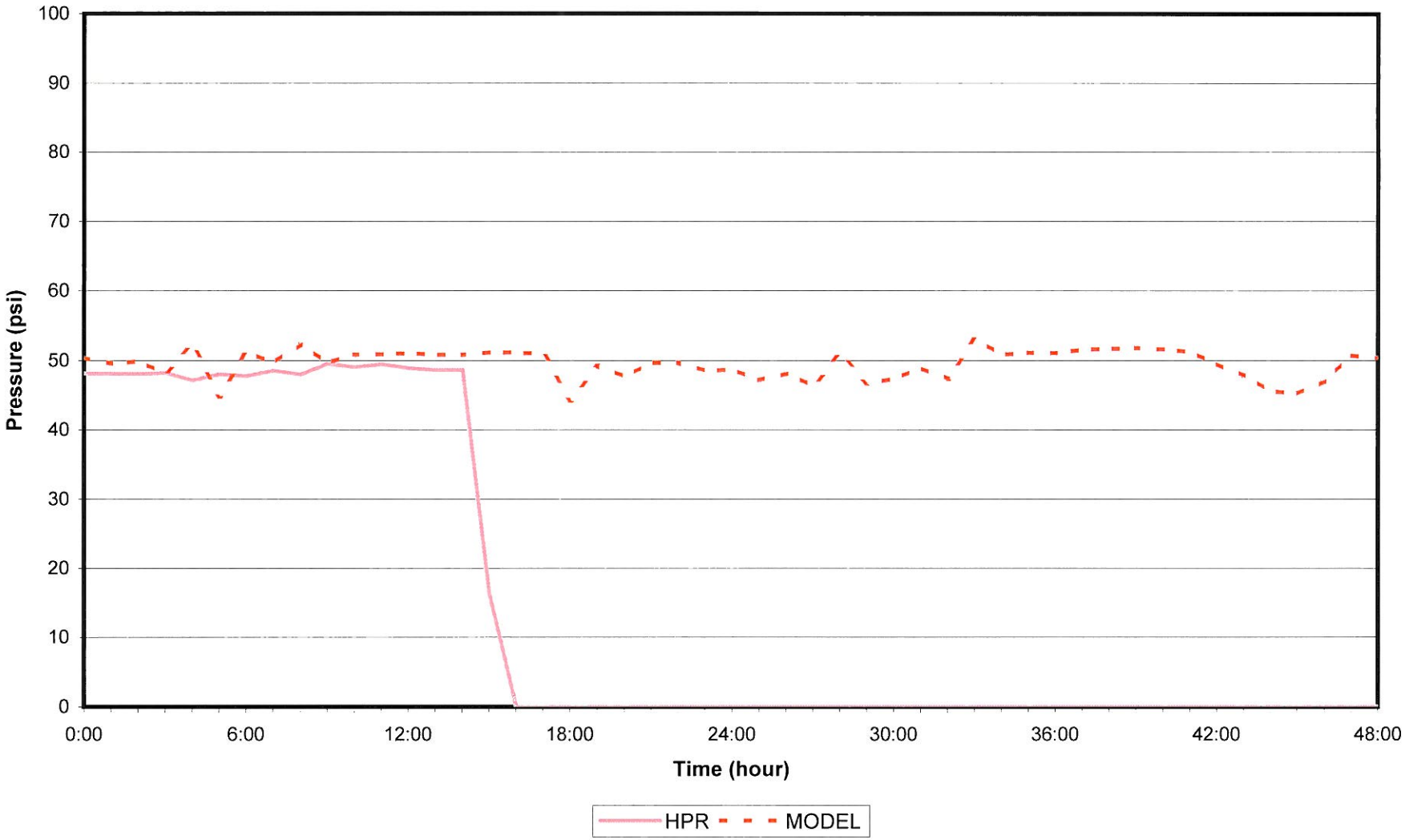

South Stockton - WSS8 Flow
9/25/06 to 9/26/06
Flow (gpm)
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model


South Stockton - WSS8 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

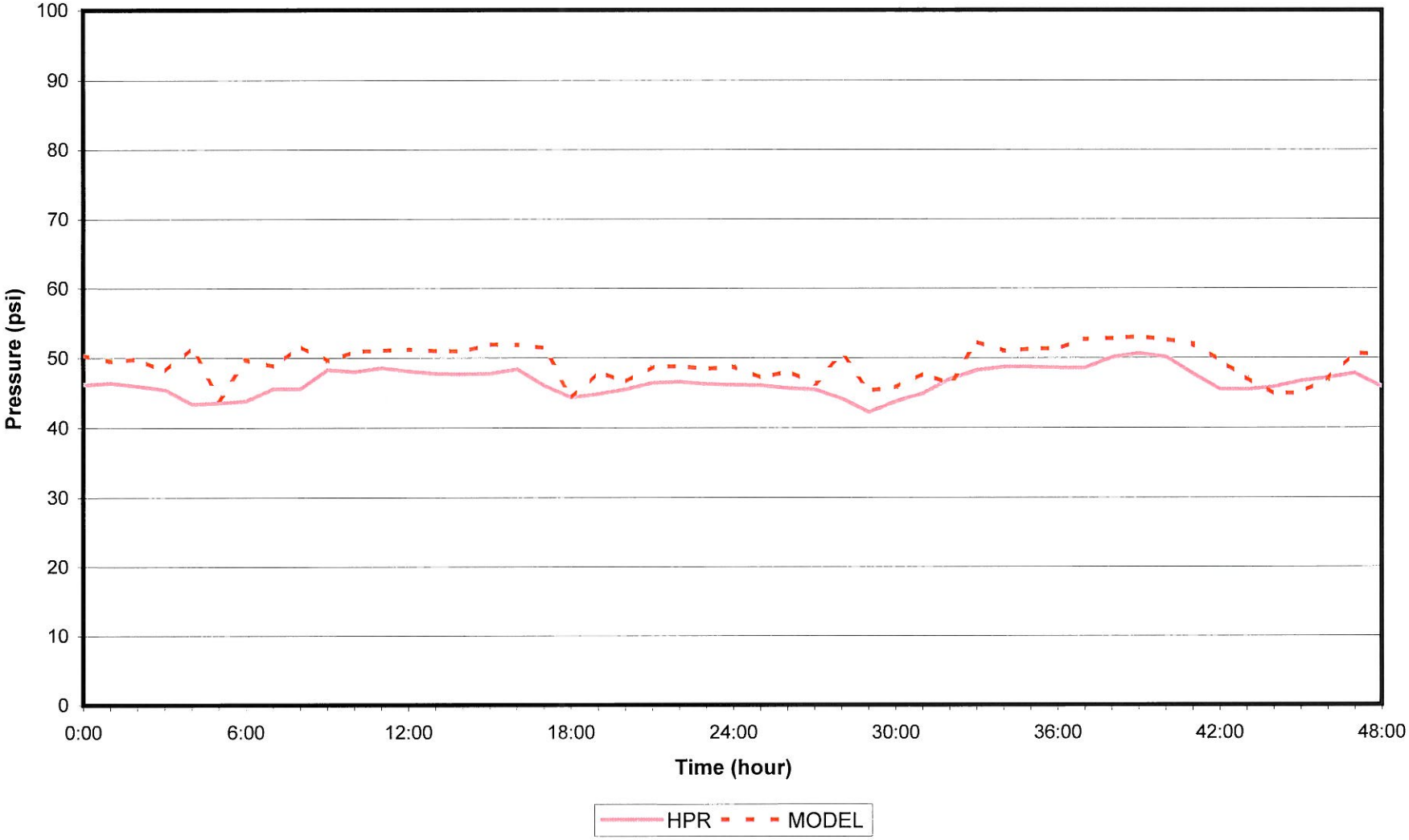

South Stockton - WSS9 Flow
9/25/06 to 9/26/06
Flow (gpm)
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model


South Stockton - WSS9 Pressure
9/25/06 to 9/26/06
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
00:00
06:00
12:00
18:00
24:00
30:00
36:00
42:00
48:00
Time (hour)
SCADA
Model

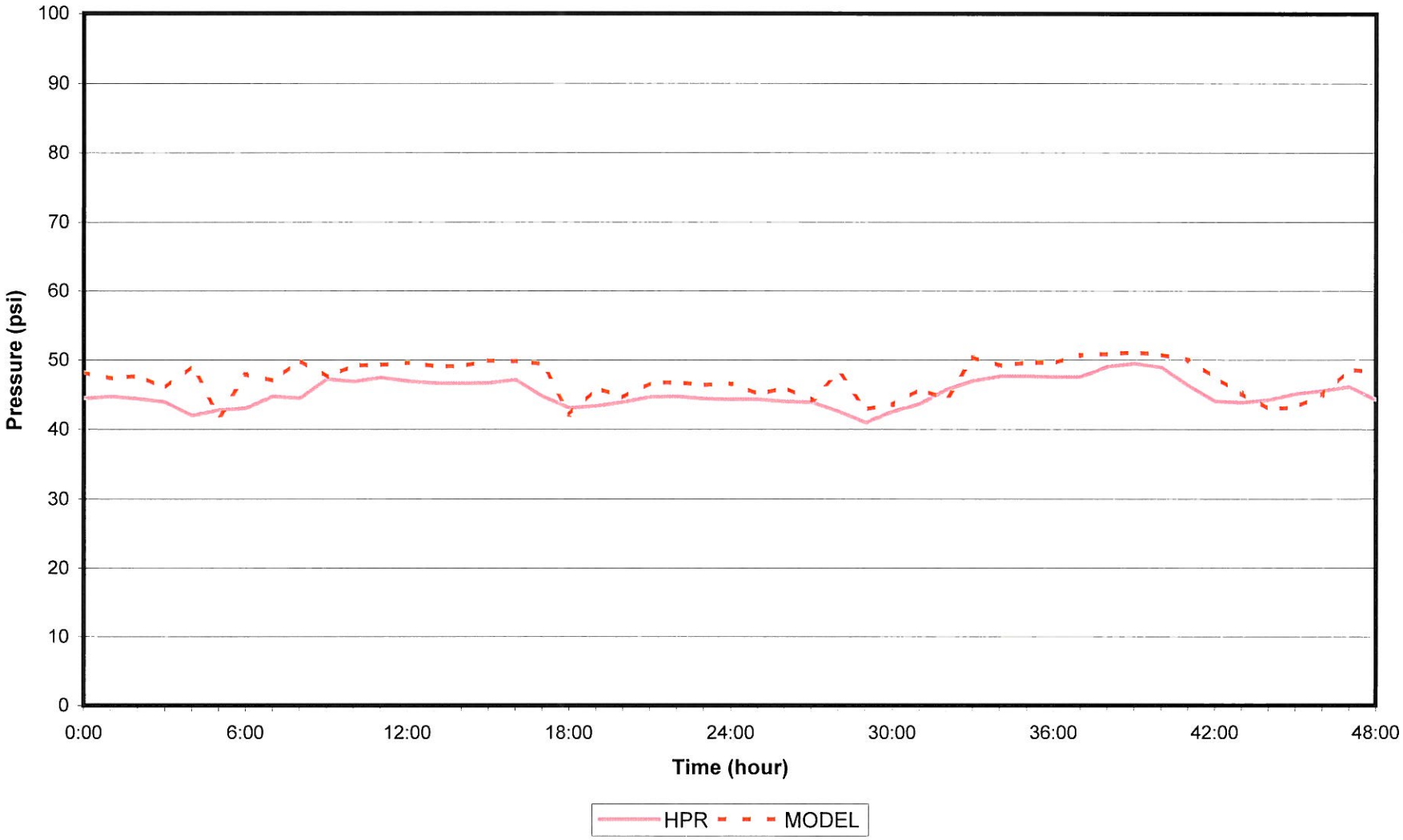
HPR B-1: ALONG A G SPANOS BLVD. NORTH OF IRON CANYON CIR.
9/25/06 to 9/26/06



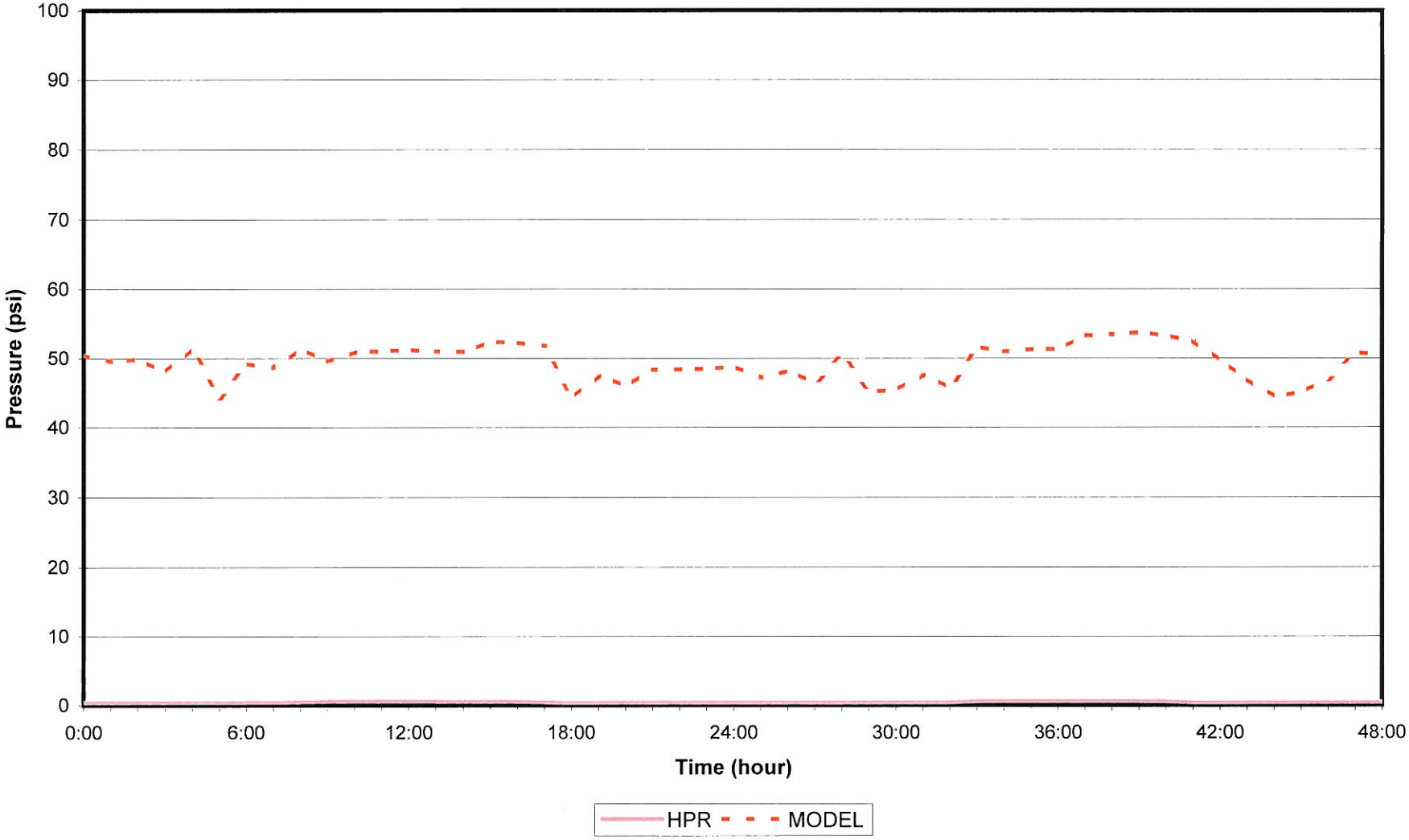
HPR B-2: 3069 WAGNER HEIGHTS RD.
9/25/06 to 9/26/06



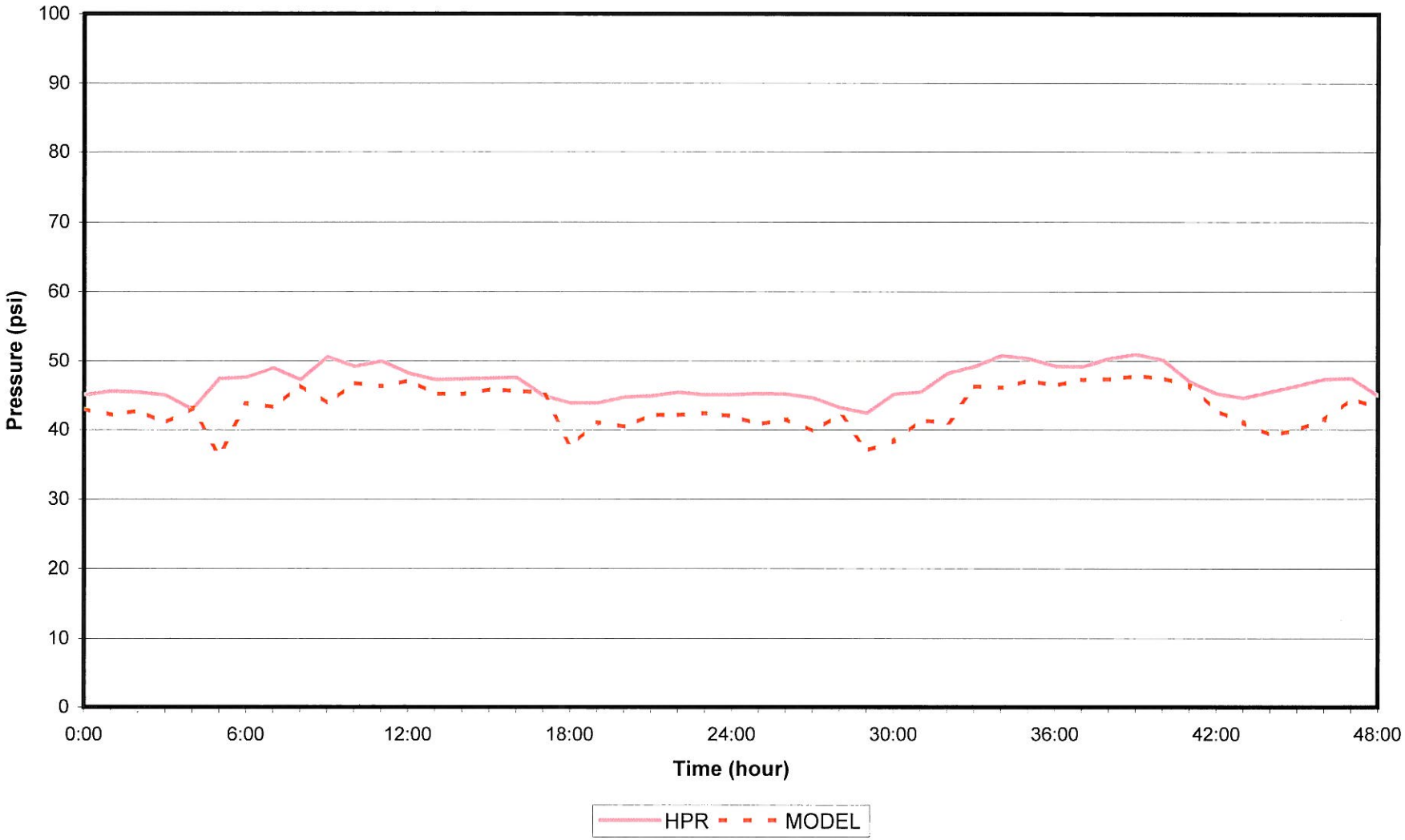
HPR B-3: 1927 WAUDMAN AV.
09/25/06 to 09/26/06



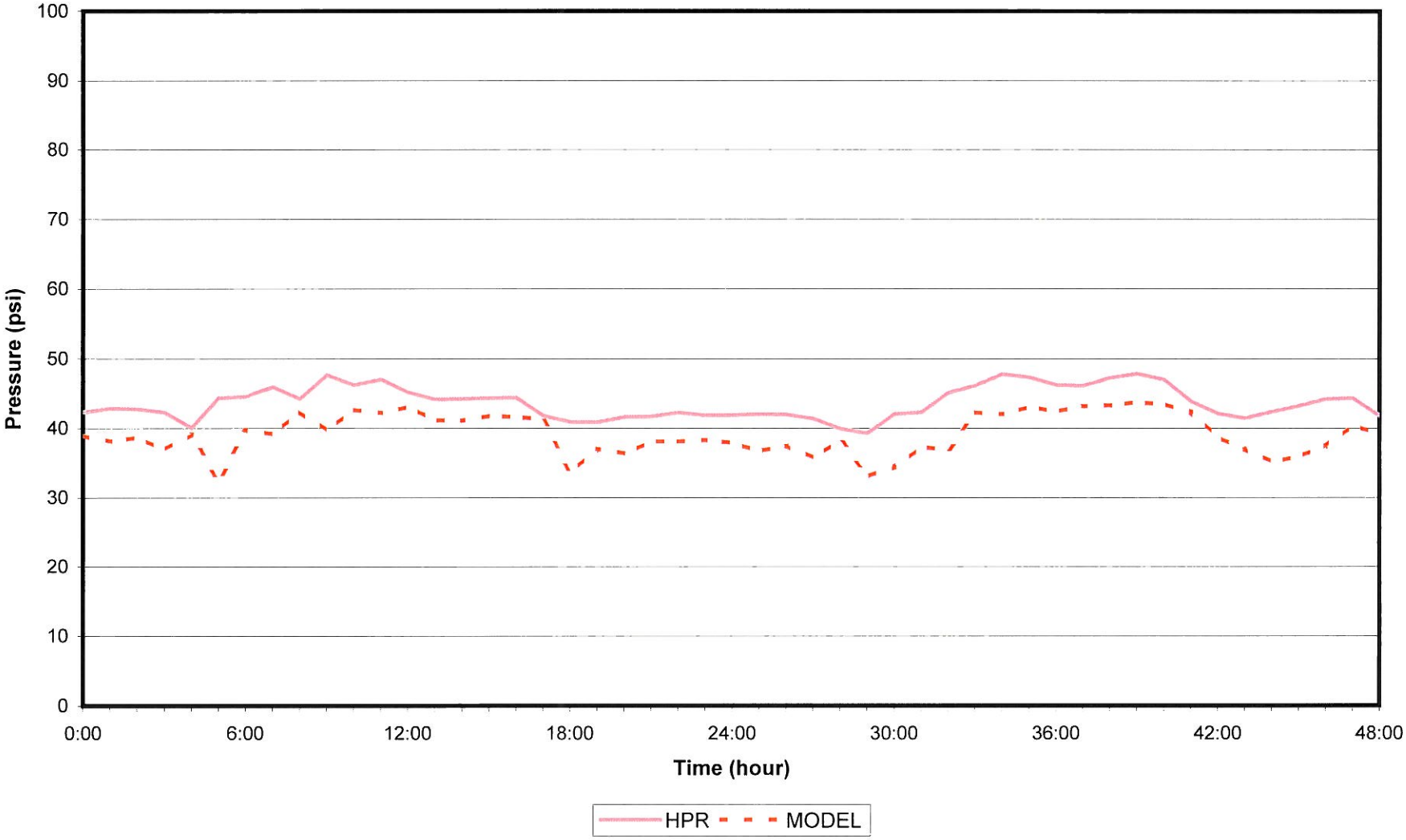
HPR B-4: 3305 W. HAMMER LN.
9/25/06 to 9/26/06



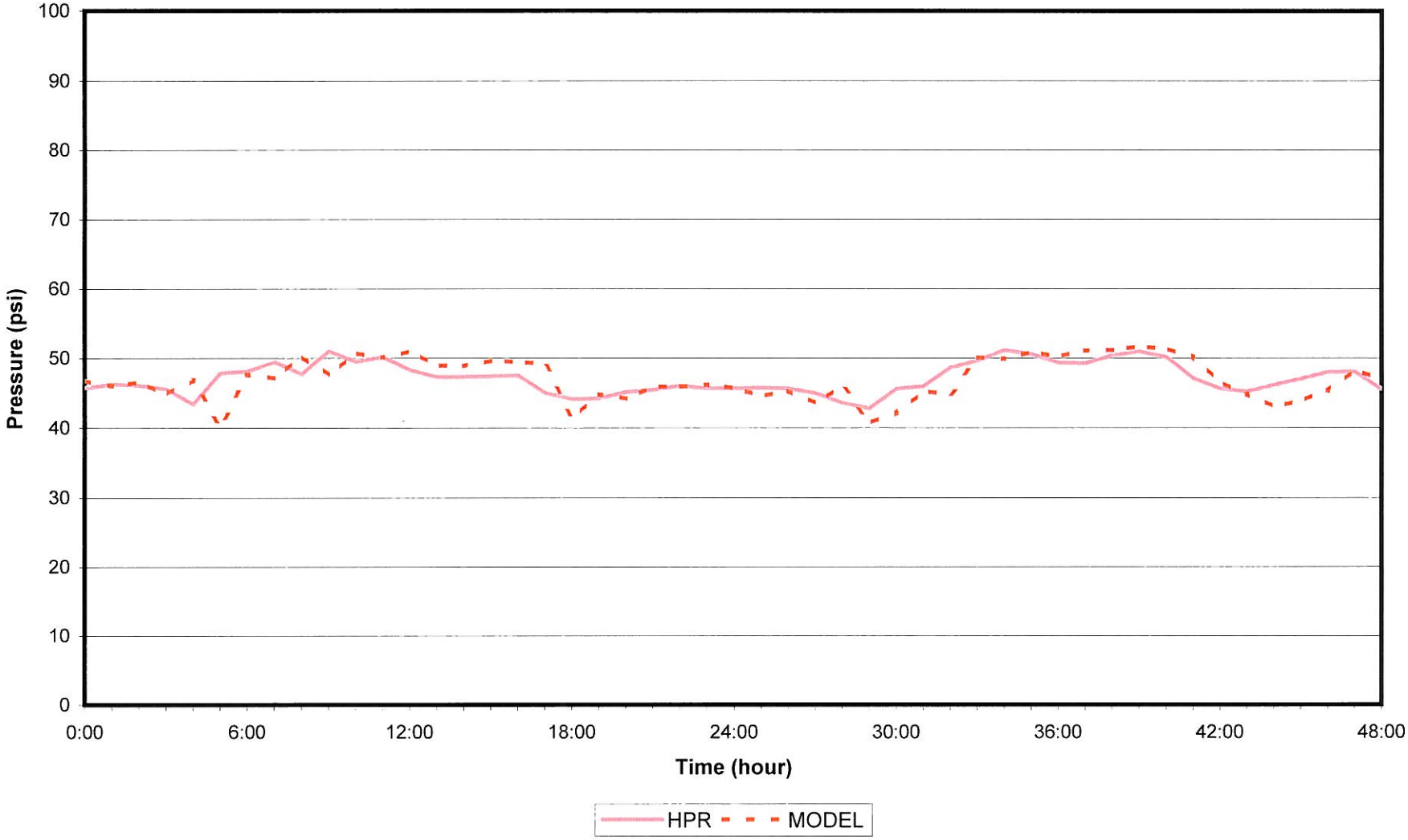
HPR B-5: 9103 CHERBOURG WY.
9/25/06 to 9/26/06



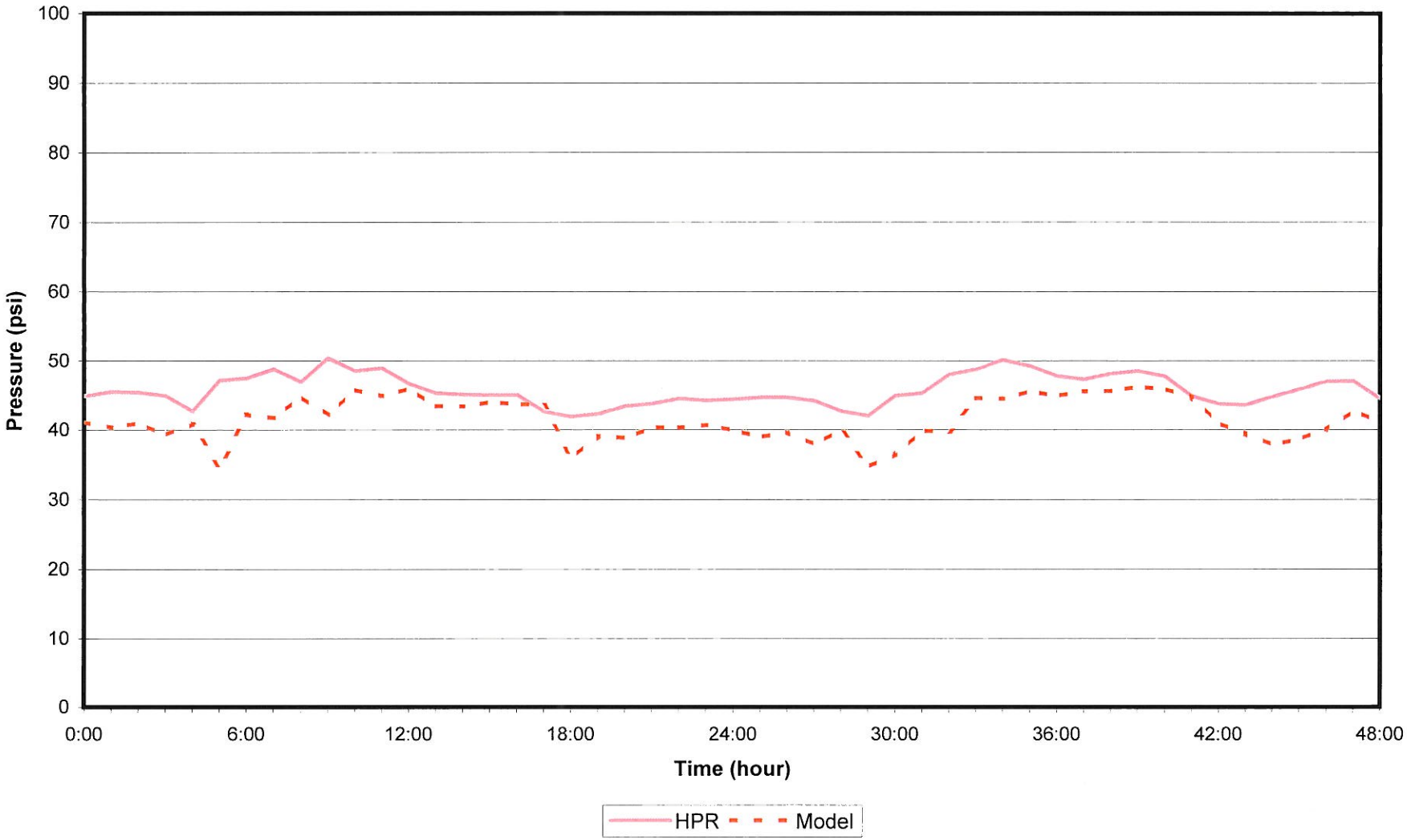
HPR B-6: 9081 BARBARESCO CIR.
9/25/06 to 9/26/06



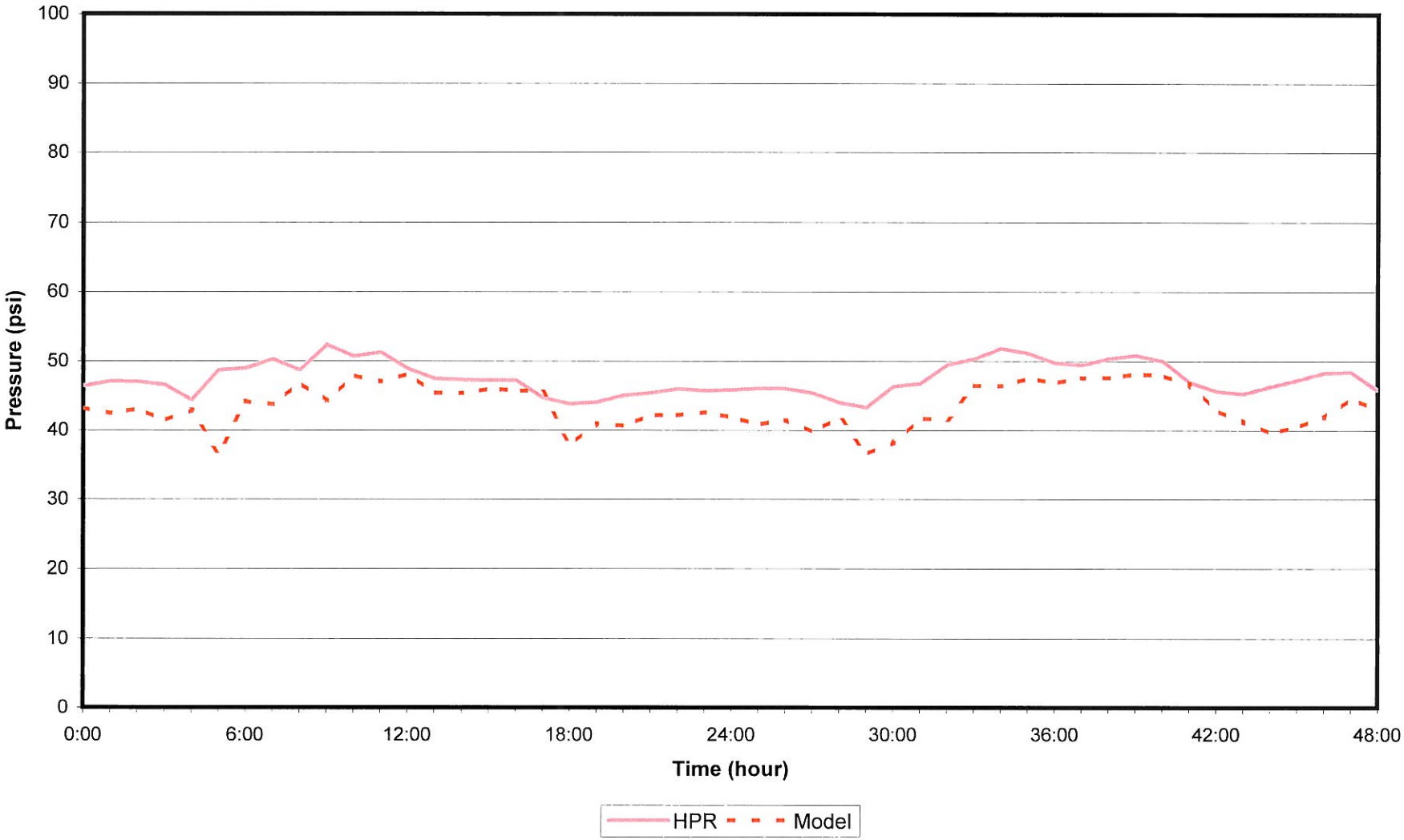
HPR B-7: 2875 TAM O SHANTER DR.
9/25/06 to 9/26/06



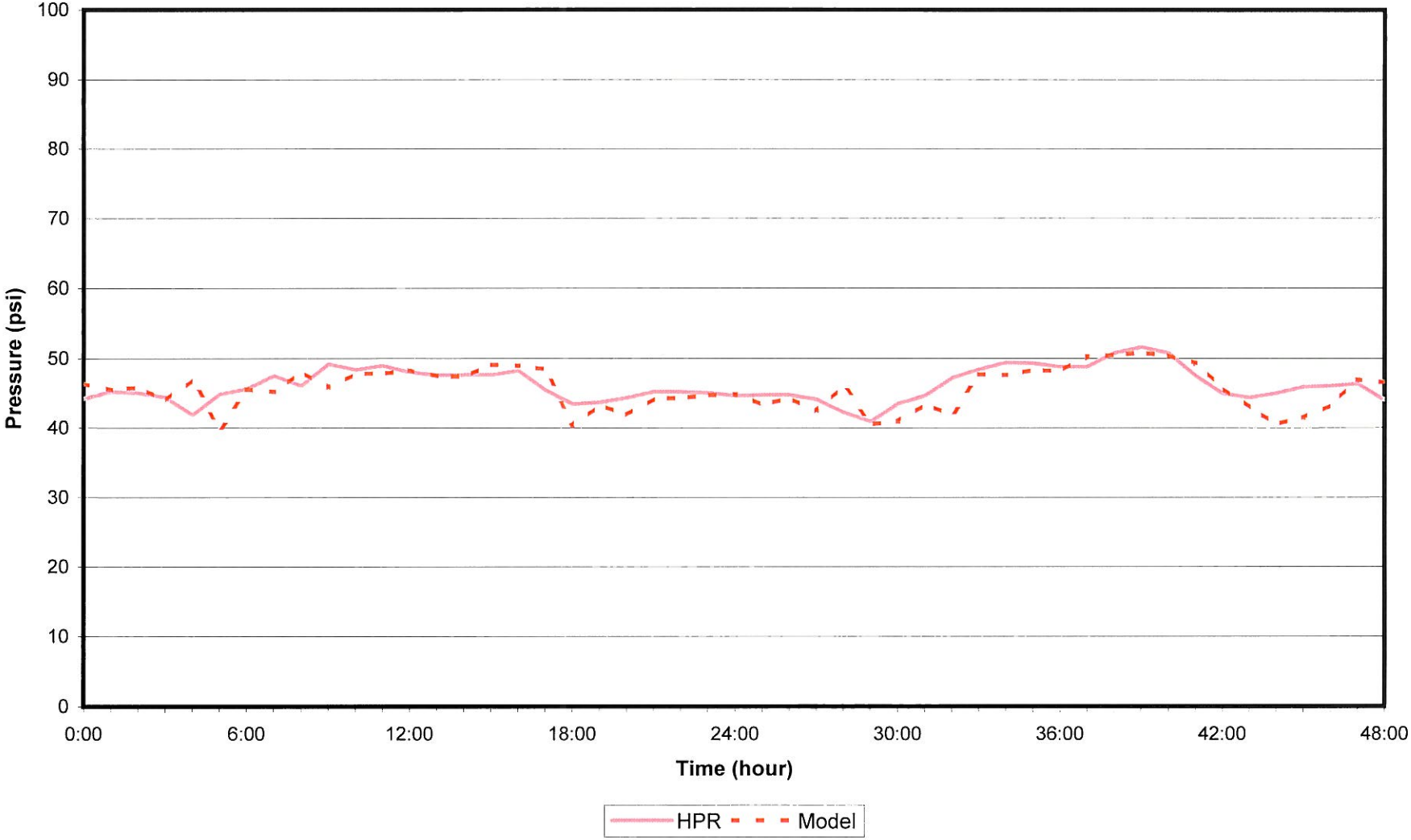
HPR B-8: 2874 AUTO CENTER CIR.
9/25/06 to 9/26/06



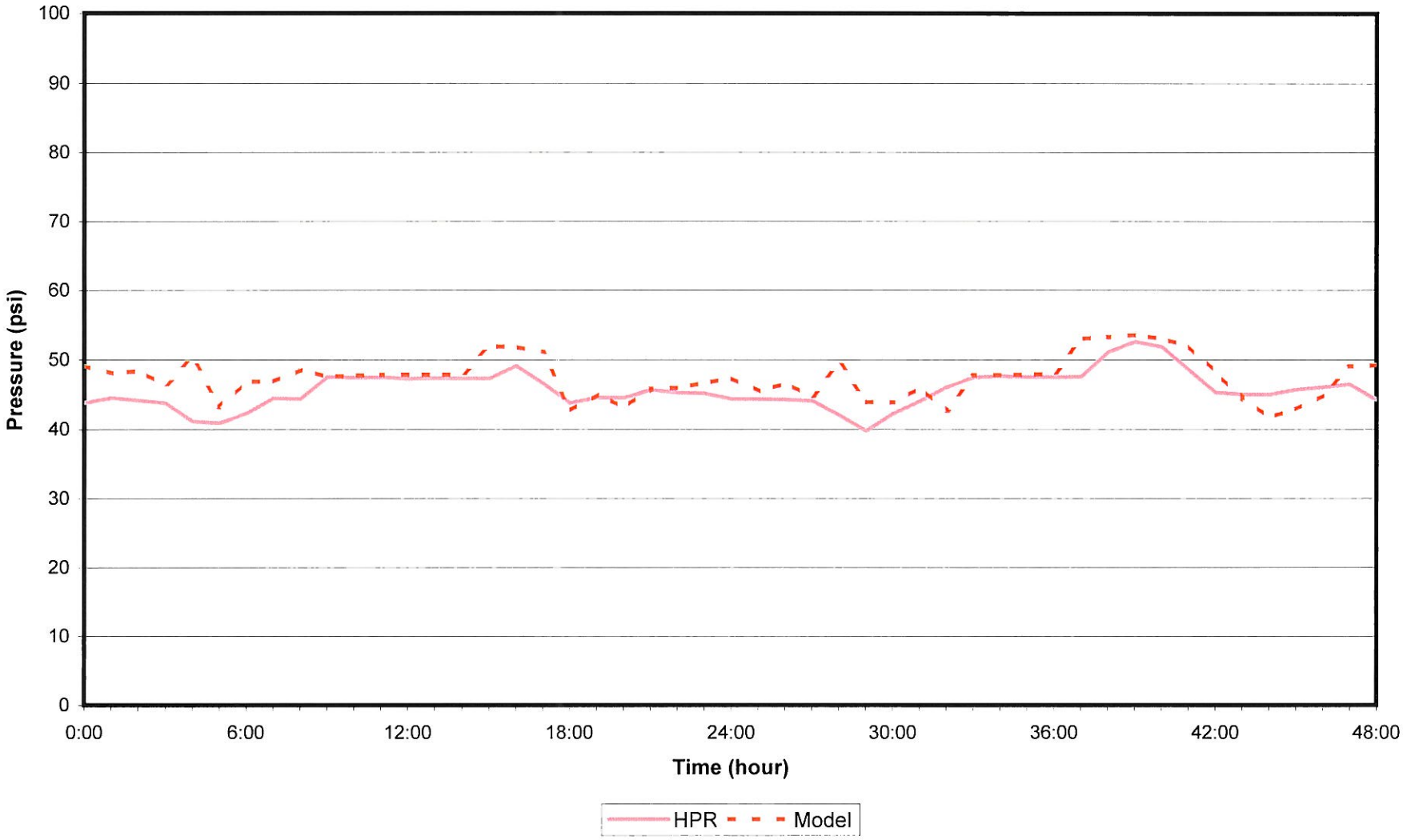
HPR B-9: 1503 E. MARCH LN.
9/25/06 to 9/26/06



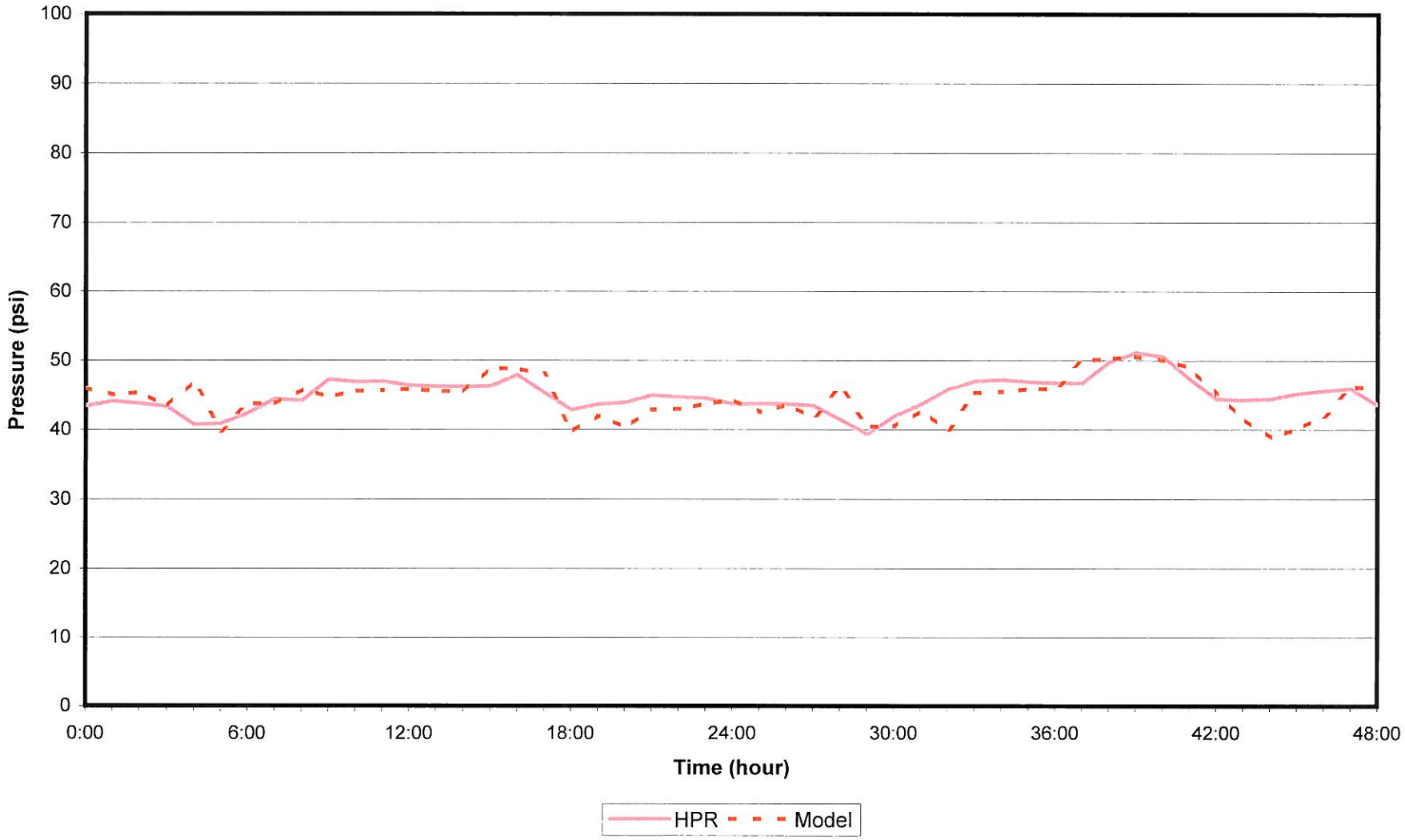
HPR B-10: 6502 PACIFIC AV.
9/25/06 to 9/26/06



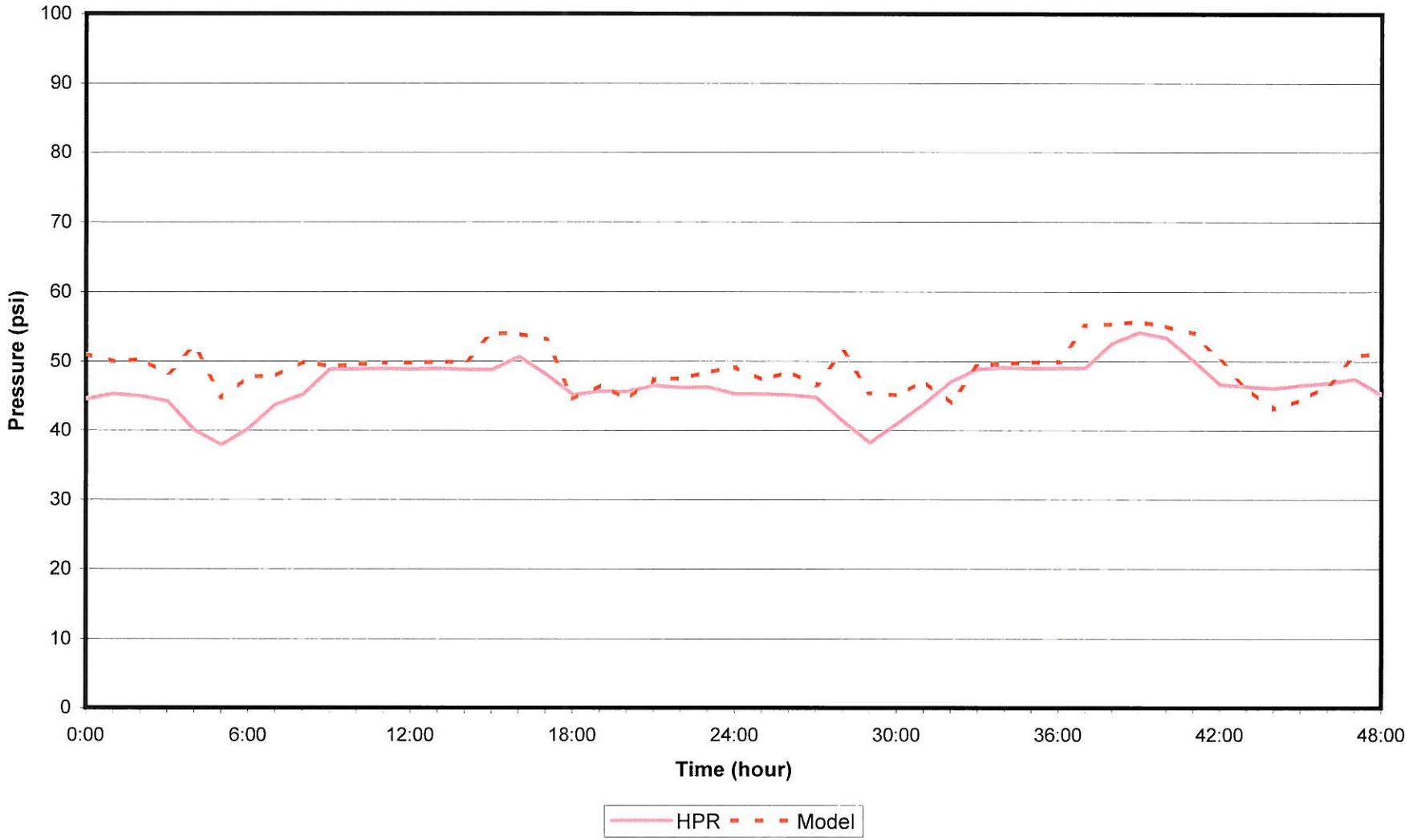
HPR B-11: 2602 GRIZZLY HOLLOW WY.
9/25/06 to 9/26/06



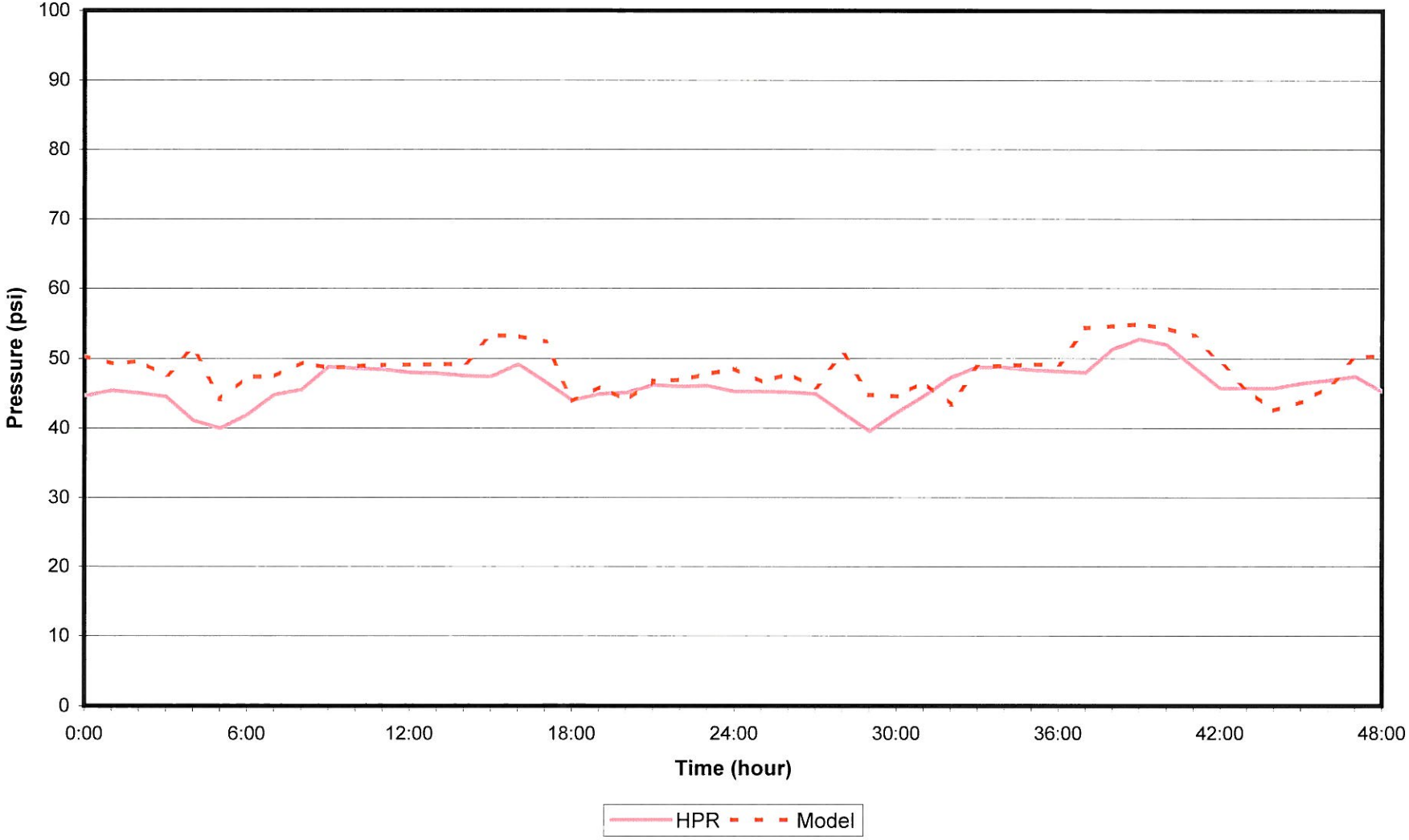
HPR B-12: 1607 W. MARCH LN.
9/25/06 to 9/26/06



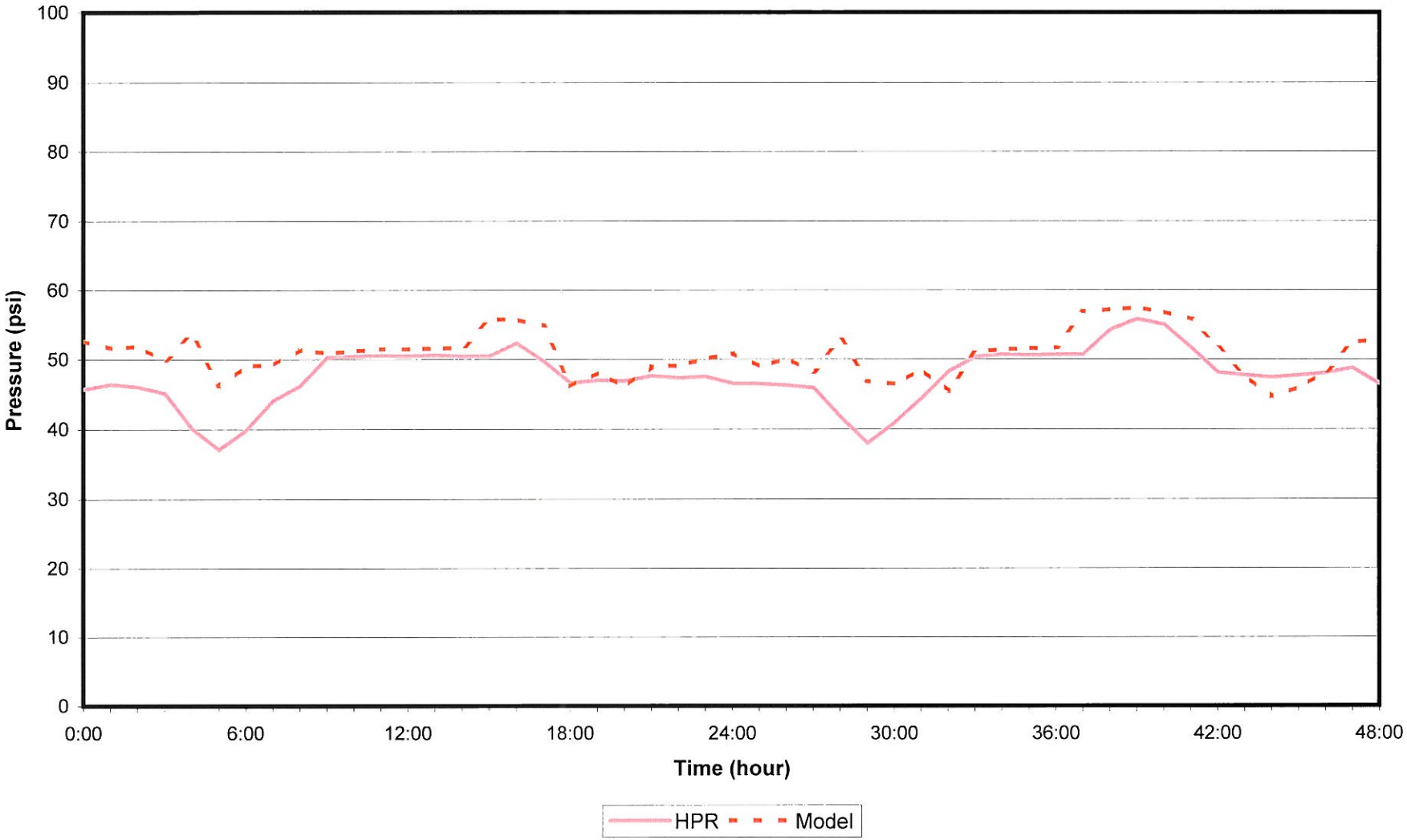
HPR B-13: 3273 AUTUMN CHASE CIR.
9/25/06 to 9/26/06



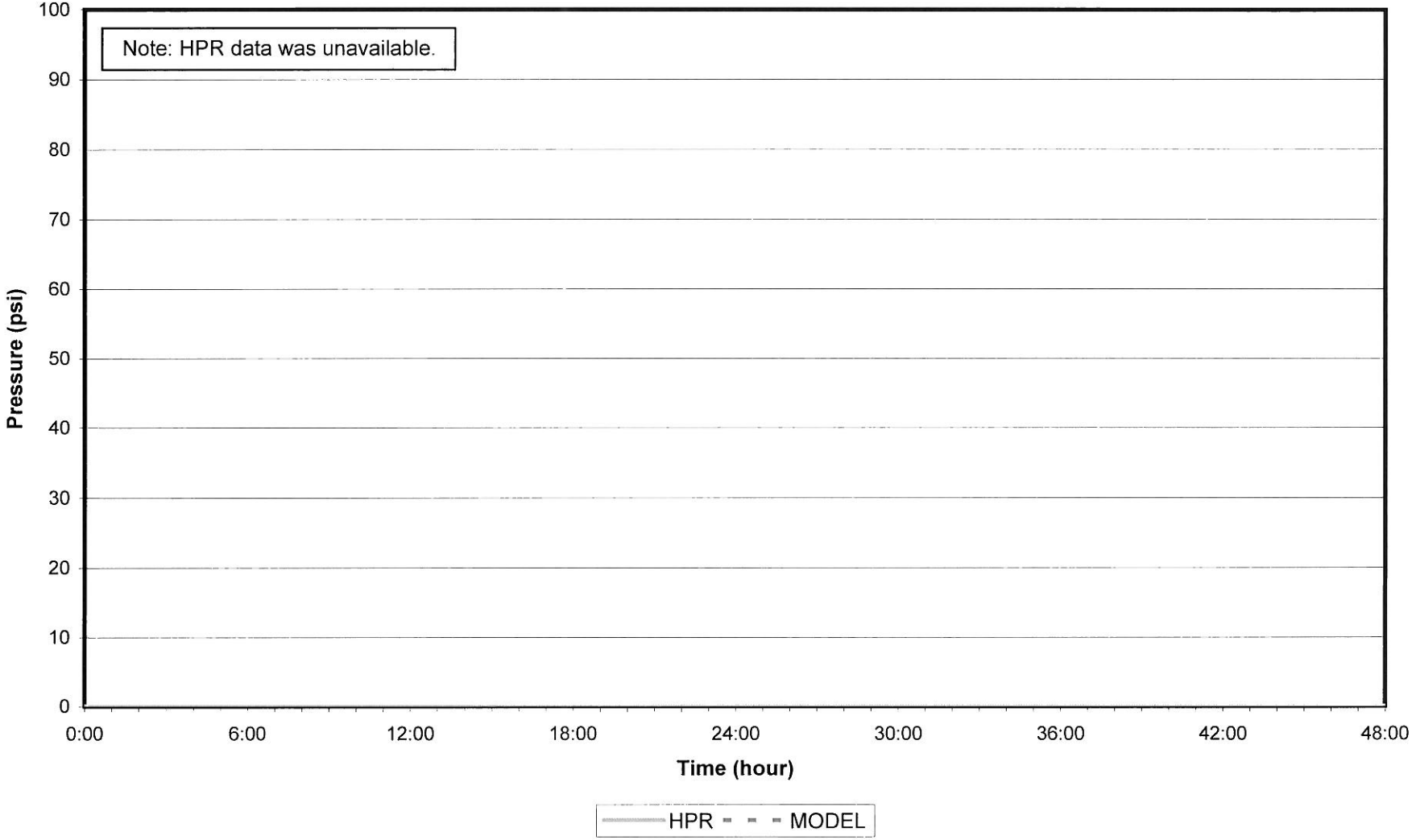
HPR B-14: 2701 W. MARCH LN.
9/25/06 to 9/26/06



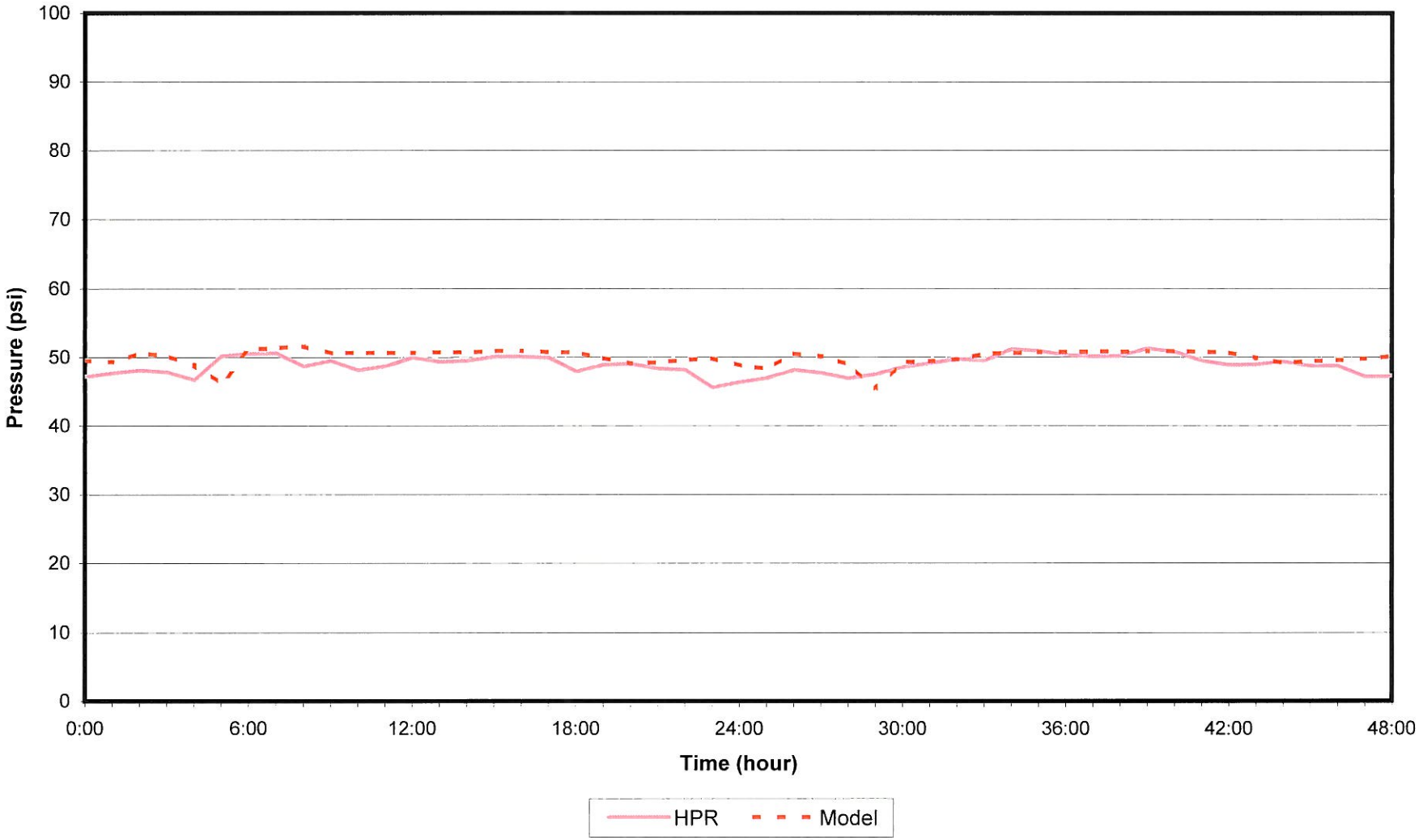
HPR B-15: 6189 HUNTINGDALE CIR.
9/25/06 to 9/26/06



HPR B-16: 2877 WILD ROSE LN.
09/25/06 to 09/26/06



HPR B-18: 2031 ARCH AIRPORT RD.
9/25/06 to 9/26/06



City of Stockton
Water Master Plan Update

WYA Last Revised: June 2007
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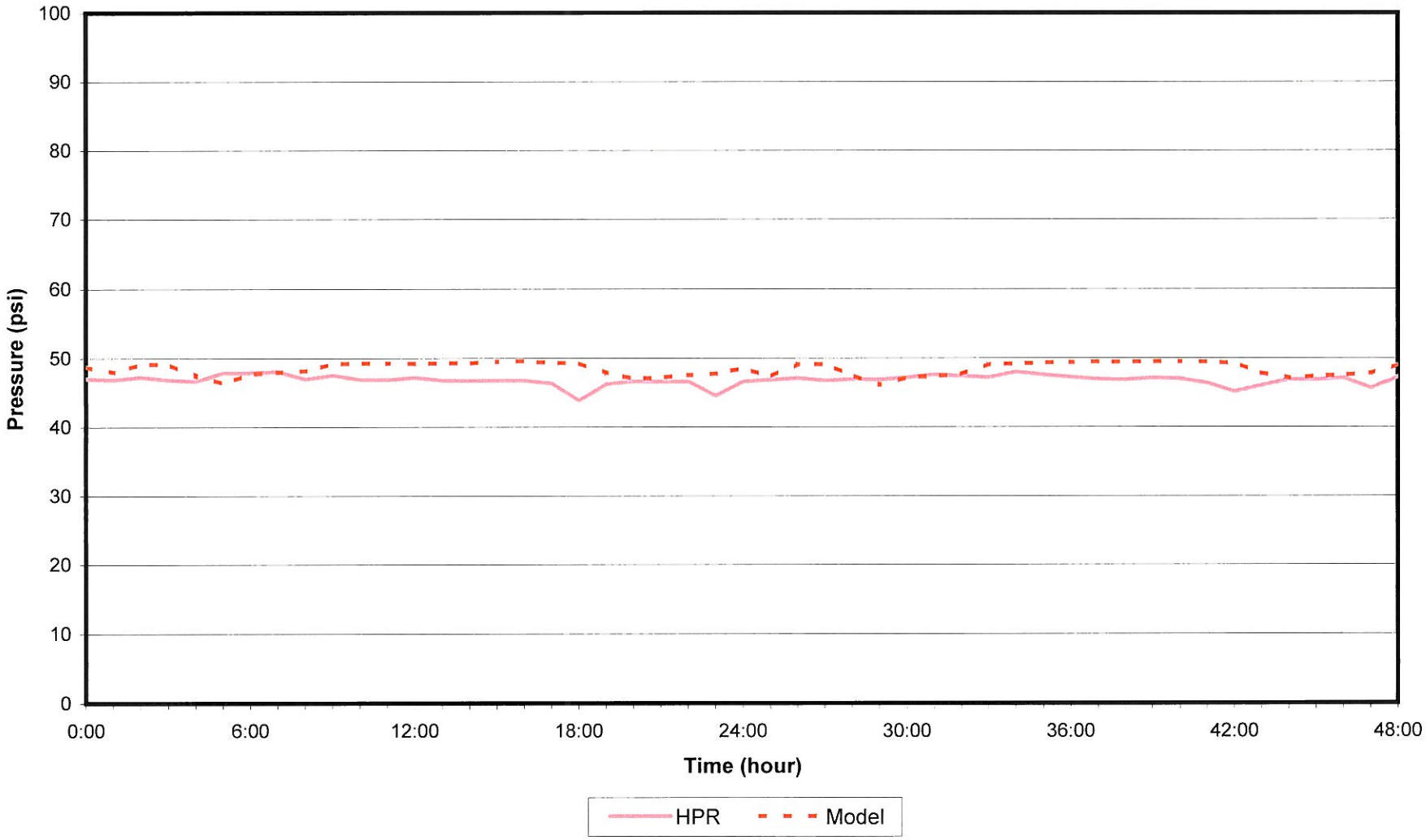
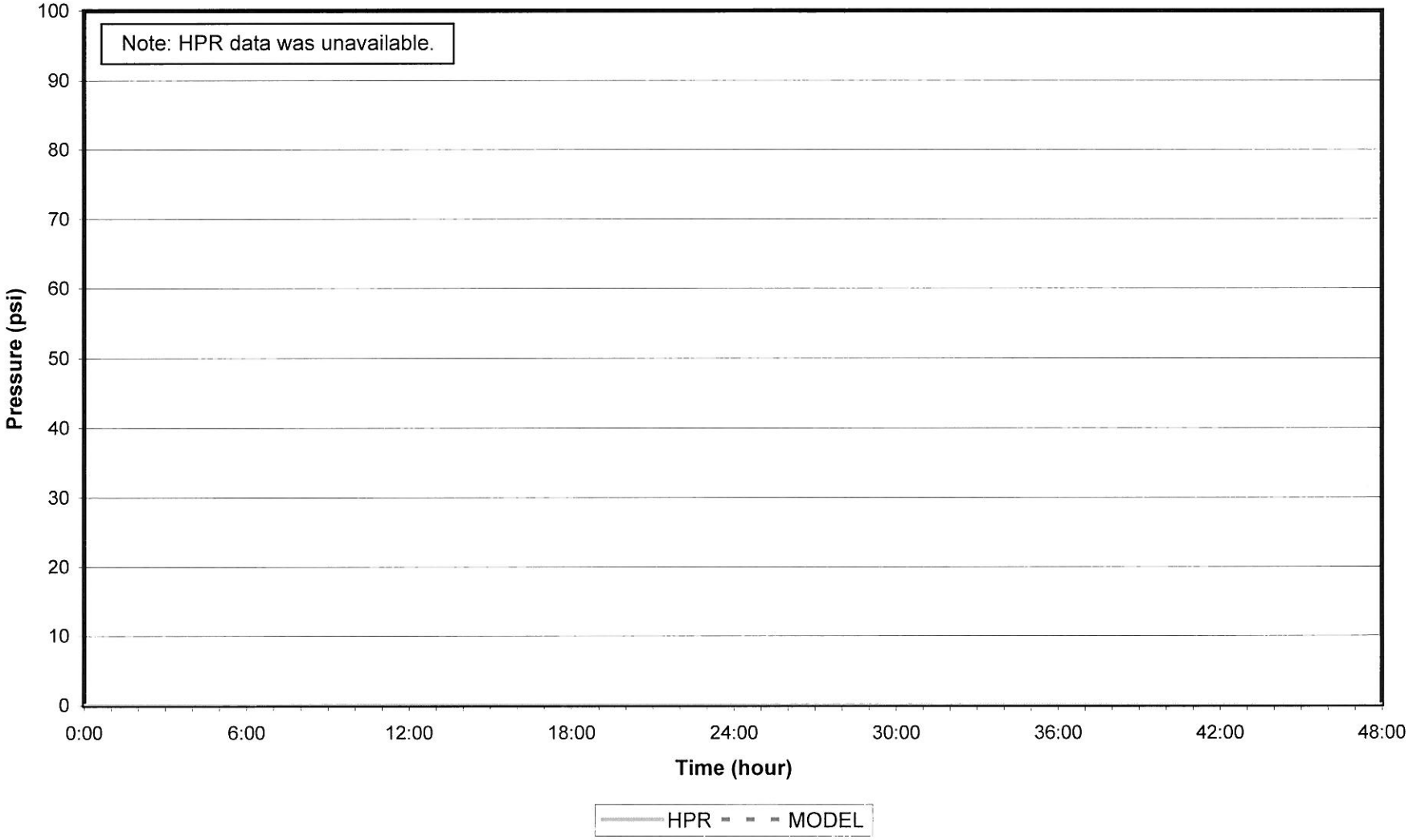
HPR B-19: 2871 PERFORMANCE DR.
9/25/06 to 9/26/06



City of Stockton
Water Master Plan Update

WYA Last Revised: June 2007
o:\e\408\02-06-12\e\t1\hpr\WDS Verification_logic\CH_B-19

HPR B-20: ALONG S. HARLAND RD. SOUTH OF E. COUNTY HOSPITAL RD.
09/25/06 to 09/26/06



APPENDIX C

Construction Costs for Planning and Design

APPENDIX C. CONSTRUCTION COSTS FOR PLANNING AND DESIGN

For budgetary estimating purposes, construction costs used to estimate the cost of recommended water system facility improvements are presented in Tables C-1 through C-4. The costs were developed based on data supplied by manufacturers, published industry standard cost data and curves, construction costs for similar facilities built by the COS MUD and/or other public agencies, and construction costs previously estimated by the COS MUD for similar facilities with similar construction cost indexes. All construction costs have been adjusted to reflect July 2008 costs at an ENR index of 8293. These costs are to be used for conceptual cost estimates only, and should be updated regularly.

Additionally, these costs are for construction only and do not include unexpected construction costs (e.g., variations in final quantities) or cost estimates for land acquisition, engineering, legal costs, environmental review, inspections and/or contract administration. These additional cost items are referred to as contingency costs and are further described in the last section of this appendix.

Construction cost data presented in this appendix are not intended to represent the lowest prices in the industry for each type of construction; rather they are representative of average or typical construction costs. The planning level cost estimates have been prepared for guidance in evaluating various options, and are intended for budgetary purposes only, within the context of this master planning effort.

Water Treatment Plant

Identification of additional treatment plant capacity and treatment process is not a part of this Water Master Plan Update. The COS MUD is evaluating an additional water treatment plant in the Delta Water Supply Project Feasibility Study and other ongoing studies. The capital costs that are associated with those alternative evaluations are detailed there. In the development of a comprehensive CIP, WYA will take the estimated costs of additional treatment from those detailed studies.

Pipelines

Unit construction costs for water pipelines 6- through 54-inches in diameter are provided in Table C-1. These costs are to be used for typical pipeline construction in urban areas (urban) and construction across open fields or areas that are not yet developed (rural). These costs generally include pipe materials, trenching, placing and jointing pipe, valves, fittings, hydrants, service connections, placing imported pipe bedding, native backfill material, and asphalt pavement replacement, if required. These costs do not include the cost of boring and jacking pipe, which is listed in Table C-2.

Table C-1. Unit Construction Costs for Pipelines[a]

Pipe Diameter (inches)	Unit Construction Cost ($/linear foot)	
	Rural	Urban
6	90	100
8	120	130
10	140	160
12	160	190
14	190	220
16	210	240
18	230	260
20	250	300
24	290	340
30	340	410
36	390	470
42	450	540
48	500	600
54	550	670

(a) Based on the July 2008 ENR index of 8293.

Table C-2. Unit Construction Costs for Jack & Boring[a]

Size	Unit Construction Cost $/linear foot[b]
8-inch pipe (16-inch casing)	380
12-inch pipe (21-inch casing)	440
16-inch pipe (24-inch casing)	510
20-inch pipe (30-inch casing)	620
54-inch pipe (66-inch casing)	1,270
Tunnel	2,650

(a) Based on the July 2008 ENR index of 8293.
(b) Conductor pipe not included in cost.

Treated Water Storage Tanks

Table C-3 lists the estimated total construction costs for water storage tanks in the size ranges of 1.0 to 6.0 MG. Because these costs represent budgetary numbers for planning purposes, WYA based them on partially buried pre-stressed concrete tanks rather than above ground steel tanks;

this provides the COS MUD with a more conservative planning budget. As previously stated, these costs are representative of construction conducted under normal excavation and foundation conditions, and would be significantly higher for special or difficult foundation requirements.

Table C-3. Construction Costs for Treated Water Storage Tanks[(a)]

Capacity, mg	Estimated Construction Cost Pre-Stressed Concrete Storage Tank, $
1.0	1,200,000
2.0	2,400,000
3.0	3,600,000
4.0	4,800,000
5.0	6,100,000
6.0	7,300,000

(a) Based on the July 2008 ENR index of 8293.

Treated Water Booster Pump Stations

Distribution pumping station costs vary considerably, depending on such factors as architectural design, pumping head, and station capacity. Estimated average construction costs for distribution pumping stations, as shown in Table C-4 are based on enclosed stations with architectural and landscaping treatment suitable for residential areas. Pump station cost estimates include backup/standby generators and SCADA, and are based on the typical COS MUD configuration, which includes 4 to 5 pumps at 5 to 20 mgd located adjacent to storage tanks.

Table C-4. Construction Costs for Booster Pump Stations[(a)]

Capacity, mgd	Estimated Construction Cost, $
0.5	609,000
1	763,000
2	945,000
3	1,135,000
5	1,518,000
10	2,426,000
20	3,743,000
30	5,088,000
40	6,441,000

(a) Based on the July 2008 ENR index of 8293.

Municipal Groundwater Production Wells

Well construction consists of pilot hole drilling, water quality/soil sampling, pilot hole reaming, well construction, well development and providing the necessary housing, pump, motor, automatic control equipment, discharge piping, SCADA, and disinfection equipment. Costs are estimated to be approximately $1,000,000 per well, for a 1,500 to 2,000-gpm well, approximately 400 to 500 feet deep. These costs are representative of construction conducted under normal drilling conditions, and would be significantly higher for special or difficult locations.

Property Acquisition Allowance

Until final alignments are selected and development plans are in place, it is not possible to identify the number or size of easements or purchases in fee title that will be needed for the planned improvements. Many of the facilities will be constructed in public rights-of-way, or on land dedicated to the City under development agreements. Some facilities, however, will require purchase of land or easements. For the purposes of this Master Plan, it is assumed that land acquisition costs for pump stations, wells, tanks and pipelines will be negligible or that land will be dedicated to the City by the development.

Contingencies and Other Project Costs

Contingency costs must be reviewed on a case-by-case basis because they will vary considerably with each project. However, to assist the COS MUD in budgeting for these future construction projects, contingency costs will be added to the planning budget as percentages of the estimated construction cost, divided into two categories: Construction Contingency Costs and Other Project Construction Contingency Costs.

Construction Contingency Costs: The construction costs presented above are representative of the construction of water system facilities under normal construction conditions and schedules; consequently, it is appropriate to allow for uncertainties unavoidably associated with the preliminary layout of projects. Such factors as unexpected construction conditions, the need for unforeseen mechanical items, and variations in final quantities are a few of the items that can increase project costs for which it is wise to make allowances in preliminary estimates. An allowance of 35 percent of the base construction cost will be included to cover such project related construction contingencies.

Other Project Construction Contingency Costs: Other project construction contingency costs are divided into 3 subcategories, totaling 35 percent: 10 percent engineering, 15 percent construction management, and 10 percent program implementation. Engineering services associated with new facilities include preliminary investigations and reports, right-of-way acquisition, foundation explorations, preparation of drawings and specifications during construction, surveying and staking, sampling of testing material, and start-up services. For this study, engineering costs are assumed to be 10 percent of the base construction cost estimates.

Construction management covers such items as contract management and inspection during construction (including City inspection). The cost of these items can also vary, but for the purpose of this study, it is assumed that construction management charges will equal approximately 15 percent of the base construction costs.

Finally, there are program implementation costs, which cover such items as legal fees, environmental/CEQA compliance requirements, financing expenses, administrative costs, permit fees, and interest during construction. The cost of these items can also vary, but for the purpose of this study, it is assumed that program implementation costs will equal approximately 10 percent of the base construction costs.

As shown below, the total cost of all project construction contingencies: construction, engineering services, construction management, and program implementation is approximately 70 percent of the base construction costs for each project.

Example:

Base Construction Costs	**$1,000,000**
Construction Contingency (35%)	350,000
Engineering Costs (10%)	100,000
Construction Management (15%)	150,000
Program Implementation (10%)	100,000
Total Construction Cost	**$1,700,000**

RECOMMENDATIONS

WYA recommends that the COS MUD use the construction cost guidelines and contingencies presented in this appendix to budget for future system improvements.